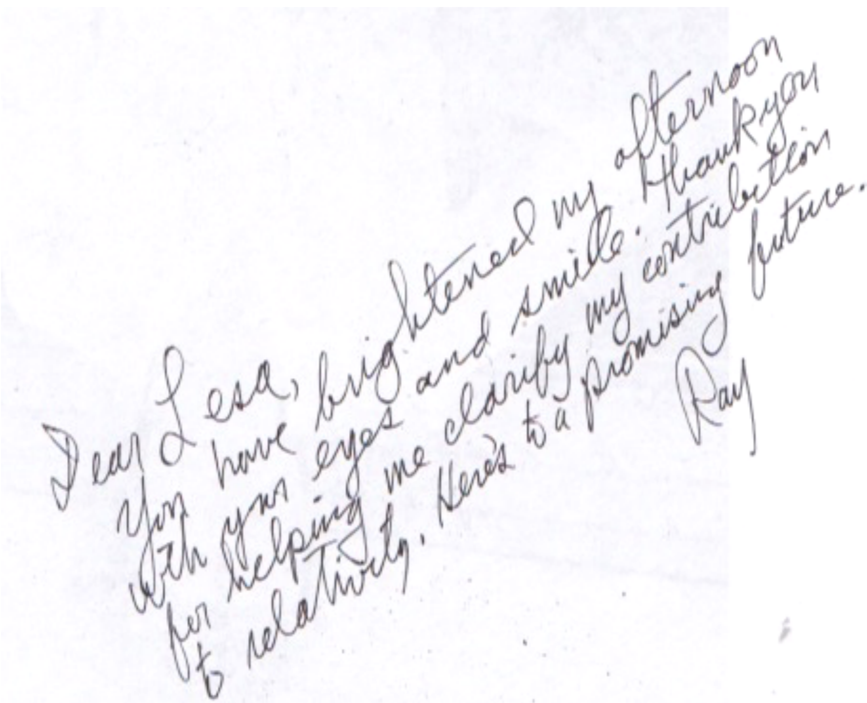
Aberrations of Relativity


Dear Lesa,
You have brightened my afternoon
with your eyes and smile. Thank you
for helping me clarify my contribution
to relativity. Here's to a promising future.
Ray

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There seem frequently to be those disclaimers at the beginnings of scientific books involving the author having stood on the shoulders of giants, but this author knows no giants who would permit him to speak so gratuitously in their regard in this regard, so he won't.

I love my wife and children of course! But they don't really enjoy the kind of stuff I have printed here, so other than wanting me to 'realize myself,' they're not to blame either. They have tolerated me magnificently, for which I am grateful, but one could hardly say that this tome resulted from that, however marvelous, toleration.

Ray Bonn, 2007

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PREFACE

For most of the last half century, new paradigms for a final theory have consumed the physics community. In the last quarter of a century, nothing of consequence has resulted. You won't find notions of 'grand unification' here. There is too much to be done, and re-done correctly, before that.

This book tries to recapture Einstein's initial epiphany of space and time as relations unique to each observer rather than some underlying fabric of an absolute universal 'reality'. It finds a natural uncertainty in the relativity of events. Somewhere along the line, this was lost.

The emphasis here is observational integrity rather than some illusive and always subjective perception of beauty and elegance. The author concentrates on the implications of relativistic aberration because they are the most directly observable effects of relative motion and because those most obvious implications tend to have been ignored in traditional treatments of the theory. Readers should come away from this book with a broader perspective of Einstein's theory and why alternative interpretations of the formalities cannot be ruled out unless, and until, additional tests are performed to refute them. The author puts forward alternative conjectures to resolve outstanding issues.

The scientific journals where science typically gets done are quite stifling with regard to constraints on how □ and whether □ one may present alternative views, but one must find a way to get them out anyway. Science is more than what appears in journals. It is the correct way for a person to look at every aspect of his world; it is very personal.

Consideration of whether it is sensible to even discuss the merits – let alone drawbacks – of physical theories with participants who do not possess expertise in narrowly defined fields to appreciate all the nuances of elaborate physical theories introduces several provocative issues: Are we at a point where the physical sciences have become so esoteric that there must be a priesthood who asks and answers all meaningful questions concerning the nature of reality? Have the physical sciences become too mathematical to be useful in epistemological endeavors? Are laymen of whatever level of intelligence out of place questioning the conclusions of scientific theories even if those conclusions bear on the very significance of their individual lives? Should not those with knowledge in a field be obligated to produce accurate descriptions that would suffice for interactive feedback from intelligent non-experts? In other words, may we not reason with dignity (as against merely being impressed or disgusted) outside our own fields of endeavor?

Many of the problems that the author sees in the approach of the scientific establishment involve it taking itself way too seriously. The vehemence with which the establishment attacks skeptics! Is that not insecurity concerning that of which certainty is claimed? So this compendium, unlike anything you may ever have read, begins with a critical assessment that takes some long overdue shots at just such establishmentarian arrogance.

Ray Bonn, 2007

I Learned It, But I Don't Believe It!

"*This is the true scientific spirit. Some people still think as Plato did when he had established himself as a learned Pythagorean sage, that Socrates' agnostic attitude must be explained by the lack of success of the science of his day. But this only shows that they do not understand this spirit, and that they are still possessed by the pre-Socratic magical attitude towards science, and towards the scientist, whom they consider as a somewhat glorified shaman, as wise, learned, initiated. They judge him by the amount of knowledge in his possession, instead of taking, with Socrates, his awareness of what he does not know as a measure of his scientific level as well as of his intellectual honesty.*"[1]

While a senior physics major at the University of Washington many years ago, Roger Penrose's somewhat earlier discovery[2] that the appearance of a sphere speeding past at high speed should retain its circular profile (rather than appearing contracted) intrigued me. This was explained in a class lecture on 'Modern Physics' by Professor Fred Schmidt – one of the few professors in the department with whom I was on a first name basis (even though for me it was legally a second). Dr. Schmidt was trying to entice us to undertake extracurricular investigations into the 'literature,' i. e., suggesting we begin at once to read the physics journals. He explained that although it might prove somewhat difficult for us at first since we would have to stretch to obtain the meaning of papers, that it could prove most rewarding. Penrose's paper showing that Lorentz contraction could never be observed became a case in point, which he demonstrated by going through and deciphering the paper with us. In that brief exercise – perhaps unlike my peers – my so-recently established faith in the accepted relativity theory came unraveled. Later that same year Dr. Neddermeyer gave the final lectures in our Senior Honors Seminar class, telling us that the quantum theory we had learned had indeed proved tremendously successful and that we must, therefore, become adept at using it, but that we should never forget that it was *wrong* –

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1 Popper, K. R., ***The Open Society and Its Enemies – Vol. 1 The Spell of Plato***, Princeton Press, Princeton, New Jersey, (1962), pp. 128 – 129.

2 Penrose, R., "Apparent shape of a relativistically moving sphere," ***Cambridge Philosophical Society Proceedings***, Vol. 55, Pt. 1 (January 1957), pp. 137-139

not just a *little* wrong mind you, but *all* wrong! And he elaborated many of the reasons why he was so convinced that was the case.

For those of you who did not learn physics in the *old school* from professors like Fred Schmidt and Seth Neddermeyer, I can understand why your faith in establishment might be secure. And if you are just learning *about* modern physics, or are even 'doing' some of it for the DOD, as against *re*-doing it *properly*, yours is perhaps an ideal mindset. If you'd rather not look under the floorboards, I fully understand. It's ugly under here. But the Schmidts and Neddermeyers[3] are *not* the whackos of the physics community, so don't get too sanctimonious on us.

Listing to the dark side

At any rate, for me the biggest mystery of modern physics became that it worked at all. It was not that earlier ether theories or classical mechanics seemed more correct to me because, of course, they were demonstrably outmoded, but that the 'modern' theories were not yet adequate; there was (and still is) much work to be done. I will admit that ever since those days that I associate with enlightenment, I have had a certain disdain of those for whom the world retains a purply lavender nursery pinkness. And despite Dr. Neddermeyer's insistence that it was quantum theory that was "all wrong," I suspected that he had not yet read Penrose's paper, or at least not gotten the message from it that I had, and that therefore relativity was the more vulnerable to the slash of Occam's razor.

Having fallen from grace as a nonbeliever, I became an engineer, from which yoke of bondage I am finally retired. (Yes, I had fallen in love and was married while at the university becoming an 'engineer' to pay for that full measure of happiness for which I have no regrets.) But throughout the years I retained my love of physics even though I disbelieved, reading journal articles, studying into late hours, and doing my share of theorizing about how the two major theories might yet be salvaged. So although it might seem ludicrous after all this time to now presume on how *legitimate* physicists should do their jobs, when I am obviously well past 26 – beyond which age true innovation in physics is thought to be impossible – I opt for that. Maybe at the age of 62 a new 'window' will open up for me. While putting things on end and shattering icons, why not that one too?

But back to my first having listed to the dark side: Penrose showed in his paper that for an observer in relative motion objects would *not*

[3] Drs. Neddermeyer's and Schmidt's credentials are a matter of record discussed briefly in the following article.

appear foreshortened commensurate with Lorentz contraction as Einstein had insisted would be the case, but rather appear rotated through an angle whose cosine is given by the familiar contraction factor. Thus, observers moving relative to an object under observation would actually see portions of the object that should by all rights be obscured *behind* the object! I am not sure that even Penrose realized the significance of his findings. Because most of his brief paper was an apology for how contraction really *does occur*, but that, when we view an *object* (as against a single event?) there is an *additional* transformation, which he denominated "the transformation of the field of vision," in addition to the Lorentz transformation equations that must be performed to determine what will be seen. That transformation, in effect, *undoes* Lorentz contraction. And although Penrose's apologetics were adequate to salvage the dogma of the established theory – even to my mind – they yet did *not* satisfy me for philosophical reasons. By that time in my career I had pretty much bought into positivism as the meaningful basis of physics. I still believe that is its legitimate basis although I realize that this hard-nosed view of objective reality has softened over the years with the mathematicians who now claim to be the *real* physicists. I still believe that observation and experimental test are the ultimate arbiters of truth in science, not 'elegance' nor 'beauty,' or whatever terms may be used to bedizen pet theories. The absence of elegance provides clues to something amiss in Denmark, but however much elegance may be included, neither that, nor any other hocus pocus, can *confirm* truth any more than eloquence guarantees the integrity of an orator's message. In short, the medium is *not* the message of science – if indeed it is in *any* meaningful endeavor.

Science is about observation and the proper role of relativity is to provide a basis for understanding relationships between those observations made by observers in differing dynamic situations. It is *not* to presuppose the existence of a mathematical grid of umpteen dimensions – pretending that to be *the* Reality – into which framework observers may place their 'objects' and register their mundane observations in a sense that would have appealed to Plato who referred to space as that "which provides a home for all generated things."[4] I hold with Einstein's earlier intuitions with regard to space – and in that same spirit, *spacetime* – as being nothing other than the relationships between observed *objects* (whatever that theory laden term might legitimately come to suggest) and the events that pertain to them, and

[4] Plato, ***Timaeeus***, 52b.

by which we come to know them. The established interpretation, from which contraction of 'rigid bodies' and 'time dilation' derive, however, *does* embrace spacetime as something *much* other than the nothingness between the reality of events. And the otherwise unnecessary concept of a *rigid body* (as against associated events) is co-defined to correspond with spacetime, albeit now contorted by the physical objects *within* it.

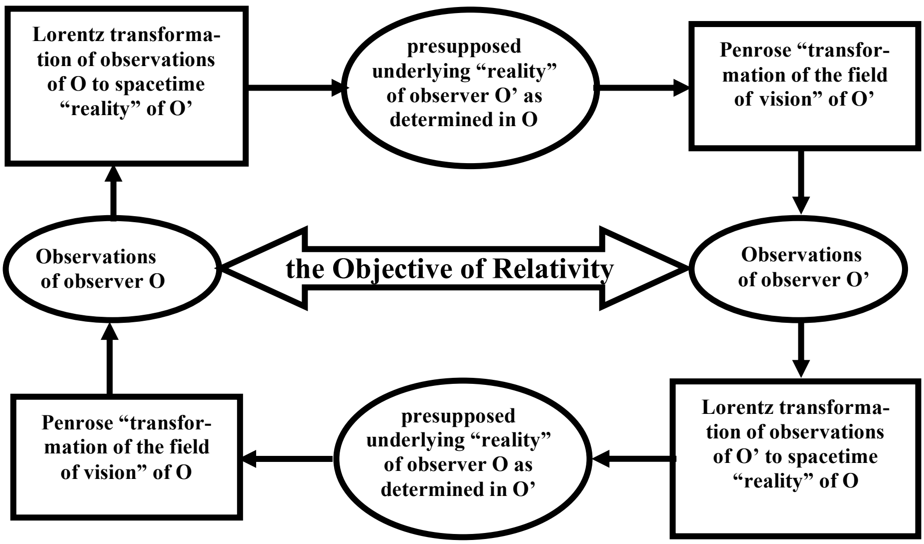
Thus, Penrose's concession seemed to me then – as it still does – to constitute a kind of categorical error of focus analogous to one becoming so involved with the form one must file to petition for a privilege that the value of that privilege, without which the form has no meaning, is maligned. This commitment to form seemed to legitimize for Penrose that although the Lorentz transformation does not, in itself, transform observations between observers if its interpretation is to be retained as Einstein insisted, it remains a *significant* aspect of the relativistic transformation of observations.

Whether this is legitimate from a philosophical perspective or not I leave to the reader, but for me it is not. In geometry, for example, one could not legitimately construct a line starting at A and ending somewhere other than at B, and yet claim to have drawn a line from A to B, suggesting that the rest of the construction is merely the routine drudgery one might engage in to really *get there*, but whose necessity is of little significance. There are, in fact, an infinite number of *combinations* of transformations which can effect a given transformation, just as there are an infinite number of combinations of two line segments to get from A to B. If the result of one of these component transformations does not produce constructs that are in themselves physically testable, then there is no epistemological standing to that intermediate step or any associated level of reality. It is merely one of an infinitude of magical realms that only an idealist could argue to be 'Reality' and "what *really* happens!"

Although Penrose did show that contraction cannot be observed, he yet maintained that, in *actuality*, it *does* 'occur' albeit at a metaphysical level between corresponding observations. He concluded, in effect, that it is not observable only because, as a *fact* of *reality*, it is *obscured* from our observations by the mundane processes by which observation takes place.

This suggestion that the products and processes of observation are not themselves primary concerns of modern day physics traces to Plato's idyllic forms to which the mundane world only aspires with limited success to clutter pure minds. It is also at extreme odds with quantum mechanics – that most successful of modern theories from a testability point of view – Dr. Neddermeyer's views notwithstanding.

Observation involves 'observing', which is very different from *calculating* what one would (or *should*, or might *want* to) observe using mathematical formulations! And, therefore, Einstein's notion, while certainly not proven by Penrose to be in *error* – since this interpretation *can* be applied to a contorted composite transformation path to effect what will *actually* be observed – at least in limited cases as Penrose showed – is philosophically untenable!



The constructs of Einstein-Penrose relativity

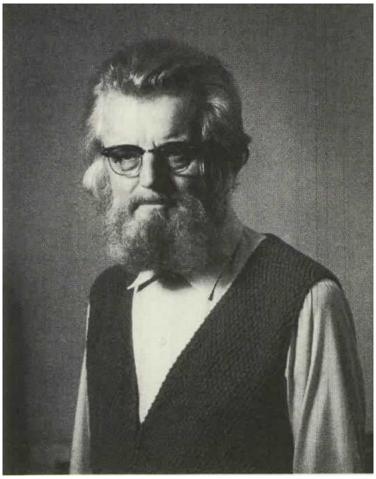
Once one climbs to the pinnacle that Penrose had reached, it would have been straight-forward to question philosophical issues and address the major philosophical cleavage in modern physics with regard to the nature and significance of observation itself. Even to have attempted to *define* 'observation' compatible with *both* of the major theoretical paradigms of physics. Admittedly philosophy had long since been denigrated as the divorcee of physics, in ill repute and unworthy of even helping to raise the family, supposedly no longer having any bearing with regard to the *new realities* that modern physics was unveiling that (again supposedly) *superseded* philosophical considerations altogether.

But, to ignore this issue seemed quite inexcusable to me back then. It still does.

I guess either one gets that or else he or she doesn't. If you don't get that, then you probably won't get anything else in this book.

Remembering Professors

Seth Neddermeyer was a cosmic ray physicist, the co-discoverer of the Muon and Positron and as such, was later awarded the Fermi Prize (1982), perhaps in consolation for not having been adequately acknowledged in Carl Anderson's Nobel prize. He also invented the method of implosion used on the first Plutonium bomb during his work with the Manhattan Project in WW II. (In the movie *Fat Man and Little Boy* about that project, his part – played by Joseph d'Angerio – is an important one.)



Seth Neddermeyer co-discoverer of the mu meson and positron

"Carl [Anderson] and his graduate student, Seth Neddermeyer, deter-mined to follow Millikan's lead and take their cloud chamber to high altitudes and various latitudes. The cloud chamber was mounted on an old flatbed truck and, with great difficulty, driven to the summit of Pike's Peak. In fact, they were towed up most of the way. The two experi-menters found evidence for a new short-lived particle intermediate in mass between the electron and the proton. This was originally called the mesotron, but is now known as the mu meson. Photographs taken in Pasadena and in Panama confirmed the existence of this new particle."

– by William H. Pickering

On one occasion when I was in Dr. Neddermeyer's office he spoke enthusiastically of the redesign of the Wilson Cloud chamber to reduce the distortions caused by forcing a single side of the chamber to accelerate outward rather than forcing all sides to accelerate. So it is easy for me to envision the enthusiasm he must have had for such problems; implosion must indeed have intrigued him very much, although at the time, and to this day, such contraptions do not interest me very much.

Once he reconvened our Senior Honors Seminar class to a tavern that was off campus. This I was told by a peer since I was not in attendance on that occasion. We few, who had been given invitations to the Senior Honors Seminar, did not respect the honor of his tutelege nearly as highly as we ought to have. Listening to the brash ideas of our peers was embarassing to

us although I think he rather enjoyed
what we had to say.

For the final two sessions of our seminar, he chose to expound his own views of physics. He told us that quantum theory is the most accurate theory there is, but... it wrong – not just a little mind you, but totally wrong. He then proceeded to tell us the basis on which he held that belief.

He was a rather cynical old curmudgeon and a staunch atheist. His assistant (whose name happened to have been Peter) once told me that he and another assistant had been introduced to Seth's brother-in-law (who happened to have been an ordained minister) as his "apostles Peter and Paul" much to the chagrin of the brother-in-law. Peter also told me that on one occasion a bunch of undergraduate students had complained to him that Dr. Neddermeyer had promised them that they would not have to memorize any formulas for a final exam. If they needed a formula it would be included on the exam, he had told them. Their complaint was that the final exam had indeed listed all necessary formulas, but they were presented in the context of a problem where correct formulas had to be identified and incorrect ones *corrected*. Peter said that when he presented their case to Dr. Neddermeyer that he had thrown back his head and laughed heartily. "Not remember formulas for a physics exam? They couldn't possibly have believed that!"

So was he spoofing about quantum physics too? I don't think so. He was deadly serious about his disbelief, and since he paid us the honor of not requiring a Ph.D to discuss such topics with him, should we have asked for an affidavit?

Fred Schmidt too was a well known physicist. His work was key to development of the first high energy synchrocyclotron and he too had participated in the Manhattan Project. He was acknowledged as a Guggenheim Fellow in 1956.

In addition to Modern Physics my senior year, he had taught Mechanics my sophomore year. I was never into doing homework and depended on exam scores for my grades. So after the final I had gone to pick up my graded exam outside his office. Class grades were posted by his door. Since I had aced the final – the highest score in the class on that occasion – I was somewhat taken aback at my class grade of B+.

He evidently read my expression, although I had not been aware that he was even in his office. I was startled when he asked, "Is something wrong?"

I replied meekly that I had thought that if I did as well as I had on the final exam that I would have gotten an A for the semester.

He insisted that I come into his office. He got out his grade book from which we looked over my scores on everything for the quarter, including my embarassingly sub-par homework scores, and the sheet on which he had ordered all the students according to their totals for the quarter. I ranked fourth in the large class.

"Oh," he said, "I remember. Ordinarily I would have given four or five A's in a class this size but when I looked at the distribution it was obvious that the three top scores were separated from yours by much more than yours was separated from the rest."

I too could see that very clearly; it made sense to me. Physics is that way too. And we became friends from that time forward. He always made a point of calling me "Fred" in recognition of our common denominator.

Anticipating Scientific Change

Similar to the plate tectonics that explain the ebb and flow of continents on this thin crust of our sphere of existence, there are processes and concepts applicable to the brittle solidified plates of knowledge that float on the molten currents of a much more basic reality. These plates on whose stability our very lives depend jar against each other occasionally – sometimes to spectacular effect. Just as geologists are now coming to anticipate the next major terrestrial volcanic eruption or earthquake, it seems reasonable to look at major fault line activities in science and predict where the next major paradigm shift may occur.

These *plates* or regions of relative scientific stability are "scientific domains." The concept of a *scientific domain* is particularly conducive to obtaining an understanding of the overall operation and objective of scientific endeavors. I will, therefore, defer to this concept throughout this article as an aid to understanding the nature of the current situation with regard to a resolution of incompatibilities between quantum and relativity theories. Here, for example, notions of wave function collapse and Lorentz relationships between events, although primarily theoretical in nature, are major elements of the respective domains for which one entertains hope of a compatible synthesis. Scientific domains provide the workbenches for the creation of scientific theories.

The scientific domain of a theory is defined to avoid the awkwardness of the distinctions traditionally made between 'theory' and 'observation.' To be useful, scientific domains must include not only facts (or data) of an area of research, but theoretical considerations as well; they must encompass all of the related scientific 'information' as against mere factual 'knowledge' since all this varied information must ultimately be accounted. Shapere[1] states: "As conceived by philosophers of science, the distinctions between 'observations' and 'theory' has proved to be unclear, partly because what they considered 'observational' is found, in actual scientific usage, to be 'theory laden,' but also – a point not usually emphasized by critics of that tradition – because what they considered to be 'theories' are often treated in science the way 'facts' or 'observations' ('the given') are."

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[1] Dudley Shapere. "Scientific Theories and Their Domains," ***The Structure of Scientific Theories, 2nd edition,*** edited by Frederick Suppe, University of Illinois Press, Urbana and Chicago, 1977, pp. 518-564.

The natural evolution of species as propounded originally by Charles Darwin and as further elaborated in more recent times, involves a continual (although by no means continuous) speciation from the more general to the more specific. This type of trend, while it is suggestive of analogous operations of science within specific scientific domains, does not characterize an overall historical trend in science itself, or even trends within any major branch of science. To understand the nature of these counter evolutionary developments, it will be essential to understand the nature of these entities that counter evolve from the more specific to the more general. With this understanding will come an awareness of why science is essentially an inductive process.

A scientific theory 'covers' some particular scope of phenomena for which it provides the answers to questions which, without the theory, would remain puzzling in some sense. This scope or range of applicability of an associated theory is identified with its scientific domain. These scientific domains are groupings of a hodgepodge of natural phenomena, experimental and theoretical techniques, etc. that have been brought together exclusively by their common anticipation (or realization) of a unified theoretical explanation. The concept of scientific domain clarifies the role of the theories in science and provides a basis for understanding the natural anticipations that theories satisfy. One first must assemble all the related information and then by inductive processes determine a model or set of rules that apply to all the assembled information within that domain. The theories themselves may use formal mathematical descriptions – often without explanation – to provide a uniquely mechanical shorthand means of accounting for physical phenomena. Once a theory is in place it may be used to deduce results. *One does not properly deduce a law of nature nor, of course, the theory that describes it*!

In his essay Shapere identified a few questions whose answers help to define a scientific domain for which covering theories are to be anticipated:

"1. What considerations...lead scientists to regard a certain body of information as...constituting a unified subject matter or domain to be examined or dealt with?
"2. How is description of the items of the domain achieved and modified at sophisticated stages of scientific development?
"3. What sorts of inadequacies, leading to the need for further work, are found in such bodies of information, and what are the grounds

for considering these to be inadequacies or problems requiring further research?

"4. What considerations lead to the generation of specific lines of research, and what are the reasons...for considering some lines of research to be more promising than others in the attempt to resolve problems about the domain?

"5. What are the reasons for expecting (sometimes to the extent of demanding) that answers of certain sorts, having certain characteristics, be sought for those problems?

"6. What are the reasons...for accepting a certain solution of scientific problem regarding a domain as adequate?"

These questions will be helpful in further analyzing adjoining scientific domains to assess whether it is reasonable to expect their merger into a more comprehensive domain. The issues raised by these questions are precisely those that must be addressed in particular in the resulting common domain, including both the facts and verified theoretical notions appropriate to both theories. But there is an additional seventh question that seems most germane to this endeavor that must be answered first. By defining the process whereby major theoretical transitions are effected, Kuhn's concept of a scientific *paradigm* answered the question we formulate now as:

7. What is the nature of interactions between scientific domains that have become juxtaposed, overlap or are hierarchically related?

This article will certainly not attempt resolutions of all these questions adequate for general philosophical inquiry, but specifically and in small scope, in reference to quantum and relativity theories in several cases. The determination of whether the time is right is key to the author's interest.

A deeper relationship must exist between the scientific domains of quantum and relativity theories than implied by current *ad hoc* applications of one theory into the domain more traditionally belonging to the other. Relativistic quantum theory, for example, makes no pretense of addressing prototheoretical origins of such a common ground, whose discovery would facilitate a *grand* unification of physics. Although, much more *grandiose* schemes derived using deduction rather than induction have more typically been so denominated.

It is sometimes argued that P. A. M. Dirac had effected such a synthesis, but he suffered no such delusion. See for example his following discussion of that topic: "The dilemma that has been reached in the present stage of physics is that, on the one hand, each of these [quantum and relativity] theories needs the other for its completion on its own terms, but on the other hand, since there are logical dichotomies in the union of the axioms of each of these theories, they cannot be logically unified. The implication of this state of affairs is that we will achieve real progress in our understanding of the nature of elementary matter only if we either abandon the basis of one of these theories for the other, or else abandon both theories for an entirely new (yet to be discovered) view. Taking the former stance, it must still be necessary to recover the successful mathematical results of the abandoned theory."

Note also, for example, Dirac's additional comment concerning such a shortcoming of his own synthesis: "It is against the spirit of relativity, but it is the best we can do." And to this he appended: "We cannot be content with such a theory."

Any common scientific ground for these two so disjoint theories must ultimately involve observable aspects of the interactions between material entities at a microscopic level of existence where large relative velocities are the norm. The objectives are at once compatible. QM is concerned primarily with a domain of microscopic dimensions and high energies, SR with a domain of large relative velocities and these domains are frequently (Nay! typically) realized in the same experiments. 'Experimental observation' is, however, a concept that is incompatibly conceptualized by the two theories and, therefore, this most essential aspect of physics must first be resolved to provide an appropriate basis for inspecting natural phenomena traditionally 'viewed' uniquely by each discipline. Without this there is no hope of merging the disjoint domains nor, therefore, of achieving a consistent covering theory.

It has long been the general contention of the 'Copenhagen Interpretation' of QM that the state (even to the extent of conscious aspects) of the observer has a significant bearing on the measurable state of an object. Also, it has been shown in particular that the very form of the uncertainty principle must ultimately involve the relative motion of subject and object. QM is basically an empirical correlation theory concerned with the relationships between observed objects and the observer. SR, on the other hand, is deterministic but also exclusively concerned with relationships between states of observers when they are in uniform relative motion.

In QM it is the inevitable effects of observation on the state of the objects of observation that are principally at issue. In SR it is the inevitable effect of relative motion (the state) of the observer on the observed state of the object that is at issue. Thus, disparate aspects of the same process are the avowed objects of interest. But 'observers' are defined by incompatible prescriptions such that 'observations' in SR are treated as deductions from an assumed underlying structure of events whereas in QM, induction is deemed the only appropriate basis of determining any underlying structure.

As Einstein vehemently maintained, it is the very nature of light (now most completely described by quantum theories) that is at the heart of the formalism of SR. But now Quantum Electrodynamics encompasses the explanation of electron energy exchanges and has, therefore, supplanted classical electrodynamics which was developed by Maxwell for the detailed explanation of related phenomena. In Lorentz's mathematical precursor of SR the derivation was based on an electron theory which forced equations of electrodynamics to be invariant under uniform relative motions (in his case with respect to an ether). Einstein also demonstrated the invariance of Maxwell's equations with respect to a Lorentz transformation as signally significant. One should certainly have expected two thus intricately related theories for which a complimentary symmetry could be established between scientific domains, to have exhibited complimentary formalisms. Far from being the case, however, SR is based exclusively on a simple set of algebraic equations relating classical parameters in the state vector of an observed object (or event on the object) to that what would be observed by another in a simple one-to-one mapping assuming deterministic projection. QM on the other hand is embodied in Schrödinger's complex differential operator equation (or equivalently in Heisenberg's matrix mechanics) for which solutions have no direct classical analog. Their only consistent meaning involves interpretation of a product of the solution with its complex conjugate to form a probability density function from which 'expected' classical parameter values for the observable state vector can be calculated. These differences are somewhat understandable since SR provides the analogy of coordinate conversion and Schrödinger's approach is more directly analogous to electromagnetic field equations, but SR was validated with respect to those classical equations which Schrödinger replaced. However, the basic postulate of SR is that all of the fundamental laws of physics must be invariant under Lorentz transformations and this most basic equation of QM isn't – although a Klein-Gordon version does provide that nominal covariance. Furthermore, the assumption of a deterministic projection as assumed by SR is inherently incompatible with indeterminism as demanded by QM.

Thus, the formalisms and methodologies of the two theories have been totally unique from inception onward. Both of the theories are considered to be firmly based on confirmed observations, but they embrace different conceptions of what even constitutes an observer or an observation. SR credulously embraces a sentient framework endowed with capabilities to assess space and time values for any event occurring within a space/time cone encompassing all past and future events of the entire universe that can in any way be causally related within the particular reference frame. QM, on the other hand, addresses observation with extreme suspicion; it assumes the very act of observation to be no less significant in many cases than the action that is being observed, and in general to be associated with an uncertainty in determination of the objects of observation. SR employs extreme realism to the extent that 'real' contraction is assumed even after its having been shown by Penrose and others that such contractions *cannot* be observed. (Actually, a second transformation is required in determining contemporaneous observations whose results can be considered on a par with what are called 'observables' in QM. Lorentz transformations provide four-dimensional correspondences with what are noncontemporaneous events on a rigid structure in the 'other' frame assuming observations equivalent to what would be the case if light sources were stationary with respect to the observer.) Correspondence requires a further transformation of the 'field of vision' to obtain the contemporaneous 'visual' observation prediction for another observer. Thus Einstein's interpretation of the results of the Lorentz transformations (invoking a unique space/time metric) presupposes the existence of an intermediate level of reality beneath (*visual*) observation with related confusing terminologies involving 'actual' and 'observed' as essential to an interpretation of experiments. QM, on the other hand, has been interpreted almost exclusively over the last three quarters of a century according to a Copenhagen Interpretation embracing a most extreme form of positivism, sometimes called 'logical empiricism,' that denies that there can even be meaning to concepts for which direct observation cannot be obtained. Thus, QM requires a direct correlation with 'observation' in a sense other than could be supported by any of the currently accepted interpretations of an 'observation' in relativity. Furthermore, alternative observations by separate (or even the same) observers of an event on an object in QM can only be statistically correlated since each observation involves its own inherently unique state variations. SR assumes inherently unique coordinate realities for relatively moving coincident observers, but the vehicle of observation (a 'ray' of light) is according to Einstein's interpretation shared by the two observers to accommodate the precise anticipation of an observation by third parties using a velocity addition formula. The essential philosophical differences of these theories, therefore, result in each entirely refuting the validity of the approach taken by the other.

If the geological theory of plate tectonics were to be applied by analogy to stresses accumulating between adjacent domains within our scientific 'World View,' it would surely indicate that we are overdue for seismic activity along this fault line. Or as Kuhn would say, "In fact, however, step by step their deep divergences and incoherencies emerge increasingly within the scientific community, but people do not see them until finally the confusion becomes so great that the situation breaks down."

It is inevitable that physical theories should be continually replaced, but a completely smooth evolution of their domains does not occur. This is partly, of course, because of incommensurabilities that Khun has identified with alternative theoretical paradigms that are as inevitable as change itself, but in addition, human loyalty tends to weigh more heavily than objective thinking or the surpassing value of sincerity ought to accommodate. In deference to William of Occam it should be acknowledged that it is much simpler not to rock a floating boat to obtain a marginally better oarsman and, therefore, to be replaced, a theory must offend much more than *mere* philosophy. But, inevitably, change *does* occur. There are many reasons why theories are ultimately replaced – why alternative, even though mathematically equivalent, interpretations *must* be changed. Experimental data may accumulate which cannot (or which can only awkwardly) be accounted by the original theory. Analogies of terminology may become so completely absurd that previously unquestioned relationships must either now be demonstrated to be independent of the analogy or withdrawn. More comprehensive formalization accommodates a merger of theoretical treatments of various theories that were formerly appropriate but only within a more restricted scientific domain. Finally, it seems altogether fitting that as (and if) the philosophy of science matures, the credibility of older, philosophically unsound, theories may completely erode, even if only gradually, until they are completely undermined.

All these factors favoring change are present in varying degrees in the current situation; it seems to the author that they are more especially damaging to SR than to QM as currently interpreted by Cramer, although this is not the conventional wisdom. At any rate, there have been considerably more revolutionary developments since SR was originally conceived than is the case for QM, even if the years to have transpired are only so slightly greater.

Is a Photon ^Just an ^other Object?

Even very intelligent people sometimes abandon logic when discussing the special theory of relativity and especially when they come face to face with concepts pertaining to *frame independence* and *mutual observability*. Of the latter most people remain oblivious. These integral aspects of the special theory derive from a common sense presumption that a *ray of light* (typically associated, although illegitimately, with a 'photon'), emitted or detected at a given point in spacetime, could have been emitted or detected by any *other* source or observer, respectively, that happened to have been coincident at that particular instant in time. It was common sense prior to 1910, but because of discoveries concerning the quantum nature of light made so shortly thereafter, it really makes very little sense. The presumption results from Einstein's insistence that the Lorentz transformation "relations must be so chosen that *the law of the transmission of light* in vacuo is satisfied for one and the same ray of light (and of course for every ray)…"[1] with respect to coincident observers in uniform relative motion. Thus, a *photon* is presumed to be a mutually observable *real* object.

Well, it isn't.

Subsequent to Einstein's coining of this phrase concerning his 'law of the transmission of light' in the first decade of the last century, much that was common sense about light had to be reevaluated and corrected because of light's notoriously *non*-commonsensical behavior. Einstein himself was a major contributor to that revised understanding that did not near completion for another twenty years. In fact, when he received the Nobel Prize for physics in 1921 it was for his powerful insights into the nature of light and the 'photo-electric' effect in particular which involves the interaction of light and matter. In bestowing that honor, no mention was made of his more exhaustive efforts in relativity and, most certainly, not his 'law' that had given rise to *frame independence* and *mutual observability*.

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[1] A. Einstein, ***Relativity – The Special and the General Theory***, Crown, New York, p. 32. (1961)

There have been notable challenges to this doctrine. For example, as early as 1926 in discussing the "nature of light" Gilbert Lewis who was the one who originally coined the term "photon", stated, "…we can no longer consider one atom the active agent and the other as an accidental and passive recipient, but both atoms must play coordinate and symmetrical parts in the process of exchange."[2] So that to presume that a photon of light is just an object that passes a point in spacetime available for inspection by *any* observer (rather than a specific emitter/absorber pair) had become extremely questionable within a couple of decades of Einstein's having coined his own catch phrase. By that time re-evaluation of whatever concepts depend upon it had become an outstanding obligation, but in this case it was an obligation that would never be addressed by those accepting the established interpretation of the Lorentz equations. Lewis's position was notably cited by Wheeler and Feynman in their analyses of light as an inter-particle interaction in contrast to its being *just another object* or undiscriminating "wave/particle duality".[3] But such interaction concepts with regard to the transmission of light do not seem ever to have been addressed specifically in the context of re-examining this cornerstone of the established interpretation of the Lorentz equations. And although the phrase still shows up in virtually every didactic treatment of the special theory of relativity, the degree to which the concept is a cornerstone of the established interpretation of that theory would no-doubt be disavowed by all. Cramer did, however, address this misconception in his Transaction Interpretation of quantum mechanics.[4]

Einstein's and Minkowski's interpretation of the Lorentz equations postulates that events involving the emission, refraction or absorption of light in one frame of reference must be observable in these same senses by observers in *any* momentarily coincident frame of reference using their own equipment. This interchangeability insists not only on the possibility of *coincident* observation by relatively moving observers, but posits *coincident observation of the very same events*, which denies the unique role of the observer (absorber) in effecting Lewis's ultimate observation transaction.

To instruct us with regard to the significance of this mutuality demand with respect to the interpretation of the Lorentz equations,

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[2] G. N. Lewis, "The Nature of Light," Proc. N. A. S., Vol. 12, pp. 23-24 (1926)

[3] J. A. Wheeler and R. P. Feyman, "Interactions with the Absorber as the Mechanism of Radiation," *Rev. Mod. Phys.*, 17, 157 (1945); and J. A. Wheeler and R. P. Feynman, "Classical Electrodynamics in Terms of Direct Interparticle Action," *Rev. Mod. Phys.*, 21, 425 (1949).

[4] J. Cramer, "Transaction Interpretation of Quantum Mechanics," ***Rev. Mod. Phys.***, 58,3, 647-687 (1986).

Aharoni lays out the scheme very succinctly as follows: "Had an event not possessed absolute significance there could be no question of transforming its coordinates from one frame to another."[5] So quite apart from the experimentally verified Lorentz relationship between observed events, a velocity addition formula was conjectured which was not tested for refutation, and that conjecture ennobled the equations as a coordinate 'transformation.' So the very meaning of the Lorentz *transformation* equations as a transformation of a *single* event rather than a correspondence between *two separate and distinct* events is at issue. Resolution of this matter is of major epistemological significance.

Certainly, without experimental verification these equations ought not to have been presumed, because of vague similarities to other mathematical forms, to fall into a category of coordinate *conversion of identical events* rather than a simpler *correspondence between unique events* related by the nature of observation. The latter is in more or less the same sense that observation is handled in quantum theories where the observer and what is observed are inextricably entwined. This interpretation would not violate other verified aspects of relativity; it would merely indicate that an event observable *now* by one observer *corresponds* to a different event on the world line of the source observable *now* by another. It would be in complete agreement with Einstein's insistence that the results of Lorentz calculations be considered as measurable coordinate values. Both events would be observable by the *other* observer at *some* time, just not while in coincidence. This interpretation is similar to that of the parallax relationship of everyday experience. The Lorentz equations are at least as directly related to such a parallax *translation* of coordinates interpretation as they are to the usual didactic association with skew *rotation* employed in typical relativity texts as we will see.

The differences between these alternative interpretations of the mapping of events provided by Lorentz's equations must be subject to the usual refutation/verification procedures of experimental physics. So let us consider requirements on experiments that could determine whether such Lorentz-*transformed* events (more correctly 'Lorentz-*correspondent* events') can possibly be the very *same* or must be *distinct* one from the other so as to *comply* with, or *violate*, the conjectured *frame independence* and *mutual observability* hypotheses.

An adequate test requires each of two relatively moving observers to obtain two types of data as shown in the figure below. The data must

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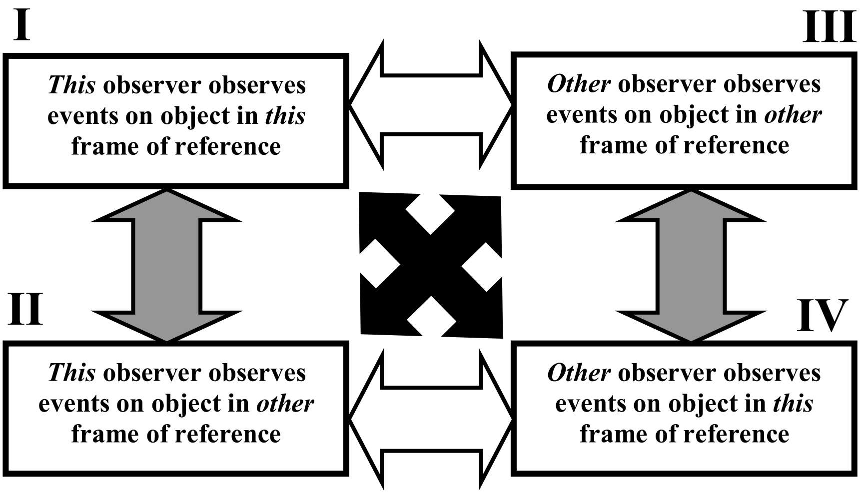
[5] J. Aharoni, *The Special Theory of Relativity*, 2nd Ed., Dover, New York (1985), p. 38.

include that which an observer *himself* (or a displaced but relatively stationary synchronized assistant) observes directly, and that observed and communicated at coincidence by the *other* observer or *his* synchronized assistant who will also be in uniform relative motion with the same velocity. The experiment will, furthermore, involve both measurements of electromagnetic emission and absorption events occurring exclusively *within* each observer's own apparatus and measurements involving interactive phenomena with the atoms and molecules of the apparatus of the *other* observer. Altogether this requires comparison of four categories of observation as shown – not just two as has always been assumed.



four categories of observations and their various relationships that are possible in experimental tests of relativity

The six relationships among these four types of experimental data pertinent to refutation of *frame independence* and *mutual observability* are also shown. Diagonally related observation types (I with IV, as well as II with III) pertain to observations of 'common' events (or more explicitly to one specific event occurring on one particular object) by relatively moving observers and are presumed by theory to be related by the *Lorentz equations*. Note that these are the *proper* subject matter of the special theory. Note also that it has not been feasible to conduct such experiments.

Horizontally related observation types (I with III, as well as II with IV) pertain to observations of analogous (i. e., *similar but definitely not* the *same*) events in the other frame of reference. Legitimacy of the assumed analogs depends upon the apparatus of each observer being constructed in accordance with identical drawings and that initiation of the identical experimental procedures by the observers be synchronized so as to maintain symmetry. These are sometimes erroneously assumed to exhibit a Lorentz relationship ostensibly pertaining to comparisons of II with III (and presumably I with IV) and to have thereby confirmed length contraction and time dilation. They don't. They *can't*.

Data obtained in horizontal categories (I with III as well as II with IV) require communication between observers with coincident assistants involved as appropriate for a definitive comparison.

The relationship between comparisons I with III (and those of II with IV) would seem by the covariance principle to be characterized as *identical*, but this is counter to the established interpretation in which the *other* observer's clocks are presumed dilated, etc.. Performing all these tests would substantiate or falsify the conjecture concerning light being just another object upon which so much of Einstein's and Minkowski's interpretation rests.

Although experiments are still not feasible for comprehensively comparing all these measurements, one can at the very least use a logical analysis to test for consistency as a minimal criterion of validity of the various possible interpretations of Lorentz's equations. The author believes there to be a serious lack in the required consistency if one insists upon the currently accepted interpretation. This inconsistency suggests that even if refutation of frame independence and mutual observability were to fail, that another conjecture must be conceived to resolve the difficulties since the established interpretation fails in this department.

In what the author has called "observational relativity" further on, it is proposed that a slightly different set of equations (exhibiting the very same observable aberration characteristics as the Lorentz equations) might resolve these problems.

At this juncture it is sufficient to acknowledge the possibility of error and submit the alternative conjectures to experimental test.

Some Skeptical Thoughts with regard to Frame-Independence of Light Sources in Special Relativity[*]

It is possible for intelligent people to disagree on the paternity and/or veracity of any concept whose umbilical has yet to be tied, and until similarly equipped *observers* pass each other at appreciable speeds with respect to that of light, there *will be* such loose ends in relativity. Most physicists reject that such a high speed travel requirement imposed on macroscopic observers is a "loose end," of course, since they accept muons, other high energy particles, and cesium atoms as viable 'observers' in their own right, equipped with their own clocks and rulers to determine according to their own *devices* when to call Dr. Kavorkian, while yet rejecting as uncertain the death of a certain cat. But as I indicate elsewhere, I don't. I consider radioactive decay to exemplify energy-dependent probabilistic quantum phenomena – not events triggered by on-board *observers* using obscure clocks and random number generators to determine their own demise.

Beyond a very basic understanding of the extreme differences between the propagation of sound and light, it gets a bit hazy with regard to a preponderance of beliefs of 'legitimate' physicists with respect to the 'law of the transmission of light.' There is of course the tie-in with the classical Poynting vector and Quantum Electro Dynamics (QED), for which wave functions are rather obscurely related to the probability of finding a photon at the spot of observation. But even within the framework of classical physics there was some ambiguity. Were the electromagnetic fields, by which light is perceived to propagate, to be associated in some obscure way with a medium pervading all matter, the electric and magnetic fields of the source particles of the emissions, or *per chance* with the ultimate absorbers of the radiation – *the observers* of special relativity. An all-pervading ether medium having been ruled out of the question (in accordance with the results of the Michelson-Morley and other earlier experiments), left the debate as one between whether the fields were somehow to be associated with the emitter or with the absorber. Einstein opted for the latter, Ritz the former, Tetrode and Lewis a combination closer to the latter. Wheeler and Feynman, and more

[*] This article was in response to an article by another author espousing the usual relativistic concept of "frame independence”.

recently Cramer, chose to average the two since both produce valid solutions to Maxwell's (and the Klein-Gordon version of the quantum mechanical) equations that in any case dictate the same velocity in all directions in whatever should turn out to be the frame of reference of *the fields*.

I will show elsewhere how, if one accepts one of the two transverse fields in Maxwell's equations as being associated with the emitter and the other with the absorber as would seem logical from their defined roles in key experiments, that then the Lorentz transformation equations can be shown to apply with regard to the distance and time intervals for light transmission between end points of emission-absorption transactions. This relationship does not result for any other such field associations. So in consideration of this condition on the electromagnetic fields, special relativistic spacetime distortions would correspondingly seem to apply specifically to the interactions *between* relatively moving atoms and *not* to isolated clocks and rulers that are merely metrical artifacts *owned and operated* by one observer or the other totally within his own frame of reference. In this approach, the time it takes an electromagnetic transaction to complete (a duration which most would probably consider tantamount to knowing the velocity of light, although I consider it somewhat ambiguous) depends intimately on the relative velocity of the emitter and absorber.

This relative source velocity *independence* of light transmissions seems always to be treated as incontrovertible *fact* in texts; notwithstanding that *this* principle has never been satisfactorily confirmed – tested for possible refutation if you will. Everything about interactions involving either relatively moving coincident emitters or coincident absorbers with a separated source or emitter, respectively, suggests extreme *dependence* on the relative velocity of a source (and observer). The observed dependencies include wavelengths in the two instances of the absorbed light, the observed angles to the sources, the times at which the emissions are said to have taken place according to the Lorentz equations, etc.. To accept differences in these times as implying that light from one source literally takes longer *in transit* is hardly more ridiculous than other attempts to make more explicit sense of it all. An equivalent source-dependent light velocity conjecture comes readily to mind, as we will see. Such an explication could eliminate previously identified physical antinomies in relativity based simply on 'observed' physical effects.

The objective of theorizing to uncover the truth with regard to the inner workings of our universe would seem best served by analyzing *all* possible alternatives to the accepted set of assumptions rather than by selecting only one or two *ad hoc*. There is a major difference between a *stab in the dark* which one then obsessively defends to the death and a systematic investigation of all the alternatives to determine which of the possible alternative assumptions are most consistent with *observed* facts. The former approach might indeed prove successful in obtaining the correct solution on occasion, but only if one were to be phenomenally *lucky* in the selection of *that* set of assumptions that might thereby thereafter be accepted as *facts*.

In reopening such a selection process, 'frame independence' should certainly be included as an assumption to be reconsidered.

Elsewhere 'mutual observability' will be discussed as an extreme vulnerability of the special theory. Ostensibly that phrase means that two instantaneously coincident observers have access to the very same photons from which 'observation' derives. But under that rubric the author includes *frame independence* of the light source as described here as well. Emission and detection are but separate aspects of a duality involved in coordinating end points of a photon transaction. The question then is whether coincident events involving the interaction of light and matter (whether emission *or* absorption) can in principle be treated interchangeably, i. e., as 'frame independent' and 'mutually observable' by observers in relative motion

It is that which one must have the audacity to at least doubt.

Are There Inevitable Uncertainties in our Maps of the Universe?

Einstein was uncomfortable with notions associated with an inherent uncertainty implied by the Copenhagen Interpretation of quantum mechanics. Whether we ourselves might ever know the precise locations and/or momenta of particular particles at particular moments in time, Einstein had faith that at least *God* had reason to know such things. Far from this revealing an unwavering belief in an omniscient personal savior, it merely expressed the metaphysical perspective that *everything has to be somewhere, whether we know it or not*! And I guess we must grant some, even if minimal, credulity to that presumption.

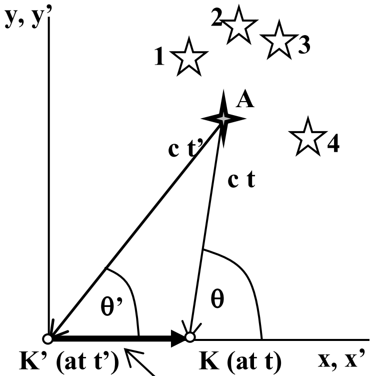
This insistence on knowledge of the way things *are* – as against what is *measured* or *observed* – came increasingly to haunt his work and that of the many dedicated theorists who have religiously pursued those paradigms Einstein established. The Great Divide between two major branches of physics – on both sides of which Einstein's influence was monumental – involves this very issue. He opted in favor of determinism early on in his work with relativity, although his initial philosophical leanings seemed more definitely positivistic. Those early tendencies are revealed by comments such as, "we entirely shun the vague word 'space,' of which we must honestly acknowledge, we cannot form the slightest conception, and we replace it by 'motion relative to a practically rigid body of reference'." He had also indicated that spacetime coordinate magnitudes should be regarded as though the actual "results of physical measurements." But in interpreting values that result from the Lorentz transformation equations – the formal basis of his theory that he had thus insisted be directly measurable – he failed to question *all* of the common sense notions of his time. Valid explanations of 'double slit' and other high profile experiments and related phenomena that assure us that light is *anything but* common sense, were unknown when Einstein coined his phrase "the law of transmission of light" for this common sense notion that even a photon must be *somewhere*. But *we* know they are *not* some particular where! They seem, in fact, to be *nowhere* until and unless they are observed.

But this “law” was not specifically about how light is transmitted *per se*, but about the meaning of relativistic aberration – a legitimate hypothesis in as much as it is certainly refutable. But because it seemed merely 'common sense,' apparently no one ever bothered to doubt it sufficiently to attempt a refutation. But in *this* universe any legitimate God who could be invoked in a scientific context, blesses doubt!

Aberration caused by relative motion was a familiar phenomenon years before Einstein’s relativity came along. It is very much like parallax in which separated sightings of the same field of objects result in distortions between observers’ fields of view. The illustrations below illustrate this effect for parallax where observers have different perspectives on objects arising from differences in their viewing locations.

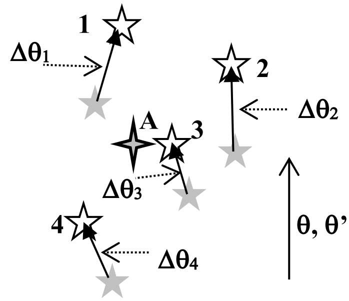
Parallax provides a useful analogy for explaining aberration. And it is easy to show that differences as well as similarities between parallax and aberration effects derive from the finiteness of the speed of light. Further, the fact that its speed can be considered the same (in a vacuum) for every observer accounts for *relativistic* aberration that differs slightly from what had been thought to be the case earlier. These facts necessitate that the distances that light travels, ct and ct’ in the first panel of the figure below, differ for two observers both for parallax *and* for aberration – except, of course, for the special case of an object occupying a position on the perpendicular plane bisecting their line of separation.

In the analogy of relative motion, for which relativistic aberration applies, the universality of the speed of light imposes constraints associated with the triangle K’KA, the geometric details of which define coincident observation of such relatively moving observers. Apparent differences in perspective for such *coincident* observers caused by their relative motion are extremely similar to those caused by a *separation* between relatively stationary observers since there *had*, in fact, to have been spatial separation between the observers at the time the observed light would have been emitted from the object. If observer K’ moves to the right in the figure with relative velocity β with respect to K such that $\beta t' = X$, the analogous separation in a parallax situation, then the two angles θ and θ' at which an object is observed will be given by the relativistic aberration formula to be discussed later. The extent of the difference between Einstein’s relativity and previous considerations involves the use of $\beta t'$ (rather than βt) to produce the relationship, i. e., it derives from Einstein’s *Second Postulate*.



Figure

Separation x'=X (or x'= β t') of K and K' observers is responsible for perspective differences in both parallax and aberration effects.

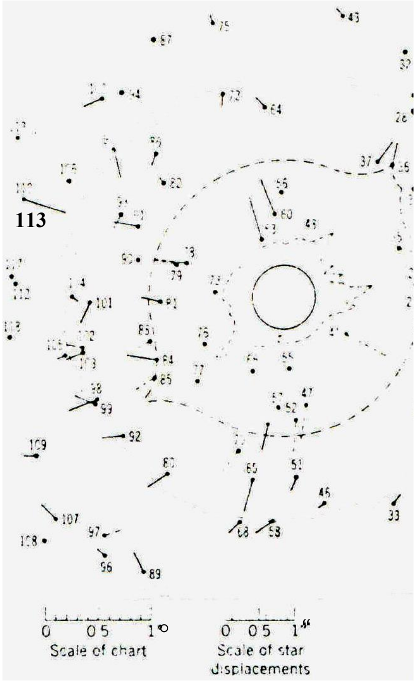


Mapping of displacements $\Delta\theta_m$ for each object m about a point A (the fixed center of alignment of the fields of view) of K and K'

However, where there are multiple objects at various distances (and velocities) being observed, distortions resulting from parallax computations become largely unpredictable from a single observation point as shown in the second panel of the figure above. Displacements $\Delta\theta_m$ of objects within a field of view of K' relative to where the object was viewed by K cannot be determined exclusively from angular measurements made by K of the object *m*. For its determination there must be some *a priori* knowledge of the relative distance and directional velocity of *m*. It is a singular fact, however, that such nondeterminism does *not* arise in relativistic aberration formulas when (or *because*) Einstein's 'law of the transmission of light' is applied. *Whatever* is observed by K can be *unilaterally* transformed to obtain a corresponding observation in K' with absolutely no knowledge of static or dynamic information of the objects being viewed relative to *either* observer!

Does observation bear this out? Even the closest of the distant stars are so remote that during the course of an entire year their considerable velocities do not appreciably alter their apparent positions in the sky. This fact is used in analyzing eclipse data to determine the bending of starlight around the sun; whatever differences appear in star field observations made six months apart can be used to measure the effect of gravity on the photons of the light from these stars during eclipse. However, gravitational effects of the sun and moon that intervene in the one image and not the other do not produce the most significant differences in registration of these star fields. The fact that the earth is moving in the opposite direction at orbital velocity in the two instances produces a much larger effect.

The two star maps that are used have inevitably been 'observed' while in approximately uniform relative motion with relative velocity twice the orbital velocity, i. e., about 36 miles per second, producing a special relativistic aberration effect *much* larger than the gravitational (general relativistic) effect. This aberration effect produces an angular displacement of more than 40 arc seconds, whereas the gravitational effect is less than 1 arc second at two angular radii from the sun. So displacements in stellar images, obtained at observations six months apart by (effectively two separate) relatively moving observers superimposed upon one another in a *best fit* (as in figure presented earlier) but offset by 41 arc seconds, are all that can then be used to register maps as a basis for measuring the gravitational effect. Over the extent of the several degree star field, differences in morphology (as against the total aberration effect) caused by annual motion of the earth about the sun should be less than about 0.2 arc seconds. This is according to Einstein's conjecture of the applicability of the Lorentz transformation calculations employed by the special theory of relativity to account for such cascaded phenomena. But actual data taken during solar eclipses reveal much broader variation than this. (See the figure below.) Error analyses suggest that even though a least squares fit of data does confirm predicted gravitational effects – actually in excess by an appreciable percentage across the entire star field – a satisfying rationale for the magnitude of variation has *not* been achieved. This has not changed in all the years since this effect was first observed. Misner, Thorne, and Wheeler provide Dicke's summary of results through 1964, "The scatter would not be too bad if one could believe that the technique was free of systematic errors. It appears that one must consider this observation uncertain to at least 10 percent, and



stellar displacements (away from filled circles) as they were prepared by Campbell and Trumpler (1923) in analysis of eclipse of 1922. (Dotted lines represent the sun's corona.)

perhaps as much as 20 percent."[1] Radio astronomical results reveal the same order of magnitude uncertainties as for the optical observations. There is some azimuthal dependence in the uncertainties as one might have suspected, but as shown for the displacement identified as "113" in the figure below, oppositely-directed displacements *exceeding* magnitudes of the *predicted* gravitational effect occur as well. (Notice that the displacement scale is greatly expanded relative to stellar positions.)

Is this a refutation of Einstein's conjecture concerning that *law of the transmission of light* or just some fluke of a truly difficult observation? What if stars winged about at appreciable fractions of the speed of light as occurs at microscopic levels of our universe rather than mere tens of miles per second? Could usable maps be constructed that would have even nominal utility by another observer?

Einstein's special theory provides deterministic mappings of observa-tions of one observer onto those of another in uniform relative motion. This is true even in cases where observations pertain to events on world lines of objects at widely varying distances and velocities. When interpreting the results of Lorentz transformations according to Einstein's hypothesis of *the law of transmission of light*, all variation becomes moot. This "law" is effected by imposing an additional constraint on the Lorentz equations – namely the "velocity addition formula" – that has, of course, never been independently confirmed, or non-refuted as a scientist would prefer to say, but is a 'necessary' consequence of the interpretation of the Lorentz equations *as* a 'transformation' rather than as merely establishing a 'correspondence' between *actually observed* events on the world line of the same object.

This piece of peripheral dogma only comes into play with regard to events on 'third party' platforms that would otherwise need to be mapped using direct assessments of relative velocity. What this frame independent 'buddy system' enforces is that the Lorentz equations produce a single coordinate direction independent of differences in the relative positions and velocities of the sources of all the events seen as occurring in this direction by one particular observer in *his* spacetime. That seems to the author to negate the very purpose and usefulness of relativity as a coordination (as against *determination*) of 'observations'!

In 'observing' an event as against our merely 'hypothesizing' one for someone else whose composite relative spacetime situation we cannot assess – as indeed we do not even completely know our own –

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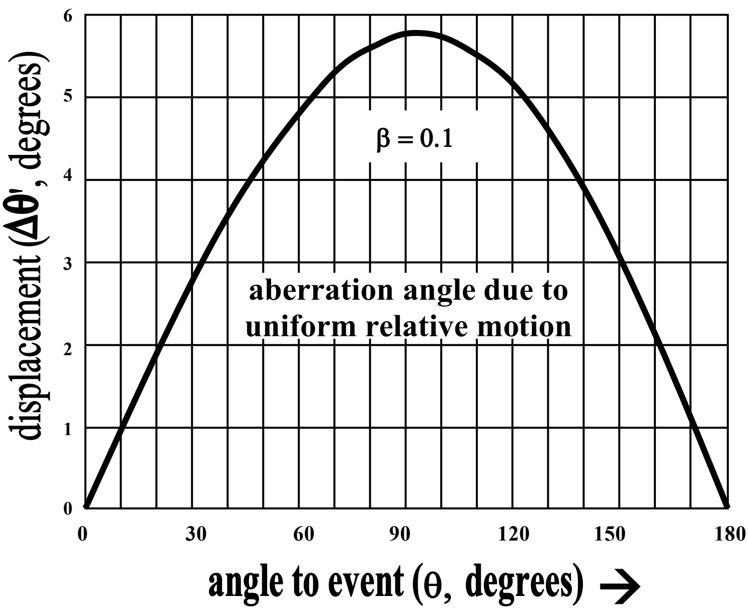
[1] Misner, Thorne, and Wheeler, ***Gravitation***, Freeman, New York, p. 1104 (1973)

with regard to the source of events before the observation is made, actual *observation* is key. By various inferences one observer might be able to deduce from line spectra that the object has a specific radial velocity, but one still would not know its tangential velocity with any accuracy at all! The supposition that relativity can precisely transform observations made by one observer into what any other with a known relative motion (with respect to the first observer) could expect to observe – independent of the nature of what is to be observed – seems to the author patently absurd.

Certainly the conjecture is refutable, and yet, refutation must pend an actual two-observer observation situation, foregoing a natural urge to gedanken experiments that are particularly vulnerable when testing *common sense* notions!

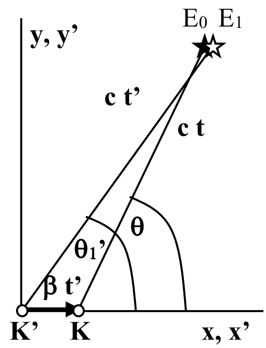
But first we must know what to look for. We'll discuss that next.



The Certainty Principle

It was stated earlier that Einstein's insistence on an archaic notion of *the law of transmission of light* that was nothing more or less than common sense at the time, constrained his interpretation of the Lorentz transformation equations – determinism being the inevitable result. Let's consider this:

Suppose that we (K) are coincident with another observer K' who is moving at the velocity β = 0.1 in units of c with respect to us in frame K. And let's suppose further that there are stars or other sources of radiation observable from a distance, and that these sources have random velocities that are as high as half the speed of light. To coordinate observations with K' we employ the relativistic aberration formula derived directly from the Lorentz's equations:



$$\cos \theta_1' = (\cos \theta - \beta) / (1 - \beta \cos \theta)$$

Notice in the figure that lines ct', ct, and βt' do not form a triangle. (At least formally there are two events.) The deviation between angles, Δθ' = θ – θ' is shown as the curve in the figure on the previous page. This curve shows the amount of aberration between the two observers' observations as a function of the angle θ of the observation with respect to the direction of their relative motion. Whereas with only twice earth's orbital velocity the aberration would reach merely 41 arc seconds as mentioned in the previous article, here it is nearly six degrees. But other than the differences across a field of view, this can easily (and deterministically) be compensated. But with regard to events on objects moving relative to both observers what is the situation?

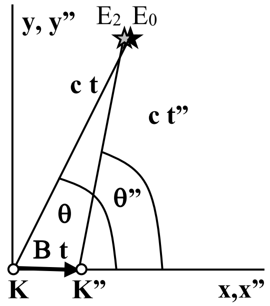
Let us consider light from an event on an object whose velocity is B = o.5 relative to us in K and along the direction of our relative velocity with K'. And suppose that there is an observer K" – stationary with respect to that object who just happens to be coincident with K and K' at the moment all make their observations for comparison. K" sees the event at θ", as shown below. K will see the same event at the angle θ given by the following:

$$\cos \theta = (\cos \theta" - B) / (1 - B \cos \theta") ,$$

and likewise, therefore, we have:

$\cos \theta'' = (\cos \theta + B) / (1 + B \cos \theta)$

We wish now to determine where such an event will appear for K' who happens at that instant to be coincident with both K" and K when they observe the event. To accomplish this goal of third-party coordination according to the established theory, the following relativistic velocity addition formula (what is called 'boosting') must be employed:



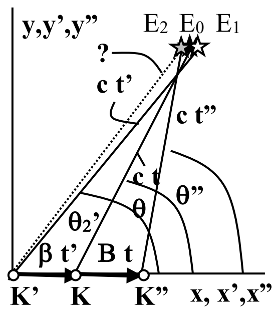
$B' = (B + \beta) / (1 + \beta B)$.

By substitution we obtain:

$\cos \theta_2' = (\cos \theta'' - B') / (1 - B' \cos \theta'')$

$= [(1 + \beta B) \cos \theta'' - (B + \beta)] / [(1 + \beta B) - (B + \beta) \cos \theta'']$

To assess how this affects the displacement of events from the perspective of K' corresponding to event transformations from our relatively stationary apparatus, θ_1, we must substitute now for $\cos \theta''$ from the equation above, so that now we obtain the following:



$\cos \theta_2' = [(1 + \beta B) (\cos \theta + B) - (B + \beta) (1 + B \cos \theta)]$

$/ [(1+ \beta B) (1 + B \cos \theta) - (B + \beta) (\cos \theta + B)]$

By carrying out the operations indicated and canceling factors we find:

$\cos \theta_2' = (\cos \theta - \beta) / (1 - \beta \cos \theta) = \cos \theta_1'$,

which is independent of B, such that the very same angle results between K' and K in both cases, which is rather amazing if you think about it – or I guess more assuredly, if you *don't*. As shown in the figure above the events labeled E_1 and E_2, which are at least by formality treated as *separate* events, are situated to the right and left of E_0 respectively, and yet all three are hereby said to be at the very same angle for K' no matter how this defies depiction as per Lorentz equations illustrated in figure 3 on page 46.

It is very obvious why in all cases it turns out this way. According to the common sense notion embodied in the *law of transmission of light*, whatever *anyone* sees at a point in spacetime *any* coincident observer should also be able to see so that all events seen while in coincidence are mutually *shared*. (The velocity addition formula guarantees this will be the case.) 'Seeing' just involves photons, after all, that happen to hit one observer in the eye rather than another coincident observer…right? Well, I don't think light works that way, but pursuing this as though we do, we find that the velocity addition formula is shorthand for a cascading of the Lorentz equations to substantiate the claim that they form a 'transformation group'. The logic behind this accepted approach to coordination of observations is as follows:

If we let $L(\varepsilon)$ indicate the Lorentz transformation of event, ε, such that:

$$(t', x', y', z') = L_\beta (t, x, y, z)$$

and

$$(t, x, y, z) = L_B (t'', x'', y'', z''),$$

then, does that imply:

$$(t', x', y', z') = L_\beta (L_B (t'', x'', y'', z''))$$

or not? That is the question. If so, it would make sense to define:

$$L_{B'} \equiv L_\beta (L_B),$$

which implies:

$$B' = (B + \beta) / (1 + \beta B)$$

as used above.

With this accepted logic there can be no basis in the established theory for any uncertainty in predicted angular positions of events in space no matter what the unknown and *unknowable* variations in the velocities of the objects on which the events arise. The velocity addition formula distorts all space and time to collapse separate events E_0, E_1 and E_2 to the net effect preserving determinism.

But what – other than an archaic notion of 'common sense' and expediency – necessitated that the Lorentz relationships must constitute a coordinate transformation rather than a mere correspondence? The answer is: Nothing!

All this abracadabra is unnecessary if we free ourselves from the notion that *even a photon must be somewhere* available for scrutiny by either of alternative observers as dictated by Einstein's *law of the transmission of light*![1] We'll have to determine whether discarding such an obsolete notion brings relativity into agreement with observations of course. It is tempting to suggest that possibly the eclipse data, discussed earlier, refute Einstein's velocity addition formula, but the uncertainties there are too large to be due to the instantaneous relative velocities, so it is felt that the magnitude of those uncertainties relate more directly to the range of likely accelerations of stars in the star field – another interesting issue to discuss sometime.

[1] Another alternative will be discussed in subsequent articles in this volume and ultimately further defines as the viable solution which chooses another transformation altogether. See for example, Vaughan (2010).

The Overarching Significance of Angular Observations

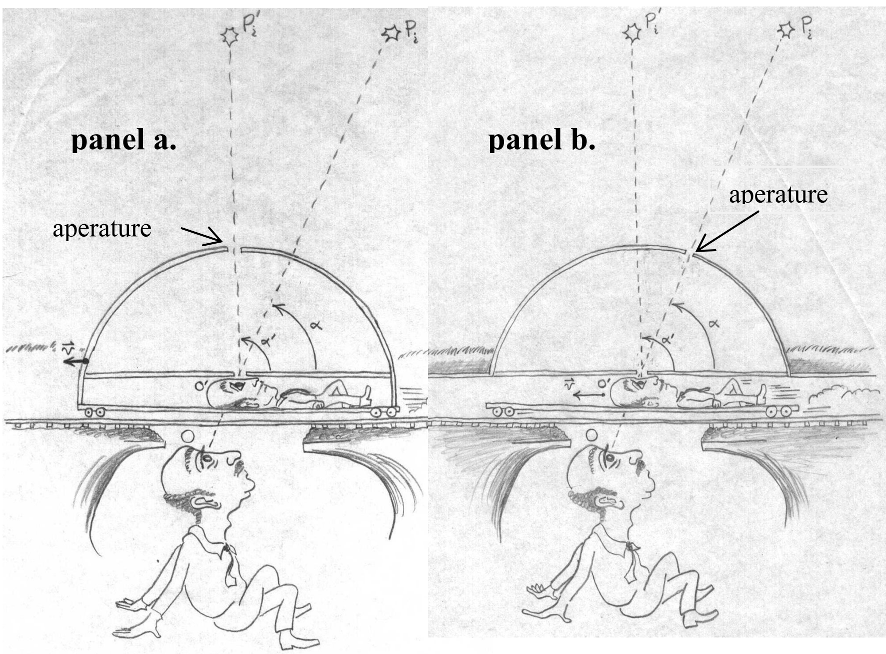
This volume is somewhat dedicated to the idea that aberration is the *real* phenomenon of relative motion that one must deal with first and foremost when trying to understand the manifold ramifications of relativity. Here the attempt is to ferret out a different aspect of that same notion. Although also accepting the same body of experimental data accepted as legitimate by establishment with regard to aberration, the author stubbornly maintains that observations involving this phenomenon are more reasonably accepted as the most essential aspect of relative motion and would more properly be acknowledged as the phenomenological base of any associated theory.

Einstein and Minkowski asserted that the Lorentz equations constitute a *transformation* in the same mathematical sense as a *rotation* of spatial coordinates accompanying deterministic shifts in the locations of points on a rigid body. The analogy accommodates (enforces) completely deterministic relationships between observations of the universe (however predictably distorted) from any one observer to any other in uniform relative motion through a vacuum. In a very real sense equations of this form *do* provide such a function, but the author maintains that it transforms the *perspectives* of the observers, *not* the realities that surround them, which distinction has extreme epistemological significance of course, and is thus worthy of some discussion. The equations provide in any case a most likely place to look for a corresponding event viewed from a relatively moving frame of reference. But the inevitable determinism associated with the established interpretation is unnecessary *and*, since it is incompatible with other highly successful theories of physics, it seems reasonable to attempt to find viable alternatives, subjecting all options to scientifically refutable experimental test.

It has been suggested elsewhere that Einstein's *law of the transmission of light* which is the ontological basis of the established interpretation of the Lorentz correspondence between measured space and time values is invalid in light of subsequent discoveries. Furthermore, it denies validity to *actual* measurements since once an event has been observed by one observer, what *could be* observed by any *other* observer is, thereby, completely determined. Logical consistency therefore forces us to seek alternative explanations of the pertinent and unilaterally accepted experimental results.

The velocity addition formula, discussed in the previous article, is *not* a necessary concomitant of maintaining *all motion is relative*, but is required merely to support the currently accepted interpretation as shown elsewhere. In this article we discuss comparisons with the implications of a relativistic theory that retains a traditional velocity addition formula. Notice that abandoning this particular facet while retaining the Lorentz relationship between observed angles and distances to events, in no way jeopardizes any acknowledged postulate of Einstein's relativity. The speed of light can still be accepted as the same for every observer of an event, etc..

We will make several fascinating observations: First of all, if an observer were to have a firmly affixed transparent celestial sphere marked off with traditional declination and right ascension grid lines for easy reference to the directions of his observations, then the lines marked out on this sphere would *transform* for another observer in relative motion as determined by the Lorentz transformation equations. But the stellar or other objects that were aligned with



***antinomy in the underground observatory*,**
drawn by R. F. Vaughan author circa 1975

Figure 1: ***Two relatively moving observers observing through celestial spheres***

those marks for that observer would not possess the same (however distorted) alignment with respect to these grid lines for another observer unless the objects happened to share the motion of the first observer. If, for example, an object appeared at the interstices between declination 89° 59' 59" – 90° and right ascension 101° – 101° 1' 1", it would not reside between those lines if its motion relative to the first observer were sufficiently great. Where it would actually appear would depend intimately on its unique relative velocity. That is actually what *relative-to-me* rather than *relative-to-him* is all about whether the "him" is taken as an *absolute* reference or not. And quite independent of one's stance on the velocity addition formula, one should realize that any constructed celestial spheres would differ considerably even with regard to the 'fixed' observations of another observer. See panels a. and b. in figure 1 above. Observations that appear straight-up for one observer migrate toward the horizon for another in relative motion. This is shown succinctly in figure 2, where the geometric distortion between the two becomes obvious. If its relative velocity were near that of the velocity of light, the source of a light emission event would appear at an increasing distance back along its path of approach. This is all very obvious if you think about it: Trace out a line of sight to a point on the trajectory of the object to determine the transit time for light from the object, then draw out the motion of the object from this position (A) to a distance V*t* further along its worldline trajectory (B) which will be how far the object travels while light is proceeding to *this* observer. This construction epitomizes Lorentz relationships between the observations of observers in relative motion. A coincident observer stationary with respect to the object would *not* observe the object at the specific location B obtained by this construction, but at B*'* only because of the factor of γ. See figure 3 below and on page 33. And if it is given that the relatively *stationary* observer observes the object at location B*'*, then where an observer in *relative motion* will observe the event is at A ≠ A' which must be determined by reversing the source

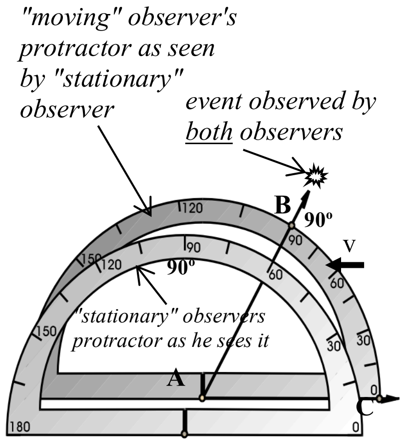


Figure 2: ***Uniformly moving observers do not share mutual geometrical understandings of events observed "in common".***

velocity in the Lorentz equations for *him*. The appropriate relativistic aberration formula is the following:

$$\cos \alpha' = \frac{\cos \alpha - V/c}{1 - [V/c]}$$

In figure 4 we use this formula to illustrate the predicted angles α' for the various angles α with relative velocity ranging between the negative and positive value of the speed of light – approaching and receding sources of observed events. So for any given observed event in one frame of reference, event coordinates that would be observed from another is easily calculable.

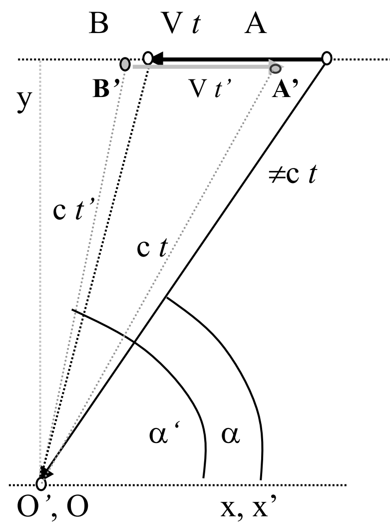


Figure 3: ***Construction of angles***

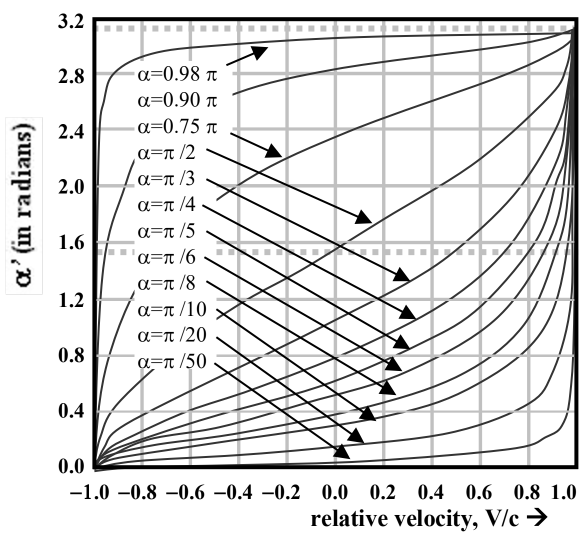


Figure 4: ***Aberration as a function of angle***

All this discussion applies without too major of disagreement on account of one insisting on one alternative interpretation or the other and the epistemological meaning of the associated Lorentz formulas – at least to the extent of it making an easily quantifiable difference. (Most macroscopic 'objects' emit continuously and the relatively 'stationary' observer will see all of these events as occurring at the same location and distance in the past. The only question is which one of these continuously replaced events a coincident relatively moving observer will actually witness for appropriate comparison.) But this applies only to a world all of whose observable objects are stationary with regard to one observer or the other. What about a truly dynamic world, the *real* world, the one we live in? Where there are multiple motions such ambiguities must needs be resolved.

In this more generalized case, the observed location and time of occurrence of witnessed events will depend intimately on the individual motions of the platforms upon which the events occur just as we have seen above, and neither observer has a monopoly on the angular orientation of an entire sequence of events occurring on an object. Knowing the individual motions and when and where the events occurred in the *stationary* frames of the various objects, we could predict precisely where and when each event would be witnessed using the appropriate set of Lorentz 'transformation' equations that relate the frame of the object and that of any particular observer. About that there is no controversy. However, whether knowing the observations of a single observer, but without foreknowledge of where and when the observed events occurred in the various frames of reference of the objects upon which the events *actually* occurred, is sufficient to determine similar angular observations for another observer in uniform relative motion is what is at issue here.

Undismayed by the fact that a myriad of unique transformations would be required to determine the coordinates of any observer's observations, Einstein's interpretation of the Lorentz equations is that they have sufficient power to disambiguate all the uncertainties in predicting the observations of a second observer knowing *only* his motion relative to the first. This 'feature' of that interpretation – if you consider it such – is valid if and only if Einstein's velocity addition formula is accepted as true as we saw in the previous article. This formula (if valid) would allow one to group all of the various possible motions of objects upon which observed events appear to occur at a given angle for the first observer into a single transformation group that all transform to the very same angle for a second observer independent of their individual relative motions, again as shown in the previous article. If the set V_i includes all the unknown individual velocities of objects on which events occur that are seen in a given direction by one observer and v is the uniform relative velocity of the two observers, then the velocity addition formula maintains that the set of velocities of the objects in the frame of reference of the second observer would be V_i', as given by:

$$V_i' = \frac{v \pm V_i}{1 \pm v\, V_i / c^2} \quad ,$$

Here only the velocity component along a single direction of relative motion will be considered. If this formula is valid, then all events designated by i observed as occurring along the given line of sight by one observer will appear along a single line of sight also for any other coincident observer no matter what his motion. This is not 'more relative' than the traditional formula $V_i' = v \pm V_i$, of course, although it is much more *handy* if one wants to sweep uncertainty under the rug. But if we have learned anything during the last century, it is that uncertainty will *not* be swept under the rug. So we are left to assess whether – in addition to being *handy* – this formula happens to be scientifically *valid*!

The first line of thought to be pursued in this regard should be whether there is a quantifiable difference that would refute one formula or the other. To this endeavor one must compute the difference between the associated aberration angle predictions, because that difference is the uncertainty that would pertain if Einstein's and Minkowski's interpretation were wrong. And if they are not wrong, then uncertainty's entry into our world must be via some other route. The two equations to be tested are:

$$\cos \alpha' = \frac{\cos \alpha - (v \pm V_i)/c}{1 - [(v \pm V_i)/c] \cos \alpha}$$

and

$$\cos \alpha' = \frac{\cos \alpha - (v \pm V_i)/(1 \pm vV_i /c^2)c}{1 - [(v \pm V_i)/(1 \pm vV_i /c^2)c] \cos \alpha}$$

Naturally large relative velocities are required to make a measurable difference in the values computed in the two cases. There is also an angular dependence that affects the size of the difference. These variabilities are all exhibited in figure 5.

Clearly the predicted uncertainties associated with the traditional formula become very large for large values of v and V_i. But for velocities experienced even by the earth in its orbit about the sun (an annual variation of 2×10^{-4} c) a maximum uncertainty to be expected of stellar observations is smaller than the resolution of telescope observations – in fact, much less than 10^{-9} radians. But we have be-come accustomed to our macroscopic world not seeming to exhibit uncertainties known to characterize microscopic do-mains to which quantum realities pertain. But in thermodynamics, where molecular velocities at quite mundane temperatures can attain component velocities that are appreciable relative to the speed of light, some strange things happen.

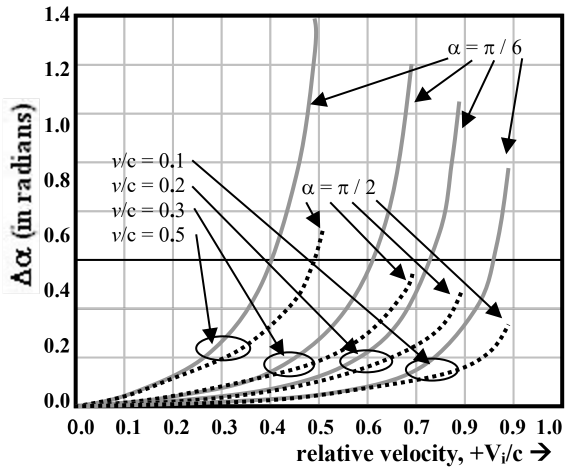


Figure 5: ***The amount of uncertainty in angular position α' to be expected as a function of directions of line-of-sight α, relative velocity of observers v, and the relative velocities V_i of platforms of the various events.***

It should be noted that the velocity addition formula (boosting) as discussed here does *not* pertain to the velocity of a photon of light emitted from a relatively moving source. Photons are *not* 'objects' in any similar sense to that of billiard balls. The 'velocity of light' to the extent that light can be considered to travel *through* space must be handled differently as double slit and other experiments with light have indicated.

So without sufficient instrumental accuracy to refute one interpretation or the other, is it really reasonable to fight quite so vindictively for the established view based on a 1906 vintage 'law of the transmission of light'? Letting it go may be the key to the compatibility of the so disparate theories of physics, the dissimilarities of which involve the treatment of observation and uncertainty both at issue here. Certainly there is reason for confusion in this regard and one can never return to that state of bliss before relative motion was found to legitimately confound all the epistemological options concerning our perceptions. The relative locations and times of occurrence that one must associate with observed events that are being viewed *here* and *now* differ considerably from one observer to another who does not happen to share the same relative velocity to observed objects. The fact that one of the implications of relative motion may be weirder than was first thought, while others are less so, need hardly alarm a world accepting of uncertainty. That those implications should altogether prohibit laying out mutually agreeable arrays of numbers as a metric of a physical space and time acceptable to any and all observers giving rise to epistemological problems in dealing with such anomalies should prove little more than fascinating.

Of course there are weighty issues at stake with regard to changing the established interpretation. Much of the dogma associated with spacetime would be rendered supercilious were we to embrace something closer to what Kant conceived – that space and time (and indeed all mathematics) are logical rather than physical constructs. It seems to the author that space and time are merely associated with our viewing the world, *not* empirical knowledge concerning the world itself. This is what we should always have anticipated, and questioning an establishmentarian view that has remained sacrosanct for too long, has scientific value as well.

Although one's reputation could be in serious jeopardy by attempting to disassociate what God himself (according to one guru or another) seems to have united in holy matrimony, it can provide a certain amount of exhilaration so necessary for aging curmudgeons such as the current author. So he will allow himself the luxury of contemplating even such a *disaster* as a divorce of space and time, remembering that idyllic virginity before Minkowski sanctified their holy union with, "henceforth these *two* shall be *one*!"

Another View of Lorentz 'Transformations'

"*Compared to location and time, all other knowledge is moonshine*."
– H. L. Mencken

In Special Relativity (SR) the Lorentz Transformation (LT) equations have been interpreted as a *quasi*-coordinate conversion, relating the locations and times of occurrence of events observed in one frame of reference to those that could be observed by a coincident observer in uniform relative motion. An intuitive understanding of this interpretation of the equations is obtained by considering coordinate conversions generally, including both the *translation* and *rotation* of coordinates in relatively stationary coordinate frames. The literature of SR has tended toward graphic analogies with the *rotation of coordinates* using *spacetime* diagrams of the temporal and a single spatial coordinate axis appropriate to the nontrivial equations. Because the nature of the phenomena portrayed in such a diagram is not *visually* observable in actuality, rotation analogies (although soundly based in the formalism) fail to illicit the intuitive understanding that goes with a depiction of what could (at least in principle) be set up for direct viewing. For this and other reasons we will break with that graphic tradition here, preferring the analogy with the *translation of coordinates*. In the translation analogy, *relativistic aberration* and *parallax* will be demonstrated to exhibit comparable roles promoting visualization and comprehension. The analogy of the LT with coordinate rotation breaks down with regard to the illustrated axes being 'skewed' *toward* each other rather than 'rotated' in the same direction. The analogy with translation breaks down with respect to a scale factor along the direction of motion that differs from unity. Clearly, there is, as should have been suspected, more than just traditional coordinate conversion involved.

Figure 1 illustrates the relationship of measured coordinate values of an event seen by two displaced but relatively stationary observers situated at respective origins of their own frames of reference. The appropriate coordinate 'transformation' equations are provided at the left of the figure. The parameter x_0 is the permanent separation of the two observers, $|ct|$ is the distance to the observed phenomena, $|t|$ being the time interval between occurrence of the observed event and its observation by the *unprimed* observer O, and c is the speed of light. *Primed* parameters indicate a corresponding distance or coordinate value that is measured relative to the 'primed' observer O'. All values of t are negative since observed events occurred prior to the observation that is assumed to take place at $t_o = 0$.

Figure 1: Coordinate translation transformation equations (relatively stationary observers)

$$x = c\,t\,\cos\theta$$
$$y = c\,t\,\sin\theta$$
$$x' = c\,t'\cos\theta' = x - x_o$$
$$y' = c\,t'\sin\theta' = y, \text{ where}$$
$$c\,t' = c\,t\,(1 - 2\beta\,x/c\,t + \beta^2)^{½}$$
$$\beta = |x_o| / |c\,t|$$

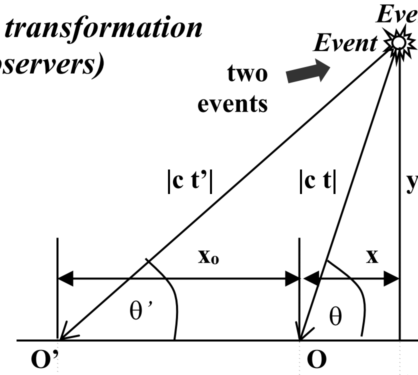


Figure 2: Galilean transformation equations (observers moving uniformly)

$$x = c\,t\,\cos\theta$$
$$y = c\,t\,\sin\theta$$
$$x' = c\,t'\cos\theta' = x - v\,t$$
$$y' = c\,t'\sin\theta' = y, \text{ where}$$
$$c'\,t = c\,t\,(1 - 2\beta\,x/c\,t + \beta^2)^{½}$$
$$\beta = |v\,t| / |c\,t| = |v/c|$$

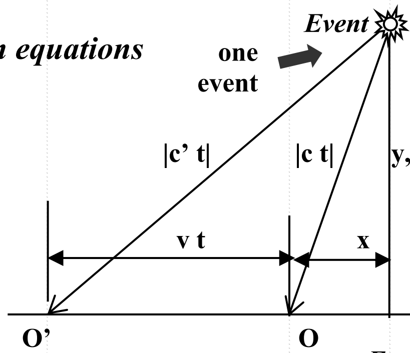
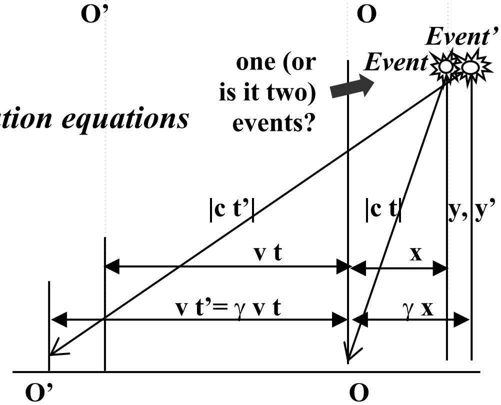


Figure 3: Lorentz transformation equations (observers moving uniformly)

$$x = c\,t\,\cos\theta$$
$$y = c\,t\,\sin\theta$$
$$x' = c\,t'\cos\theta' = \gamma\,(x - v\,t)$$
$$y' = c\,t'\sin\theta' = y, \text{ where}$$
$$c\,t' = \gamma\,c\,t\,(1 - \beta\,x/c\,t)$$
$$\beta = |v/c|$$
$$\gamma = (1 - \beta^2)^{-½}$$



In the general situation for which an event occurs at clock time t_e, the observations will occur at unique clock times t_{o1} and t_{o2}. (Actually either their observations take place at different times, t_{o1} and t_{o2}, or they pertain to different events occurring at the distinct times, t_{e1} and t_{e2}, because of the unique distances from the event and an assumed universality of speed of light for relatively stationary but displaced observers. There is a plane of events that will be co-observed because they are equidistant from the two observers.) So that using times, t_e,

t_{o1} and t_{o2}, obtained from synchronized clocks and observations of a single event, the coordinate time interval parameters are defined by, $t \equiv t_e - t_{o1}$ and $t' \equiv t_e - t_{o2}$. (Notice that the same values would have resulted if we had defined $t \equiv t_{e1} - t_o$ and $t' \equiv t_{e2} - t_o$, in which case the time intervals would have pertained to unique events observed simultaneously. Equivalent values leave the interpretation of the equations open in this case.) Either inter-pretation uses the same coordinate translation equations to bring the two observers' observations into complete agreement by recreating a single point and time in a common space-time at which each observed event took place. Thus, two similar observations made at different times can be compatible with a single exterior event observed uniquely by each observer, or alternatively, unique observations made at precisely the same time according to synchronized clocks may be reconciled with *separate* events occurring at the same place but at different times. This is in spite of the fact that in either case the event will have occurred in the more distant past for one of the observers than for the other with respect to the time of their respective observations. 'Time' in these equations is tantamount to that distance.

It was presumed for centuries that the appropriate transformation of coordinates for two frames in uniform relative motion would be very like that realized for stationary displaced observers. The apparent displacement would be a function of the distance to the observed event, the relative velocity of the observers,[2] and the speed of light. The implications of these assumptions are shown in figure 2 where the analogs to figure 1 are readily apparent. Again the appropriate equations for this case are included at the left of the figure. The distances vt and ct in the equations were retained without canceling factors of t in order to illustrate similarities to the final two equations in figure 1. Because of a common sense consideration involving both observers having necessarily to be able to observe the same "ray of light," the propagation distance equation was not considered in this case to represent the relationship of time intervals between occurrence of the event and its respective observation, however. It was naturally assumed that observation of a single event could be performed by either or both observers when they were in coincidence. Thus, this equation was interpreted instead to relate the respective effective speeds of light. That the speed of light might be a universal constant

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[2] This relative velocity is with respect to the frame of reference in which the speed of light was assumed to be equal to c. For the *ether theory*, this would be with respect to the ether medium, for *Ritz's theory* (which assumed a universal speed of light with respect to every *source* of radiation) it would have been with respect to that source.

with respect to each *observer* (rather than with respect to absolute space or the source) for which case a direct analogy to parallax would have seemed to apply, was not even considered a legitimate possibility. It would have meant that coincident, although relatively moving, observers could *not* observe the same events – an unthinkable consequence at the turn of the twentieth century and to virtually everyone even now.

This *Galilean* transformation (GT), as it was called did not account for an increasing number of optical experiments performed before the turn of the twentieth century in any case.[3] A transformation (the LT) developed by Lorentz and others did. A more direct comparison of the geometrical relationships implied, respectively, by the LT and GT equations is illustrated in figure 3. In figure 4, a generalized mapping of events in the x,y plane onto an x',y' plane is demonstrated; the same sort of mapping applies to the x,z and x',z' planes. Clearly, the LT equations imply a stretching along the direction of relative motion in spatial displacements between locations of the event and its observation with respect to what had been anticipated from the GT equations. The indicated circles correspond to cross-sections of spherical surfaces of simultaneously occurring events. Ellipses correspond to the cross sections of ellipsoidal surfaces of events corresponding to these simultaneous events from the other frame of reference. Notice that the symbols, $\mathscr{L}_v$, $\mathscr{L}_v^{-1}$, $\mathscr{L}_{-v}$, and $\mathscr{L}_{-v}^{-1}$ all refer to the LT equations or their inverse (which is also an LT associated with an oppositely directed relative velocity). Each is associated with a relative velocity of v or $-v$.

$$(x', y', z', t') = \mathscr{L}_v\,(x, y, z, t)\ ,$$

where the values of x', y', z' and t' are given respectively by the LT equations provided at the left of figure 3. With these equations the inverse identities, $\mathscr{L}_v^{-1} = \mathscr{L}_{-v}$ and $\mathscr{L}_{-v}^{-1} = \mathscr{L}_v$, can easily be proven establishing a one-to-one isomorphic relationship.

In figure 3 above the apparent distance and time interval to the occurrence of the observed event (if one embraces the universality of the speed of light as Einstein did) is easily demonstrated within each frame of reference by a straight-forward application of the Pythagorean

[3] See for example any optics text where the Fizzeau, Sagnac, Michelson Morley and other optical experiments are described.

theorem to the distances of the respective event coordinates in the two reference frames.

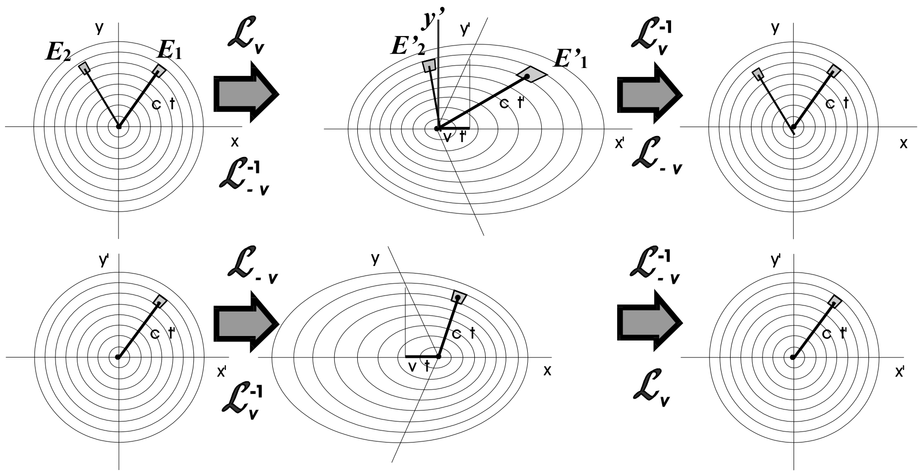

Figure 4: ***Lorentz Mapping of the x-y Plane (t is proportional to distance from origin)***

In this way the postulated universal speed of light relative to every *observer* is shown to be associated with the temporal Lorentz equation for which there was no direct analog in the GT equations. However, it is easily seen that the *effectual* difference between the Lorentz temporal equation shown at the left in figure 3 and the Galilean "speed of light" equation shown in figure 2 involves only second and higher order terms in β. The effect of relative motion on observation is apparently much more similar to the parallax situation of two relatively stationary observers separated by the distance *vt* as shown in figure 1 than had been anticipated by the GT equations, since the time of occurrence of the event rather than the speed of light is at issue. The primary difference between the sets of equations pertains to whether the differences of $|c'\,t|$ or $|c\,t'|$ from $|c\,t|$ of two co-located observers is to be presumed to reflect a difference in *when separate events* occurred or in *how long it takes* the light to propagate from *the same event*. Interpretation of these Lorentz equations might have gone either way. But as we will see, Einstein's interpretation was addressed at what he called the kinematics problem, i. e., constraining the electromagnetic events to occur at locations where the light source would have been situated at those times.

Since the coordinates of the objects are *not* the same as those of corresponding events, the mensurable distances and time intervals were attributed to differences in the scales of rods and clocks of relatively moving observers so that even though different values for the distances and amounts of time for light to propagate for the two observers were predicted similar to parallax situations, the two events in figure 3 could be forced to be the same event. This would preserve the value of the speed of light (with the caveat that it only applied within a single observer's frame of reference) and *also* the common sense notion of a single event being observable by both. Only later did it arise that common sense does not apply in quantum domains to which "laws of the transmission of light" pertain. Certainly major differences in our understanding of light, time, and space would have resulted with any viable alternative interpretation that might have accepted instead. We will discuss some of them in subsequent articles.

The two events E_1 and E_2 in figure 4 are representative of an entire class of simultaneous events in the unprimed reference frame. They are equidistant from an observer in reference frame O and map into another class of events (E'_1 and E'_2) that could be observed by another relatively moving coincident observer in frame O*'* in accordance with the LT equations. (This simultaneity condition in O is realized for reflection from the various interior points on a concave spherical mirror of radius equal to cT assuming an instantaneous flash of light had occurred at the center of the apparatus for example.) Although the spatial mapping of this class of simultaneous events on the surface of a sphere is easily verified to generate an elongated ellipsoid of associated events as shown in the other frame, the corresponding times of occurrence for the two sets of events are rather more difficult to visualize. It should be noted that events for which x is less than zero (E_2 in the figure) are deferred in O*'* relative to their times of occurrence in O, i. e., they occur at later times. For events for which x is greater than zero (E_1 in the figure), the opposite is the case.

To illustrate the meaning of the mapping of spheres into ellipsoids in figure 4, figure 5 includes nine panels that depict the progress of a wave front initiated in panel a. at time $t' = -\gamma T$ on the X ' axis at $x' = \gamma v T$. In figure 5.b and in subsequent panels the progress of this wave front is depicted as the cross section of a spherical surface at intervals of $\Delta t' = \frac{1}{4} \gamma T$. Black dots indicate reflectors on a cross section of a rigid spherical mirror where reflection events occur in O and the smaller open circles surrounded by a flash in panels 5.c through 5.g indicate where corresponding reflection events occur in O'. These reflection points on the ellipsoid do not correspond to a rigid body in the same sense as for the spherical mirror apparatus of O, however. The total of all reflection points correspond instead to a mere ephemeral ellipsoidal mapping of those events, i. e., the spatial locations of the reflection events in O' that occur at different times. The wave front is not simultaneously reflected in O' as it is in O, some are reflected before, and others after the instant of coincidence of the observers in panel 5.e as was would be the case for the two events in figure 4. The reflection events from a sphere are directly correlated with events situated at the surface of a stationary ellipsoid in the *other* (O*'*) frame as shown.

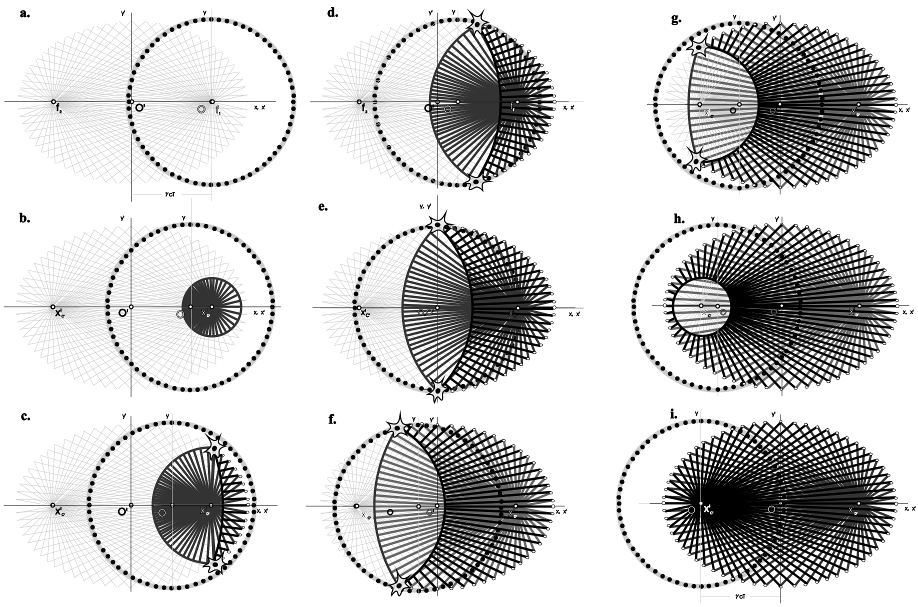

Figure 5: Demonstration illustrating most basic interpretation of LT equations as relating the times and positions of reflection events in the two frames of reference. (Light emanates from the center of the sphere as a convex spherical surface until it experiences reflection after which it constitutes a concave spherical surface converging back to the center of the sphere.)

Paradoxically, reflection phenomena on the surface of the rigid sphere would *not* be coincident with the events on the associated ellipsoid at the time the events occurred except for a circular ring of events for which $x = x' = 0$ at $t = t' = 0$. This situation refers to the current reflection events depicted in figure 5.e with the flash indications at top and bottom. Divergence and convergence of the light shown in figures 5.a and 5.i, respectively, coincide at the respective times, i. e., $t_e' = -\gamma T$ and $t_e' = +\gamma T$ in K′ with coincidence of the origin of O at these times. These events occur at $x_e' = +\gamma v T$ and x_e'

$= -\gamma\, v\, T$ in O'. So that for these two significant events, according to the relatively moving observer, it is possible for the material object associated with the source of the emission to be co-located with the respective events at the respective times of observation and emission. But the time of occurrence of emission and detection will be unique to each of the two observers (i. e., $t\,' = \pm\gamma\, T$ rather than $t = \pm T$). Therefore, we still have the condition that the position of the center of the apparatus at the time of the emission must have been different (i. e., $x_e' = +\gamma\; v\, T$ rather than $x_e = +v\, T$) for the two observers when in coincidence. Both these conditions are associated with the seemingly paradoxical situation in which the emission event (for example) would seem to have occurred *twice* although each of the two similar events would only be observable by the respective observer!

To avoid this apparent incongruent situation for 'rigid body kinematics', Einstein hypothesized, as had Fitzgerald, Lorentz, *et. al.,* that space-time coordinate values must be scaled uniquely for each observer in uniform relative motion. To understand this hypothesis, consider what spatial deformation of the spherical apparatus shown in figure 5.a through 5.i would produce the required coincidence of the reflection events in *both* of the two frames of reference. Clearly, rigid body contraction provides coincidence of observed events and corresponding points on a rigid body in the K' frame of reference as shown in figure 6. Then, if there were to be an associated time dilation of round trip light transmission times in addition to account for the longer duration's of light propagation as shown, the 'kinematics' problem would seem to be resolved. Notice that in the panels of figure 6 (unlike in figure 5) reflection occurs *when* and *where* the contracted rigid 'sphere' intersects the elongated ellipsoidal reflection surface. Thus, we arrive at Einstein's rationale for contraction and time dilation hypotheses that have been accepted as integral parts of SR.

"For just this reason it is hardly possible to illustrate Einstein's kinematics by means of models. These certainly give the relationships between lengths and times in the various systems correctly, but they are inconsistent with the principle of identity of the units of measure; nothing can be done but choose two different scales of length in the two system S and S' of the model moving relative to each other.

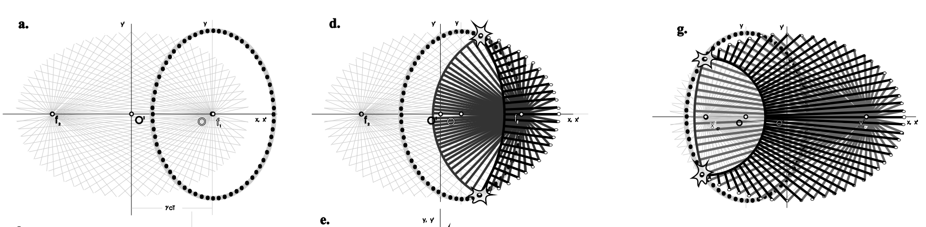

Figure 6: Demonstration of Einstein's solution to the "kinematics" problem establishing common times and places of reflection events in the two frames. (Light emanating from the center of the contracted sphere as a convex spherical surface encounters the contracted rigid sphere at the moment it experiences reflection after which it constitutes a concave spherical surface converging back to the center of the contracted sphere.)

"According to Einstein, the state of affairs is quite different in the real world. In it the new kinematic is to be valid just when the *same* rod and the *same* clock are used first in the system S and then in the system S' to fix lengths and times. This is the feature of Einstein's theory by which it rises above the standpoint of a mere convention and asserts definite properties of real bodies. This gives it its fundamental importance for the whole physical view of nature."[3]

Any explanation of *why* such a contraction and time dilation should occur has been considered "off limits" by a view of physical philosophy that was in vogue throughout much of the 20th century. According to this philosophy scientific theories merely describe phenomena. Explanations are held to be superfluous. But the *only* role of Einstein and Minkowski's metric interpretation hypothesis is as metaphysical explanation to accompany the strange phenomena otherwise adequately described by the LT. There is really no other excuse available for this conjecture and it is considerably at odds with quantum concepts. The door certainly seems open to alternative

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[3] Max Born, ***Einstein's Theory of Relativity***, Dover, New York (1924,1962) p. 252.

interpretations or theoretical mechanisms that might *explain* why this strange phenomenon of the electromagnetic phenomena and material object coordinates must be fudged to fit each other.

The author will argue in other articles that supposed experimental confirmations of aspects of relativity that involve this kinematics interpretation such as time dilation can actually be seen as refuting these hypotheses instead. Elsewhere the author argues that others of the supposed "confirmations" of Einstein's interpretation of the LT are also problematical to say the least. The status of spatial contraction as a non-observable phenomenon will be explained in detail in another article as well.

Alternative explanations of phenomena that are characterized by the LT relationships (one interpretation in agreement only for round-trip light experiments that tend to characterize legitimate empirical data) seem to account more consistently for the same phenomena. Such straight forward explanations relate more directly to electromagnetic absorption and quantum theories rather than merely endorsing an inexcusable replacement of natural philosophy with mathematical expressions. It is felt by the author that an alternative interpretation will eventually tie in with the other major physical theories of modern physics to provide a much more compatible basis for understanding the nature of our physical universe without losing the obvious benefits of SR.

Constancy of the Speed of Light – What Does It Really Mean in Einstein's Special Relativity

Relativity is the branch of physics that formally addresses the coordination of observations of physical phenomena made by pairs of observers in situations involving unique perspectives. By such invariant formulations of the *laws of nature*, we come ultimately to know the universe independent of the particulars of individual situations.

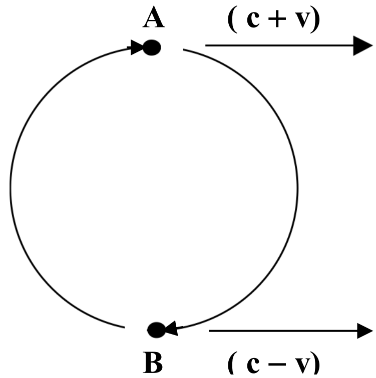
That these coordinations have been adequately resolved by the genius of Albert Einstein in his theory of relativity is generally assumed. If anything of significance had not been resolved, one would think that it must certainly have been clarified by now, which leaves the rote job of *doing it* as all that remains in this branch of physics. However technologically useful these calculations, one must acknowledge that such accounting tasks are inherently mundane. To act as a scientist one must demonstrate quite another interest in the subject matter, and that interest must always be to question all that may not have been adequately tested for a possible refutation. Fortunately in this regard, there are a few problems with Einstein's conception of relativity involving both its experimental verification and much broader philosophical issues whose resolutions are *beneath* no one, but yet, perhaps not *beyond* us all either.

Special relativity has had dramatic successes, but it is not the only theory to which many of these successes might have applied. Nor has the special theory satisfactorily accounted for all experimental results, namely Sagnac's experiment, obtained to distinguish between it and other non-ether theories of the time. Predicted differences between Einstein's and Ritz's theories in particular ranged from zero to second order terms involving the ratio of the observers' relative velocity and the speed of light, less in fact than experimental accuracies for most laboratory experiments that had been performed at that time for this purpose. But in 1913 a Dutch astronomer named Wilhelm de Sitter tipped the balance in favor of Einstein's theory by describing a supposed first order effect. The following is my own translation of a particularly expressive excerpt from that short paper:

"Now it is very simple for one to see that Ritz's theory, where the velocity of light [c] is dependent on the velocity of the source [v], is absolutely inadmissible.

"Consider binary stars and observations at a great distance [d] in the orbital plane. From the star at dot A (see figure), outgoing light will, according to Ritz's theory, be observed after a time d/(c+v), that from B after a time d/(c−v). We know T, the semi cycle of the star (whose orbit is thought to be circular for simplicity), so that the time interval between the two observations is $T + 2\,vd/c^2$*. In the second half of the period the star goes from B to A, so that the observed time interval is* $T - 2\,vd/c^2$*. In the customary theory, both intervals are exactly the same. If now* $2vd/c^2$ *is as large as T, it would, if Ritz's theory were correct, be impossible to bring these observations into harmony with Keplerian motion…*

"The existence of spectroscopic binaries and the circumstances that in most cases detailed radial velocity observations can be completely represented by Keplerian motion is therefore strong evidence for the constancy of the velocity of light..."[1]



a reconstruction of de Sitter's drawing

This brief note is often cited as *the* reason for accepting the special theory rather than Ritz's theory, since the Michelson/Morley and other experiments could not be used to discriminate between them. De Sitter's inference does not seem ever to have been impugned although practical issues involving the extinction and re-emission of light in transit have been considered in excruciating detail by the physics community.[2]

The implication that one must embrace the special theory rather than something else *because of the apparent motion of binary stars* is invalid nonetheless! Although c is invariant in Einstein's theory, having the same value in all Lorentz frames, the distances that light travels and the corresponding transit time intervals *aren't*! The special theory most definitely does *not* predict equivalent *transit times* for light

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[1] Wilhelm De Sitter, "Ein astronomischer Beweis fur die Konstanz der Lichtgeschindigkeit," ***Physikalische Zeitschrift***. 49, 429 (1913).

[2] And rightly so, since the special theory applies to coordination of two observers in uniform relative motion in *a vacuum*, a condition of degree virtually never realized to any appreciable extent in real world situations. See for example, "New Limit on Constancy of Velocity of Light," ***Physics Today***. 19 (March 1978).

emitted from binary stars at opposite sides of their orbits at dots A and B (in the figure above) using only the special theory as a basis for making such an argument. In fact, when one employs the Lorentz transformation equations correctly, arrival time differences are computed which differ from those that De Sitter calculated using Ritz's theory by only the usual validly-inferred second-order gamma factor difference, where this factor is given by:

$$\gamma = 1 / (1 - v^2/c^2)^{½}$$

The computation is included in the following paragraph only to more fully document refutation of an error accepted as though it were indisputable fact for nearly a century. (That is a dead horse that needs kicking!)

Define three Lorentz frames, one associated with each star position, A and B in the figure, and a third for an earth-bound observer. Consider the time of emission of light from the two stars, t_A and t_B as measured by a clock in the earth bound frame stationary with respect to the center of rotation. Time values t'_A and t'_B are respectively the emission times as measured in the frames of A and B. The Lorentz transformations dictate.

$$t_A = \gamma (t'_A - d\, v/c^2), \text{ and } t_B = \gamma (t'_B + d\, v/c^2).$$

The times of emission t'_A and t'_B are assumed to have been synchronized. For example, without losing generality one can treat this as though there were two adjacent out of phase binary star systems for which dot A of one is in coincidence with dot B of the other so as to simultaneously be emitting light while in coincidence so that $t'_A = t'_B$. Therefore:

$$t_B - t_A = 2\, \gamma\, d\, v/c^2$$

Emission is thus seen to occur at different times in the earth-bound frame. The equality of the velocity of light from each star according to the special theory therefore assures *unequal* arrival times will be predicted by that theory. The observed equality of transit times for light from the components of binary star systems as demonstrated by De Sitter would, therefore, seem to contemn Einstein’s theory to an even larger degree than Ritz's theory, since the gamma factor is greater than unity.[3] This should have been expected since differences between Einstein's and other competing theories have always been understood as being of second-order in v/c or less.

So why don't we see what De Sitter called "ghost images" or the hypothetically distorted appearances of binary stars? The answer of course lies in the fact that the stars are not in uniform motion as de Sitter assumed in his (and we in our) computations. Ritz's theory hypothesized light that propagates on the fields (rigidly?) associated with the source, and so time interval differences would naturally be associated with differences to *distances* to the star at the time the image *arrives* – assuming the entire distance were traversed entirely in vacuum without extinction. In this sense, Ritz's theory *also* results in the constancy of the velocity of light relative to the observer, but only with respect to the distance from the source's location at the *time of arrival* rather than that of departure of the observed light.[4]) The stars remain in their tight orbits and predicted arrival time differences remain negligible!

As an intuitive aid to understanding with what certainty De Sitter's inference is incorrect for the special theory, consider the following: Sagnac and others had set up experiments with rapidly rotating mirrors which Ritz's theory accounted for and the special theory could not. Langevin, recognized as an authority in general relativity, supposedly went through the difficult mathematics to conclude that the generalized theory could account for the result in that case – the generalization being required because of the centripetal acceleration of the mirrors.[5] So in Einstein's framework how can an adequate understanding of observations of binary star systems involving extremely massive bodies moving at high angular velocities with similar extreme accelerations, avoid the necessity of the general theory to account for their behavior? Since the general theory was confirmed by the effect of our sun on starlight during solar eclipses, the close proximity of the other massive component in binary star systems might certainly be supposed to affect the light transmitted from each component. If De Sitter was correct however, the general theory could have no observable affect since the special theory would account for such data

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[3] However, it should be noted that De Sitter approximated $1/(c^2 - v^2)$ with $1/c^2$ which is more closely approximated by $(1/c^2)(1 + v^2/c^2)$, whereas $(\gamma/c^2) \approx (1/c^2)(1 + ½ v^2/c^2)$ so that Ritz's theory actually does predict a very slightly (and insignificantly) larger disparity than the special theory. It is a *second order* difference rather than *first order* as De Sitter suggested in any case.

[4] The *constancy of the velocity of light* in the special theory is relative to the position of the source at the time of emission of light.

[5] R. Ditchburn, ***Light***, 2nd Edition, Interscience Publishers, 445 (1963).

all by itself. This is merely additional *reductio ad absurdum* proof from which it follows that *neither* Ritz's theory *nor* Einstein's special theory accounts for binary star phenomena very adequately. To act upon this test as legitimate is to short-circuit the scientific selection process.

One could say that the special theory would almost certainly have been accepted anyway, but that is by no means obvious for the following reasons: First of all, one of the most salient features of the special theory is spatial contraction which was never observed and was finally shown to be a mere metaphysical feature which can never be observed.[6] For a much more in-depth discussion of this topic refer to Vaughan's treatment.[4] Secondly, in the next decade after De Sitter's pronouncement, nondeterministic paradigms and phenomenalism became explicit norms of physical theories. The special theory does not satisfy these requirements, but more on that in another article.

"So what?" you well might ask. "Everyone knows life is frequently unfair. Why should theories fare better than people?"

The concern here is not a pointless bemoaning of immeasurable differences between theories predicting nearly equivalent results, and who gets the Nobel Prize while someone else gets the fast track to obscurity.[7] The real issue is the resulting state of science and philosophy with its current closure of discussion with regard to the Special Theory and its *Alice in Wonderland* view of the universe. Philosophically sound theories are necessary to assist our natural pursuit of 'Truth.' The selection process for acceptance of scientific theories is of paramount importance to good science and there can be no immunity for flaws no matter how long ago the violation occurred. Re-evaluation can never be precluded by supposed statutes of limitation with regard to the laws of nature!

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6 R. Penrose, "The Apparent Shape of a relativistically Moving Sphere," ***Cambridge Philosophical Society Proceedin***gs, 55, 137-9 (January 1957).

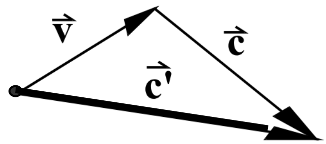
7 R. F. Vaughan, ***The Relativity of Visual Observations***, (2010)

8 In fact Ritz was dead by the time De Sitter published his short paper or he probably would have remonstrated as he did against other of Einstein's assumptions in other contexts.

*How Might the Speed of Light Relate to the Velocity of Its Source?**

Perhaps the most spectacular aspect of special relativity is that the observed velocity of light whose energy is transmitted via photons seems unaffected by the relative velocity of its source. The Lorentz equations feature the concept of the observed velocity being totally independent of relative motion of the observer and the source of the light.

It would have been reasonable to suppose before 1905 that vector addition applied such that the equation:



$$\vec{\mathbf{c}}' = \vec{\mathbf{c}} + \vec{\mathbf{v}}$$

was implied as shown in the figure at right. It is typical of a particularly irritating type of scientific crank who frequently attacks Einstein's relativity that they seem incapable of understanding that this formula does *not* apply, and that it cannot, therefore, be used to disprove the theory. It is a common sense notion they cannot overcome.

But the usefulness of equations interpreted as featuring the constancy of the velocity of light for every observer in no way precludes discussion of alternative interpretations to an identical effect. And just as the Galilean transformation could be (and was!) interpreted to embody modification of the relative velocity of light through a vacuum for an observer in uniform relative motion with respect to the source of the light, the very same perspective could have been explored for the Lorentz equations as pertaining to a variant of the velocity of light rather than variably-perceived transit distances and time intervals for the light – the accepted interpretation. In the alternative interpretation there would have to be a non-isotropic angular dependence of the velocity of light just as there is a non-isotropic angular dependence of transit time in the conventional interpretation. It is just another way of looking at the same equations. But it somewhat complicates the kinematics problem Einstein was attempting to resolve with his interpretation, i. e., it does not enforce that the electromagnetic

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* This discussion pertains to something very different from the apparent velocities of objects viewed from relatively moving reference frames, i. e., Einstein's "velocity addition formula". That a different treatment might be required in that case follows from the fact that photons are totally unlike any objects from which they may be emitted or absorbed.

interaction events, occurring at a point on an object which can be observed by coincident observers, are identically the same. If either the *effective* velocity of light or the *actual* distance to an emission event differs, then one might legitimately infer that *different* events were being observed. That there are at least some 'differences' in the observed events is a fact in any case.

An approach exists that seems in many ways epistemologically superior to rescaling space and time for the two observers to resolve these apparent differences. It suggests possible physical (rather than merely mathematically descriptive) reasons for the so disparate observations of observers in relatively moving frames of reference that also accommodates mechanical kinematics that was of major concern to Einstein. Rather than vicariously attributing the disagreement to the scale of measuring space and time coordinate values of the emission or detection events in the 'other' frame of reference, suppose we accept those observations at face value; there is after all something suspect in always attributing a level of illegitimacy to the 'other' observer's observations. Since we have light propagated from an emission event in the apparatus of one frame of reference that is then observed (or reflected, but at least interacts directly with matter) in another frame of reference, it seems only reasonable to determine differences in these directly *measurable* distances and time intervals as measured in the frame of reference involved, to see what is implied with regard to what the velocity of light would have to have been to account for the actual observations of both observers. Performing this straight forward operation does indeed assess a necessary velocity for propagation between events. In doing this we will obtain a very different view of relative motion, and the beginnings of an understanding of mechanisms responsible for Lorentz relationships.

Let us suspend belief and ignore caveats with regard to disputable clock rate and measuring rod length attributions to the *other* observer involved in determining an actual measurement of whatever velocity *is* implied. We will merely use the time and position values applicable within the particular frame at each end of an electromagnetic interaction according to the Lorentz equations, blithely ignoring conjectured differences in units of measure. Doing this we retain the legitimacy of measurements in both frames of reference and secure agreement on round trip travel times and distances appropriate also in both frames. Since light does, in fact, get from *here* to *there* and back again in spite of presumed metric differences in the usual interpretation, measured time intervals and distances of transmission are applicable to a velocity of light addition formula that would use the

Lorentz transformation equations *without* altering the scales of measurable values in either frame of reference. Such an approach can account equally well for observations that have been experimentally tested for refutation to date.

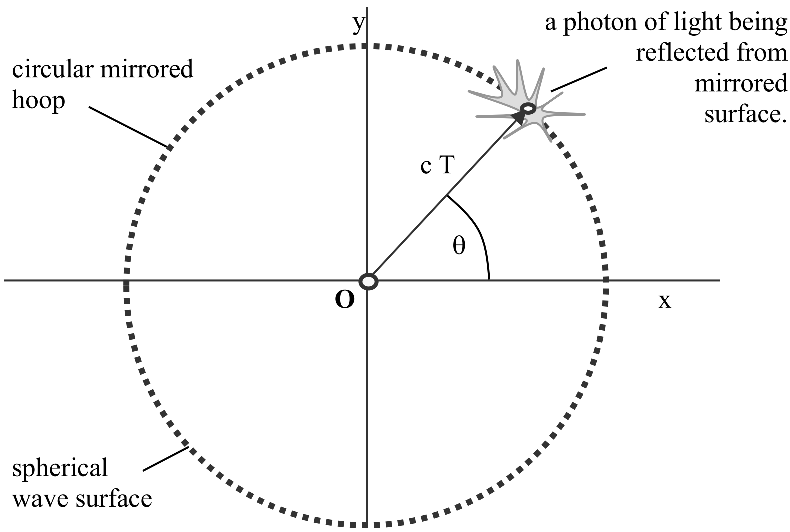
There are profound differences that apply to the two interpretations in explaining kinematic problems of alignment of electromagnetic interaction events accounted by the Lorentz equations with the coordinates occupied by the material sources of the radiation at the calculated times and positions of occurrence of events. For the very same round trip transit times and positions the alternative interpretations exhibit major differences as follows:

1) Clock time dilation and Lorentz contraction in the 'other' frame of reference are necessary according the established interpretation,
2) Coincident observers do not witness the same events on the world line of the source of the radiation according to the alternative interpretation.

Consider relatively moving observers, one with a circular hoop or cross section of a sphere of radius R = c T silvered on its inner surface with a light source at its center (O) which could be activated for a momentary emission of light in all directions. The wave surface from such a burst of events would simultaneously reach the mirrored surface after a period of time T. The reflection event for a single such photon at the angle θ to the x axis is shown in the figure below. In this case both the simultaneous progress of the wave surface and the hoop's material surface are identical after a time T. The reflection back to the center will be accomplished after another equal time interval so that it will converge back to the center at time t = 2 T.

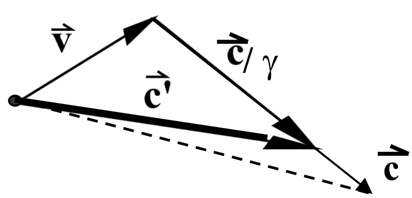
Suppose that this hoop is in motion relative to an observer O*'* at velocity v along the direction of the negative x axis for O*'*, and that when its center reaches a point F_+ – one of the foci of an elliptical structure silvered on its inner surface as shown in the figure below – light is emitted either from the coincident *moving*, or relatively *stationar*y, apparatus. This experimental configuration was illustrated on pages 33 to 34 above.

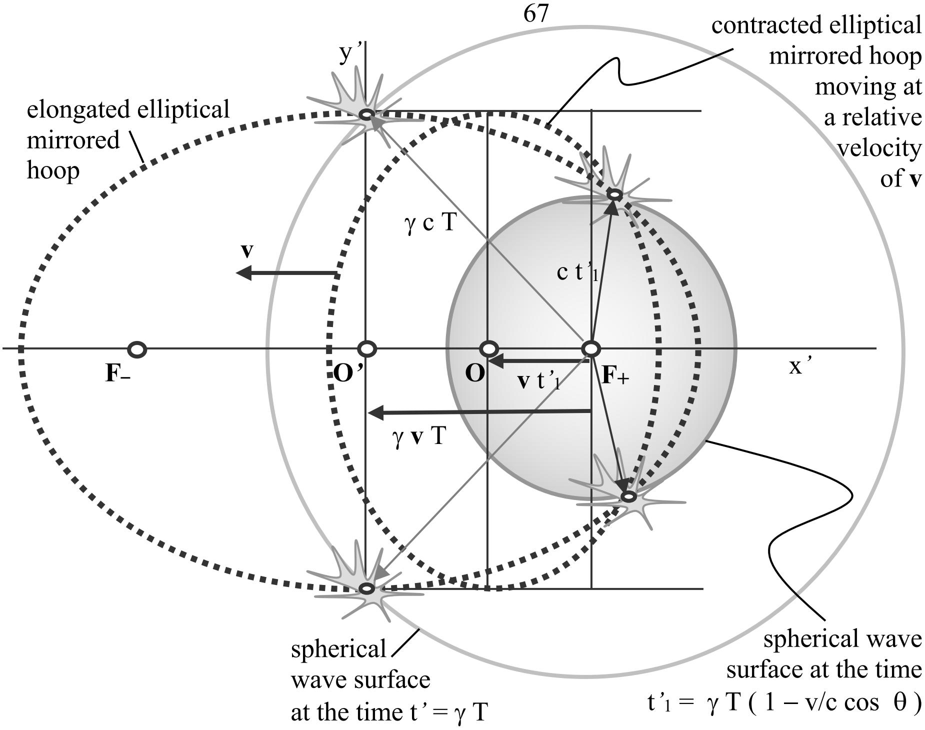
The circular hoop mirror passes with coincident observers O and O*'* centrally located with respect to this mirror at the moment both define as t=t*'*=0 as shown. If there is simultaneous reflection off of the mirror as detected by assistants of O at that moment, then accepting the velocity of light as c, O and his assistants will naturally assume the light to have been emitted from the center of the mirror at t = −R/c in their frame of reference. O will infer that he was a distance d = v/c R to the right of O*'* at that moment. According to the Lorentz transformation and Einstein's special theory, however, this emission would have to have occurred at x*'* = γ v/c R and t' = –γ R/c at one focus of an ellipse on whose surface reflection occurs to converge back to the other focus of this ellipse at x*'* = –γ v/c R and t' = +γ R/c in the frame of reference of O*'*. One *can* resolve these differences without repudiating or rescaling any of the basic measurements made by either observer as determined in accordance with the Lorentz equations.



By rejecting clock time dilation and rigid body contraction which were only introduced to resolve *this* problem, and accepting Lorentz coordinate assessments at face value for the observer who actually *makes* them in his own frame of reference, we see that for the observer who is relatively moving with regard to the source of the radiation, the velocity of light must have progressed at a velocity c/γ over the longer period of time, that is, t' = γ t, with respect to him. Whereas, for the observer experiencing no relative motion with regard to the emission apparatus the velocity of light remains unchanged. So the revised vector formula must be:

$$\vec{\mathbf{c}}' = \vec{\mathbf{c}} / \gamma + \vec{\mathbf{v}}$$

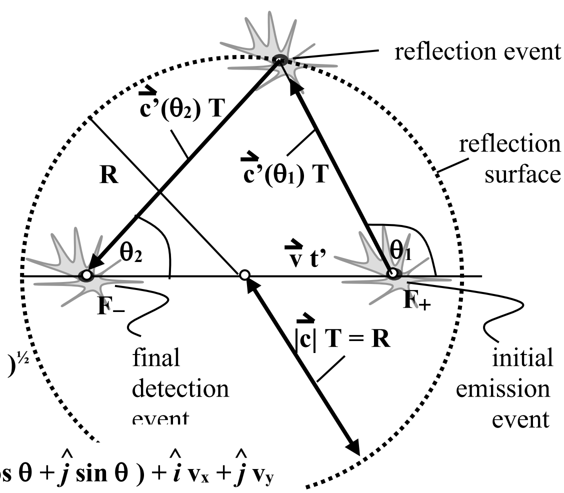




The figure at right illustrates implications of this formula. The value for the velocity of light in this formula can be applied to *both* (all) observers on any transmissions between emitters and absorbers, reflectors, or refractors for which there is relative motion. The velocity of light between relatively stationary emitters, absorbers, reflectors, and/or refractors would, of course, revert to the usual value of c on all such transmissions, since in all relatively stationary cases $\gamma = 1$ for $v = 0$. Using this formula the following diagrams illustrate a conceptualized progress of emanating photons from the apparatus at a point F_+ to reflection events in the other frame of reference and thence back to the original apparatus at point F_- in the emission frame. The center of the reflecting hoop moves from F_+ to F_- while the light propagates to the mirror and back. The difference between this and Einstein's interpretation is that there are two scenarios of events going on contemporaneously with a 1-to-1 correspondence between the respective events rather than their coordinates being re-scaled to obscure their separate identities.

Suffice it here to point out that a unilateral altering of the velocity of light in this rather quirky way resolves the kinematics problem every bit as well as distorting clocks and rigid bodies in at least as quirky of a manner. At this time we will resist a temptation to delve into the details of the topic of what might *cause* these effects of special relativity, i. e., what are the underlying phenomena that account for the strange Lorentz correspondence of spatial and temporal values? We *will* address those at length a little further on. But from a positivist's point of view – to which the author’s bears some resemblance – one must accept a simplest description of behavior itself as long as it is consistent. Since light does somehow get from *here* (in one frame) to *there* (in another) in a measurably determinate amount of time according to rods and clocks in the two frames (however distorted one might think those in the *other* frame to be), there is indeed be a velocity that characterizes that transmission without applying incommensurable units of length and time. Having accomplished that, we are left with scientifically refutable differences between the methods of accounting.

Perhaps this all seems quite naïve and counter to claims made elsewhere with respect to alternative interpretations of the Lorentz transformation equations for which universality of the speed of light remained unquestioned as required by electromagnetic theory, etc.. As will be shown elsewhere in this volume, the author maintains the veracity of those claims albeit in a nontrivial sense since in cases of relative motion helical transmission paths result, along which the universal speed of light *does* apply. And before contemning as naïve an investigation of whether, let alone concluding that, coincident observers may witness different events corresponding to light having taken alternative paths along which there are different *net* velocities, consider briefly the arguments that favor this.



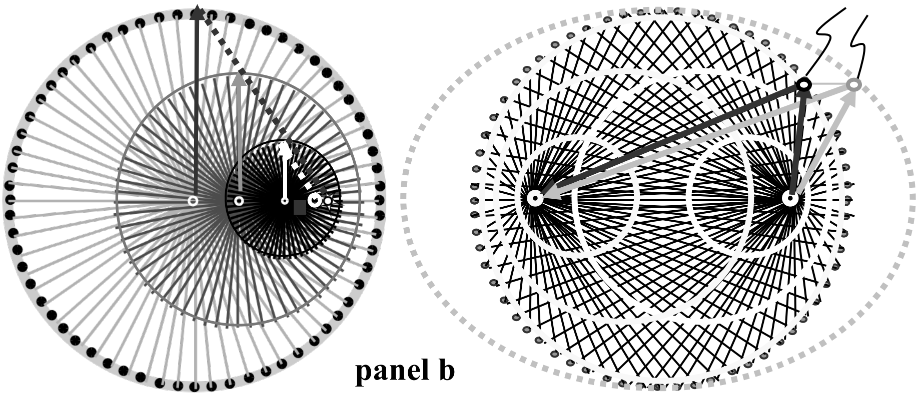
$$|\mathbf{c}'| = v \cos\theta + |\mathbf{c}|\,(1-(v/c)^2)^{1/2}$$

$$\vec{\mathbf{c}}(\theta) = |\mathbf{c}|\,(\hat{i}\cos\theta + \hat{j}\sin\theta)$$

$$\vec{\mathbf{c}}'(\theta) = |\mathbf{c}|\,(1-(v/c)^2)^{1/2}(\hat{i}\cos\theta + \hat{j}\sin\theta) + \hat{i}\,v_x + \hat{j}\,v_y$$

effects of modifying the ‘vector velocity’ of light

Lorentz correspondence
Events *E* and *E'*

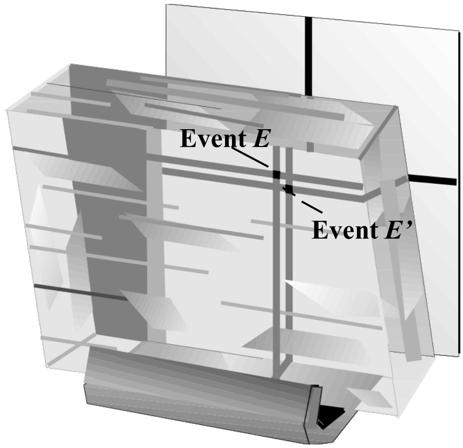


two views of the progress of time-lapsed wave surfaces between relatively moving frames at intervals of T/3 – at left outward wave surface always seeming to be central to the hoop, at right centered on focal points of the ellipse in O' but reaching the circular hoop simultaneously

An open mind must at the very least question *frame independence* and *mutual observability* hypotheses as well as every other conjecture put forward before the reality and strangeness of photons were even surmised by the scientific community. Refusing to allow the possibility that light from an emission event might proceed differently as ultimately determined by the state of alternative observers would be tantamount to denying the most basic tenets of quantum theory. And this hypothesis is not unlike what is accepted even in classical theory with regard to birefringence that occurs in anisotropic optical substances. In calcite for example photons from a single point source of light may be seen to arrive at the eye along alternative paths characterized by different effective speeds of light. Birefringence is a phenomenon resulting from the interrelationship of the polarization of light and the crystalline structure of anisotropic substances. That reorientation of polarized electromagnetic fields is implied also in cases involving relative motion will be supported in subsequent detailed analyses. Coincident observers are thereby enabled to witness events at the same locations on the same object but at disparate line-of-sight angles and times of emission just as determined by the Lorentz equations.

See the figure and discussion on next page.

A Calcite Connection



With regard to observational distortions of relativistic aberration and discussions questioning 'frame independence' and 'mutual observability', it may be worth considering that there is a precedent for polarization considerations causing light to proceed from an object coordinate location along two separate paths to an observation point at which two separate events associated with the same object's spatial coordinate can be observed.

The extent to which this analogy applies to relatively moving observers is left to the reader.

ANALYSIS OF EXPERIMENTAL DATA SUPPOSING TO CONFIRM CLOCK TIME DILATION

If one were to consider all evidence for a supposed time dilation, it would fall into a general category of alterations in rates associated with spontaneous state transitions between energy levels in matter. It has been dramatically demonstrated by radioactive decay phenomena where half-lives of basic particles are substantially altered when their relative motions are increased with respect to the laboratory in precise agreement with Einstein's formula.[1] If the half-life of the particle type were assumed to be a standard unit of clock time, a legitimate conclusion would seem to be that time is indeed dilated in such cases. The same basic numerical agreement is obtained with atomic clocks, like the cesium clocks cited by Will,[2] which involve an atomic resonance between energy levels as a standard unit of time.

It has been argued elsewhere, however, that clocks (and measuring rods) of relatively moving observers need not (and could in fact only inconsistently) be culpable in the case of there being unique values of time and space measurements obtained by relatively moving observers that are related by the Lorentz transformation. So, if that were true as the author believes, why do timed state transitions with well-defined half-lives and resonances exhibit increases in the value of this 'standard unit of time' parameter exactly as would be predicted if time dilation were the correct interpretation of the temporal Lorentz Transformation equation? In other words, in the face of such convincing data that seem to confirm time dilation, how could one rationally still maintain that there is no such thing?

***

To begin this discussion, let us consider how handy it is that the most basic building blocks of nature should carry clocks by which we can verify the interpretations of our theories – or do they? Whatever the nature of these "clocks," they were most certainly not *designed* specifically to check our theories, so we must investigate the degree to which the temporal quantities produced agree with the specified characteristics of clocks defined in special relativity. In other words,

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[1] Schwinger, pp. 55-58.
[2] Will, pp. 54-57.

to what extent do measured decay rate data represent standard time units generated by an ideal clock? This will obviously involve the issue of what constitutes such an ideal clock. Let us consider this.

Invariance of the measured time interval duration of a periodic mechanism is key. Precise periodicity is exhibited on earth by gravitational pendulums, astronomically by Keplerian motions and statistically at microscopic levels of reality by ensembles of radioactively decaying particles and resonating atoms. Of systems that have been used as clocks, the measured time intervals associated with resonance frequencies of atoms exhibit the highest degree of invariance. On the other hand, radioactive particles are the easiest to accelerate to extreme velocities and so they have typically been the clocks selected for relativistic experimentation.

When such radioactive particles are moving at a constant velocity (as in a collimated beam) relative to laboratory apparatus, the distribution of the distances traveled prior to decay provides an accurate assessment of their half-lives. Half-life may be determined as, $T_V = \langle d \rangle / v$, where T_V is the half-life, $\langle d \rangle$ is the average distance traveled and v is the velocity of the particles. Notice that this is merely an empirical formula for measuring half-life, *not* a theoretical parametrical derivation for determining it *a priori*.

In the case of the pendulum and Keplerian motion we have some understanding of the mechanisms or 'workings' of the clocks so that a theoretical *a priori* prediction *can* be obtained for sizes of time intervals between successive cycles as functions of parameters pertinent to the construction of the clock. For example, to a high order approximation, the differences in the cycle time of a pendulum on the moon and an identical version on earth would not be attributable to differences in the scale of time on the moon and on earth. This is because the difference can be traced directly to a parametrical difference between the descriptions of the two clocks, namely the ratio of the mass of the moon relative to that of the earth that determines the force pulling the pendulum back to its null position.

In the case of atomic and subatomic clocks, therefore, before we can attribute measurable differences to one cause or another, we must know something concerning the mechanism of radioactive decay. One could not otherwise discriminate between the half-life of radioactive particles being altered by a time scale difference affected by the relative motion as predicted by Einstein or by the decay process proceeding differently when a particle is accelerated. It has of course been demonstrated to depend on relative velocity in accordance with the peculiar functionality of the time dilation formula. However, that might either be an indication of direct functionality through parameters of operation such as energy content or, as typically accepted, the presumed change in the scale of time itself. For example, if it were to be conjectured that time proceeds more slowly on the moon in accordance with the ratio of the masses of the earth and moon, the results of the pendulum experiment would make the absurd hypothesis somewhat difficult to disprove just because all data would seem to confirm it. One would be forced to demonstrate that the peculiar functionality of a pendulum, and not the nature of time itself, has determined that behavior. So we are forced to attempt an understanding of the possible mechanism of particle decay, acknowledging nonetheless that such a mechanism has *not* currently been identified so we are at an extreme disadvantage.

However quantum mechanics is based on experimental evidence of phenomena that fall into the category of energy dependent state transitions. There is a large body of data and an accepted theory that confirm that the likelihood of a system transitioning to a "lower" energy state is directly dependent on the difference in energy between the states. This is true also of the types of particles whose decay is assumed pertinent to time dilation measurements – *mu* mesons in particular. For example, Jackson[3] states that:

"Since the rate of decay depends sensitively on the energy release, [difference between energy levels]...tightly bound negative *mu* mesons exhibit a considerably slower rate of decay than unbound ones..."

Now, it can be shown as a direct consequence of the Lorentz transformation (without having to assume scale differences in the units of measure) that the mass of a particle moving at the velocity, v, relative to the observer increases with respect to its rest mass, m_o. This increase is given by the formula, $m_v = \gamma\, m_o$. By the well-known related formula, the total energy of a particle is shown to be, $E_v = m_v\, c^2$, where E_v and m_v indicate, respectively, the energy and mass of the particle when it is moving at the velocity v relative to the observer. So that in general we have the relation between the energy of a relatively stationary and moving particle as follows:

$$E_v = \gamma\, E_o$$

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[3] Jackson, p. 358.

Radioactive decay formulas are characterized by exponentially decreasing quantities as explicit functions of time: They have the form:

$$N(t) = N_o \, e^{-\kappa t}$$

where N(t) is the number of particles which have not decayed after a time, t, if there were N_o particles originally. If κ is large, decay is rapid. Since the half-life, T_o, of the particles can be determined by measuring the amount of time, $t = T_o$, required to reduce N(t) to one half its original value:

$$N(T_o) / N_o = 1/2$$

So that:

$$\kappa = \ln 2 / T_o$$

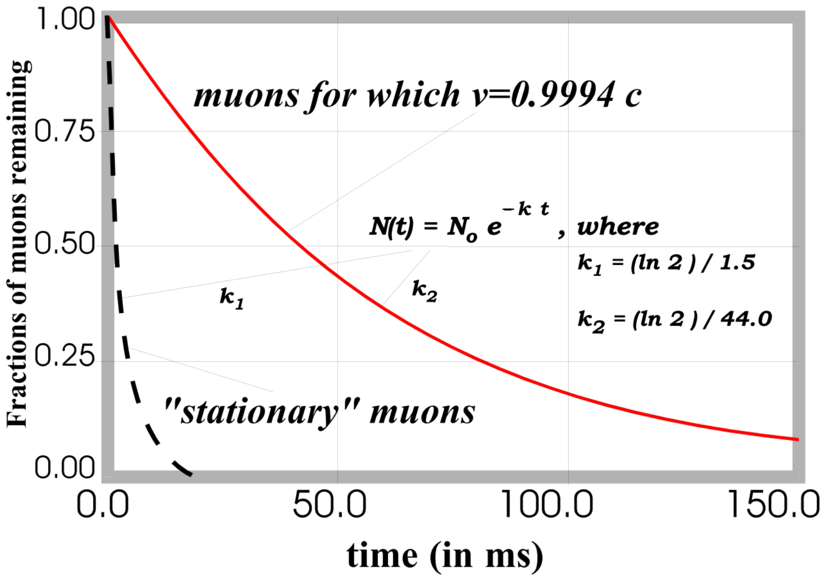
This is merely an empirical formula, of course, for fitting the exponential decay formula to the actual decay distribution data. But, the parameter κ is potentially derivable from quantum mechanical considerations like those used by Gamow, Condon and Gurney for deriving alpha particle emission rates in radioactive elements in 1928 that were in excellent agreement with the empirical data.[4] Decay rate data is highly dependent on the binding energy as indicated in Jackson's comment above where the higher the energy the less likely is decay. Let us posit, in particular, therefore, a relation $\kappa \sim 1/E$. Then we obtain:

$$T_o \sim E_o \ln 2$$

Thus, we should expect $T_v \sim E_v \ln 2$, for a moving particle, from which it follows that:

$$T_o = T_v / \gamma = T_v \sqrt{1 - v^2 / c^2}.$$

[4] Eisberg, pp. 238-239.



This might appear to be in complete agreement with Einstein's prediction since the half-life for a stationary particle is predicted to be less than that for a moving particle in precisely the right proportion, but it most certainly is *not* in agreement with that hypothesis! In this case, we have predicted that from *all perspectives* the particles will decay more slowly. We have not attempted to take into account that the rate of ticking of some abstract clock, supposedly residing in the particle, might in some obscure sense have ticked off T_o seconds while laboratory clocks were ticking off T_v. In fact, it has been demonstrated to be precisely like the analogy of placing a pendulum on the moon. The difference in the generated interval of the mechanism has already been determined as a coincidence of the functionality of the decay of matter from one energy state to another. Like in the analogy, an observer whether on the moon or on earth, on the particle or in the laboratory, would measure decay to have occurred after the same time interval according to his clock. If we were to additionally take into account the supposition that the scale of time is affected as suggested by Einstein and virtually every physicist with any credentials on this subject, we would obtain:

$$T_o = T_v \;/\; \gamma^2 = T_v\,(\;1 - v^2 / c^2\;).$$

The additional factor of γ completely contradicts the hypothesis of the time dilation formula and is refuted by the experimental data.

So the meaning of the temporal Lorentz transformation equation cannot be that the scales of clocks must be transformed so as to compensate any observed differences. The time intervals to corresponding events must *actually* differ according to that equation without the caveat, "It's actually the same amount of time, but his clock is dilated." The nature of that correspondence between transformed events now becomes the key issue of any viable theory of special relativity since the events that are being correlated by the Lorentz equations cannot be identical without introducing inconsistency.

A full explanation of why the two sets of events correlate as they do has been illusive indeed. But one does not need an alternative in order to reject inconsistent logic. That is the role of intelligence. It is, perhaps, a legitimate role of faith to allow one to survive periods without answers.

Bibliography:

1. Robert Eisberg, ***Fundamentals of Modern Physics***, John Wiley & Sons, 1961.

2. John Jackson, ***Classical Electrodynamics***, John Wiley & Sons, 1962.

3. Julian Schwinger, ***Einstein's Legacy – The Unity of Space and Time***, Scientific American Books, Inc., 1986. 58.

4. Clifford Will, ***Was Einstein Right? Putting General Relativity to the Test***, Basic Books, Inc., 1986.

Time Dilation & the Twin Paradox in Special Relativity

In Einstein's relativity two of the most basic assumptions are:

1. The velocity of light in a vacuum is the same for *any* observer.
2. Emission and detection of light is independence of the frame of reference.

The first of these assumptions demands that the time for light to reach observers in relative motion will differ. The second further constrains this condition by demanding that the *same* photons could be observed by either of relatively moving observers. Conflicts between these demands are resolved in Einstein's theory by rescaling to effect time dilation and Lorentz contraction as described elsewhere in this volume. Observer-peculiar clock time intervals become a major part of that resolution.

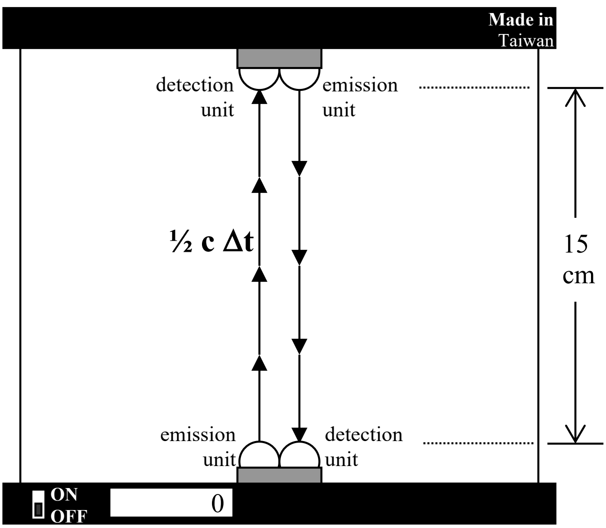


Figure 1: Resonant clock

Consider resonant clocks similar in principle to atomic clocks. The clock is a completely evacuated box with glass sides as shown at right with light detection/emission units at the top and bottom. When the clock is started by an on/off switch at the bottom (in the orientation shown), the counter will be reset to zero, and then immediately light will be emitted upward (no gravitational implication in this case) to the unit above it, which will detect light and immediately re-emit it downward. When this light is detected by the bottom unit, in addition to re-emitting light in the upward direction, it will increment the counter. So if the clock is constructed such that the top and bottom units are 15 centimeters apart, then one tick of the clock (i. e., one increment on the counter) would correspond to a nanosecond. Since this depends only on the velocity of light it will work equally well for any observer independent of his uniform relative motion.

Two observers (twins?) equipped with such identical clocks start them when they are in momentary coincidence. One observer (that we will denominate #2) is considered to be moving uniformly relative to the other (#1) who perceives himself as 'stationary'. Assistants of #1, who can be spatially situated so as to observe #2's clock tick while in coincidence when #2 passes, would notice that the status of #2's clock at successive half nanosecond intervals will look as shown in figure 2. According to this explanation an assistants' clocks (synchronized when the observers pass at point A) will measure a full tick *prior to* the passing clock counter (at B) having ticked a full unit.

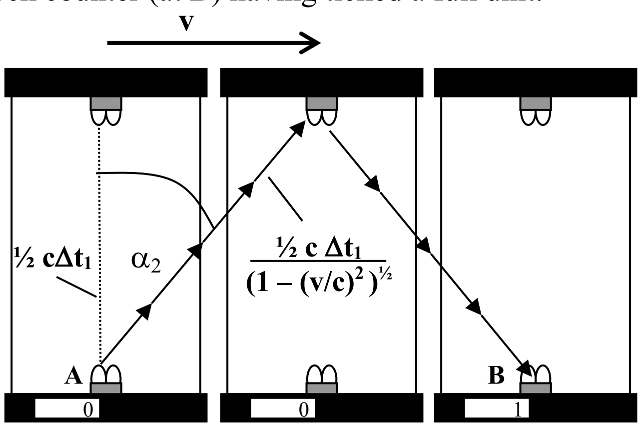


Figure 2: Envisioned appearance of clock in relative motion

It should be made perfectly clear in this clock time comparison that there is a change in frame involved with regard to not only the reading of the time value, but also with regard to who envisions the universally constant velocity of light which is the basis of the operation of the clock. If observer #1 were to emit the light in the left-most frame directed so as to hit the top detector of the moving clock of observer #2, he would have to aim the light at the angle

$$\alpha_1 = \sin^{-1} v/c$$

However, from the perspective of #2, in whose frame this would only takes 15 nanoseconds, he will envision himself as having only moved through a distance for which the following angle is appropriate:

$$\alpha_2 = \sin^{-1} [\ 1 + (v/c)^2\ ]^{-1} v/c$$

This is what is at issue with regard to the time dilation resolution of the paradox of the two conflicted assumptions of special relativity. The fact remains, however that the emitter and detector are both encapsulated within the framework of observer #2, and so – other than by presumption – frame dependence is built right into any such clock. As we indicated, observer #1 at A and his assistant at B may envision the light as being transmitted in *their* frame of reference, but it *isn't*! All the assistant at B can see is the register either having incremented or not. The mechanism of the emission and detection cycles, the light paths, etc. are not subject to his actually scrutinizing them. Of course observer #1 could construct a modified clock to instantiate his conceptual understanding of the operation of observer #2's clock as shown in figure 3.

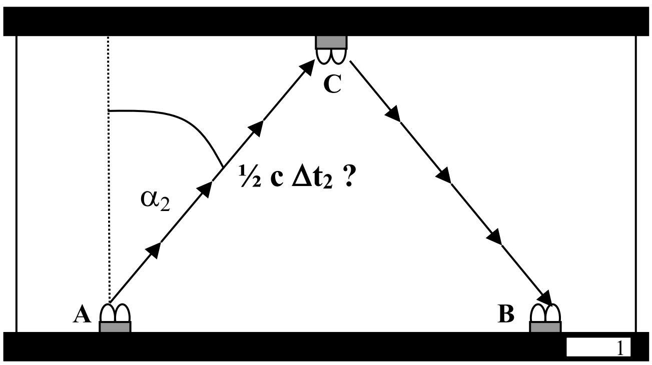


Figure 3: Modified clock of observer #1 and his assistant

At issue is, of course, the validity of the frame independence hypothesis. It should be clear that the construction of the clock for parallel use by observer #1 in figure 3 would do nothing to verify the operation of the relatively moving clock of observer #2. A different implementation is involved. Clearly, the re-emission from point C (even if from observer #2's equipment in his frame of reference at the time of coincidence of the emitters) would necessarily be detected at B the same amount of time later, i. e., after $\frac{1}{2}$ c Δt_1 / (1 – $(v/c)^2$)$^{\frac{1}{2}}$ units of time because of the first assumption of the constancy of the speed of light relative to each *observer*. But when would observer #2 have detected either or both re-emissions? At $\frac{1}{2}$ c Δt_1 according to his clock, naturally. But again, that is not what is at issue.

What is at issue is whether they are witnessing the same event, i. e., does *mutual observability* apply? They disagree on the location along the world line of observer #2 at which the re-emission in question took place. Why are we so certain that these two variously perceived events were in fact the *same* event taking place at the *same* location? The author would like to cast considerable doubt on that.

The two observers can construct symmetrically equivalent situations with clocks as shown in figure 3 that support conflicting conclusions with regard to the operation of the *other* clock. But since the principle of relativity must be honored, how can this be?

In order to compare the clocks of 'twins' directly without the necessity of assistants as we have attempted above, one observer would have to decelerate and return to the other observer. And certainly, in order to have accelerated to an appreciable velocity (more than half the speed of light as illustrated in figure 4) would have required an appreciable period of time, but we can assume that over short enough time intervals the velocity will be essentially constant as in figures 2 and 3 even during such periods. But the cosine of the angle α that is indicative of their relative speed in these figures will increase as long as the acceleration continues such that the increments in #1's clock and those of the assistants of #1 who will be in coincidence with #2 at the various points will increasingly disagree with the clock time intervals of #2 such that:

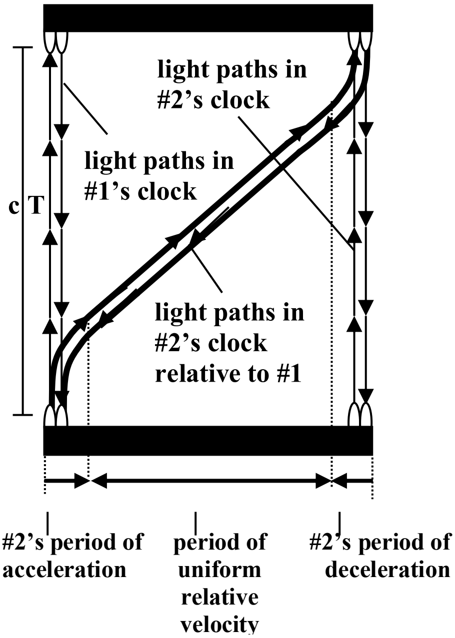


Figure 4: Longer period of time required for round trip of rocket with observer #1's clock

$$\Delta t_2 = \Delta t_1 / (1 - (v/c)^2)^{½}$$

If we consider space as though it were a giant clock with a mirror at a perpendicular distance c T away from the two observers' starting point and the rockets path as shown in figure 4, we get an idea of what the clocks of the two observers will be measuring at each point in time along the path of observer #1. Light's re-emission return path would retrace the original path of the light.

Clearly for long enough periods of travel the much shorter periods of acceleration and deceleration become negligible with regard to the total amount of time of the travel as shown. So if we take the cruise velocity of the rocket (or whatever mechanism is employed by observer #2) as V, then the difference in the amount of time required according to the two observers will be:

$$T_1 = T_2 / (1 - (V/c)^2)^{½}$$

So if #2 has been going at half the speed of light relative to #1 and according to #1's clock he has been gone for ten years, then according to #1, #2's clock should register eleven and a half years.

Figure 4 is drawn as though the clock were colossal – in fact, instead of 15 cm in height, it would have to be 5 light years in height, or half the distance that light would travel in the ten years that observer #2 believes he has been gone. But this is just to simplify the diagram; the concept is the same as observer #2 carrying a smaller clock that would accumulate 1.6×10^{17} ticks rather than just the one.

That is a more or less orthodox version of the twin paradox. But, of course, there are caveats to this explanation and this author does not accept those explanations as valid because of those caveats as follows:

It is typically argued that the rationale for one twin having aged more than the other during the time of their separation is because one of them had to have accelerated, which destroys the symmetry of the principle of relativity between them, and *that* is the source of the paradox. However, one could as well put both of the twins on equivalent timer mechanisms of their own, to program identical acceleration and deceleration profiles so as to retain symmetry – the same conflict would arise concerning light paths within the 'other's' clock relative to light's paths in 'this' clock, because in fact the relative velocity, not the acceleration, is the major contributor to the assumed phenomenon.

The resonant clocks (although not currently feasible as described), are indeed similar in concept to cesium clocks which have actually been used to experimentally measure clock time differences for equivalent clocks with one traveling around the earth on airplanes relative to the other. Such tests are presumed to have authenticated the clock time dilation phenomenon. An alternative rationale for these observed measurements has been presented in the previous article explaining why such measurements do *not* validly measure time dilation, but rather energy-dependent quantum phenomena.

Mechanisms like the macroscopic resonant clock presented here are frequently employed in such venues as instruction videos with prominent physics professors explaining these concepts in the very same way as we have here. So this discussion is not unfair to currently held notions of the physics community. But such notions seem invalid to the author nonetheless!

On the Impossibility of Aligning Lorentz Reference Frames and Its Implications

If Einstein's special theory of relativity is to be seriously applied, in addition to synchronization of clocks one must align the spatial coordinate axes to establish Lorentz reference frames. Surprisingly, one does not hear much about the latter requirement. One could infer that no one of import has ever even considered it to be a problem — certainly Einstein did not consider it an important problem, but I do.

A brief discussion of my perception of that problem will be presented as a precursor to a physically intuitive solution to the problem of observed differences in the positions and times of occurrence of events observed by uniformly moving but momentarily coincident observers.

The alignment problem arises because Lorentz reference frames, although presumed to be compatible with requirements for parallel alignment of respective axes in a flat space-time, can in fact *not* be physically aligned. Implications of this incapacity are quite profound inasmuch as they suggest an explanation of otherwise inexplicable features of space-time and the universal constancy of the speed of light which is at the heart of the issue.

a. Construction of Einstein's spatial coordinate systems

Lorentz frames constitute a basis for all modern physics. Einstein acknowledged requirements for establishing material coordinate frames as a basis for coordination of relatively moving observers without which their measurements would be meaningless.

"*In the first place we entirely shun the vague word 'space,' of which we must honestly acknowledge, we cannot form the slightest conception, and we replace it by 'motion relative to a practically rigid body of reference.'*"[1]

He further elaborated the details of these structures against which physical measurements could be registered as follows:

"*…we can imagine this reference body supplemented laterally and in a vertical direction by means of a framework of rods, so that an event which takes place anywhere can be localised with reference to this framework. Similarly, we can imagine the train travelling with the*

[1] A. Einstein, ***Relativity – The Special and General*** *Theory*, Crown, New York 1961, p. 9.

velocity v to be continued across the whole of space, so that every event, no matter how far off it may be, could also be localised with respect to the second framework. Without committing any fundamental error, we can disregard the fact that in reality these frameworks would continually interfere with each other, owing to the impenetrability of bodies. In every such framework we imagine three surfaces perpendicular to each other marked out, and designated as 'co-ordinate planes' ('co-ordinate systems') ... Relative to K', the same event would be fixed in respect of space and time by x, y, z, t. It has already been set forth in detail how these magnitudes are to be regarded as results of physical measurements."[2]

b. Alignment of Einstein's spatial coordinate systems

The alignment of these spatial coordinate axes of relatively moving observers did not seem to motivate any particular concern for Einstein. With regard to the alignment of two such frames, he said only:

"*Let us in stationary space take two systems of coordinates, i. e. two systems, each of three rigid material lines, perpendicular to one another, and issuing from a point. Let the axes of X of the two systems coincide, and their axes of Y and Z respectively be parallel...*

Now to the origin of one of the two systems (K') let a constant velocity v be imparted in the direction of the increasing x of the other stationary system (K), and let this velocity be communicated to the axes of the coordinates, the measuring-rod, and the clocks."[3]

His prescription of constructing two identical framework structures and then setting one of them in motion as a means of assuring their alignment is a bit frivolous to say the least. Certainly the treatment is weak in comparison to emphasis he placed on the clock synchronization problem – he might as well have said, "make sure the clocks have been calibrated and set to the same time and then set one in motion." But he didn't because he realized the problem was deeper than that – and it is *much* deeper than that with regard to alignment as well. Besides the mere impracticality of his approach to the alignment of axes, it assumes that there is nothing inherent in relative motion (or in the ignored requirement for acceleration up to the designated speed) that could affect alignment in any way –an assumption that is questionable at best, particularly in lieu of his subsequent dramatic

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2 ibid pp. 31-32.

3 Einstein, A., "On the Electrodynamics of Moving Bodies," ***The Principle of Relativity***, Dover, Toronto, 1952, p. 43.

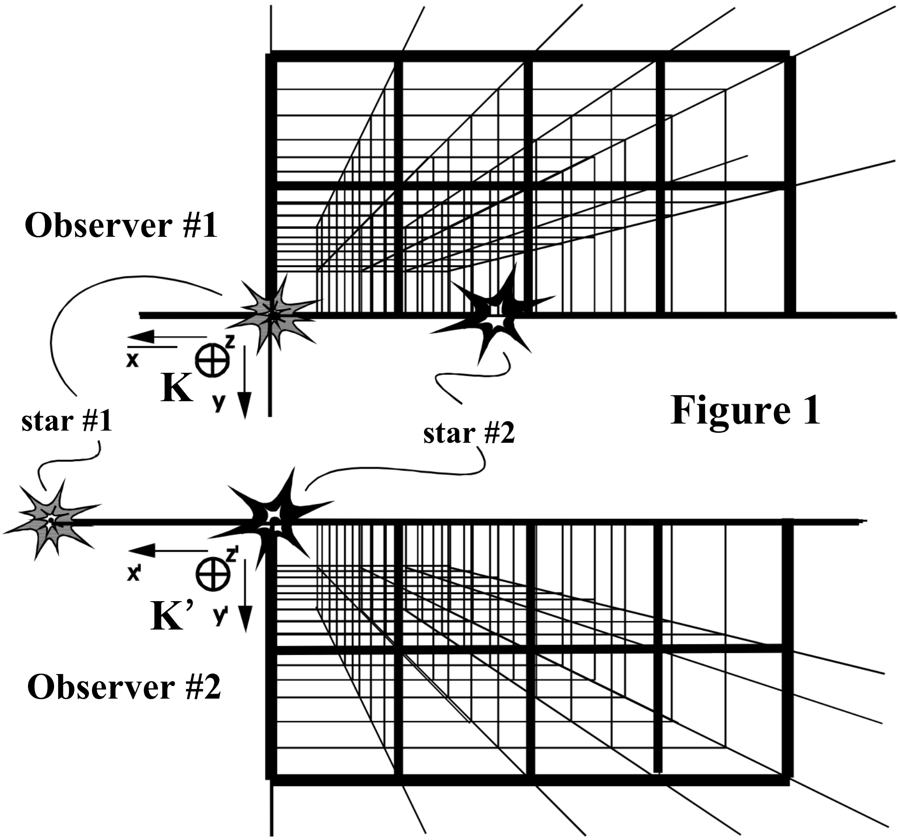
conclusions with regard to disparities between clocks and rigid bodies in relative motion. For reasons that might seem to be of a merely practical nature, some verification would be required once the system K' got up to speed. So let us consider the much more realistic problems associated with alignment and the possible methods that might be employed in a determination of whether two such frames in relative motion are actually aligned.

In Einstein's time, trains came to mind as everyday modes of relative motion for which box cars provided an immediate image of rectangular Cartesian coordinates; orthogonality in this context must have seemed hardly worth questioning. In our day space vehicles come immediately to mind, as for example, two space vehicles passing close by each other at extremely high relative velocity. Diligence is required in establishment and maintenance of alignment of reference frames as an everyday operation in this environment since all *inertial reference systems* tend to drift. In real life at this stage of history, stellar navigation procedures are employed as a matter of course to compensate for this phenomenon.

To establish aligned coordinate references, light sensors are used to scan for particularly bright stars distinguished by magnitude and spectra. A space vehicle will alter its attitude so as to align a body axis with the star. Next it will maneuver a second sensor mounted with an orientation perpendicular to the first until the second sensor "locks on" a second pre-designated star in the plane perpendicular to the first. Finally a third star on the same plane as the second star that is perpendicular to the direction of the first star will be used to align the third axis.

To coordinate observations between two such vehicles (K and K') in relative motion it would be advantageous to align the two vehicle-mounted coordinate systems with the same triad of stars. We will soon see that this situation is in fact impossible to achieve, but let us proceed naively to attempt to select three such stars nonetheless. We choose the first to be in the direction of their relative motion. They both readily agree on this direction in space and select a mutually agreed star/quasar or other distant object. Both alter their attitudes until each has a body axis aligned with this direction. They call these respectively aligned axes X and X*'* as shown in figure 1.

Next, K suggests a star (star #1) which is in a direction perpendicular (from his perspective) with respect to the agreed upon X direction as a candidate for their Y axes. After a little inspection, K' subtly reminds K that there is an orthogonality requirement and that the star is not perpendicular to the first from his perspective. K' suggests an alternative (star #2) in the vicinity but K finds that that star is not perpendicular to the direction to *his* X star. At some point in their collaborative efforts they arrive at the fact that the aberration of light has altered the "apparent" directionality of their selected stars because there is relative motion involved.

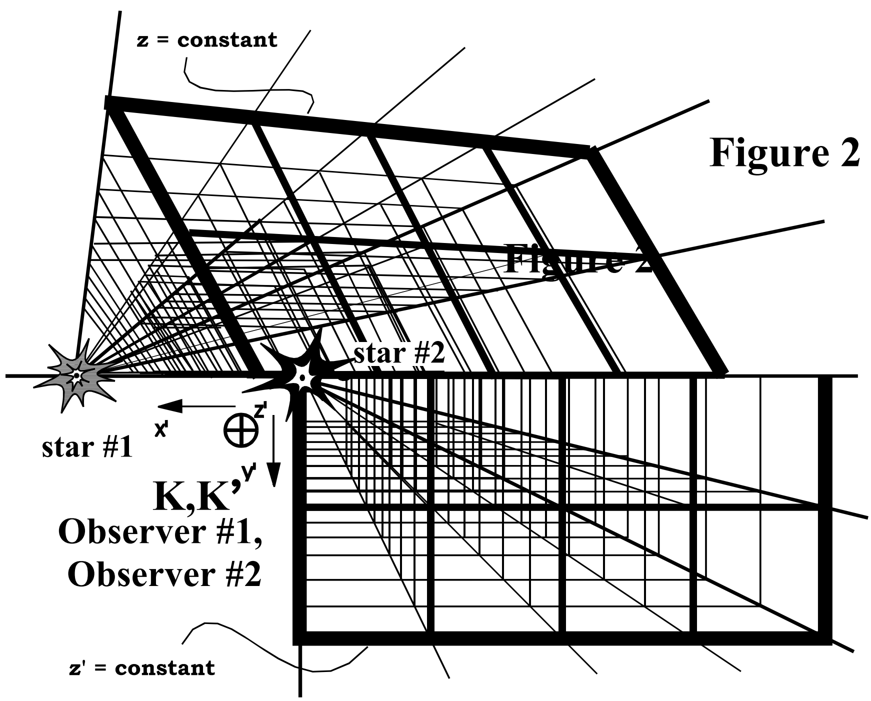


They then decide to continue alignment while acknowledging the added difficulty of their having to use unique (but still coplanar) stars to align their respective Y and Z axes. They both, of course, insist on the ever-practical orthogonal reference frames. Finally, both K and K' have established orthogonal triads which are as nearly aligned as possible. The facts of the "other" observer's triad seeming to be bent like an umbrella in a wind is understood by both in terms of the relativistic aberration of light. (We must be very careful, however, not to take such mere *appearances* too lightly.)

So, have the two observers established *Lorentz reference frames*?

No, they have not! A Lorentz reference frame involves demonstrably mutually parallel axes and our observers' reference frames definitely do *not* have that property.

You might think that the fact that *apparent* directions to particular stars have been altered by aberration does not mean that the respective axes are not *actually* mutually parallel and, therefore, aligned. Euclidean geometrical reasoning, since all of their own axes constitute an orthogonal set with one of them co-aligned with its counterpart, would certainly seem to guarantee that the remaining coplanar axes *must* be aligned. Euclid's fourth postulate guarantees it – doesn't it? But in what sense *are* they aligned? They are known to point at different objects, which are displaced from each other by the same amount according to both observers. When the vehicles pass each other, sighting along an extension of the axes would reveal the misalignment as different vanishing points as shown in figure 2. In fact they would each agree that the other's axis *does*, in fact, point at the star he also avers that it does. So why would we accept Euclidean geometrical assurances with regard to the fourth postulate that contradicts observation here when we are going to be asked to abandoned the fifth postulate by subsequent considerations for, if anything, lesser reasons? Only by placing physical properties of alignment in a domain beyond verification and utility can we maintain that such properties hold for their respective frames of reference. By all possible measurements the observers' axes are *not* parallel. There is but one direction in space upon which they can agree.



The misalignment conjecture probably seems preposterous to the reader upon first encountering it. How could the mere aberration of light imply a commensurable aberration of the entire spatial aspect of the other observer's world including his protractors and compasses? Indeed. But how could the same basic equations imply contraction and time dilation which are at least equally obtuse and much less directly observable?

c. Implications of misaligned spatial coordinate systems

As Einstein indicated in the quote cited above, space has no measurable aspect apart from the observations of objects, which we assume to occupy locations *within* it. Distant stars — perhaps quasars — are the most apparently stationary objects with the most independence of the motions of local observers. There is absolutely no way to assess tangential motions of these remote objects — so whose frame of reference should be considered aberrant?

And the results are no different even if we consider local objects.

In fact, consider the directions of the electromagnetic fields of the light from the perspective of the respective observers. A field in one frame will be aligned with one direction whereas in the other frame the field associated with charges in that very same object will be commensurably misaligned. This altered directionality can easily be determined by how charged particles are affected by the radiation. And – lest we forget – perpendicular alignment of the electric and magnetic fields is essential to the propagation of these *conservative* force fields. Thus, fields that propagate as transverse waves in one frame of reference could not propagate *in the same way* in the other!

So what is being said here?

That light that propagates without absorption in one frame of reference would be attenuated in the other? That light which is observed in one frame of reference could not be observed in the other? Actually, I prefer the latter. Again, preposterous? I don't think so.

Each observer is in a very real sense essential to the light he observes. This is nothing new; it is only the *extent* to which absorption theory *is* true that has never been fully acknowledged. Wheeler and Feynman,[4,5] Tetrode,[6] and Lewis[7] all acknowledged that

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[4] J. A. Wheeler and R. P. Feynman, "Interaction with the Absorber as the Mechanism of Radiation," *Rev. Mod. Phy.*, 17, 157 (1945)

[5] J. A. Wheeler and R. P. Feynman, "Classical Electrodynamics in Terms of Direct Interparticle Action," *Rev. Mod. Phy.*, 21, 425 (1949)

[6] H. Tetrode, Zeits. f. Physik 10,317 (1922)

[7] G. N. Lewis, "The Nature of Light," *Proc. N. A. S.*, 12, 22 (1926) Lewis went so far as to say: "I propose to eliminate the idea of mere emission of light and substitute the idea of

electromagnetic interactions involve the emitter and absorber equally. Although I believe that Wheeler's and Feynman's explanation involving exactly half the field strengths being assigned to each is inadequate. The author prefers one field vector associated with absorption, one with emission combining in accordance with Maxwell's equations to effect the propagation of light as I will elaborate in more detail further on after first introducing the approach here.

Maxwell had had to hypothesize the existence of induced "displacement currents" associated with the detecting medium in order to establish the necessary fields to support the propagation of light. Of course the "redundant" electric field vectors D and E as well as their magnetic counterparts H and B are hypothesized as being respectively parallel in a vacuum or isotropic media. (The relation between them depends on the properties of the medium if the propagation is not in a vacuum, no longer being parallel in anisotropic media.) One of each pair of vectors is associated with the absorber (i. e., the "observer") of the radiation in a vacuum and the directionality of that vector must, therefore, be affected by his/her relative motion in accordance with misalignments as shown in figure 3. So that, if light is observed in K' that originated in K, the D' vector would be skewed with respect to E and H' with respect to B since the fields are associated respectively with K' and K whose *mutually* "perpendicular" directions are misaligned.

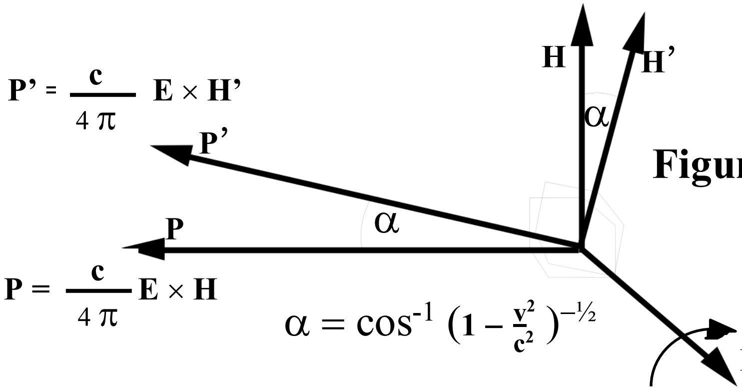

Figure 3

According to this hypothesis, light which is propagated along the X axis in relatively moving frames will have one of its field vectors tipped by the misalignment described above with regard to the same

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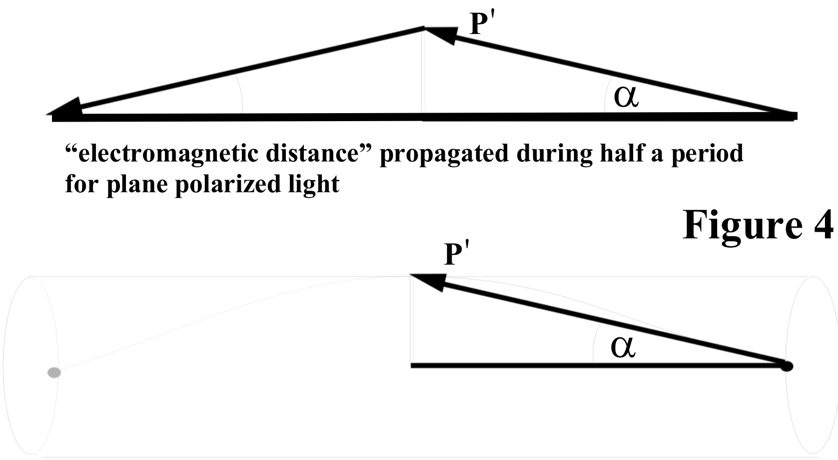
transmission, or a process of exchange of energy between two definite atoms or molecules."

field vector in the other frame. Because of this, the Poynting vector P corresponding to the electromagnetic momentum and instantaneous direction of propagation will oscillate (for plane polarized light as shown in panel a) or spiral in a helix (for circularly polarized light as shown in panel b) about the direction between the light source and the observer as shown in figure 4. The associated oscillation or helical spiraling will produce elongated transmission paths and hence dilate transmission times in accordance with the Lorentz temporal equation, i. e., the light will travel different "distances" in transmission between two points which will effect different transmission times by slowing the "net" transmission velocity to c/γ. This is not particularly subtle. What Low has indicated with regard to conventional solutions to this problem is the following:

"*In geometric terms, what the effect is saying is that two curves joining the same endpoints need not have the same length. This is a statement with which nobody would take issue; it is when this length is interpreted as the time measured by a clock that preconceptions about the nature of time start to cloud the reasoning powers.*"[8]



"electromagnetic distance" propagated during half a period for plane polarized light

Figure 4

"electromagnetic distance" propagated during half a period for circularly polarized light

In Low's special case example, space-time itself and not just the light path is assumed to provide the curvature and, in fairness, he concludes that *a clock* was dilated and not just that the measured time interval was thereby elongated. That the transmission at identical speed along a longer path should take longer than along a shorter path

8 R. J. Low., "An acceleration-free version of the clock paradox," ***Eur. J. Phys.*,** 11, 25 (1990)

is straight-forward; that a clock traveling along such a path should, thereby, be dilated *does* seem to "cloud the reasoning powers" for the current author, however.

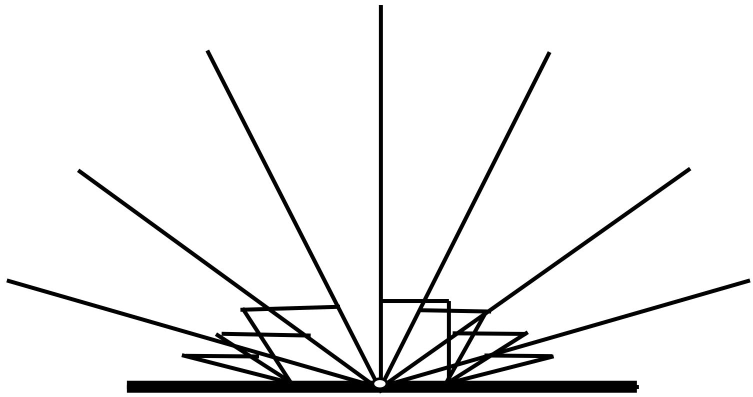
Naturally there is much more to the alternative interpretation of the Lorentz transformation equations than that, but this is the broad brush of a solution. In this solution time need not be dilated at all in the sense of clocks running slow or fast. Nor need objects be contracted. In this solution there is an electromagnetic collusion which results in observations that only seem to confirm Einstein's clock time dilation hypothesis just as we saw in the previous article. The Lorentz transformation is compatible with this very different interpretation. It embraces all experimental observations of relativity as described elsewhere without the inconsistencies.

Conventional interpretations of relativity rely almost exclusively on a mathematical description that can scarcely be visualized. In fact, Einstein sometimes cautioned against even attempting to visualize much of his special relativity – and for good reason. The foregoing solution is based on an alternative interpretation of the formalities of special relativity which could 'explain' why the strange phenomena of relativity is observed – and might, for example, allow the word 'incomprehensible' to be eradicated from the adjectives describing modern physical theories.

The physical world has many puzzles that have not yet been solved. Many of these have been mathematically *described* and it has for some time remained in vogue to pretend that description is all there is – all there can ever be – but don't believe it. Ironically, Einstein didn't believe it with regard to anyone else's theory of cats. (Perhaps it was analogous to his belief that the *other* observer's clocks and rods were suspect.) As for me, if I thought that the reasons for things *being* invariably *as they are* were beyond the abilities of the human species to comprehend, I would consider myself and the whole human race an insane, sorry lot.

Then perhaps we would all be in agreement which would constitute a *covariant* formulation of physical phenomena, I guess. So maybe I'm wrong.

Why Take the *Fifth*?



Toleration of the presumption that one of Euclid's postulates upon which he based *The Elements* of his geometry might be flawed, or worse yet, *unnecessary* is, of course, an integral part of establishmentarian mathematics and physics. The Fifth of these postulates, that *through any point only one line can be drawn parallel to any other* has been unanimously selected as the culpable postulate presumably invalidated by general relativity at the larger scales of our universe and particularly in the neighborhood of black holes. Of course mathematicians began to explore the alternative geometrical possibilities deriving from other sets of assumptions long before there was any inkling that we might live in such an alternative universe.[1] But with the advent of Einstein's relativity, the notion that coordinates of a combined spacetime exhibit strange relationships has been accepted by the scientific community and so an alternative geometry was readily received. Suddenly then the works of pioneering mathematicians were evaluated with renewed interest, and the former discoveries concerning viable geometries that did not require the Fifth Postulate became the starting place for a new, and one must suppose, *revitalized* mathematical physics.

There have been many attempts at alternative phrasings of Euclid's postulates and while perhaps alternative phraseology is not without merit, there might just be a *different* axiom more appropriate for modification to provide compatibility with the formalism of relativity. One must note that even in the general theory of relativity, physical

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[1] Gauss, of course, attempted measurements employing light signals to determine empirically whether such might be the case on the earth's surface.

experiments are always considered as being conducted within *locally Lorentz reference frames*. What this means is that even though an observer may experience wild gyrations of acceleration due to gravitation or his own rocket engines, at each moment in time, it is supposed that only his instantaneous velocity relative to another observer is pertinent to mapping observations between such observers in relative motion. So the geometry of special relativity would seem to be *the* local geometry of choice. This has been thought to involve a *flat* spacetime, but with regard to the *observational* aspects of relativity this is hardly the case as we show will repeatedly in other articles in this volume.

Let us look at Euclid's postulates and attempt to determine for ourselves which postulate seems most likely to be at odds with observational inferences made from Lorentz reference frames. Here are the five postulates[2]:

1. *Only one straight line can be drawn between any two points.*

2. *A finite straight line can be extended indefinitely.*

3. *Only one circle of a given radius can be centered at a given point.*

4. *Through a point at a distance from a given line there is only one line that can be drawn in the same plane that is perpendicular to the given line.*

5. *Through a point at a distance from a given line there is only one line that can be drawn in the same plane that is parallel to the given line.* [3]

In lieu of the spatial distortions of perpendiculars to the direction of relative motion identified so repeatedly that one tires of repeating it again, why this preoccupation with the Fifth Postulate anyway? What we have found is that two coincident observers witness the other observer's perpendicular directions to be misaligned with regard to

[2] This version is a rephrasing of those given by Sir Thomas Heath in his ***The Elements of Euclid*** to parallel Playfair's rephrasing of the Fifth Postulate.

[3] In 1795, John Playfair (1748-1819) offered an alternative version of the originally translated postulate involving interior angles, which was: *That if a straight line falling on two straight lines makes the interior angles on the same side less than two right angles, the straight lines, if produced indefinitely, will meet on that side on which the angles are less that two right angles*. This alternative version gives rise to the identical geometry as Euclid's. It is Playfair's version of the Fifth Postulate that most often appears in discussions of Euclidean Geometry.

their own, and furthermore, they cannot possibly be aligned! Two parallel lines in one frame of reference could still be parallel relative to the each other although both would be pointing off in a different direction according to the other observer in relative motion.

So it seems self-evident that to make sense of the coordination of the geometrical observations and constructions between relatively moving observers, we must reject the *Fourth* Postulate instead of the *Fifth*!

What's a 'Curled Up' Dimension Supposed to Do Anyway?

Multidimensionality does seem to be an "Ooh, Ah!" sort of thing that mathematicians and physicists pull out of their hats when they play at being amateur magicians. But quite mundane (though nonetheless complex) systems are described with multidimensional spaces and the fact that some function may have more variables than three is hardly the stuff of wizardry. But the very issue of what is meant by a dimension should be considered when one tries to make sense of currently popular concept of 'curled-up' dimensions.

To the extent that we are familiar with three dimensions, the concept encompasses the common sense notion that the simplest description of a location in space involves three real values with regard to distances along three mutually orthogonal directions such as *Forward*, *Left*, *Up*; or *North*, *East*, *Down*; etc.. It is difficult to visualize (as against merely conjecture) more dimensions than these usual three that involve traditional mutual orthogonality in everyday experience. But in the book *The Elegant Universe* an excellent illustration and discussion is provided involving an ant walking on a cylindrical hose in the context of explaining the curled up dimensions that string theorists have posited.[1] If the ant wishes to proceed along the general direction of the hose he still has two additional degrees of freedom with regard to his motion. So if progress along an x-axis (in say the *positive x* direction) were constrained by some perversion of reality to include excursions involving such additional degrees of freedom, it would be presumptuous to protest too loudly about whether those degrees of freedom constitute additional dimensions I would guess.

Our sense of both direction and distance in space as well as temporal relations of a traditional fourth dimension are all intimately tied up with the propagation of light as elaborated under the rubric of the special theory of relativity. So it should not be surprising if what is meant by legitimate degrees of freedom and dimensionality in general involves the *modus operandi* of photons rather than ants. With that in mind I propose to consider aspects of the electromagnetic and relativity theories rather than entomology to clarify what is meant when such "dimensions" are discussed.

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[1] Brian Greene, ***The Elegant Universe***, W. W. Norton, New York (1999), p. 186.

In seminal papers published in the 1940s Wheeler and Feynman[2] elaborated earlier intuitions of Schwarzschild, Ritz, Tetrode, Lewis,[3] and others concerning various electromagnetic absorption theories. Later (in the 1980s) Cramer[4] introduced a commensurable *Transaction Interpretation* of quantum mechanics.

With such an extensive background of serious work, it should hardly be considered a wild speculation to suggest at this juncture that vector fields from both an emitting and an absorbing atom might contribute equally to the energy and momentum of photons producing the transactions of energy and momentum between atoms. The momentum carried in the propagating electromagnetic fields is traditionally characterized by a *Poynting* pseudo vector cross product *P* of a *microscopic* electric field *E* (associated with the emitter) and a *macroscopic* magnetic field *H* (associated with the absorber) as follows:

$$\boldsymbol{P} = \boldsymbol{E} \times \boldsymbol{H}$$

This was illustrated in a previous article. Similarly, the energy density of such radiation involves all four fields, two associated with emission and two with absorption as follows:

$$\mathcal{E} = \tfrac{1}{2}\,(\boldsymbol{E} \bullet \boldsymbol{D} + \boldsymbol{B} \bullet \boldsymbol{H})$$

where ***D*** is the *electric induction* field associated with absorption as defined by Maxwell, and ***B*** the magnetic field associated with the emitter. (These concepts will be discussed later.) When there is no relative motion between the emitter and absorber the transverse wave that is circularly polarized in the most general solution to Maxwell's equations, proceeds directly along the line of sight direction of the Poynting vector between the two interacting atoms. This is shown at the top of the diagram in figure 1; either field (***E*** or ***H***) is very much

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2 J. A. Wheeler and R. P. Feynman, "Interaction with the Absorber as the Mechanism of Radiation," ***Rev. Mod. Phys.***, 17, 157-181 (1945), and J. A. Wheeler and R. P. Feynman, "Classical Electrodynamics in Terms of Direct Interparticle Action," ***Rev. Mod. Phys.***, 17, 157-181 (1949).

3 Gilbert N. Lewis, "The Nature of Light," ***Proc. N. A. S.***, 12, 22-29 (1926).

4 John G. Cramer, "The transaction Interpretation of Quantum Mechanics," ***Rev. Mod. Phys.***, 58,3, 647-687 (1986), and John G. Cramer, "Generalized Absorber Theory and the Einstein-Podolsky-Rosen Paradox," ***Phys. Rev. D***, 22, 2, 362-376 (1980).

like a "hand of a stop-watch" traveling with the photon as described so admirably by Feynman in his fascinating treatment in his *QED*.[6]

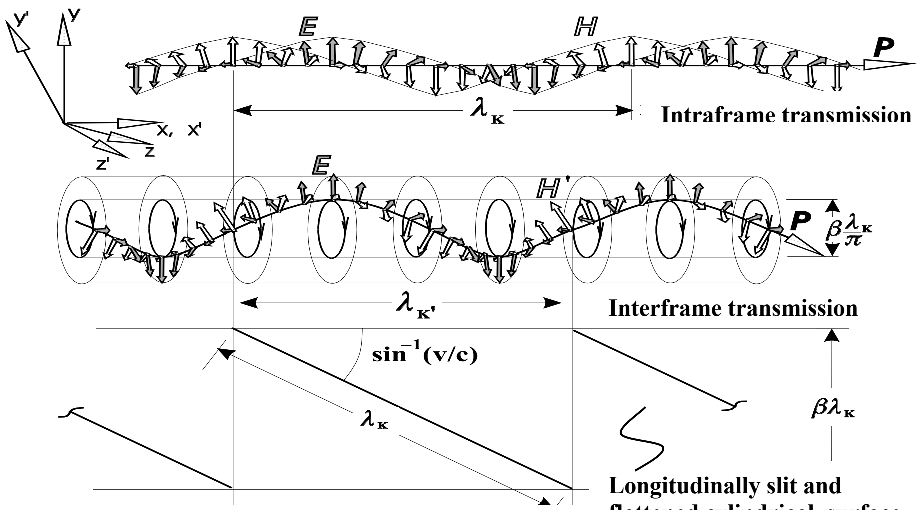

Figure 1

However, relative motion of the interacting atoms substantially alters the momentum and energy transfer of such transactions. So let us consider in what way this classical (and even quantum mechanical) picture of transverse wave propagation must be altered by the relativistic aberration formula in cases where the emitter and absorber experience uniform relative motion.

The appearance of any Lorentz reference frame fitted with three perpendicular rods to represent the basis vector directions as viewed by an observer in uniform relative motion would be affected by aberration. Remember that in a very real sense, 'appearance' is the *reality* of each observer. The author has discussed various aspects of this straight-forward observational interpretation of the Lorentz transformation in several articles appearing in this volume. See also the thorough treatment by Vaughan.[5] In figure 1, the generalized mapping of coordinates from one frame of reference to another in uniform relative motion has been illustrated in accordance with the Lorentz equations. The indicated circles on the left and right correspond to cross-sections of spherical surfaces of simultaneously occurring events in the observer's "stationary" frame of reference. The ellipses, each with one coincident focus, at the center of the diagram correspond to the cross sections of elongated ellipsoidal surfaces of

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[6] Richard Feynman, ***QED – The Strange Theory of Light and Matter***, Princeton Univ. Press, Princeton, (1985), p. 28.

[5] R. F. Vaughan, ***The Relativity of Visual Observations*** (2010)

events corresponding to the presumed simultaneous events in the *other* frame of reference. The symbols, $\mathcal{L}_v$, $\mathcal{L}_v^{-1}$, $\mathcal{L}_{-v}$, and $\mathcal{L}_{-v}^{-1}$ all refer to the familiar Lorentz transformation equations or their inverses, which are also Lorentz transformations associated with oppositely directed relative velocities that have been denominated v and $-v$, such that:

$$(t', x', y', z'') = \mathcal{L}_v\,(t, x, y, z)\ ,$$

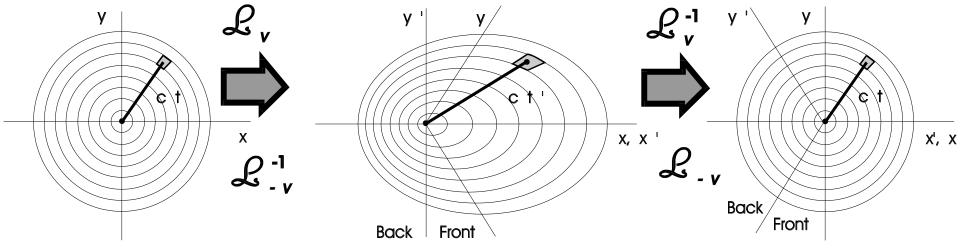


Figure 2

where the values of x', y', z' and t' are given respectively by the usual Lorentz transformation equations in terms of x, y, z and t, and the following identities can easily be shown to apply:

$$\mathcal{L}_v^{-1} = \mathcal{L}_{-v} \text{ and } \mathcal{L}_{-v}^{-1} = \mathcal{L}_v$$

Spatial distances to corresponding events from coincident origins of the two frames are related by the temporal Lorentz equation as a distance that light must travel in a corresponding amount of time. This determines both the corresponding spatial distance r or r' and time interval t or t' to observed events on respective surfaces since the speed of light is assumed identical for observers in both frames such that $r = ct$ and $r' = ct'$ to the corresponding events.

If relative motion of an emitter and absorber were to be along the direction of their common centers, perpendiculars to this direction for the "other" observer with regard to this common axis would appear "tipped" by aberration through the angle whose sine is $\beta \equiv$ v/c as shown in the previous article. In this expression v is their relative velocity and c the speed of light. So that any direction perpendicular to a shared direction of relative motion in one frame of reference would appear to be at an acute or obtuse angle (depending on the sense of their relative motion) for the other. (See the orientation of the *perpendicular* y-axis as viewed in the *other* frame of reference in figure 2 above for an illustration of this aberration effect.) You might have to think about whether an electromagnetic field vector aligned with the y-axis in the unprimed system would be tipped *in actuality* rather than just *appear* to be tipped for an observer in the primed system. But you'll get it – you have been blessed with intelligence.

Now consider the directional relationships of ***E*** and ***H*** field vectors associated respectively with an emitter and absorber situated on the x-axes. For propagation of light from the emitter to the absorber, these vectors will be *tipped* with respect to corresponding vectors in the other frame of reference, with the one that appears tipped depending on whether the emitter's or the absorber's frame of reference is considered. In figure 1 the emitter's frame of reference was assumed, so the prime is used on ***H'***, which is therefore aberrant, i. e., tipped. This tipping will be conically symmetric throughout the entire circular polarization cycle so the Poynting vector will spiral tangentially about the outside of a cylinder aligned with the common direction joining the centerlines of the emitter and absorber as shown in the second diagram of the figure. Thus, when compared with radiation exchanged between atoms in a single frame of reference there accrue appreciable differences. For transmission along the x axes the light must travel further by the gamma factor of

$$\gamma = 1 / \sqrt{(1 - \beta^2)}$$

along the helical path to effect the same distance for the primed observer, where again $\beta = v/c$. So the 'effective' lineal velocity of the light relative to the *other* frame of reference, even while maintaining its universal speed in both frames will be:

$$c' = c \sqrt{(1 - \beta^2)}$$

which as we saw in an earlier article produces *the same effect* as the Lorentz transformation equations on round trip travel times between frames or on using values appropriate to different frames on one-way photon interactions. Thus, curled up dimensions provide a very intuitive interpretation of the physics of uniform relative motion that maps spacetime coordinates. The radius of curvature of the curled up 2-space for the single 3-dimensional coordinate is rather tiny i. e.,

$$10^{-20} \text{ cm} < \beta\lambda/2\pi < 10^{-10} \text{ cm}$$

for usual wavelengths and velocities in our macroscopic world.

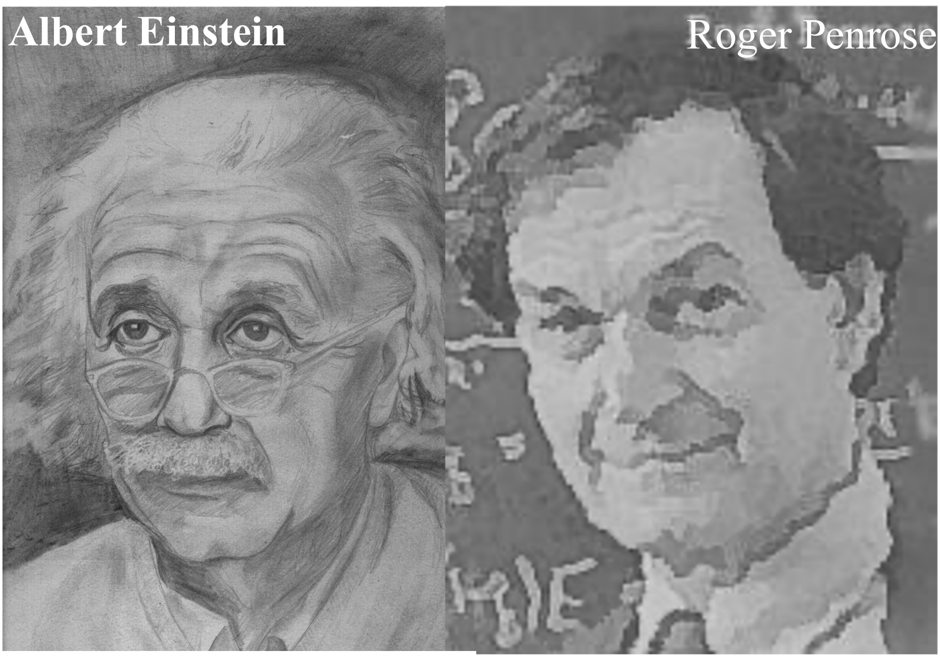
It has been found that the unification of the electromagnetic, weak and strong nuclear forces can most effectively be accomplished in a mathematical framework of nine spatial dimensions, where only three of them are observable. The remaining two dimensions per spatial dimension have been assumed as being tightly 'curled up'. So once again the potential for uniting relativity and quantum theories is enhanced by an interaction interpretation of the special theory.

So you see light – and not just ants – may require more than one dimension to screw around with even while more or less proceeding along a 'single' direction. The preeminence of light to not only instrument measurements, but also to determine our epistemological understanding, of time and space must surely lend to this curled up dimensionality some universal significance. Sure, maybe it's just “fried eggs” (as someone once opined about what a mathematician could do with multiple dimensions) or another way of looking at things. But then, you'll have to admit that it's the only way we have.

The Case Against Contraction

"You have tantalized us with allusions to several intriguing areas (e.g., you imply that the scientific community ought not to be so defensive about the Einsteinian Canon, yet you leave us hanging as to what should replace it...)" [1]

"For we do not mean to say that a body which is moving uniformly in a straight line with respect to an inertial system S 'undergoes a change,' although it actually changes its situation with respect to the system S. Nor is it clear a priori what 'changes' physics counts as effects for which causes are to be found; rather, this is to be determined by experimental research itself." [2]



As response to the challenge from my friend that is quoted above, I've rolled in a bit of heavy artillery to set against that very "canon." In a prologue article I stated what it was that I saw as significant in Penrose's discovery in 1957 that Lorentz contraction could not ever even be observed. Clearly, the problem I was having back so long ago involved an Emperor's philosophical wardrobe scam worthy of

[1] A friend, Mike Hess, had responded in this way to an article entitled "Musings on the Reformation of Science" that the author had contributed to a private society journal.

[2] Max Born, ***Einstein's Theory of Relativity***, Dover, New York (1924,1962) p. 253.

even *his* attention. But neither Penrose nor (do I suspect) anyone else assigns to his short paper anywhere near the degree of importance that I have over the years. After all, he merely modestly concluded that contraction – like the Emperor's robe – is a *fact,* even though *it cannot be observed* by crass observers such as you and me. But, since I see the matter as of extreme importance, I would like to illustrate without his somewhat more abstract mathematical flourish just how he reached that conclusion and how such analyses relate to the concept of time dilation that I also consider to be problematical. Additionally, some philosophical legitimacy issues that were brought up earlier need to be clarified.

Then enough of cynical blasphemy regarding the king's tailors while offering nothing in which to swaddle a naked king: In later articles I will formulate conjectures to be provided in the Popperian spirit of all good science – as alternatives to keep a meaningful discussion alive and to attempt to *refute* (the only legitimate purpose).[3] For obvious reasons alternatives will be couched in terms of "observational relativity" with no more perception of naked kings!

WHY CAN WE NOT OBSERVE LENGTH CONTRACTION?

Consider figure 1 in which four points are drawn on a spherical ball – a basketball, so that its orientation will be readily observable. Atoms in areas on the surface of the sphere around these points will continually emit photons, to which emission 'events' make reference. Visual perception of the resulting image might be expected to involve leading and trailing edges of the sphere, from the respective perspectives of two relatively moving observers O and O' as shown, who are observing a basketball when in coincidence. Assume that observer O is stationary with respect to the sphere while O' is moving at a speed *v* with respect to O. Events E_1 and E_3 occur at A_1 and

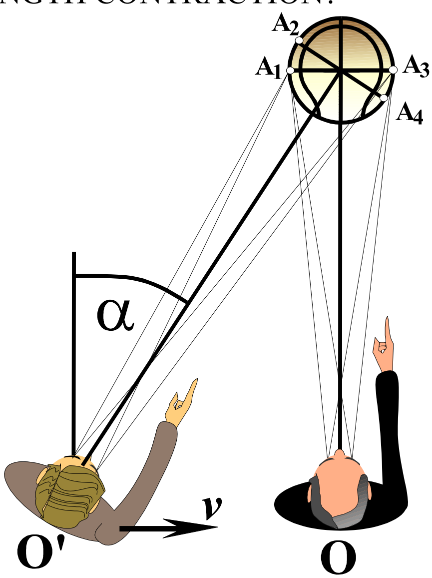


Figure 1: Two views of a single sphere, or two spheres two be viewed?

[3] That portion of the original paper has been presented separately a little farther on.

A_3, respectively, and appear at the outer edges of the image of the sphere for O. These events must occur simultaneously for him since they occur at points on the sphere that are equally distant from him. Events E_2 and E_4 occur at the outer edge of an expected image of the sphere for O' and one must suppose that they would therefore be simultaneous in *his* frame of reference. But Einstein maintained that E_1 and E_3 would appear at the extremities of a contracted image of the sphere for O' also rather than E_2 and E_4. E_4 would occur in the front of the sphere as it does for O, but E_2 would be totally out of sight behind the sphere as it also is for O.

Penrose concluded that although Einstein was incorrect with regard to appearances of contraction, he was correct with regard to both the observers witnessing the same extremities, and that indeed events from A_1 and A_3 *would* appear at the edges of the image for O', with A_2 and A_4 deposed somewhat as Einstein had supposed. So how can accepting practitioners of relativity theory account for this?

The four labeled areas on the ball in figure 1 are identified as endpoints of diameters which are at an angle of α with respect to each other such that the angle between them is given by,

$$\cos^{-1} \alpha = \sqrt{1 - v^2/c^2}$$

This is familiar to us all as the *Lorentz contraction factor*; with α the *relativistic aberration* angle in this case as well. Figure 2 illustrates the explanation as follows:

The event E_1 occurs at time t_1 in area A_1 prior to the observers coming into coincidence, and will be observed when both are in coincidence. Corresponding to event $E_1 = (t,x,y,z)$ will be its Lorentz transform,

$$E_1' = \mathscr{L}_v(E_1) = (t',x',y',z')$$

given by:

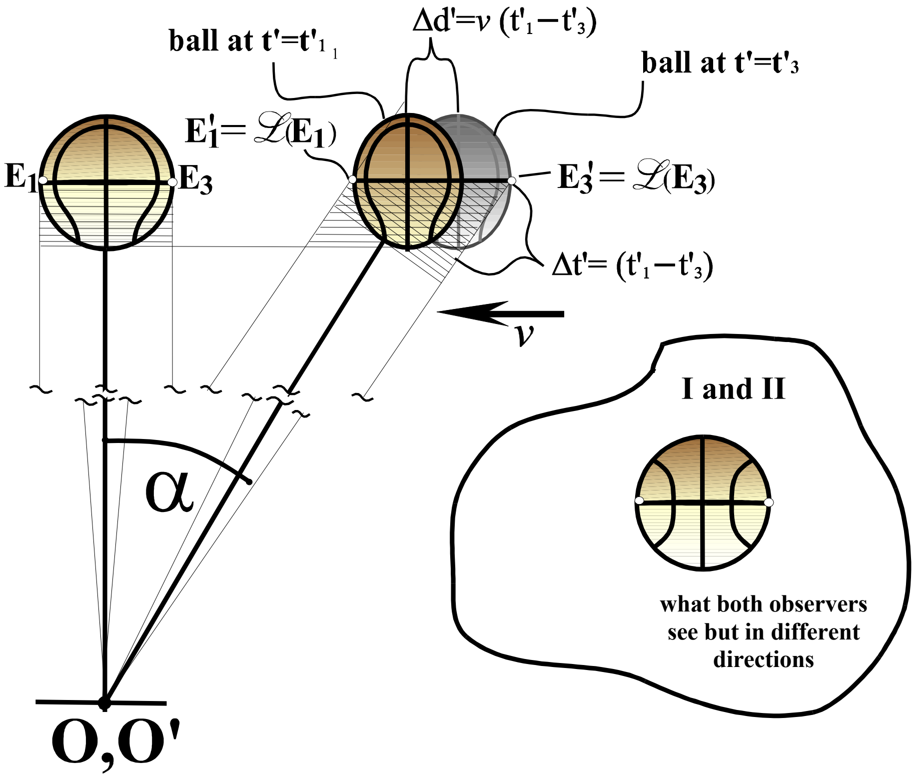
$$x' = (x - v\,t) / \sqrt{1 - v^2/c^2}\ ,$$

$$y' = y,$$

$$z' = z,$$

$$t' = (t - v\,x/c^2) / \sqrt{1 - v^2/c^2}.$$

It occurs an amount of time t_1' prior to their encounter that takes place at $t = t' = 0$ for O′ as well as for O.



Projections assume ball is at a distance large relative to the diameter of the ball.

Figure 2: Construction from the ball that is stationary with respect to O using contraction and time dilation to determine what will be an apparent rotation

According to the established interpretation of the Lorentz transformation, the sphere will be Lorentz-contracted in the frame of reference of O′ and situated as the left-most contracted ellipsoid shown at t_1'. The same process when applied to E_3 will obtain E_3', so another contracted sphere will be situated even further to the right corresponding to an earlier time, t_3' resulting from the Lorentz transform of E_3. This ellipsoid is shown behind and to the right of the former because it corresponds to an earlier situation. But since the speed of light is the same for O’ as for O according to the special theory, events E_1' an E_3' (even though *occurring* at different times) will nonetheless still be seen at the *same* time by O’ since the light from A_3

must travel farther than light from A_1 relative to him as can be seen in figure 1. It is easy to show that the required *head start* $\Delta t'$ of the light from E_3' is precisely the amount needed to just place the image of the right end of the 'contracted' diameter (A_3) at a distance from where event E_1' occurs (at A_1) to conspire to precisely nullify the contraction factor as shown, because the traveled distance $\Delta d'$ must be added to the length of the contracted diameter and a perspective projection taken to effect the observed separation of the two events. So the combined effects of 'Lorentz contraction' and 'time dilation' produce what appears to O′ to be *no* contraction at all. Instead there is a skew rotation of the y axis through the same angle α at which the sphere is seen due to the relativistic aberration effect. The image that would be seen by both observers is shown at the bottom right of figure 2. (Notice that this image corresponds to a perspective at right angles to the plane of the page appropriate to the rest of the figure.) Both observers' images are exactly the same although seen at a different angle to their vertical.

But, as can be seen in figure 1, if the ball had happened to be stationary with respect to the observer O′ rather than O, both would witness the ball with A_2A_4 replacing A_1A_3 in the analyses above with a reversed direction Lorentz transformation involved such that both would witness a different spherical image as shown in figure 3. It is the image anticipated by O', and both observers see it the same way, but at a different angle relative to their vertical.

HOW SHOULD 'OBSERVATION' BE DEFINED?

The single situation illustrated in figure 1 has generated four unique image VISUAL observation situations. These reflect the four required test situations suggested in the figure on page 20, as follows:

I. O observes the ball in O.

II. O′ observes the ball in O.

III. O′ observes the ball in O′.

IV. O observes the ball in O′.

But even this characterization is hardly exhaustive of what is required to understand all the interrelationships of observations that could be made by two observers in uniform relative motion. In figure 1 we assumed that observer O enjoyed the privileged position of having his ball situated in a direction perpendicular to their relative motion. In order to rectify this situation and allow full symmetry there would need to be four balls and eight unique observations as will be discussed in other articles dealing with tests of the *frame independence* and *mutual observability* hypotheses. We restrict ourselves to these four possibilities here, using the roman numerals to indicate which observation type is involved. It goes without saying that Penrose did *not* address the full breadth of the issue of whether contraction *actually* occurs.

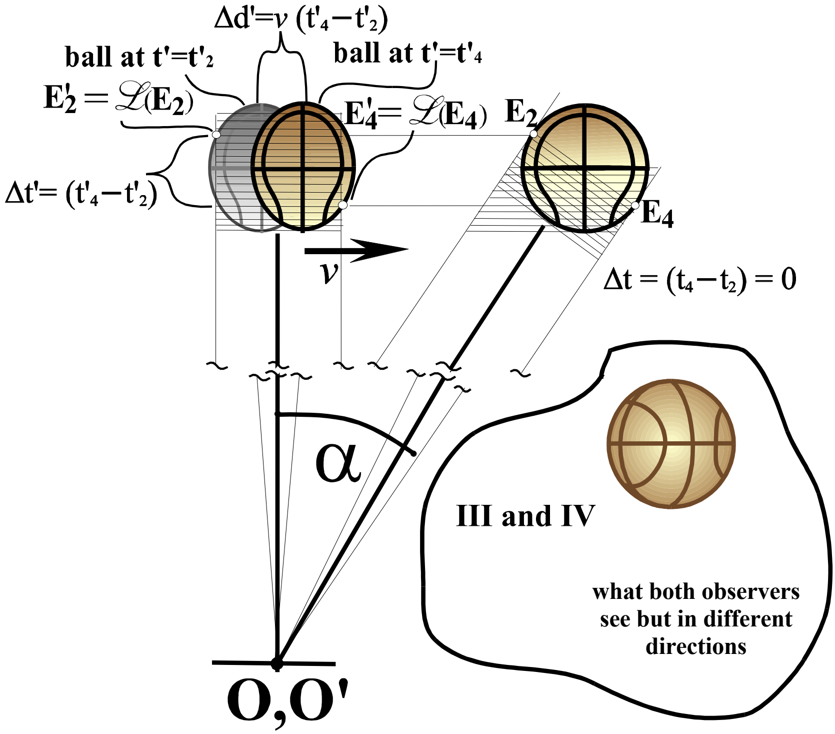


Figure 3: Construction from ball stationary with respect to O' using contraction and time dilation to effect an apparent rotation

Admittedly both observers witness the same images albeit at differing angles relative to the direction of their relative motion. But *when* do they witness these common sights? O' will have his own – and the other – ball at a greater distance from his ultimate location of observation than will O in situations like those shown in figure 1. And what about clock time dilation?

CAN CLOCK TIME DILATION BE OBSERVED?

Let's consider a cross section of a transparent sphere as indicated by the diameter A_1A_3 as shown in figure 1 to be the similar 9-to-3 diameter of a circular wall clock. Suppose that a huge clock could be set up so that it could be viewed by telescope at a distance 669,600,000 miles[4] from where the observers will be in coincidence to view its face at 12:00 o'clock according to both observers. They synchronize all clocks stationary with respect to themselves such that this moment of coincidence will occur at 12:00 o'clock in both frames. (Let the relative motion be half the speed of light as was used in the geometrical considerations of the illustrations above.)

Clearly both observers will see exactly the same image of the clock since what applied to E_1 and E_3 above applies linearly across the extent of the entire clock face. This is after all just a spatial image being observed – not a clock *per se* – isn't it? How would the fact of there being a mechanism *behind* the clock face, causing it to behave *as* a clock, produce a difference in the image from what it would be if it had just been pre-painted onto a white circular surface a moment before the image they both will view was transmitted? That is, if both observers do indeed observe the very same events as supposed by the *frame independence* and *mutual observability* hypotheses accepted for the theory as discussed elsewhere. The minute hand cannot switch to a different position in images for O' than for O if the same events are being witnessed. I mean…think about it!

According to established interpretation of the Lorentz transformation, a clock reading in the frame of O' at the same location in spacetime where the photons left the clock face stationary for O should, however, have read approximately 10:50:30, *not* 11:00:00 o'clock if its synchronization took place exclusively in O'. This is also in accord with the Lorentz time equation which O uses to calculate that the time on the clock of O' should read approximately 10:50:30 o'clock when his reads 11:00.

So let us suppose that O' has a wall clock also and that is at the same vertical distance from the direction of their relative motion. It is located far to the right of O' (similar to the geometry shown in figure 1 above) however, so it takes longer for the image to arrive at O'. An assistant of O' on location at the clock would certainly notice that the two clocks read different times when the two clocks were in coincidence.[5] At any rate this moment of coincidence for the two clocks was when events occurred that generate the images of the faces of the clocks analogous to those shown in figures 2 and 3 above.

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4 This distance to the clock was calculated to be the distance that light travels in one hour.

5 Let us not quibble about their not being "precisely" coincident so as to avoid a catastrophic collision! We'll offset one in the z direction by a few feet, which relative to the distance 669,600,000 miles is a measly quibble!

Now what does each observer actually see when he looks at the clock of O′? Figure 4 illustrates what they see, again by the same basic analyses used by Penrose. Here we have apparent foreshortening in O, because of the re-versed sense of Δt in this case. This too will be associated with apparent rotation as applicable to figure 3, as shown. But again, clock images look the same to both observers. If we addressed all of the possible configurations mentioned above of clocks *in* both frames viewed *from* both frames, we would see that the clocks in the *other* frame do *not* run slower. In some cases it might seem as though they do but in symmetric situations it turns out the other way around. And the appearances are always the same for both! (The four cases for both basketballs and clocks are shown on page 108 where additional explanation is provided.)

So… what do *you* think? Do Lorentz contraction and time dilation *really* occur? Is it just me who can't see the king's robes and is embarrassed for him?

I think he's stark naked!

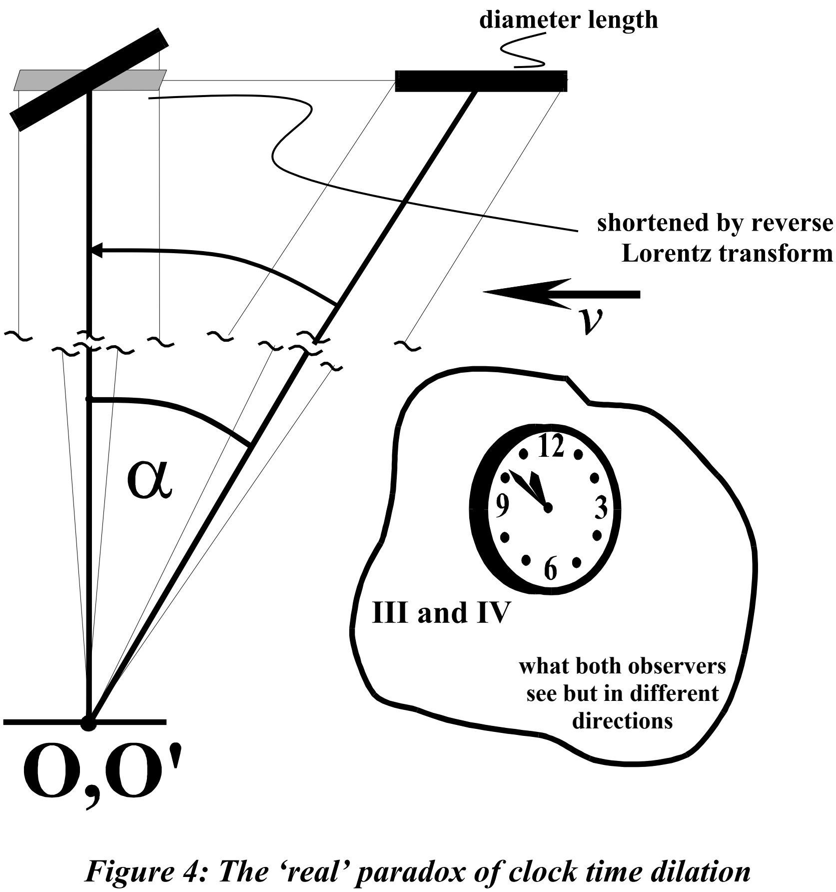


Figure 4: The 'real' paradox of clock time dilation

The Role of Asymmetry in Special Relativity

The observations that differ one from the other only with respect to the relative motion of the observers and not with regard to what both are observing is what is directly predicted in the special theory. These are the observations characterized by I and IV in figure 1 below and on page 20. It was discussed in the previous article with regard to the four required categories of any reasonable test of the special theory.

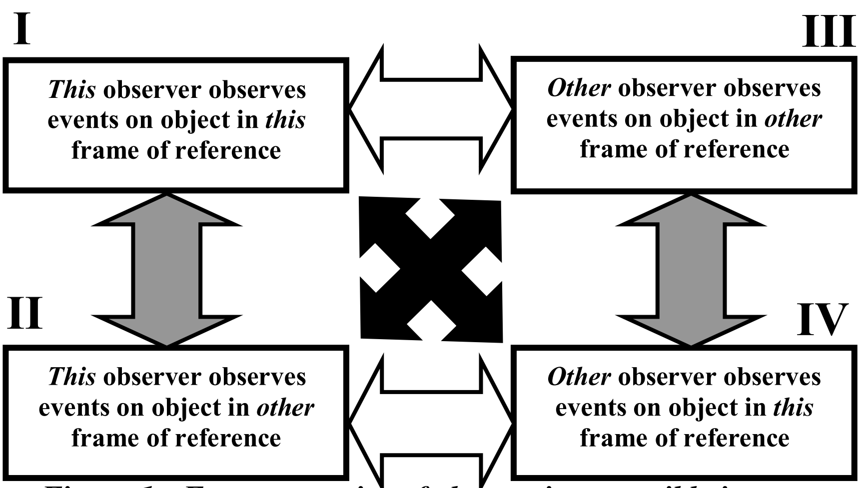


Figure 1: Four categories of observations possible in tests of relativity and their various relationships

However, it is the comparison of tests I and IV that *has never actually been conducted*!

The Lorentz equations have been demonstrated repeatedly to apply to comparisons of *specially prepared* data obtained from tests I and II, making assumptions with regard to III, and we must, therefore, suppose that they also apply by symmetry to comparisons for tests III and IV in that same sense. However, neither of these relationships satisfies the criterion for detecting any direct relationship between the clocks and rods of relatively moving *observers*. In these test cases the *same* observer obtains *both* of the sets of compared observation data using only his own measurement devices. The material basis of the observed phenomena (an unmetered object) and *not* the observers and their clocks and measuring rods experiences either relative motion or is stationary with regard to the *single (as in only one!) of the observers*. Nor is there even any basis whatsoever for concluding that the *same* events on the object are giving rise to the observations of *both* observers where two are involved. Clearly in these cases they *don't*! Different atoms seem obviously to be involved according to all measurements and observations.

However, because of symmetry differences in the reversed directionality, additional aspects of both experimental apparatuses must be considered in order for each observer to have an equivalent role in his own version of each test – particularly if coincident events are to be considered. Then the issue, of whether complete symmetry can even be established, arises. (The situation of observers in relative motion is *not* similar to a single observer approaching a mirror; if the *real* observer is right-handed in this case, his mirror image would be left-handed.) In figure 2 below a 'primed' and an 'unprimed' observer (K' and K) in uniform relative motion prepare events E_1 and E_2 respectively which bear similar relationships to the origin (where they each reside) in their own frames of reference. The motion is assumed to be such that K' moves to the right relative to K. Clearly there are problems here: What appears to be an identity relationship between classes I and III (in the figure above) gives rise to a second order relationship between classes II and IV which undermines the very concept of covariance.

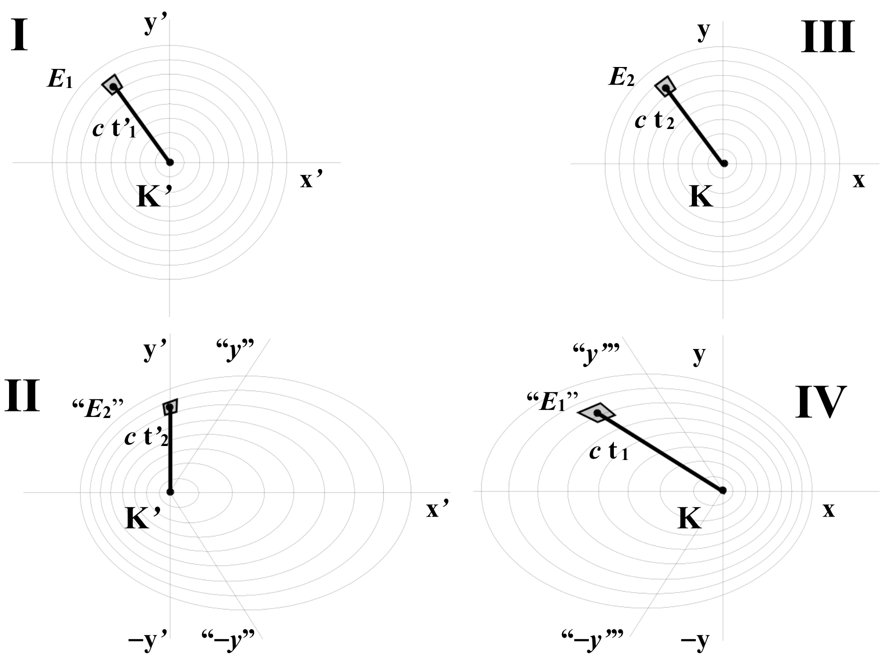


Figure 1: Observation of identical and analogous events

This problem arises in part because the events E_1 and E_2 cannot occur while the objects upon which they reside are in coincidence. To establish such a case we must accept a reversed symmetry between the approaching observers in which we attempt to construct an apparatus for which the two events may occur while in coincidence to subsequently be observed at the instant when the two observers themselves are in coincidence. In figure 3 we construct such a geometrical relationship.

Although we do not have the experimental results we would like to have to more comprehensively compare the various measurements, we can at the very least pursue investigations of consistency that may shed light on the validity of various interpretations of the Lorentz formalisms incorporated into the special theory. We will do that next.

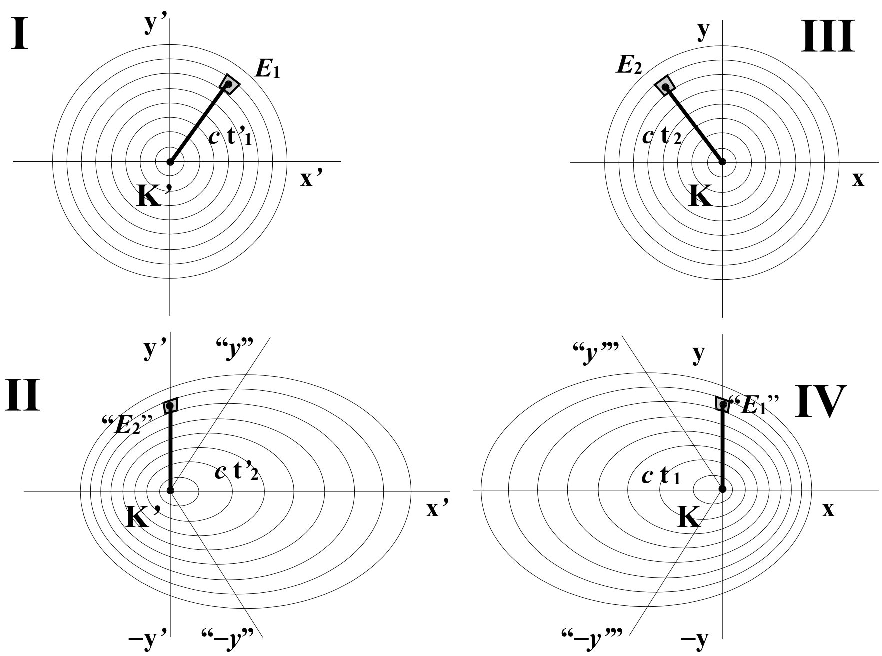


Figure 2: Observation of identical and analogous events prepared to occur while in coincidence on relatively moving objects

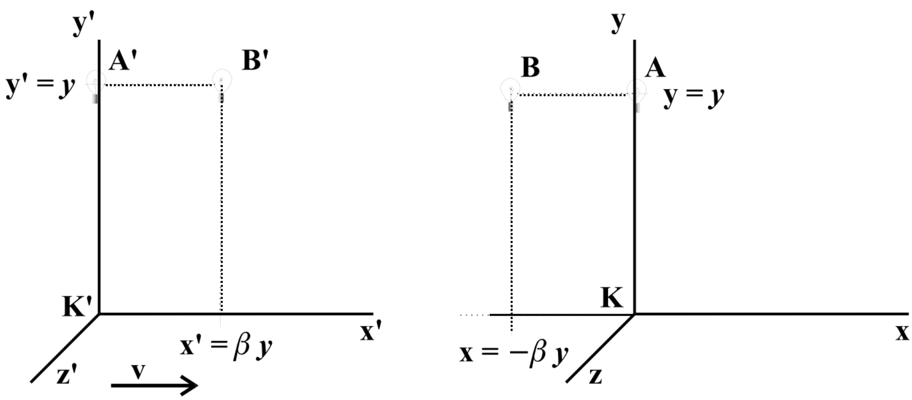
Evaluating Alternative Interpretations Lorentz 'Transformation' Equations

"…when we realized our error: That *we had chosen unfortunate interpretations for the symbols. By changing the interpretations, we regained consistency. It now becomes clear that consistency is not an intrinsic property of any formal system per se, but depends on the interpretation which is proposed for it.*" –

Hoffstadtler[1]

There are various alternative interpretations of the Lorentz transformation equations that are possible. And it is, after all, neither the equations nor resulting parametric values, but the interpretations that we assign to otherwise hollow *formalities* that can elevate a theory to a valid representation of reality. In light of such considerations, let us consider in more detail two alternative interpretations of the Lorentz equations:

Consider, for example, the two relatively moving observers (identified as 'primed' and 'unprimed' with coordinate systems K' and K, respectively). They and their associated apparatuses move in a vacuum with uniform relative velocity v with respect to each other. Each observer is equipped with flash bulbs A (or A') fixed a distance $+y$ along the y (or y') axis and B (or B') fixed at (x,y) positions ($\pm \gamma\beta y, y$), where the plus and minus signs apply respectively to primed and unprimed coordinate systems (K' and K) as shown in the figures below. Here $\beta = v/c$, $\gamma = 1/(1 - \beta^2)^{½}$, and c is the speed of light.



1 D. R. Hoffstadtler, ***Gödel, Escher, Bach – An Eternal Golden Braid,*** Vintage, New York, p. 94 (1979).

Figure 1: Flashbulb layouts for both observers

Observers' clocks are synchronized with both set to read t (and t') = 0 at the moment when the observers are in coincidence. Initially, each observer wires *his own* A (A') bulb to flash at t (t') = $-y/c$, and *his own* B (B') bulb to flash at $t,t' = -\gamma y/c$. The Lorentz transformation equations provided below associate space-time coordinates of the respective flashing events in the two frames of reference as shown from the perspectives of the two observers at their moment of coincidence. The reader may verify that the Lorentz equations as denoted by $\mathscr{L}$ (*Event*) as provided below determine distortion of the *other's* apparatus as shown in figures 2 and 3. Furthermore, there are *eight* events that result, *not* just two!

$\mathscr{L}$(A' event)

$x_{A'} = \gamma(\, x'_{A'} + v\, t'_{A'}\,) = -\,\gamma\beta y$

$t_{A'} = \gamma(\, t'_{A'} + x'_{A'}\,\beta/c\,) = -\,\gamma y/c$

since $x'_{A'} = 0$, and $t'_{A'} = -\,y/c$

$\mathscr{L}'$ (A event)

$x'_{A} = \gamma(\, x_{A} - v\, t_{A}\,) = +\,\gamma\beta y$

$t'_{A} = \gamma(\, t_{A} - x_{A}\,\beta/c\,) = -\,\gamma y/c$

since $x_{A} = 0$, and $t_{A} = -\,y/c$

$\mathscr{L}$(B' event)

$x_{B'} = \gamma(\, x'_{B'} + v\, t'_{B'}) = 0$

$t_{B'} = \gamma(\, t'_{B'} + x'_{B'}\,\beta y/c\,) = -\,y/c$

since $x'_{B'} = \gamma\beta y$, and $t'_{B'} = -\,\gamma y/c$

$\mathscr{L}'$(B event)

$x'_{B} = \gamma(\, x_{B} - v\, t_{B}) = 0$

$t'_{B} = \gamma(\, t_{B} - x_{B}\,\beta y/c\,) = -\,y/c$

since $x_{B} = \gamma\beta y$, and $t_{B} = -\,\gamma y/c$

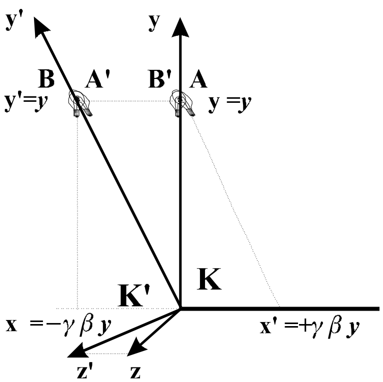


Figure 2: From a perspective of observer K

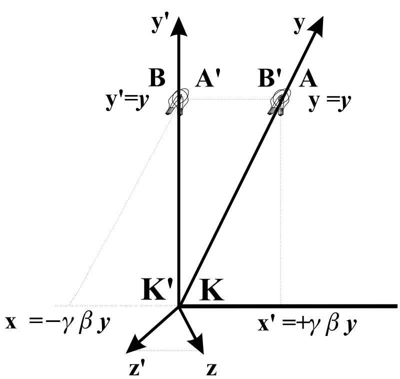


Figure 3: From a perspective of observer K'

The coordinate values that were calculated above are shown not only in the figures, but also in an accompanying table that we provide below.

Bulb Events #1 (seen by K)*	Bulb Events #2 (seen by K')*
A flashes: $x_A = 0$, $t_A = -y/c$	flashes: $x'_A = +\gamma\beta y$, $t_A = -\gamma y/c$
B flashes: $x_B = \gamma\beta y$, $t_B = -\gamma y/c$	flashes: $x'_B = 0$, $t'_B = -y/c$
A' flashes: $x_{A'} = -\gamma\beta y$, $t_{A'} = -\gamma y/c$	flashes: $x'_{A'} = 0$, $t'_{A'} = -y/c$
B' flashes: $x_{B'} = 0$, $t_{B'} = -y/c$	flashes: $x'_{B'} = \gamma\beta y$, $t'_{B'} = -\gamma y/c$

* $y_A = y_{A'} = y'_A = y'_{A'} = y_B = y_{B'} = y'_B = y'_{B'} = +y$ and
$z_A = z_{A'} = z'_A = z'_{A'} = z_B = z_{B'} = z'_B = z'_{B'} = 0$ for all eight events.

In maintaining that both sets of events (#1 and #2) in the table above are the *very same* sets of events, the established interpretation is forced to assume that notwithstanding the visually observed y and z axis skew orientations, both observers' axes are nonetheless aligned. (I do understand why there would be a certain amount of reluctance to accept misalignment as fact, but since alignment must ultimately involve line of sight to objects whose relative tangential motions must remain unknown, it is in a very real sense inevitable just as is the uncertainty principle in quantum theory.) But significantly, this accepted interpretation must accept that the length AB (A'B') in the *other* frame is contracted. And furthermore, it accepts that the *other* observer's clocks are dilated such that what seems to require an interval *y/c* in *this* frame would require $\gamma y/c$ in the *other*. However, a unilateral dilation of time intervals for *this* observer does not suffice. An observer in K must accept that not only do the A' and B flashes occur earlier than an observer in K' will measure them, but also that the A and B' flashes will occur later than K' measures them. It is awkward indeed for either observer to resolve such a 'paradox' with synchronized clocks used to measure the *duration's* – particularly if they are allowed a sneak peek at the other observer's clock in passing. Each would measure both shorter *and* longer intervals from the time of coincident flashes till observation than the *other* observer, both using the most accurately synchronized clocks. That is the currently accepted interpretation of the Lorentz formalism however.

There *are* alternatives to this accepted application of the Lorentz equations to relativity. In more positivistic approaches propounded by the author from time to time, observers' respective y and z axes are assumed to be misaligned just as they appear to be. There is *no* length contraction or clock time dilation which (in the other interpretation) is always conveniently attributed to the *other* observer's clocks and rulers in any case. But of such alternatives there are still at least two further alternatives along this logical path that account equally well for the observed data. One such alternative is one in which the scale of the Lorentz transformation was altered by the factor $(1 - \beta^2)^{\pm 1/2}$ such that transmission times for light remained unaltered between frames so that indeed events would be mutually observable. The spacetime metric was then altered compatibly to provide the advantages of tensor treatment accorded by the generalization of the traditional approach. But here let's explore another alternative that rejects altogether the *mutual observability* conjecture that is inherent in the established interpretation.

Let us assume that all measured time intervals and distances are exactly as they are determined for each observer by the Lorentz equations. By denying contraction and dilation, one must then be observing *different* (albeit similar) events on the same world line of the same object (flash bulbs in this case) that are related by the same Lorentz transformation equations. Distinct events would now be merely *Lorentz correspondents* between *different* events rather than the *same* event *transformed*! The distinction is an observer-based one – different events occurring at the same place on *the same object* viewed by relatively moving observers while in coincidence.

In order for an observer at the origin of K to witness B' flash at the same instant as he sees the flash of A (affixed to his own y axis) while momentarily in coincidence with the origin of K', B' must *in fact* have been *wired* to fire late, i. e., at $t'_{B'} = -y/c$. A' must, *in fact*, be *wired* to fire early, i. e., at $t'_{A'} = -\gamma y/c$ because these are the *only* events on the worldlines of these bulbs, A' and B', that are observable by him at t=0 as shown in the table above. But this wiring would foul up the internal observations in K', i. e., these events on A' and B' would not be seen at t' = 0 in K'. Thus, in order for the observer at the origin of K' to see all flashes at once, the wiring of the bulbs in K would have to be wired to accommodate *his* observation, fouling up *his* own observations. The two coincident observers (at $t = t' = 0$) would each then witness all four bulbs flash at once, but they would also witness four additional flashes from the same bulbs (for a total of eight) at different points on the world lines of the various bulbs A, B, A' and B' as shown in the previous table. So the eight Lorentz correspondents would be associated with separately observable events. This is, of course, a *very* observable difference so there must be a test that would refute this interpretation if it is, in fact, incorrect.

In this alternative interpretation, when observers in K and K' are in coincidence at time zero, it is *not* assumed that they witness the same flashing event for *any* of the four bulbs even though they are witnessing the same bulbs. The observer in K will witness events A_1, B_1, A'_1, B'_1, whereas K' will witness A'_2, B'_2, A_2, B_2, where the subscripts refer to one or the other *separate* event on the world line of one of the bulbs. This seems to the author to be the only completely consistent interpretation of the Lorentz transformation equations without change; it would relate the eight measurements as shown above. But there is the credibility problem associated with coincident observers witnessing different events on the same observed objects.

Testing for Mutual Observability – the Unpostulated Assumption of Special Relativity

In this article we consider in detail the possible tests of the frame independence and mutual observability interpretation that has characterized the establishment view of the Lorentz transformation equations as discussed earlier. The general requirements have already been set out in articles presented above (see the figure that was shown on both pages 20 and 109) that identified four categories of tests – all of which need to be performed in order to be able to refute one or the other of incompatible conjectures in this regard.

Experimental apparatus

As platforms for conducting such tests, consider the set up shown in the overlapping spacetime diagrams of figure 1 where two observers experience uniform relative motion along their x axes. They are equipped with circular hoops mirrored on their inner surfaces as discussed in other previous articles; the hoops lie flat in respective x, y planes and their centers are located at the origins of their respective frames of reference. At the moment of coincidence of the observers A and B, light will just be reflecting simultaneously (events 2 and 2' in their respective frames of reference) off of their own hoops – the circles are seen as ellipses in the spacetime projection. (Notice that when we say "simultaneously" what is meant is that it will be the same amount of time as measured by each since they had emitted the momentary flashes of light from the center of their mirrors that are of identical dimensions.) Earlier light would have been emitted (events 1 and 1') in all directions of the x,y plane by each observer to set up this situation. The reflection events on the *other* hoop will *not* be simultaneous, of course, from either observer's perspective. Later the reflections off their respective mirrors will converge back to each observer as a momentary 360 degree flash (events 3 and 3'). The two envisioned tests are merely superimposed on the same diagram with the geometry appropriate to each drawn separately. Obviously the happenings of the other observer could be witnessed but for the time being we will not consider them. The apparent differences in orientations of the x and t axes trace directly to the Lorentz transformation equations. Each observer is capable of achieving the same results in accordance with the *principle of relativity* because the speed of light (where there is no interaction) is independent of the frame of reference.

The circular hooped mirror of B is comprised in spacetime of a ‘pipe’ of adjacent world lines proceeding along the direction of B's world line in the frame of A. (Refer to figure 2.) Perpendicular cross sections of this pipe correspond to the mirror itself at successive instants in B. If one were to take a projection of such a cross section of B's mirror onto the x axis of A one would obtain a Lorentz contracted *version* of the mirror appropriate to a single time in B mapped to a single time in A. Of course the contracted length of this version in A is measured between leading and trailing edges of a mere ephemeral shadow, part of which was cast in the past and part that is a mere promise from the future. It is, for related reasons, well known that Lorentz contraction is not observable in the sense of one ever being able to take a photograph of a contracted sphere, for example. Our hoop mirror would be seen as being merely a foreshortened projection of a *rotated* original. A sphere would appear skew rotated; *Lorentz contraction* is a mathematical artifact quite different than would be the actual *reduced length* of an object.

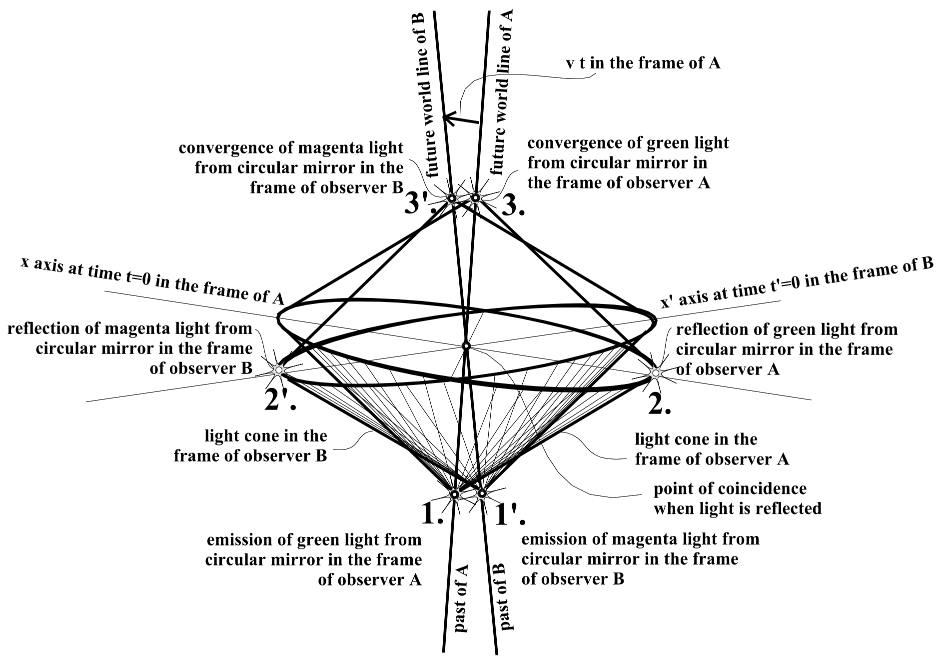


Figure 1: Spacetime diagram of light cones associated with reflection off hoop mirrors in uniform motion

One can consider the amount of time it takes light to propagate to the mirror and back again within a single frame of reference as a valid

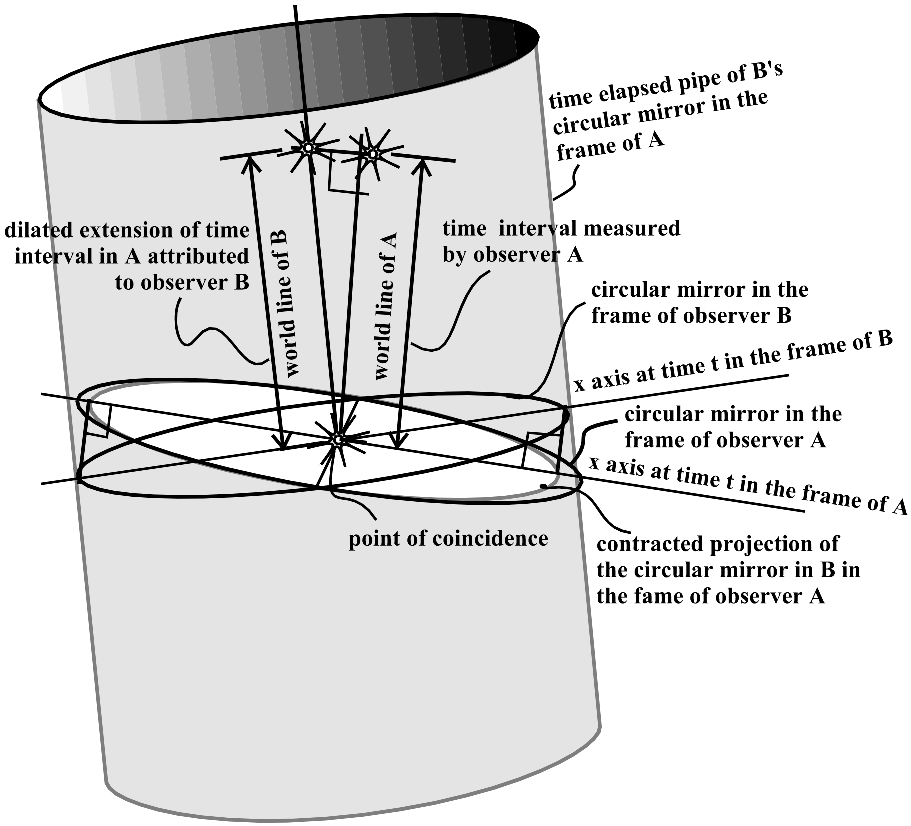


Figure 2: Red and magenta light emission, reflection and detection time intervals in frame of observer A

indication of clock time intervals because of the universality of the speed of light. Such emission, reflection and detection could go on indefinitely so as to create a persistent clock-like mechanism. In these diagrams time intervals correspond directly with the lengths of world line segments of a clock used for demarcation of a number of repeatable events from a sequence such as 1, 2 and 3 or 1', 2' and 3', respectively. If one now takes the perpendicular projection of the separation of two such events occurring on the *other* observer's world line onto *this* observer's world line, one obtains an assessment of time dilation presumed by *this* observer to have transpired for the *other*. However, this time does not correspond to an amount of time required for light to have actually been reflected off a similarly constructed mirror in his own frame between these events. Each Lorentz correspondent (although conceived as being identical with the other according to the *mutual observability* postulate) occupies a different coordinate location. So that even though associated *spacetime* *intervals* between events may be identical, the spacetime *portrayal* of observer B's events (as in figure 1) differs depending on whether the perspective is appropriate to the frame of A or B. If drawn from observer A's perspective, time intervals would be elongated such that 1' and 3' occur at $t = \pm \gamma R/c$ rather than $\pm R/c$ as in the frame of observer B. Here R is the radius of the hoop, and of course $\gamma = 1 / (1 - \beta^2)^{1/2}$, $\beta = v/c$, c is the speed of light, and v is their uniform relative velocity. See figure 2.

Interactions between frames of reference

So far, we have actually been dealing with measures obtained solely within a single frame of reference and/or suppositions with regard to deduced relationships of the length and time units of constructed apparatuses from the perspective of either one or the other frame. According to the spacetime diagram in figure 1 (representing the Lorentz equations and Einstein/Minkowski interpretation) the reflection events from the *other* mirror do *not* occur simultaneously in *this* frame of reference. They are, in fact, envisioned as beginning on the x axis of this observer at one end of the contracted projection of the other observer's hoop and proceeding in both directions around opposite sides of the rim of the projection until the final reflection event occurs at the other end. This can be envisioned in the spacetime diagram for each event of emission, detection, and reflection on the hoop in the other frame. More directly visualizable time lapse ‘snapshots’ and spacetime diagrams of such interactions have appeared in other articles included in this volume by the current author.

Let us consider now reflection off of the *other* observer's (B's) mirror that is detected by *this* observer (A) so as to obtain first-hand *gedanken* experimental "measurements" from which to reason about the nature of electromagnetic interactions between relatively moving observers. We will consider initially the restricted situation where each observed ‘ray’ (or photon) of light is involved in an interaction between material entities in both of the two frames of reference. Notice in this regard that in figure 1 the directionality of the light cones for relatively moving observers is not the same in the spacetime diagrams. So we will assume the light cone profile associated with *this* observer's frame for light emitted or detected at material sources in his frame of reference. The light will then be reflected using apparatus in the *other* frame, finally to be observed back in the same frame of reference as it was emitted. This is to say that the spacetime diagram is drawn from A's perspective.

In figure 3 we have established the position of coincidence of the two observers to correspond to the time and place for which (x, y, z, t) = (x', y', z', t') = (0, 0, 0, 0), when light would just be reflecting in simultaneous events around their own mirrors. To facilitate the setup, two assistants a_2 and a_1 are affixed to observer A's x axis at locations $x = \pm \gamma \beta R$, respectively. According to the conjecture of time dilation, light had to have been emitted in A's frame at the time $t = -\gamma R/c$ by B in order to meet this initial condition. Accordingly, at the time the light is emitted by B, a_1 will be in coincidence with B. If we assume frame independence and mutual observability, *either* B *or* the coincident assistant a_1 can equally well provide the light source. So we will have the assistant a_1 emit the light to meet our desired frame interaction condition.

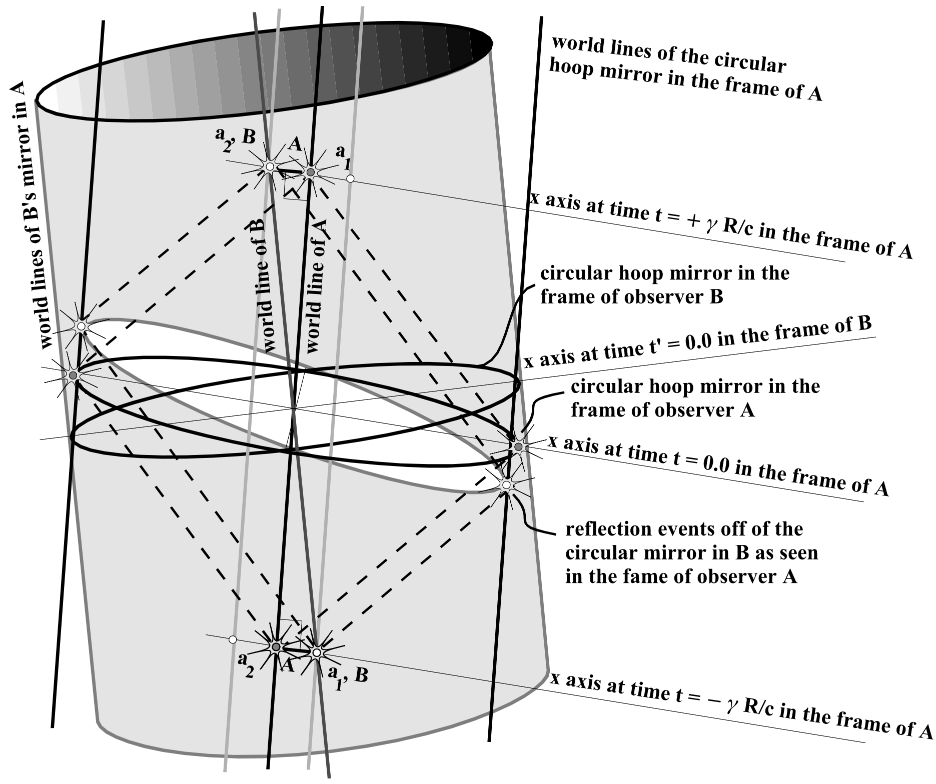


Figure 3: Illustration that the four unique types of events for two observers cannot be collapsed into only two

Notice that for this emission event *Lorentz correspondence* applies between a_{1e} and B_e, i. e., $\mathscr{L}(a_{1e}) = B_e$ and $\mathscr{L}^{-1}(B_e) = a_{1e}$ in accordance with the familiar Lorentz transformation equations symbolized by:

$\mathscr{L}$(*a spacetime event in A*) = *a spacetime event in B*.

Each reflection event in B will also have a *Lorentz correspondent* in A. A similar situation will arise at convergence and we will assume that assistant a_2 is located so as to be available for this detection such that $\mathscr{L}$ (a_{2d}) = B_d and $\mathscr{L}^{-1}(B_d)$ = a_{2d} for this detection event correspondence. At issue is whether the correspondents refer to an identically *same* event or two *unique* events.

The assistant a_1 will use red light so as to distinguish the reflection events of interest off the mirror in B. A circular flash of reflected red light will be detected by a_2 at the time $t = +\gamma R/c$. We also assume that observer A will emit green light from his own source at $t = -R/c$. Observer A will, of course, detect the circular flash of green light himself at time $t = +R/c$. Figure 4 depicts the geometrical layout of this red and green light experiment.

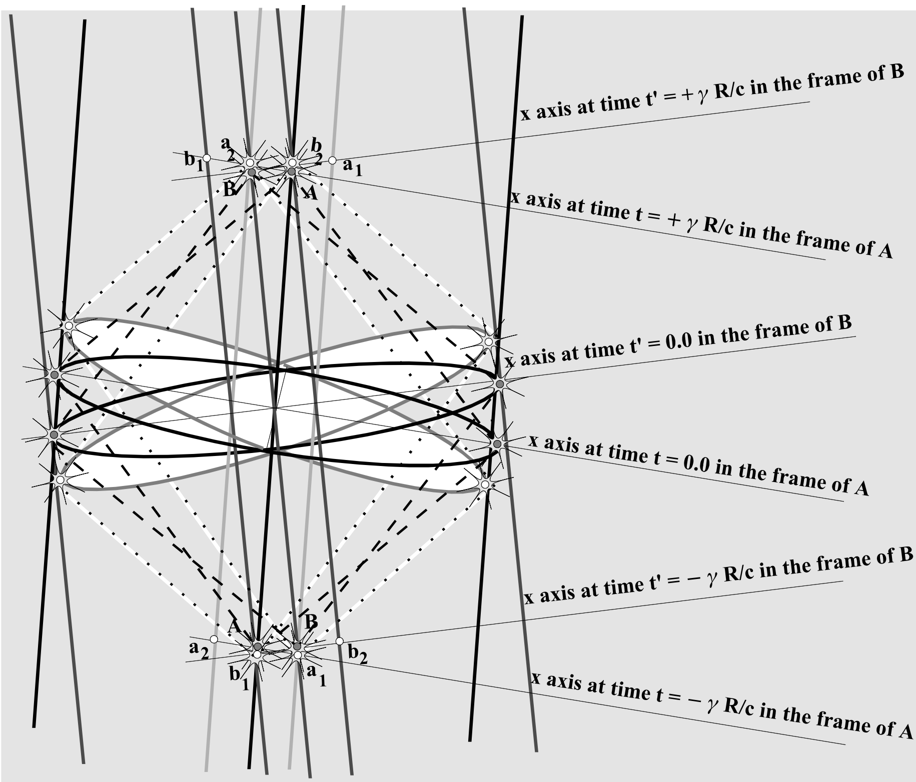


Figure 4: Illustration that the four unique types of events for two observers cannot be collapsed into two

Analysis of experimental results

In the reference frame of observer A we have now conducted two classes of timed experiment that involve two sets of light paths – one requiring a total duration of $\Delta t_A = 2$ R/c and the other $\Delta t_a = 2\ \gamma$ R/c. (It is interesting that the second time interval and the spacetime locations of all emission, reflection and detection events would remain unchanged if a fixed elliptically elongated mirror in the frame of A were substituted for the circular hoop mirror in B. In this case only atoms in A would be involved, with *no* relative motion. In such case, B_e and B_d would still be the *Lorentz correspondents* of a_{1e} and a_{2d} at emission and detection, respectively, according to the *mutual observability* maxim. Furthermore, reflection events off mirrors in the two frames would also be so-related.) Upon cursory inspection these results might appear to be completely in accord with the Einstein/Minkowski interpretation. However, that is *not* the case! The reason it cannot be the case is that our assumptions have introduced a *reductio ad absurdum* contradiction as follows:

In the reference frame of observer A we have established two classes of timed experiment that involve two sets of light paths that must be compared with associated time intervals in B. The duration Δt_a had been attributed to dilation of observer B's clock, but this time interval is now being measured exclusively by a clock for which the regular sequence of events involving light paths from a_1 to a_2 to a_3 to a_4,… is synchronized with observer A's clock, of course, although it involves a longer period than a repetitive reflection sequence of intervals A to A to A… etc.. But all these clocks are synchronized in the same frame and all agree about what time it is when the events occur as well as how long between emission and detection events for A and all his assistants.

By the relativity principle, observer B could perform the experiment to reach the same conclusions. He would determine that light diverging to, reflecting simultaneously at, and converging back from, his own circular hoop mirror requires a duration of time $\Delta t_B = 2$ R/c, while for that off of the mirror in A between analogous assistants b_1 and b_2 requires $\Delta t_b = 2\ \gamma$ R/c. He and his assistants use magenta and yellow light signals to complete the symmetry with what was set up in frame A. But we must now ask ourselves: "Are b_1 and b_2 *in actuality* in coincidence with A when he emits and detects his green light?" *Frame independence and mutual observability* resulting from Einstein's law *of the transmission of light* would insist that they must be. In which case, however, we have the situation where on the one hand a_1 and a_2 inspect B's clock while in coincidence to determine that B's clock must be *dilated*, i. e., observer B's clock measures $\Delta t_B = 2$ R/c, but it "really" takes $\Delta t_a = 2\ \gamma$ R/c according to A's clocks. So the assistants of A (and therefore A himself) might conclude that B's clocks have been *dilated*. Whereas observer A could inspect the clocks of b_1 and b_2 and conclude from their readings that they think it takes $\Delta t_b = 2$ γ R/c, but it "really" takes $\Delta t_A = 2$ R/c. Their clocks (although synchronized with B's) must, therefore, be *contracted* instead of dilated! Analogous observations with reversed conclusions can, of course, be made in observer B's frame of reference. So there is indeed a conflict.

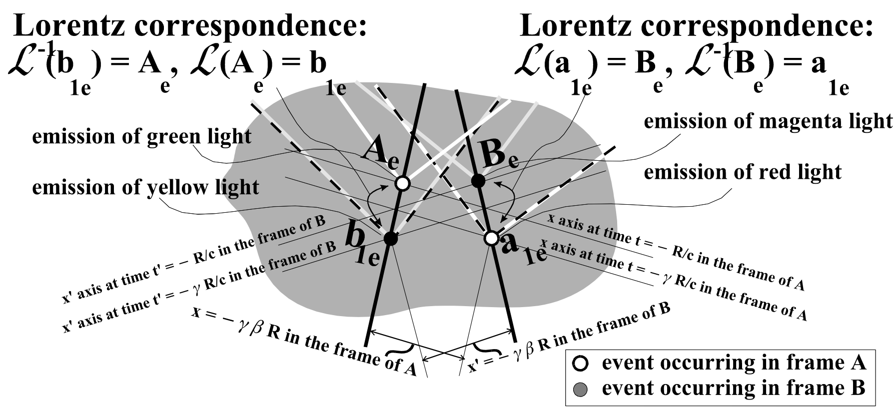


Figure 5: Detail of the four unique types of emission events for the two observers shown in figure 4

Obviously unilateral clock time dilation cann*ot* resolve the symmetric time differences between the two sets of *Lorentz correspondents* if we are to maintain that a_{1e} and B_e as well as b_{1e} and A_e are interchangeable emission events as required by frame independence. Observer B's synchronized clocks cannot be both *dilated* and *contracted* during the same time intervals.

Conclusion

So what has gone wrong? Obviously one of our assumptions is in error. The primary assumption was the veracity of *frame independence* and *mutual observability* of emission and detection events. It would appear that that maxim has failed our test. The Lorentz equations must relate *unique* events rather than merely assigning unique coordinate values involving clock time dilation and spatial contraction to *identical* events. So what is implied by rejection of *frame independence* and *mutual observability*?

Observationally relativity would not change all that much. We *would* have to acknowledge, however, that coincident emission, reflection and detection events in relatively moving frames, such as A_e and b_{1e}, B_d, and a_{2d}, as well as B_e and a_{1e}, and A_d, and b_{2d} in figures 4 and 5 each have their own independent existence and cannot be combined as merely sets of two *Lorentz correspondent* emission events A_e,b_{1e} and B_e,a_{1e}, etc. as we attempted earlier in figure 3, for example. Clearly, although figures 4 and 5 attempt to show both perspectives, the separated event pairs with one registered in each of the two frames of reference cann*ot* both occur simultaneously as is required by the *frame independence* and *mutual observability* hypotheses. The placement of combined events to describe the phenomena is impossible – either temporal or spatial coordinate positions fail to correspond with the determined values in one frame or the other. Similar interpretational differences were described in an earlier article by the author that provided a diagrammatic description of such differences in three-space. There are severe limitations on the capabilities of spacetime diagrams to portray situations for both of two observers A and B in one diagram as discussed above.

Clock time dilation and Lorentz contraction *would* have to be abandoned along with the associated paradoxes. The supposed confirmations of time dilation can consistently be attributed to altered state transition rates in the decay of matter caused by altered energies as described elsewhere. Although it is claimed that clock time dilation has been repeatedly "confirmed by experiment," what has actually been *confirmed* is that the rates of physical processes associated with transitions between energetic states of material particles are affected in accordance with a *time dilation factor*. But this is more reasonably interpreted as occurring *because* relative energy is inversely related to this same factor. It can be argued based on a preponderance of physical evidence obtained from quantum mechanical considerations of the 'clocks' themselves, therefore, that such *confirmations* of time dilation derive instead from a relationship of the half-lives of state transitions of the material particles between energetic states. Thus, since mass and energy are equivalent and both are increased by acceleration, the energetic state of high-energy particles should naturally decay more slowly without thereby involving modifications to clock time scale or observer perspective – in *any* uniformly moving frame of reference.

Since Lorentz contraction has long been known *not* to be an observable phenomenon and the appearance of binary stars impugn

Einstein's relativity as surely as any other relativity theory advanced to date, the state transitioning of elementary particle "clocks" have been the primary reason for accepting the *frame independence* and *mutual observability* hypothesis. A full explanation of radioactive decay must one day be put forward. The author believes that it will ultimately be shown to derive from a relationship between the state of the particle and that of the global universe – Mach's principle at work again. This would replace its current narrowly conceived origin as an internally timed but otherwise *causeless* random phenomenon.

The time intervals and distances for propagation of electromagnetic radiation (light) are now seen to be altered in accordance with the Lorentz equations *exclusively* on interactions between frames. The author believes that the time intervals can be shown to be effectively longer than the associated Euclidean geometrical distances and universality of the instantaneous speed of light would otherwise require because of spiraling effects caused by angular distortions to field vectors involved in the transverse wave functions of light propagation. This can be shown to derive from the aberration of two of the four electromagnetic field vectors involved in such interactions as briefly described by the author elsewhere. The author intends to publish a subsequent article that will describe a classical transaction theory of radiation compatible with the Lorentz correspondences that provides a consistent *observational relativity* without paradox. [It is included further on in this volume.]

From an experimental point of view, there would be no drastic change by adopting the alternative interpretation of the Lorentz equations that currently form the formal basis of Einstein's relativity. The radioactive decay experiments thought to have confirmed time dilation since Born's first hopeful observations concerning cosmic ray mesons, must merely be acknowledged now to have confirmed $E = m c^2$ and energy-dependent state transition probabilities of quantum mechanics instead. However, from epistemological perspectives there is an extreme difference. Observers in relative motion witness a totally unique universe sharing virtually no common events even when in momentary coincidence. The universe they each see is mapped uniquely even though events occurring on each moving object are in some sense *absolute* and ultimately accessible to each observer – if multiple photons are emitted as a part of the "event." Some of the events *this* observer witnesses (and the causal effects that are experienced) derive from events not yet observable by the *other*, whereas some events experienced by the *other* observer may not be observed by *this* observer for some time. Thus, it is not a naïve simplification due to a lack of appreciation for complexities of our situation in the universe (as so often insinuated of those who insist there are problems with relativity) that drives one to this alternative interpretation. It is adherence to the results of experiment which is the only way science works properly. It is propounded with full understanding that the universe is much more complex than acknowledged by an Einstein/Minkowski interpretation for which scale factors on the rods and clocks of the *other* observer were thought to have been sufficient to bring all the observations of uniformly moving observers into accord. That was imposed by naïve determinism constraints.

From a theoretical perspective, of course, relativistic models would have to be completely modified or discarded. Physics in the latter half of the 20th century has been enamored with spacetime manifolds, and although the spacetime mapping still applies between Lorentz correspondents, it no longer supports the extended concept of mapping complete manifolds of the dynamic universe itself between observers as their own private deterministic secret. Uncertainty arises in a properly understood relativity theory as surely as in quantum theory. While theoretical physics has been most productive in generating a diversity of cosmological models in our era based on this construct, these models are anchored experimentally primarily by Hubble's hypothesis of radial Doppler redshifts of distant astronomical phenomena and have not fared too well on fitting even *that* measured relationship. Minkowski's enthusiasm with regard to space and time forever being united as mere alternative directions in a deterministic four-space has hardly met with overwhelming success. It is difficult to project the impact of discovering error, but rejecting the concept of a unilateral mapping of spacetime between observers could very well produce a period of rebirth of discovery in both experimental and theoretical physics by reaffirming the need of each for the other. Moving on to new discoveries and hypotheses is the exciting part of physics – living.

…Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.

…Well, mathematics, though it now can display only staircase-wit, has the satisfaction of being wise after the event, and is able, thanks to its happy antecedents, with its senses sharpened by an unhampered outlook to far horizons, to grasp forthwith the far-reaching consequences of such a metamorphosis of our concept of nature.

– Herman Minkowski

A Precursor Transaction Theory of Radiation

The beginnings of a relativistic interaction theory of paired emission and absorption of electromagnetic radiation is presented here. The pairing of emission and absorption relates closely to work by Lewis[1], Wheeler and Feynman[2], Cramer[3], and others who have shown that propagation of light may require an explicit pre-association of emission and absorption events. Whereas optical predictions of this theory are identical to those of earlier electromagnetic theories for relatively stationary emitters and absorbers, observational relationships of relatively moving observers will have to be characterized in this theory as only a *Lorentz correspondence* as we will see. Time intervals and distances of propagation of electromagnetic radiation are altered in accordance with the Lorentz transformation equations *exclusively* on interactions *between* relatively moving frames of reference in a vacuum. The present theory accounts for experimental observations without imposing ineffectual changes to metrics of rods and clocks in the *other* frame of reference independent of interaction. For interactions between events *residing on* material objects in relatively moving frames of reference, light is shown to travel via a *unique* mode producing what must appear to each observer as spatiotemporal disparities of the other.

Terminology

This article will shy away from much in the way of difficult mathematical prerequisites, but equations will be presented where appropriate because there is much that can be inferred from an understanding of the symmetries of the equations and descriptions of the implied operations even by someone for whom the equations may seem obtuse. Descriptions will be explicit – graphic where possible – but attempts have been made to avoid the more difficult aspects of the associated mathematics. Some minimal understanding of vector products and divergence and curl differential operations on a vector is

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[1] G. N. Lewis, "The Nature of Light," ***Proc. N. A. S.***, 12, 22-29 (1926).

[2] J. A. Wheeler and R. P. Feynman, "Interactions with the Absorber as the Mechanism of Radiation," ***Rev. Mod. Phys.***, 17, 157-181 (1945).

[3] J. G. Cramer, "The transaction Interpretation of Quantum Mechanics," ***Rev. Mod. Phys.***, 58,3, 647-687 (1986); "Generalized Absorber Theory and the Einstein-Podolsky-Rosen Paradox," ***Phys. Rev. D***, 22, 2, 362-376 (1980).

essential to an understanding of electromagnetic field theory, of course. These definitions in Cartesian coordinates are as follows:

Inner or dot product: $\mathbf{U} \bullet \mathbf{V} \equiv U_x V_x + U_y V_y + U_z V_z$

Outer (*cross*) product:
$\boldsymbol{U} \times \boldsymbol{V} \equiv \boldsymbol{i}(U_y V_z - U_z V_y) + \boldsymbol{j}(U_z V_x - U_x V_z) + \boldsymbol{k}(U_x V_y - U_y V_x)$

Gradient: $\nabla \alpha \equiv \boldsymbol{i}\, \partial\alpha/\partial \mathbf{x} + \boldsymbol{j}\, \partial\alpha/\partial \mathbf{y} + \boldsymbol{k}\, \partial\alpha/\partial \mathbf{z}$

Divergence: $\nabla \bullet \boldsymbol{U} \equiv \partial \boldsymbol{U}_x/\partial \mathbf{x} + \partial \boldsymbol{U}_y/\partial \mathbf{y} + \partial \boldsymbol{U}_z/\partial \mathbf{z}$

Curl:
$\nabla \times \boldsymbol{U} \equiv \boldsymbol{i}(\partial U_z/\partial \mathbf{y} - \partial U_y/\partial \mathbf{z}) + \boldsymbol{j}(\partial U_x/\partial \mathbf{z} - \partial U_z/\partial \mathbf{x}) + \boldsymbol{k}(\partial U_y/\partial \mathbf{x} - \partial U_x/\partial \mathbf{y})$

In the above definitions, ***U*** and ***V*** are vector fields; α, U_i's, and V_i's are scalars. The scalar U_x is the component of the vector ***U*** along the x axis. The *right-hand rule* (see figure 1) states that if you use the fingers on your right hand to indicate the direction of rotation of ***U*** into ***V***, then the extended thumb will be the direction of the vector *cross* product. In these definitions, ***U*** is a vector function of x, y, z, t. The *basis* vectors *i, j, k* are unit vectors in the directions of the x, y, z axes, respectively. The vector $\partial \boldsymbol{U}/\partial s$ is the partial derivative (the "slope" – or rate of change – of the vector function ***U***) with respect to the independent variable s. Scalars $\partial \boldsymbol{U}_i/\partial s$ are the partial derivatives of scalar components of ***U*** with respect to the independent variable s. The electric field ***E*** is, for example, the gradient of a scalar potential field. Note: Determining the *divergence* and *curl* of a vector is sufficient to determine the vector to within a vector constant throughout the region.

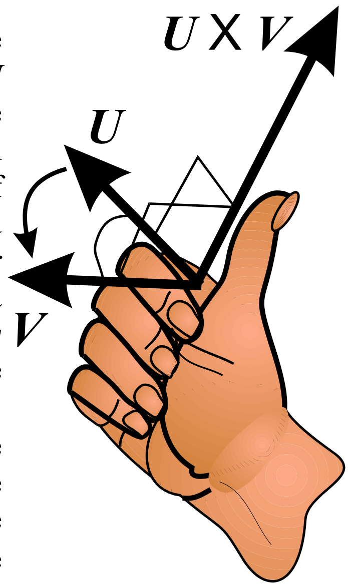

Figure 1: Right-hand rule

Electromagnetic theory

In the interaction theory of radiation being investigated here, all of the overwhelming evidence of experimental confirmation of the theoretical origins of electromagnetic theory remain unchallenged and have intentionally not been altered. Maxwell's differential equations consolidate these results and are, therefore, accepted without change. They are:

1) Coulomb's law: *macroscopic* field – inhomogeneous equation

$$\nabla \bullet \boldsymbol{D} = \rho$$

2) No monopoles: *microscopic* field – homogeneous equation

$$\nabla \bullet \boldsymbol{B} = 0$$

3) Faraday's law: *microscopic* fields – homogeneous equation

$$\nabla \times \boldsymbol{E} = -\, \partial \boldsymbol{B} / \partial \mathrm{t}$$

4) Amphere's law: *macroscopic* fields – inhomogeneous equation

$$\nabla \times \boldsymbol{H} = \boldsymbol{J} + \partial \boldsymbol{D} / \partial \mathrm{t}$$

In these equations in *rationalized mks* units experimentally known vector functions ***D***, ***H***, ***E***, ***B***, and ***J*** are related one to another.[5] Scalar function ρ is the *charge density* throughout the region for which the equations pertain. The vector quantity ***J*** is a characterization of the amount and direction of *conduction current* throughout the region. Boundary conditions of the region to which the equations are to pertain may further constrain the relationships among the various vector field quantities. The relationships define a nearly symmetric cycle; if ρ and ***J*** vanish throughout the region, all the equations become homogeneous differential equations of identical form and the symmetry is obviously complete. Since we will be dealing with the propagation of light in a vacuum, this symmetry will be assumed throughout the remainder of this article. Of the four remaining vector field quantities, two involve fields associated with electrical effects and two involve fields associated with magnetic effects. Two *constitutive* relation equations

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[5] The quantum theory of light does not substantially alter the results of Maxwell's approach that was historically significant to the development of relativity and so we will go with that more intuitive approach. This is in accordance with decisions by Wheeler and Feynman, and Cramer cited above in their similarly motivated analyses. The fashionable *geometrical* approach using generic differentiation of an *electromagnetic field strength tensor* to represent these equations, while economical in terminology, de-emphasizes the integrated nature of emission and absorption processes envisioned here, since typically the tensor has been deployed using exclusively *microscopic* fields.

define and relate dual *microscopic* and *macroscopic* electric and magnetic fields as follows:

5) electrical: *macroscopic* field relation to *microscopic* field

$$\boldsymbol{D} = \varepsilon \boldsymbol{E}$$

6) magnetic: *macroscopic* field relation to *microscopic* field

$$\boldsymbol{H} = \mu^{-1}\boldsymbol{B}$$

where ε is the *permittivity* and μ the *permeability* of the medium. Both these quantities are typically scalars, but in certain media there are anisotropic distortion effects that can be characterized by a tensor representation of these quantities. These two equations reflect the fact that only one of the quantities (called the *microscopic* field – on the right) in each field category will be associated directly with emission; it is independent of the structural characteristics of interacting media throughout the region of consideration. The other two are *induced* in part by the *microscopic* fields and are called the *macroscopic* fields; these words have to do with *externality* of origination rather than *size* in electromagnetic theory. In a vacuum, the scalar constitutive coefficients are typically identified as μ_o and ε_o, whose values depend upon the system of units chosen. The speed of propagation of a wave function that satisfies Maxwell's equations will be seen to be determined by these quantities and in particular for propagation in a vacuum, that instantaneous speed will be:

7) speed of light in vacuum:

$$c \equiv (\mu_o\ \varepsilon_o)^{-1/2}$$

In addition to Maxwell's equations, one must acknowledge the role of the *Lorentz force* on isolated charges as of extreme relevance to electrodynamics where there is relative motion of the charge in *microscopic* electromagnetic fields. It is given by:

8) Lorentz force: *microscopic* fields

$$\boldsymbol{L} = q\,(\,\boldsymbol{E} + v\ \times \boldsymbol{B}\,)$$

where q is the scalar quantity of a specific charge that is in motion and v is the vector velocity of the charge relative to a test charge of unit magnitude experiencing the force. Thus the instantaneous electromotive force on a unit charge depends on magnetic as well as the usual electric forces in that case.

Deriving and solving radiation wave equations

Derivation of the wave equations from Maxwell's equations is problematical in several regards. Although there are two *microscopic* (2 and 3) and two *macroscopic* (1 and 4) equations, substitutions using *constitutive* relations (5 and 6) must be used to obtain the wave equations. The implications of the original four field equations which seem clear can easily be lost in the process of solution. For example, by these substitutions, solutions can be obtained for the *microscopic* fields E and B with the resulting equations looking *as though* they should be interpreted as the fluctuating electric and magnetic fields of an emitter *independent* of the medium or the ultimate absorber of the radiation. Here only the speed of propagation appears to be affected by the medium:

9) $\nabla^2 \boldsymbol{E} = -\,\mu\varepsilon\,\partial^2\boldsymbol{E}/\partial t^2$

10) $\nabla^2 \boldsymbol{B} = -\,\mu\varepsilon\,\partial^2\boldsymbol{B}/\partial t^2$

The definition of $\nabla^2\boldsymbol{U}$ is elaborated from the definitions above as the dot product of a gradient operator:

$$\nabla^2\boldsymbol{U} \equiv \nabla\bullet\nabla\boldsymbol{U}.$$

The wave equations themselves derive from the vector identity,

$$\nabla\times(\nabla\times\boldsymbol{U}) \equiv \nabla(\nabla\bullet\boldsymbol{U}) - \nabla^2\boldsymbol{U}$$

and substitutions from constitutive relations into Maxwell's equations.

The wave equations 9) and 10) each derive directly from Maxwell's equations 3) and 4) in addition to either 1) or 2) with constitutive relation substitutions occurring twice in the process. So these are hardly isolated conditions applicable solely to an emitter.

These equations describe propagational wave phenomena. In general the solutions will be complex quantities, only the real parts of which are of any interest experimentally. Solutions are shown in figure 2; they are of the form:

11) $\boldsymbol{E} = \boldsymbol{E}_o\, e^{\pm i(\kappa\cdot r - i\,\omega t)}$

12) $\boldsymbol{B} = \boldsymbol{B}_o\, e^{\pm i(\kappa \cdot r - i\,\omega t)}$

$\boldsymbol{E}_o$ and $\boldsymbol{B}_o$ are constant vectors for plane polarized waves. Substitution back into Maxwell's *divergence* equations results in further constraints on ***E*** and ***B*** such that both must be perpendicular to the direction of propagation given by the *wave vector* κ, whose magnitude is given by $\kappa = (\mu\,\varepsilon)^{1/2}\omega$. (The *angular frequency* of the radiation is ω.) This constraint is the basis of the *transverse* wave nature of light. Substituting into Maxwell's *curl* equations places additional constraints on ***E*** and ***B*** such that they must always be in phase, equal in magnitude, and at right angles to each other. By superposition of linearly independent solutions with uniquely paired $\boldsymbol{E}_o$ and $\boldsymbol{B}_o$ values, one obtains the more general elliptical polarization solutions – plane and circular polarization being the special cases shown in figure 2.

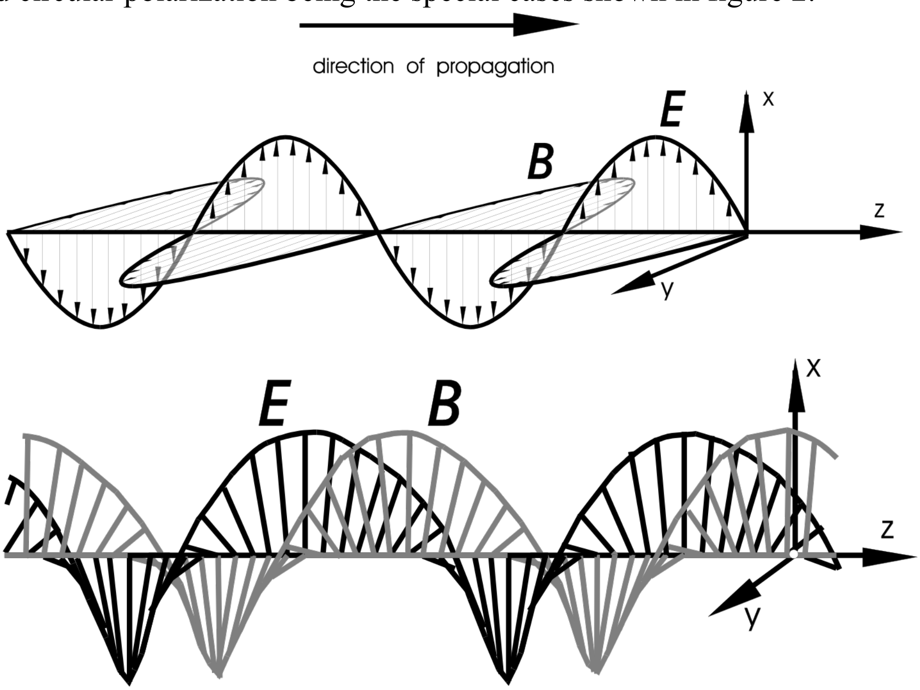

Figure 2: Plane and circularly polarized solutions of Maxwell's homogeneous differential equations

Are there preferred solutions to Maxwell's equations?

It is apparent that Maxwell's equations may be used to determine valid solutions for all four of the fields. But which wave equations (if any) *inherently couple* as a single transverse wave? In other words, do ***E*** and ***B***, ***E*** and ***H***, ***D*** and ***H***, or ***D*** and ***B*** constitute the most meaningful description of the radiation we associate with these equations? With such a plethora of possibilities, which (if any) of these solutions should be preferred?

Radiation energy density and energy flow (as electromagnetic *momentum*) equations both involve equally coupled *microscopic* and *macroscopic* fields for each as follows:

13) energy density: $u = ½ (\boldsymbol{E} \bullet \boldsymbol{D} + \boldsymbol{B} \bullet \boldsymbol{H})$

14) energy flow: $\boldsymbol{P} = \boldsymbol{E} \times \boldsymbol{H}$

The latter Poynting vector symbolizes the *transverse* nature of electromagnetic radiation (refer to the *right hand rule* above for an intuitive feel) that distinguishes it from *longitudinal* vibrations characteristic of sound propagation, and *this* equation clearly indicates equal participation by *macroscopic* fields associated with the medium and/or absorption. With only an emitting and an absorbing atom under consideration, ***E*** would clearly be associated with the emitter, ***H*** with the absorber. Thus, energy and momentum considerations would seem to suggest that ***E*** and ***H*** occupy preeminent positions, as the fields most naturally characterizing radiative energy transfer.

Proponents of absorption theory have advocated an equal role for absorption to the one usually associated exclusively with emission. They have pointed out that, in addition to field alternatives, there are two sets of valid solutions to *whichever* set of wave equations are selected. One of these alternatives – identified as the *retarded potential* solution (associated with propagation from the emitter toward the absorber) – has been the traditionally selected solution to Maxwell's equations. The other allowed solution identified as the *advanced potential* solution (associated with propagation from the absorber toward the emitter) was subsequently proposed as being equally legitimate by Wheeler and Feynman.[6] Naturally the *retarded* solution was exclusively in vogue until absorption theory was seriously considered, the *advanced* solution having always seemed to correspond to the *non-physical* situations of a signal *arriving* at the moment that emission occurs as though by divine intervention.

More recently Cramer has proposed a similar reinstatement to vitalize a "transaction interpretation" of quantum mechanics. He demonstrates the role of the two waves as illustrated in figure 3 taken from his presentations.[7]

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6 Wheeler and Feynman, ***Op. cit.***
7 Cramer (1986), ***Op. cit.*** p. 659.

Here there is an arithmetic assignment of plus and minus signs to be associated with advanced and retarded waves, but nothing that could be considered a *physical* assignment specific to the roles of emission and absorption so clearly integral to this whole process. None of these early investigators allocated fields specific to material entities associated with emission or absorption. The conclusion that redundant sets of solutions are involved equally in the transaction is a conclusion that absorption theorists have long maintained by advocating acceptance of both the plus and minus signs in the exponential expression of the wave solutions provided in the equations 11) and 12). Perhaps physical fields should also be acknowledged as being uniquely associated with these two solutions as well, rather than merely including solutions with an arbitrary mathematical sign change. This would restore physically meaningful interpretations to the two solutions. There is more to it than a mere arbitrary sign change.

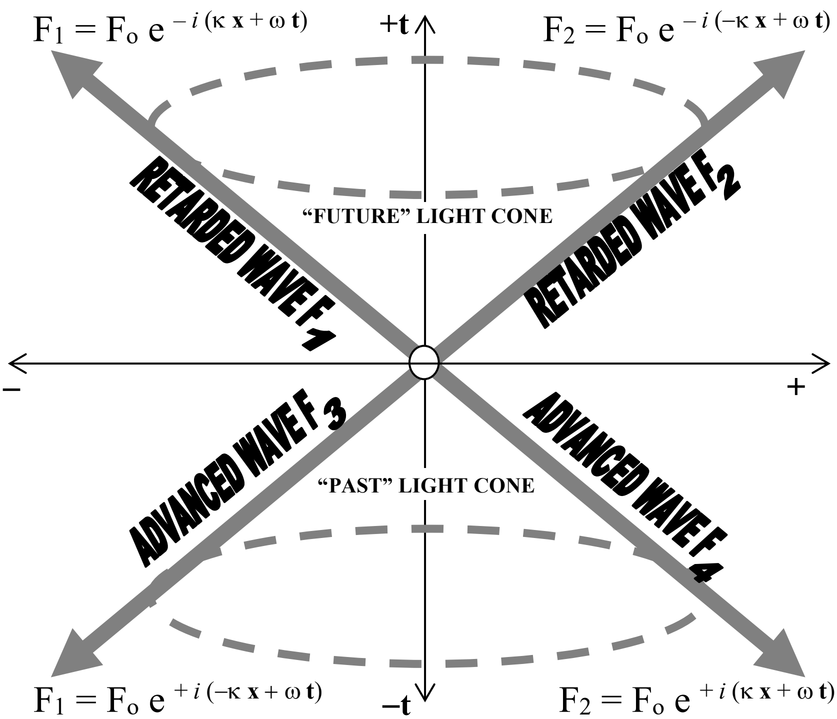

Figure 3: Minkowski diagram showing the propagation of advanced and retarded waves from emission at (x,t)=(0,0)

This reluctance to make distinctions between the frame of reference of the fields is no doubt an outgrowth of the frame independence that has resulted from Einstein's *law of the transmission of light* for which it should make no difference in which frame the source of the emission and the absorber of the radiation happen to reside. Thus, the absorption theorists did not allocate *macroscopic* fields associated specifically with *absorption* or the *microscopic* ones with *emission* as seems reasonable to this author. Nor did they attempt to exploit complimentary symmetries among the fields, which would seem so natural to that endeavor. If we had solved Maxwell's equations for ***H*** and ***D*** instead of ***E*** and ***B***, for example, we might in effect have solved for what could be called an *absorber wave equation* as against an *emitter wave equation.*

For additional reasons to be described further on, the author does not believe these to be precisely valid designations. As we've come to find out, transmission requires interaction. For that reason, we need to involve both emission and absorp-tion fields in each wave equation; that is the driving force. Perhaps we are discovering why *four*, seemingly redundant, rather than just *two* such field vectors are required to fully determine electromagnetic transact-tions even in a vacuum.

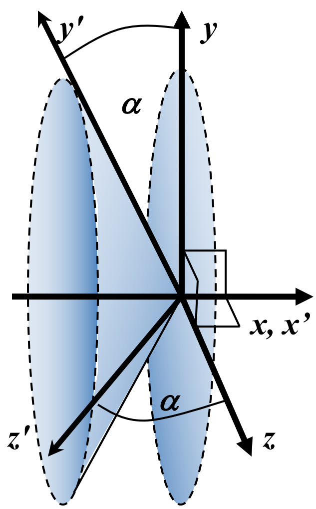

Figure 4: Distortion caused by relativistic aberration that destroys mutual orthogonality conditions relevant to transmission of electromagnetic radiation between relatively moving frames of reference

Of course, when dealing with a relatively stationary emitter and absorber there would be no measurable difference, but in dynamic situations epistemological differences abound that are not apparent in a static case as has been illustrated. These differences derive from directional distortions illustrated in figure 4.

We have pursued implications of this distortion in earlier articles where we demonstrated that such alignment differences between the absorber and emitter result in a helical light transmission path responsible for Lorentz relationships that are characteristic of relative motion.

‘Observational’ Relativity

SOME MORE BACKGROUND ON SPECIAL RELATIVITY

In less abstract treatments on the subject of relativity including Einstein's original presentation, one generally finds an illustration of two sets of orthogonal axes, one for each of two relatively moving observers. Figure 1 is typical of these. In it, two observers have established coordinate frames of reference complete with mutually aligned x, y, and z axes. This seems to be considered to have didactic value for an understanding of the problems of relative motion encountered by two such observers.

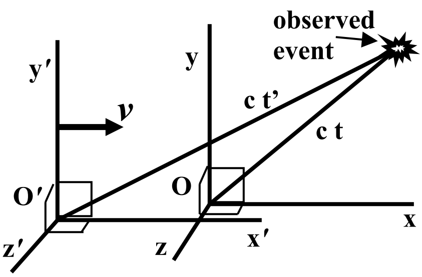

Figure 1: Mutually aligned coordinate reference frames

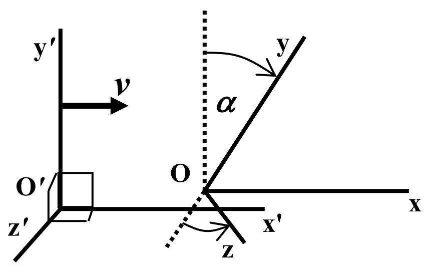

Figure 2: Observations of other frame

With regard to this typical first step Einstein had quite considerable to say. For instance, “*In the first place we entirely shun the vague word ‘space,’ of which we must honestly acknowledge, we cannot form the slightest concepttion, and we replace it by ‘motion relative to a practically rigid body of reference.*’”[1] Then, again, “*Let us in stationary space take two systems of coordinates, i. e. two systems, each of three rigid material lines, perpendicular to one another, and issuing from a point. Let the axes of X of the two systems coincide, and their axes of Y and Z respectively be parallel....*"[2] And then he proceeded to establish equations that would distinguish coordinate observations made relative to the two reference frames. The strange thing about this is that the equations *do not* match the illustration. It is impossible, in fact, to align such axes as specified! If one uses the equations to create the illustration of the respective axes, one obtains what is shown in figure 2 instead. Relativistic aberration comes into play and two such observers can't

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[1] Einstein, A., ***Relativity – The Special and General Theory***, Crown, New York 1961, p. 9.

[2] Einstein, A., “On the Electrodynamics of Moving Bodies,” ***The Principle of Relativity*** , Dover, Toronto, 1952, p. 43

really agree about such a picture involving *both* their frames of reference. When the position of events occurring along the y and z axes of the 'other' frame are calculated using the Lorentz transformation, the axes are *not* mutually orthogonal as originally specified, but tipped at an angle α, where $\sin \alpha = v/c$. Now this does not particularly shock me since I'm used to it, and know it to be a fact, but I am not in denial about it either, as all novices and many experts seem to be.

Given any direction in space for one observer, the corresponding direction for the other (complete with star or quasar at the end of the line of sight) can be determined by the *relativistic aberration formula*, which is easily derived from the Lorentz transformation equations by determining

$$\cos \theta = x / \sqrt{x^2 + y^2 + z^2}$$

in the two reference frames and determining values of x', y', z' in terms of x, y, z, t from the Lorentz transformation, which we will henceforth refer to as $\mathfrak{L}_{v}\cdot(t,x,y,z)$ as follows:

$$t' = (t - v\, x/c^2) / \sqrt{1 - v^2/c^2}$$

$$x' = (x - v\, t) / \sqrt{1 - v^2/c^2}$$

$$y' = y,$$

$$z' = z.$$

So (ignoring z for simplicity) the aberration angle formula becomes:

$$\cos \theta' = [(x - v\,t) / \sqrt{1 - v^2/c^2}] / \sqrt{[(x^2 - 2\,v\,x\,t + v^2\,t^2) / (1 - v^2/c^2)] + y^2}$$

$$= (x - v\,t) / \sqrt{(x^2 - 2\,v\,x\,t + v^2\,t^2) + (1 - v^2/c^2)\,y^2}$$

$$= (\cos \theta - v/c) / \sqrt{(1 - 2\,v \cos \theta + v^2/c^2 \cos^2 \theta)}$$

$$= (\cos \theta - v/c) / (1 - v/c \cos \theta)$$

Aberration was experimentally observed by Bradley in early attempts to measure the velocity of light. Such an effect was expected long before the full weirdness of relativity was suspected. But the expected magnitude of the effect in classical physics using the Galilean transformation was somewhat different. It was the following:

$$\cos\theta'' = (\cos\theta - v/c) / \sqrt{1 - 2\,v\cos\theta + v^2/c^2}$$

In figure 3 both relativistic aberration angles determined from the Lorentz equations and the classical construction are shown. (Notice that although coordinate values from both frames of reference are shown in this illustration, this is only in the sense of superimposing the values that each observes relative to *his own* frame of reference. So the compar-isons are in all cases between intern-ally consistent relationships.)

The relativistic aberration formula is a primary instrument for determining relationships that are actually observed in experimental verifications of relativity. That is why it was so important to Penrose's article in particular, where it was shown that objects would merely appear rotated through this angle rather than Lorentz-contracted. Radiation frequency and wavelength are also determined using relativistic Doppler formulas derived from this source. It is, therefore, a key mathematical construct for measurements, whose interpretations suggest the epistemological significance of relativity itself. It is the *crux* of special relativity, if you will.

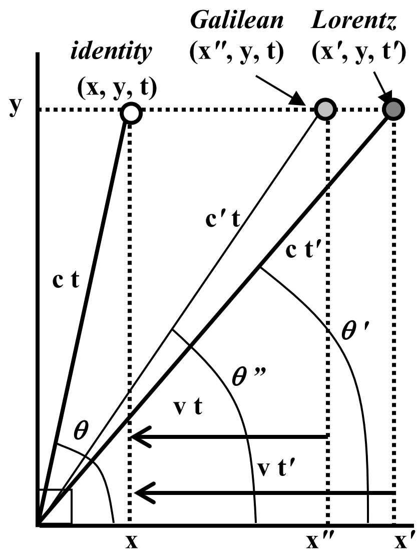


Figure 3: Classical and relativistic aberration models

DIFFERENT PERSPECTIVE ON RELATIVISTIC ABERRATION

The aberration (and Doppler) formulas are responsible for most all of the direct observational predictions of relativity. Questions concerning the physical meaning and origin of an associated effect must be answered in terms of the origin of *this* formulation, *not* the Lorentz transformation. This is true even though the equation can be seen to derive directly from the Lorentz transformation as we showed above. The reason that one can remove such from this supposed source is because of the following facts:

1) Although the aberration formula was derived from the Lorentz transformation,

2) The same formula can be derived also from a different transformation,

3) So observation cannot confirm *both* nor, therefore, *either* origin of these effects.

Let us consider whether item 2) above is, in fact, the case with regard to the relativistic aberration formula. We proceed by inspecting the third line of the derivation on the previous page; you will find that a transformation $\Theta_{v'}(x,y,z,t)$, given by:

$$t'' = t - v\,x / c^2$$

$$x'' = x - v\,t\,,$$

$$y'' = y\,\sqrt{(1 - v^2/c^2)}\,,$$

$$z'' = z\,\sqrt{(1 - v^2/c^2)}\,,$$

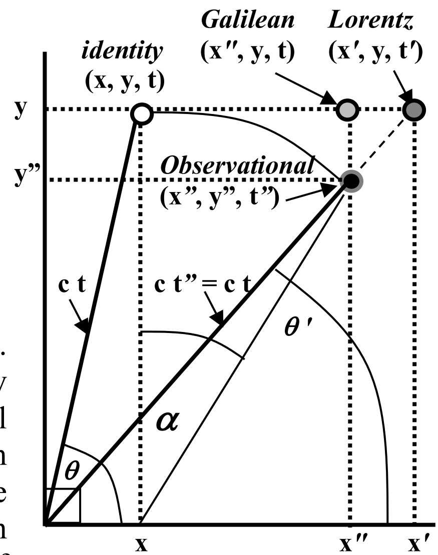


Figure 4: Equivalent but alternative relativistic aberrations

results in precisely that same formula. Notice that it produces a very different result than the classical Galilean transformation even though the x coordinate values happen to be the same. It produces, in fact, an identical functional dependence of cos θ' on cos θ as the Lorentz transformation. In figure 4 we show the classical Galilean, Lorentz, and also this ‘observational’ rotation transformations of (x,y,t). The latter effects only a rotation of the y coordinate distance onto a line of sight determined by the Lorentz transformation. The rotation angle is shown as α, where again sin α = v/c. The relationship of what the relatively moving observers will actually *observe* from a single event will be the same without regard to which coordinate location (x′, y′, t′) or (x″, y″, t″) is epistemologically "correct" as far as assigning a *position* to the event in the spacetime of either observer. All aberration and Doppler effects will ensue the same in either case, etc.. So although adherents may argue about what the situation is in *reality*, by and large their scientific measurements remain unaffected by such arguments.

Before proceeding, we should further clarify the definition of the transformation O_V since we have so far dealt exclusively with the case of an event from a relatively moving object approaching the observer. Whether relative motion is toward or away from the observer is very significant. This would be obvious if we redrew figure 2 for the case where the event (presumed to be from an object stationary with respect to O) were moving away from O' even though the velocity is unchanged, i. e., an event in the negative x half-space. In that case the rotation would be toward negative values of x for O' rather than the other way around. This case also involves the situation of a positive velocity in the positive x half-space of O'. The two cases of *toward* and *away* are easily discriminated by the switch:

$$\sigma \equiv d|x|/dt \,/\, |v| = x\,v \,/\, |x|\,|v| = \pm 1 = \begin{cases} \mathbf{1} \rightarrow \text{away} \\ \mathbf{-1} \rightarrow \text{toward} \end{cases}$$

Using this switch the distinction between motion *toward* and *away from* can then readily be taken into account in algebraic expressions. Notice that the juxtapositioning of x and v is not intended as a dyadic vector construct, but merely to indicate that the product of the signs of x and v effect the switch.

Observational transformations pertain to relations between the observations of an actual observer and a hypothetical instantaneously coincident observer stationary with respect to the object being observed since no such actual coincidences with sufficient velocity are available. Objects (usually atoms associated with larger objects) are the sources of observed events and it is the observer's position with regard to the location on the object that is key, and whether that location on the object is approaching or receding from the observer. The forward (or backward) rotation through the angle α is as shown in figure 4 for the two cases. In matrix notation the switching can be represented as follows:

$$\begin{bmatrix} \boldsymbol{t'} \\ \boldsymbol{x'} \\ \boldsymbol{y'} \\ \boldsymbol{z'} \end{bmatrix} = \gamma^{\sigma} \begin{pmatrix} \gamma & -\gamma\beta & 0 & 0 \\ -\gamma\beta & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{bmatrix} \boldsymbol{t} \\ \boldsymbol{x} \\ \boldsymbol{y} \\ \boldsymbol{z} \end{bmatrix}, \text{ implying if } \sigma = -1\text{:} \begin{pmatrix} \boldsymbol{t'} = \boldsymbol{t} - \beta \boldsymbol{x} \\ \boldsymbol{x'} = \boldsymbol{x} - \beta \boldsymbol{t} \\ \boldsymbol{y'} = \alpha \boldsymbol{y} \\ \boldsymbol{z'} = \alpha \boldsymbol{z} \end{pmatrix}$$

Here we have changed to the handier units of velocity in terms of the speed of light c, such that:

$\beta \equiv v/c \equiv$ v in units of c,

$\alpha \equiv (1 - \beta^2)^{½} = \gamma^{-1}$

The sense of this involving rotation rather than contraction and dilation was shown in figure 4. If the velocity is reversed, i. e., if:

$\sigma = +1,$

then the rotation is also reversed by the sequence: E" = γ E' followed by E = $\mathscr{L}_v$ E", which is equivalent to E = $\mathcal{O}_{-v}$ E' and we obtain the original observer's event coordinates:

$$\left\{\begin{matrix} t" & = & t \\ x" & = & x \\ y" & = & y \\ z" & = & z \end{matrix}\right\} .$$

IMAGE PROJECTION IN THE NEW SCHEME

In light of earlier discussions of Penrose's determination that high-speed objects would not appear contracted, let us see what a similar analysis produces for what we are calling the 'observational' transformation.[3] To accomplish this we'll repeat analyses illustrated above pertinent to Penrose's conclusion based on using the Lorentz transformation, but for the *observational* transformation in this case. The author showed a certain amount of disdain for the instrumentalist approach to what the author perceives as an ontological problem of whether contraction actually *occurs* or not. If the exclusive purpose of science were merely to provide a means of *calculating* a result, instrumentalism would be completely justifiable. But to maintain with Einstein that length contraction of rigid bodies *actually occurs* although as incorporated in the theory it cannot be observed, one would have to argue that *only* Lorentz transformations produce the observed effect found by Penrose. Brief inspection has shown this claim to be unwarranted. For the observation transformation identified here, effects *other* than contraction and time dilation come into play, but since it does account equally well for observation, a valid reason to accept unobserved features might be that the approach is somehow *simpler* in the sense of Occam's razor. But it isn't!

[3] Penrose, R., "Apparent shape of a relativistically moving sphere," ***Cambridge Philosophical Society Proceedings***, Vol. 55, Pt. 1 (January 1957), pp. 137-139

Figure 5 replicates pertinent aspects of that analysis. (Notice that in this figure $\theta = \pi / 2$, i. e., the ball is situated in a direction vertical to that of relative motion for observer O.) In this version of the figure, we superimpose the constructs of the observational transformation conjecture onto the same chart with those formerly applied from the established theory using Lorentz transformations. Event-by-event rotation results in a replication of the diameter at A_1A_3 to a position closer to the observer by the factor $\sqrt{(1 - v^2/c^2)}$ than for the Lorentz transformed events that are also shown. Since in this transformation also the speed of light is demonstrably universal using Einstein's methods, $E''_1 = \mathcal{O}_v \cdot E_1$ would be seen before $E''_3 = \mathcal{O}_v \cdot E_3$, by O′. So light from the area A_1 on the ball will have to be emitted after that from A_3 from the perspective view of O′ in order to see both at the same time. So the ball moves the distance $\Delta d''$ in this time interval $\Delta t''$, which is just sufficient to produce the normal width of the A_1A_3 diameter of the sphere tipped at the angle α as shown.

You'll notice that in the Lorentz transformation version of this analysis time and distance intervals were longer to make up for more distance having to be covered by the Lorentz "contracted" ball. This is because the three dimensional norm of the Lorentz transform is not unity as is the case for the observational transformation, i. e., $|\mathcal{L}_v|_3 = \gamma$; $|\mathcal{O}_v|_3 = 1$, where $\gamma = 1/\sqrt{(1 - v^2/c^2)}$. We can reverse this to get the ball back where it 'belongs' for O. But, if we perform the same analysis for a ball that is stationary relative to O′ we will find as before, that it is now rotated in the other direction for O' so as to be further away (although now along the y axis for O) as it is for O′. What they both see will appear at the very same three-dimensional distance because this transformation, $\mathcal{O}_{-v}$ involves an *actual* rotation, merely reversing the direction of α shown in figures 4 and 5, rather than a *skewed* rotation.

Poetic license has been taken in these figures to show objects from a perspective that is orthogonal to that suggested at the left in the figure 5, which is also how the inset was drawn. In this way we will see the faces of the clocks as the observers at O and O' would, for example.

CLASSES OF RELATIVISTIC VISUAL OBSERVATIONS

There are four appearance relationships that pertain in the context of relativity. In figure 10 we indicate the four cases that were discussed also with regard to Penrose's analysis, namely:

I. O observes the ball in O.

II. O′ observes the ball in O.

III. O′ observes the ball in O′.

IV. O observes the ball in O′.

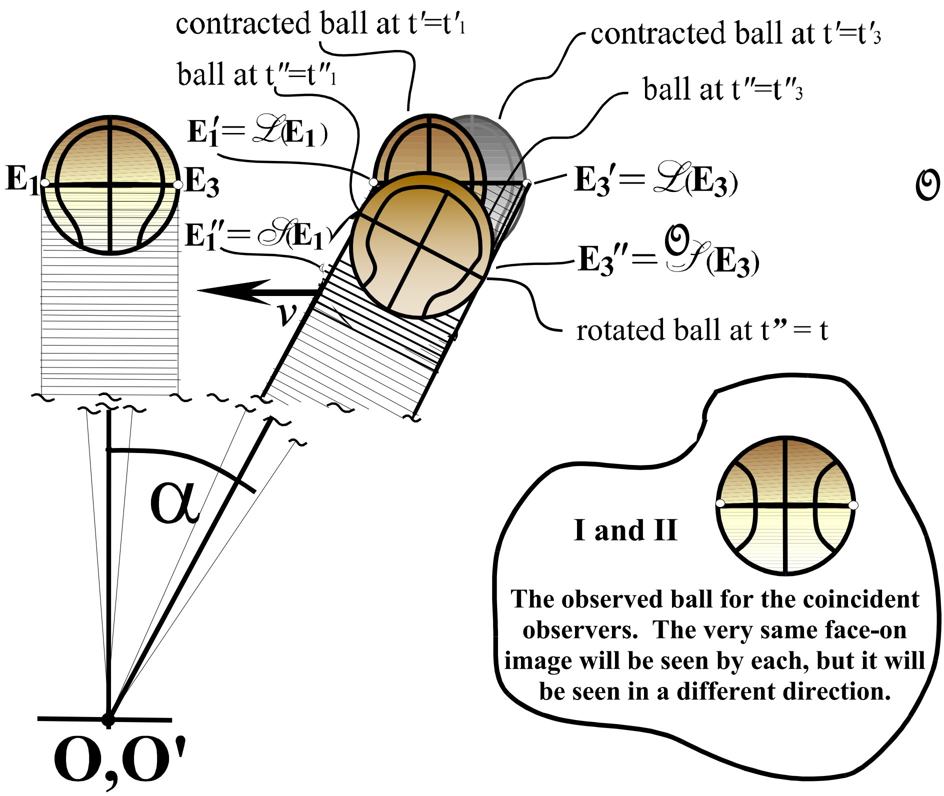


Figure 5: Two theoretical constructions for the same observed phenomenon

It is germane that in the observational relativity model for the categories I and II the ball is observed as closer to each observer than for cases III and IV as shown in figure 6. This is because the objects *are* closer to the two observers in these cases. So the images in cases III and IV would actually appear slightly smaller in *both* of the two dimensions than images for I and II but only in a perspective sense in both dimensions not involving any apparent contraction. So figure 1 in the article beginning on page 63 that describes Penrose’s analyses, the depiction is not realistic. It is merely two separate depictions superimposed upon one another. Both the observers see the other's ball as at a different angle, but at the same distance and orientation as that observer does.

A similar situation holds for wall clocks. For the observational model this is shown in figure 7. *Apparent* contraction is just the projection of a rotated clock face in cases III and IV. This same three-dimensional rotation effect is seen better in figure 6 with basketballs. Of course, the *only apparent* time dilation is seen to derive from additional time required for light to propagate the additional distances involved.[4] It is important that there be consistency between observed physical effects and the apparent workings of clocks; *this* paradox seems never to have been properly addressed before.

Of course Lorentz transformations don't accommodate the three-dimensional aspect of agreement of distance; objects slide back and forth at the same distance from the x axis. Nor did Penrose suppose his "transformation of the field of vision" to rectified this. In observational relativity it does.

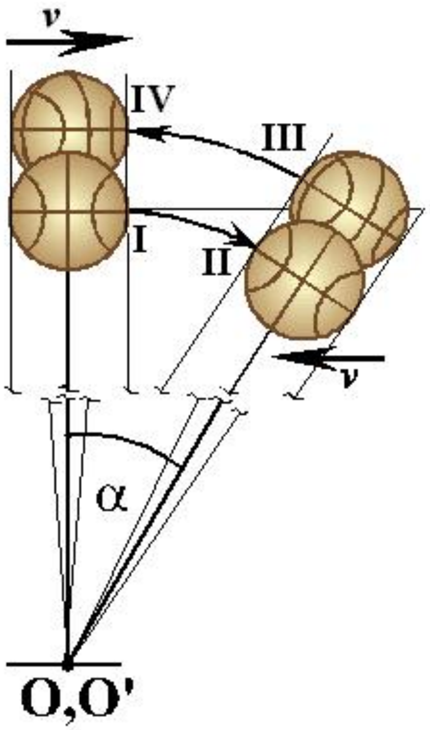


Figure 6: Four types of visual images of spherical objects

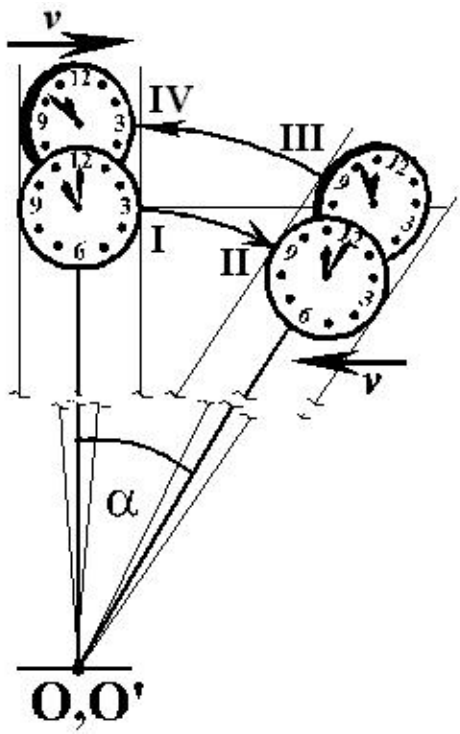


Figure 7: Four types of visual images of clock faces

[4] To understand why unstable states of matter that seem to collaborate time dilation actually *do not*, refer to the discussion in the earlier article on pages 50 – 54.

Certainly there is *more* to Special Relativity than the aberration formula and the universality of the speed of light in vacuum – both of which apply equally to the observational model. In his initial paper Einstein made a point of relativity being largely about electrodynamics. In particular he cited the *principle of relativity* as necessitating covariant formulations of the laws of physics to be shared by relatively moving observers. Having established the Lorentz transformation by his peculiar methods, he applied it to Maxwell's well-known field equations to show that these differential equations retain a similar form after having been transformed using the Lorentz transformation. Significantly, the observational transformation we have identified *also* satisfies this condition and in fact is in the same *class* as the Lorentz transformation in this regard! An operationally quite insignificant (after generalization to incorporate a now non-trivial relative metric) scale change in norms of the two transformations is all that distinguishes them as should be obvious in the following comparison:

$$\mathscr{L}_v = \begin{pmatrix} \gamma & -\gamma\beta & 0 & 0 \\ -\gamma\beta & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \text{ and } \mathscr{O}_v = \gamma^{\sigma} \begin{pmatrix} \gamma & -\gamma\beta & 0 & 0 \\ -\gamma\beta & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

such that $\mathscr{O}_v = \gamma^{-\sigma} \mathscr{L}_v$ (as we saw above), and covariance of the vector equations is guaranteed by a metric that coordinates the obvious incongruities of relative motion. We also have to distinguish *microscopic* and *macroscopic* fields treating radiation as interactions between emitter and absorber as discussed elsewhere such that interactions exclusively in either this (or the other) frame of reference will not have Lorentz transformed spatial and temporal aspects. Only inter-frame transactions require relativistic treatment as discussed in earlier articles.

Many of Einstein's analyses pertained to a broad class of transformations. Why he chose the Lorentz transformation is probably in part because Lorentz and others had selected it in analyzing Michelson-Morley and other laboratory data not actually meeting requirements for "relativistic phenomena" to salvage ether theories. That relative motion might affect "rigid bodies" such as his reference frames other than along directions of relative motion did not seem to occur to him, so satisfying the constancy of the speed of light using only x and t (limiting the generality), he locked onto a unit value for a leading multiplier left open to that point. That relativistic aberration is *real* in the *deep* sense that observers inhabit different geometrical realities on that account, is a hard sell even though observers cannot align directions to distant stars or any other mutually observed phenomena. 19^{th} century mathematicians worked out implications of altering Euclid's 5^{th} Postulate with regard to parallels, and beleaguered physicists hopped onboard. But it is the 4^{th} Postulate that is faulty with regard to even uniform relative motion. "Through any point only one perpendicular can be drawn to any straight, line" was demonstrated to be incorrect centuries ago, but only I have seemed to accept this fact.

By incorporating Lorentz contraction and time dilation Einstein forced Lorentz-transformed events to coincide with points on surfaces of rigid bodies to solve the kinematics problem incurred by the circuitous route of light transmission on inter-frame transactions. There is a *different* kinematics problem with observational relativity: Rather than a *metaphysical effect* that cannot be observed, we have *observed phenomena* that seem difficult for most to accept as *reality*.

FURTHER COMMENT

Besides the concluding remarks above, there is much more to the established theory of relativity than even the Lorentz transformation equations and constructs directly derived from it, of course. Significant additional contributions fall into a couple of categories – the one having been addressed, and another to be addressed directly:

1. The dogma that has grown up around the basic concepts includes the experiment specifications, resulting data and interpretations to conform to an accepted meaning of relativity. This has come to include a velocity addition formula and associated cascading of transformations to deterministically *calculate* the observations of other observers as against supporting actual measurements. The justifications for this are rather difficult to penetrate – much more so than the equations themselves – although we have attacked this on several fronts above. In the end, there is insufficient data *and* reason to reject that conjecture without resorting to difficult tests of refutation – that have not even been attempted in any case.

2. There have been notable generalizations into what is known as "the General Theory" which has come finally to efforts to amalgamate a viable synthesis with quantum theories. The generalization is problematic in many ways, but a major aspect that is hardly a generalization of the special theory at all is the incorporation of a

new *geometric* theory of gravitation. This is particularly problematic in the context of generalizing the special theory because the special theory as currently accepted is not viewed as ostensibly requiring a nontrivial metric tensor to effect geometrical covariance – despite all the evidence to the contrary – which (non-trivial) construct is required for further generalization. This pretense of a "flat spacetime" and mutually orthogonal Lorentz coordinate frames has been used as a point of departure. But in fact, once we address relative motion – even uniform relative motion – we have embarked on a journey all of which requires the generalization of the treatment of a metric tensor!

An aspect of the difficulties to be encountered is the obvious one of the "equivalence principle" that equates acceleration and gravitation at the local level. The author believes that a proper generalization of motion, which is in effect the extension of Cartesian mathematical analyses, must be addressed separately and independently from the physical phenomena to be addressed in that way. Any necessary synthesis would be an almost incomprehensible conclusion of tremendous import rather than an *ad hoc* going-in assumption that happens to make certain conjectures work. Conjectures must be adapted to actual phenomena to establish the isomorphism, not the other way around.

Conscientious efforts that acknowledge these additional hurdles that have been more or less successfully breached by the extended dogma of the orthodoxy of the established theory have not resulted in a satisfying closure to these concerns.

It has been discussed throughout this volume that the concepts of *frame independence* and *mutual observability* that are direct inferences from Einstein's 'law' of the transmission of light that in turn gave rise to the additional inference that a Lorentz relationship between the coordinates of observed events could legitimately be considered a "transformation" as against a mere "correspondence" between similar events that are observed by both observers. The 'law' is not only *not* a law, but is flawed on several accounts. But in observational relativity we have acquiesced to a certain extent with regard to these concepts. In earlier articles in this volume we spoke of an alternative interpretation of the Lorentz transformation equations, whereas with observational relativity we have introduced an alternative formality altogether. In this formality distances are preserved such that rigid body contraction and time dilation are not required for the possibility of mutual observability of a single event situated at a given point on a rigid body. Certainly frame independence is impossible in this framework, but the issue of mutual observability would seem to remain an open issue, and in particular the question is bound to come up with regard to whether the difference in magnitude of the perpendicular directions is *real* or just an artifact of the modes of observation. And ultimately we must come to what makes one distortion preferable to another from a scientific perspective.

There is a warping of spacetime if you will, but a rather mundane one – certainly no more complex than the 'flat' spacetime that accommodated the special theory. This concept and how it eliminates conflicts with Lorentz contraction and time dilation paradoxes is treated in detail by Vaughan.[6]

[6] R. F. Vaughan, ***The Relativity of Visual Observations*** (2010)

On Geometrical Formulations of the Invariant Laws of Physics

That methodologies could be established whereby the laws of physics might be expressed in invariant form no matter what motions an observer undergoes hardly seems extraordinary upon consideration; it would surely be a demonically choreographed world were that not to be the case. Unaccountably, however, this notion seems quite profound to many for whom it should be obvious.

Surely whatever supports valid formulations of the laws of physics transportable from one environment to others in different dynamical situations should be embraced as the epitome of relativity. But, achieving that invariance is not the Holy Grail of physics that warrants ignoring phenomena without which invariance is meaningless. *Observational Relativity* was propounded by the author as an alternative to accepted theory because what has been accepted embraces unobservable phenomena as *real*, denying that ontological status to even the observed aberration of coordinate axes. The major defense for such observational violations has seemed to be that the established theory (and by false inference, it *alone*) accommodates an invariant formulation of the laws of physics, supporting extension into more generalized realms of relativity. However, this is not the case.

A conceptual framework (one hesitates to call it philosophy) using tensor formulations to leverage independence from an individual observer's situation has proven of inestimable value and, of course, Einstein's role in supplying it was key. However, much of this profound role of tensors became manifestly obvious only after the *Special Theory* had already been accepted, which theory then became somewhat of a liability for this form of generalization. A process that should have involved a straight-forward extension from *uniform* motion, was therefore somewhat re-directed instead.

What is required of *invariant* formulations of the laws of physics?

The ostensible goal of the special relativity was an invariant formulation of the laws of physics applicable to any observer independent of uniform relative motion. The objective was achieved in part by acknowledging the finite and universally applicable speed of light, and that what we observe in nature are not objects *per se* but fleeting events whose times of occurrence must be used in labeling associated phenomena. This seems to require that the observed time of events be incorporated as a fourth coordinate in the registration of natural phenomena. If frame independence is to be retained, it's values depend not only on event position, but also on particulars of the dynamics of relative motion of observers for whom respective descriptions apply. Likewise, the assignment of a spatial position to an event (whether in accordance with Einstein's formulation using *Lorentz transformation* or the *observational transformation* formulas introduced by the author) involves dynamic aspects as well as times of occurrence of associated events. This complex entanglement of positions and times of occurrence of events is required in order to coordinate geometrical aspects of observations made by two relatively moving observers. Such complexity cannot be avoided if the observations made by those in relative motion are to be considered commensurable in any direct way, without which achieving invariance would seem to be impossible. Therefore, event context must incorporate an integrated *spacetime* continuum in at least some sense and *not* just a separably mensurable space *and* time if frame independence is retained.

Sophisticated discussions of 3-space involve "*rotation groups*" of transformations that preserve length between points on rigid bodies from the vicissitudes of observer-peculiar perspectives. There was certainly reason to believe that directly analogous *groups* would perform the similar function in dynamical situations in four dimensions. Lorentz transformations constitute such a group and perhaps the major success of the Special Theory was its applicability to invariant formulation of Maxwell's field equations. In observational relativity the Lorentz transformation is replaced by a very similar transformation with that same feature once a fully operational "metric" is incorporated as it would be in the General Theory. This avoids attribution of observational differences to physical observer-peculiar measuring devices, i. e., "rods" and "clocks," and counter-factual presumptions of mutual orthogonality of coordinate axes. But the question remains: In such a scheme what remains *invariant* in situations involving relative motion? Einstein and Minkowski chose the *spacetime interval* as an archetype of such entities. That then became a cornerstone in formulating the General Theory of relativity and has proven of inestimable value so there would seem to be no reason to challenge that choice.

Because of the finite speed of transmission of effects from one event to another the dynamics of observer motion affect the angles at which events are seen to occur (in the sense of legitimately being *observed*!) when detecting remote events as we have seen. Such effects significantly alter the measured geometry of observed events for two such relatively moving observers. Since so much of physical observation involves geometry in the sense of tracking where and when events occur, it would be particularly frustrating to have to deal with incongruent relationships in various reports of the same events. Some sort of congruency must be established if there is to be any possibility of achieving invariant formulations of the laws of physics for all observers independent of their motions. To realize this there must therefore be some construct to rectify (rather than ignore) geometrical disparities between observers. This too has a vestigial counterpart in the Special Theory; in fact it was key to later use of tensors so essential to extending relativity. But the Special Theory assigns the "metric" a role no more significant than a glorified identity matrix.

In any case we arrive at four prerequisites of scientific (or mathematical – since it *is* almost exclusively mathematics and *not* physics *per se* once we insist on frame independence) coordination of spacetime observations to support invariant formulation of the laws of physics, namely:

1. A coordinate system of basis vectors for each observer to register events,

2. A transformation of coordinates of observed events between observers,

3. A spacetime interval as an archetype of what is preserved between relatively moving observers with a prescription for how it is to be preserved, by using

4. A metric construct to rectify geometrical disparities inherent in different dynamical situations of relatively moving observers.

Of course additional tools derived from these four major artifacts that we have introduced are also needed to address the more general dynamical situations. The General Theory of relativity incorporates such necessary additional constructs, which does not preclude alternative approaches with less questionable metaphysics from providing the same invariance even if a quite impressive edifice is already in place for the established theory.

Ultimately observation, *not* invariance nor elegance, legitimizes conjectures concerning physical phenomena. Physical laws must be warranted by experiment; it then becomes a mathematical chore to express them in their invariant form in as elegant a fashion as can be mustered rather than the other way around.

The Geometrical Formulation of 'Observational Relativity'

Once physical laws have been warranted to whatever degree is feasible by experiment; it then becomes a mathematical chore to express them in an invariant form before they can be thought of as 'universal laws' of nature. It must be this way rather than the other way around. In this article we will demonstrate by example what was generalized in the previous article. In particular we will show how one determines the constructs required by an invariant tensor representation and illustrate their meaning. We use here as an example what has been referred to above as "observational relativity."

What are *basis vectors*?

The establishment of a coordinate frame for the registration of events within a framework suitable for an observer to categorize locations and times of events in a systematic way is the first step to obtaining an understanding of phenomena revealed by observed event sequences. For obvious reasons this organization must involve for each tabulated event at least one value for each of the four (or whatever number of) recognized dimensions. These values are easiest to deal with if they reflect distances along mutually perpendicular directions. (In the case of the time parameter, 'mutually perpendicular' takes on an only slightly altered meaning as we shall see.) So in four-space we establish a set of unit 'vectors',

$$\hat{e}_\mu \Rightarrow \{e_0, e_1, e_2, e_3\},$$

where the 'hat' ($\hat{}$) merely indicates that this concoction is unique in defining a whole set of *unit basis vectors*. The subscript μ is a dummy index used in tensor notation to indicate that all the indices 0 through 3 of the four dimensions are intended. All four of the individual e_μ are called basis vectors because they form the basis of the coordinate system used by the observer in determining, and organizing, observed event data. By convention index 0 is associated with the time value of an event which, to accommodate common units with the remaining three spatial coordinates incorporates the speed of light as "c*t*" where c is frequently assumed to be unity by a suitable selection of units for time. Index 1 is generally associated with the first spatial direction (usually denoted "*x*", which is also usually defined along the direction of relative motion); 2 with *y*; and 3 with *z*.

These four 'row' vectors (or '1−forms') are linearly independent (i. e., none can be expressed as a linear combination of others) unit (i. e., of unit length) vectors. We could organize them into a matrix array with first row e_0, second e_1, etc.. We'll just show them here as separate vectors as follows:

$e_0 =$ (1 0 0 0)
$e_1 =$ (0 1 0 0)
$e_2 =$ (0 0 1 0)
$e_3 =$ (0 0 0 1)

Such a matrix, denominated $(e_\mu)^\nu$ where both μ and ν are indices (ν is *not* an exponent) employed in tensor-like notation. It would correspond, of course, to an identity matrix such that multiplying it times any vector would yield the components of the vector in the specific coordinate system defined by the basis vectors. In this way the vector r indicating the position of an event in spacetime could be represented as:

$$r\,\hat{e}_\mu \equiv r^\nu = (t, x, y, z),$$

where t, x, y, and z, are the components of the vector r, for which one usually just uses r^ν in the frame of reference indicated by ν, one for each basis vector in that coordinate system.

An important aspect of *unit basis vectors* is their contribution to defining an *inner product* (•) of two vectors. This product is defined such that,

$$e_0 \bullet e_0 = -1,$$

$$e_1 \bullet e_1 = +1,$$

$$e_2 \bullet e_2 = +1,$$

$$e_3 \bullet e_3 = +1,$$

but

$$e_\mu \bullet e_\nu = 0, \text{ if } \mu \neq \nu.$$

These conditions define what is called the *self-metric*, $\eta_{\mu\nu} \equiv e_\mu \bullet e_\nu$ to be discussed in more detail further on. It is easily visualized as:

$$\eta_{\mu\nu} = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Clearly these conditions specify an observer's geometrical situation – each coordinate axis being orthogonal to every other, etc.. Here clearly time has demanded its own only slightly different treatment.

<u>What is involved in *coordinate transformation*?</u>

As indicated in the earlier paper where observational relativity was first introduced, it is most easily distinguished from Albert Einstein's special theory as employing a different coordinate transformation. What this means is that there are different (but similar) formulas used by the two theories to determine for any observation reported by one observer (in accordance with basis vectors as described above) where another coincident observer moving uniformly relative to him should expect to witness an *associated event* in his coordinate system established by the same means. It goes without saying that such a difference in formulation implies that at least some aspects of one or the other theory must be in error. Because observational relativity accepts as factual the 'appearance' of aberrant coordinate axes (*basis vectors*) of the 'other' observer – a fact denied by the special theory which insists instead on factuality of phenomena such as contraction which *cannot be* observed – it should warrant your consideration as a meaningful alternative more attuned to such observations. Nor does observational relativity insist that the transformed event coordinates will be realized if the event originated in a third reference frame since in observational relativity Einstein's velocity addition formula is rejected as having unrealistically forced a predetermination upon the observation of objects observed by another observer but whose velocity has not been determined in our own frame..

The traditional mathematical approach to coordinate transformation involves a tensor (or matrix) construct which, when multiplied times a vector in one coordinate system yields the associated vector in the other, as for example:

$$r^{\mu} = \mathcal{O}^{\mu}{}_{\nu}\, r^{\nu},$$

where $\mathcal{O}^{\mu}{}_{\nu}$ implies the observational transformation. This tensor notation can be interpreted using matrix notation as follows for a specific case:

$$r^{\mu} = \begin{bmatrix} t' \\ x' \\ y' \\ z' \end{bmatrix} = \begin{pmatrix} 1 & -\beta & 0 & 0 \\ -\beta & 1 & 0 & 0 \\ 0 & 0 & \alpha & 0 \\ 0 & 0 & 0 & \alpha \end{pmatrix} \begin{bmatrix} t \\ x \\ y \\ z \end{bmatrix}, \text{ so that: } \begin{bmatrix} t' \\ x' \\ y' \\ z' \end{bmatrix} \begin{matrix} = \\ = \\ = \\ = \end{matrix} \begin{Bmatrix} t - \beta x \\ x - \beta t \\ \alpha y \\ \alpha z \end{Bmatrix}$$

where, you will recall, $\beta \equiv$ v/c and $\alpha \equiv (1 - \beta)^{½}$. Notice that the index μ is summed in the determination implied by the tensor equation. Notice also that $\mathcal{O}^{\mu}{}_{\nu}$ differs from the corresponding Lorentz transformation $\mathcal{L}^{\mu}{}_{\nu}$ by having incorporated a leading scalar factor α in this particular case. The general class of observational transformations is most easily characterized as: $\mathcal{O}^{\mu}{}_{\nu} = \alpha^{\sigma} \mathcal{L}^{\mu}{}_{\nu}$, where $\sigma \equiv d|x|/dt / |v| = x\,v / |x|\,|v| = \pm 1$. The relationship between the inverses of the transformations in tensor notation, is: $\mathcal{O}_{\nu}{}^{\mu} = \alpha^{-\sigma} \mathcal{L}_{\nu}{}^{\mu}$. (Refer to the earlier article for a discussion of additional similarities and differences and how the two transformations stack up with regard to *visual* observation – and experimentally, if one insists on distinguishing observation types, which this author does not. Other differences and similarities will become apparent as we go along.)

What is the *spacetime interval*?

In a similar way to how "infinitesimal path difference", Δd has traditionally been defined as the distance between two nearby points along a curve in 3-space such that $\Delta d^2 \equiv \Delta x^2 + \Delta y^2 + \Delta z^2$, the path difference Δs^2 (in this case defined exclusively as the squared quantity) between *events* is defined for a four-dimensional spacetime continuum. It can be elaborated using four component quantities that reflect the extent of difference in the four associated coordinate values to obtain:

$$\Delta s^2 = -(c\,\Delta t)^2 + \Delta x^2 + \Delta y^2 + \Delta z^2 \equiv \Delta d^2 - (c\,\Delta t)^2$$

Here you will note the convention whereby the square of the temporal difference in the occurrence times of the related events is subtracted from, rather than added to, spatial aspects of event differences. This is a convention – the respective signs are sometimes reversed – but that a difference (rather than a sum) is involved is essential to its meaning, which derives from the earlier convention, $e_0 \bullet e_0 = -1$.

Recall that between the occurrence of an event and its observation (also an *event*) in each of relatively moving reference frames, the equation $(c\ \Delta t)^2 = \Delta d^2$ holds. This indicates that universality of the speed of light *c* with regard to uniform relative motion applies in both reference frames. This was supported not only by Lorentz transformations, but also by *observational* transformation as was previously discussed. Working through this for observational transformations one obtains:

$$(c\Delta t')^2 = (c\Delta t - \beta\,\Delta x)^2 = (c\,\Delta t)^2 - 2\,\beta(c\Delta t)\,\Delta x + \beta^2\,\Delta x^2,$$

$$\Delta x'^2 = (\Delta x - \beta(c\Delta t))^2 = \Delta x^2 - 2\,\beta(c\Delta t)\,\Delta x + \beta^2(c\Delta t)^2,$$

and

$$\Delta y'^2 + \Delta z'^2 = (1-\beta^2)(\Delta y^2 + \Delta z^2),$$

with a similar equation for $\Delta z'^2$, so that

$$(c\Delta t')^2 = \Delta x'^2 + \Delta y'^2 + \Delta z'^2 = \Delta d'^2.$$

This demonstrates that light has the same speed in vacuum, namely c, in both of the frames of reference in observational relativity just as it does in special relativity.

However, when we extend the meaning of Δs^2 to include differences between events other than events united by emitted/detected photons, cancellation of the factor $(1-\beta^2)$ in the equations pertinent to a photon's path that guarantees $\Delta s^2 = 0$ is invariant, does *not* seem to guarantee invariance in *all* cases. Instead what we find is that:

$$\Delta s'^2 = (1-\beta^2)\,\Delta s^2$$

In special relativity the leading factor $(1-\beta^2)$ is cancelled by a factor of $\gamma^2 \equiv 1/(1-\beta^2)$ in the $\Delta x'^2$ and $(c\Delta t')^2$ equations and do not exist in $\Delta y'^2$ and $\Delta z'^2$ equations obtained from Lorentz transformations. So does this mean that observational relativity is thereby invalidated? No. It will, however, necessitate that a *different* "metric" be used to reflect phenomenological differences in unique geometries for which *mutual orthogonality* is not realized as discussed elsewhere. In rigorous formalities employing Einstein's notation the spacetime "metric," $g_{\mu\nu}$ (analogous to *self-metric* $\eta_{\mu\nu}$ defined above) is co-defined with the *spacetime interval* in generalizing relativity, as follows:

$$\Delta s'^2 \equiv g_{\mu\nu} \Delta x^\mu \Delta x^\nu$$

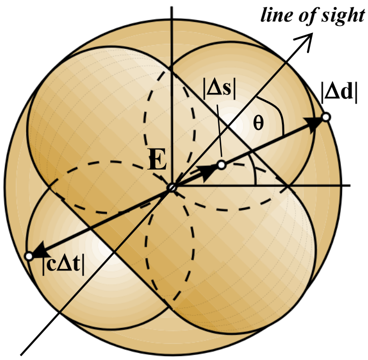


Figure 1: ***relationships between* |Δd|, |Δt|, *and* |Δs| *as functions of the angle θ from the line of sight***

using tensor notation where again summing over common upper and lower indices is assumed, and we see that Δx, etc. are 1-forms, not vectors *per se*. However, in special relativity uniformly moving observers are assumed to share a *common* metric $\eta_{\mu\nu}$, whereas observational relativity absorbs observed geometrical differences into the metric $g_{\mu\nu}$ instead – very much as it was done much later in generalizing relativity. Formally this *metric* is called into play in both theories to express covariant physical laws in tensor notation such as those involving an electromagnetic 'field strength tensor' in generalizing electrodynamics. It is used in defining a covariant derivative, and to "raise" and "lower" indices as a part of manipulating tensor constructs. So insisting on observational aspects of relativity has *not* forced us to reject either covariance or generalization, but merely to address them more formally at an earlier stage of generalization. In fact this alternative approach embraces them in a more direct and legitimate way by employing a non-trivial metric and its inverse for *all* relative motion.

Before moving on, and just for clarification of the rather non-intuitive nature of the spacetime interval, consider that the value of the spacetime interval to every event you observe is zero! A non-trivial spacetime interval is *not* an "observable" in physics. With regard to distant galaxies and in particular an event E associated with emission of a single photon of light that occurs in a galaxy a billion years ago (away), one can consider the space time interval between that event and similar events that may occur in galaxies within a vicinity of E as assessed in *our* spacetime. Events in other galaxies along our same line of sight will all have spatial components of the spacetime interval canceled by the temporal components. Those at approximately right angles to, and at short distances from, our line of sight to E will have virtually all of the spacetime interval equal to its spatial component.

In short, if two events occur simultaneously for an observer (us in this case), indicating that Δt is zero, then the spacetime interval becomes just the spatial separation between the two events. In general if,

$|c\Delta t_i| < |\Delta d_i|$,

the spacetime interval will reflect the spatial difference between the events in the frame of reference of an observer for which the events occur simultaneously. Notice that in this case there can be no possible interaction between the events. And if,

$|c\Delta t_i| > |\Delta d_i|$,

no observer in any frame can possibly witness the two events as occurring simultaneously. If, as the only other alternative,

$|c\Delta t_i| = |\Delta d_i|$,

Then the time difference is the transmission time between the emission and absorption of a photon of electromagnetic radiation.

Relationships between Δs^2, and Δd^2 and Δt^2 are illustrated in the figure above for a unit spherical spatial difference about some remote observed event E. This mapping is of a sphere onto a torus as shown. Clearly, despite its usefulness in certain cases, the spacetime interval is not based on observations and is a quite non-intuitive construct.

What is embodied in a *metric Tensor*?

To clarify previous comments, observational relativity addresses the *fact* that uniformly moving observers do not share geometrical relations among observed events, and therefore (unlike in the special theory which presumes otherwise) any *metric* presuming to encapsulate this aspect of respective perspectives must be unique to that particular motional relationship. The perspective differences of uniformly moving observers have been more or less trivialized in their 4-space generalization in special relativity by characterizing a mutual *spacetime* as merely 'flat'. In fact their *relative metrics* are presumed to be identical with their *self-metrics*, a manifestation of the fault we noted in introducing observational relativity, namely a failure to acknowledge

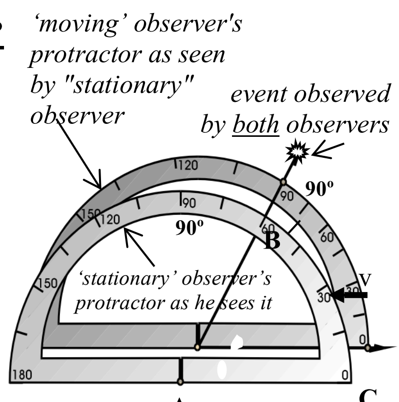


Figure 2: Two uniformly moving observers do not share mutual geometrical understandings of events observed 'in common'.

that respective basis vectors are *not* (and cannot *be*) aligned despite insistence to the contrary.

The fact that angles to mutually observed events from coincident observation points are askew with regard to each other, while perhaps seeming to some (including Roger Penrose and other pre-eminent individuals) as merely a minor embarrassment, is a situation of major significance. This is equally the case from mathematical, physical, and philosophical perspectives. That is what distinguishes "observational" from the "special" theory of relativity. Increasingly relativity theorists have assumed that spacetime provides a platonic *underlying reality* rather than merely establishing *relations* that apply to respective observations of physical reality as Kant had insisted. Lest this acknowledgement of differences be confused with that for which objects are presumed to *actually be* contracted even though they *do not appear to be*, consider that here we embrace actualities that are observed by both observers, characterizing the relationship between their *observations – not* metaphysical *realities*! With regard to "reality," as Newton said, we "frame *no* hypothesis."

The *metric* as employed in observational relativity characterizes the geometrical relationship associated with the dynamical situation of the two relatively moving observers – hence the term *relative metric*. Thus, it does not directly say anything about *nature* or *reality*, but simply about the relationship between nominal observations. By employing metrics in this way, undeniable observational similarity can be established that justifies some level of philosophical *realism* with regard to common sources of events observed from relatively unique dynamical perspectives. That geometrical relations imposed upon these observations made from these various perspectives are ineluctably unique implies that geometry as such is *not* an aspect of nature so conceived – the opinions of the most influential scientists of the last century notwithstanding. This uniqueness can, of course, be encompassed by *metrics* that address the relationships induced by the relative motions of any two observers' geometries so as to recover invariance to the formulation of apparent behavior of phenomena without presupposing an *absolute* underlying spacetime, nor therefore any 'spacetime geometry' as accepted by establishment. So *spacetime* need *not* (nor *can* it accurately) be considered the least common denominator of reality itself. As *space* was previously conceived by Kant, Russell, and others, this approach addresses the imposition of pure reason in the form of a *geometrical understanding of reality* upon reality itself more or less as Einstein *originally envisioned* as a basis for his relativity. Another time we will discuss how inertia and gravitation couple into this somewhat different relational conception of spacetime geometry to more fully generalize observational relativity without thereby incorporating presumptions of a *real* world into the domain of mathematical geometry or vice versa.

What are *relative metric* values appropriate to uniform motion?

As mentioned above, the metric derives exclusively from the basis vectors. The *self-metric* is always the trivially simple $\eta_{\mu\,\nu}$ derived from the self-basis vectors in a Euclidean four-space as shown above. The *relative metric* is computed in virtually the same way as the *self-metric* except that the conditions that guarantee orthogonality of self-basis vectors "dotted" with themselves (using the "inner" product rule) in that case no longer apply when one set is transformed using the observational rather than the Lorentz transformation. The dot product as employed in deriving the self-metric does not apply directly in non-Euclidean coordinates, so in acknowledging that according to the invariance principle using tensors this scalar product must be invariant, we must recognize at the same time that it will be computed using a somewhat modified scheme using basis vectors for "this," and "the other" observer whose geometry differs from the Euclidean form enjoyed by default by "this" observer as well as by the "other" observer separately. So we must in this case compute the dot product using the more elaborate (and rigorously more correct) formula as:

$$e_{\nu'} \bullet e_{\mu'} \equiv (g^{\nu'\kappa'} e_{\kappa'}) e_{\mu'} \equiv e_{\mu'} e^{\nu'}$$

with $g^{\nu'\kappa'}$ defined as the relative metric. We use g because of similarities in mathematical (as against physical) forms employed. Primed indices on basis vectors indicating the basis vectors as defined by the 'other' observer but transformed using the observational transformation into 'this' observer's coordinate frame. The factor shown in parentheses exclusively for didactic purposes corresponds to the symbols ($e^{\nu'}\bullet$) in the 'dot product' definition; it is a vector associated with the '1-form' as defined above with $e_{\nu'}$ whose components may in general differ substantially from the vector $e^{\nu'}$ from which it derives. Notice the role of $g^{\mu'\kappa,}$ in 'raising' the index on $e_{\mu'}$ producing the associated vector. When self-basis vectors are involved the *self-metric* $\eta_{\mu\,\kappa}$ is used instead of $g_{\mu'\kappa'}$ of course. Since it does *not* alter components, the *dot product* becomes effectively a simple operation between a presumed single type of 'vectors' in that limited case.

To maintain invariance, the same scalar values of a dot product must result for both of the relatively moving observers such that when the indices are restricted to indicate a *specific* one of the four alternative basis vectors, we must have that:

$$e_{\mu'}\, e^{\nu'} = e_{\mu}\, e^{\nu}.$$

In the previous equation $g^{\mu'\kappa'}$ and $e_{\kappa'}$ are mutually defined, i. e., $g^{\mu'\kappa'}$ is defined in terms of the $e_{\kappa'}$ and can therefore be determined by applying the invariance condition, since we know the constrained values of $e_{\mu} e^{\nu} = \eta_{\mu\nu}$ as we saw defined above. We will first show the transformed *relative basis vectors* for observational relativity and then solve the linear algebraic equations that determine the elements of $e_{\mu'}$ and $g_{\mu'\nu'}$ as follows:

$$e^{0'} = \begin{pmatrix} 1 \\ -\beta \\ 0 \\ 0 \end{pmatrix},\ e^{1'} = \begin{pmatrix} -\beta \\ 1 \\ 0 \\ 0 \end{pmatrix},\ e^{2'} = \begin{pmatrix} 0 \\ 0 \\ \alpha \\ 0 \end{pmatrix},\ e^{3'} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ \alpha \end{pmatrix}$$

$$e_{0'0} = g_{00} - \beta g_{01}; \quad e_{0'1} = -\beta g_{00} + g_{01}; \quad e_{0'2} = \alpha g_{02}; \quad e_{0'3} = \alpha g_{03};$$

$$e_{1'0} = g_{10} - \beta g_{11}; \quad e_{1'1} = -\beta\ g_{10} + g_{11}; \quad e_{1'2} = \alpha g_{12}; \quad e_{1'3} = \alpha g_{13};$$

$$e_{2'0} = g_{20} - \beta g_{21}; \quad e_{2'1} = -\beta\ g_{20} + g_{21}; \quad e_{2'2} = \alpha g_{22}; \quad e_{2'3} = \alpha g_{23};$$

$$e_{3'0} = g_{30} - \beta g_{31}; \quad e_{3'1} = -\beta\ g_{30} + g_{31}; \quad e_{3'2} = \alpha g_{32}; \quad e_{3'3} = \alpha g_{33};$$

where the second index on e is meant to imply which component of the 1-form $e_{\mu'}$ is being specified in the new coordinate system. Now that these components of $e_{\mu'\,i}$ of the 1-form $e_{\mu'}$ have been formally determined in terms of the elements of the relative metric, we can begin applying the invariance constraints:

From $e_{0'}\, e^{0'} = e_0\, e^0 = -1$ we have:

$$e_{0'0} - \beta\, e_{0'1} = -1.$$

From $e_0\, e^1 = 0$ we have:

$$-\beta\, e_{0'0} + e_{0'1} = 0.$$

From $e_0\, e^2 = 0$ we have:

$\alpha\, e_{0'2} = 0.$

From $e_0\, e^3 = 0$ we have:

$\alpha\, e_{0'3} = 0.$

After continuing to levee these constraints for the remaining three basis 1-forms $e_{\mu'}$, and then proceeding to plug into the formal values of the components for the resultant $e_{0'}\, e^{\mu'}$ constraints, we get:

$g_{00} - \beta\, g_{01} - \beta\,(g_{01} - \beta\, g_{00}) = -1$

$-\beta\,(g_{00} - \beta\, g_{01}) + g_{01} - \beta\, g_{00} = 0$

$g_{02} = 0$

$g_{03} = 0.$

from which we obtain:

$g_{00} - \beta\, g_{01} = -\gamma^2.$

Then from the $e_{1'}\, e^{\mu'}$ constraint, we get:

$g_{10} - \beta\, g_{11} - \beta\,(g_{11} - \beta\, g_{10}) = 0$

$-\beta\,(g_{10} - \beta\, g_{11}) + g_{11} - \beta\, g_{10} = 1$

$g_{12} = 0$

$g_{13} = 0.$

from which we obtain:

$g_{11} - \beta\, g_{10} = \gamma^2;$

Then from the $e_{2'}\, e^{\mu'}$ constraint, we get:

$g_{20} - \beta g_{21} - \beta (g_{21} - \beta g_{20}) \;\; = 0$

$-\beta (g_{20} - \beta g_{21}) + g_{21} - \beta g_{20} = 0$

$g_{22} = \gamma^2$

$g_{13} = 0.$

from which obtain:

$g_{20} - \beta g_{21} = 0;$

Then from the $e_{3'} \cdot e^{\mu'}$ constraint, we get:

$g_{30} - \beta g_{31} - \beta (g_{31} - \beta g_{30}) \;\; = 0$

$-\beta (g_{30} - \beta g_{31}) + g_{31} - \beta g_{30} = 0$

$g_{32} = 0$
$g_{33} = \gamma^2.$

from which we obtain:

$g_{30} - \beta g_{31} = 0;$

Then using the fact that $g_{\mu\nu}$ must be symmetric, such that $g_{10} = g_{01}$, etc. we obtain:

$$g_{\mu\nu} = \gamma^2 \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \gamma^2 \, \eta_{\mu\nu}$$

From this result it is apparent that not only the spacetime interval but *any* dot product invariant in special relativity will be invariant in observational relativity as well. This is because, as we have shown, $\mathcal{O}_\nu{}^\mu = \alpha^\sigma \mathcal{L}_\nu{}^\mu$ such that two leading factors of α are implicit in transforming the vectors involved in a dot product. They will be cancelled by the counteractive factor $\gamma^{2\sigma}$ associated with the relative metric employed by observational relativity.

Concluding remarks

In Einstein’s special theory feasibility was assumed for aligning basis vectors (corresponding to coordinate axes) of observers in uniform relative motion. But it has been shown repeatedly (although that fact has not generally been accepted) that such alignment is impossible; thus defined, Lorentz frames cannot be established with mutually parallel axes. Each of us observes his own world and furthermore, in Euclidean form. Others’ axes appear strangely askew. In addition the special theory assumes Lorentz contraction to be a *reality* when, in fact, it has been demonstrated that it cannot be observed. What *is* observed is the rotation through the observed skew angle of the “other” observer’s axes assumed perpendicular to the direction of relative motion.

A *relative metric* as defined in observational relativity, supports transformation of another observer's observations to accord with both observers employing Euclidean concepts. No scientist should ever accept being told to pretend that what is at right angles for someone else would be for them as well unless, in actual fact, it *is* – as supported by observation. And in general it *won’t* be! Scientific endeavors would be intolerable with pretenses of what is measured as at right angles being labeled as being, for example, 60 degrees instead, as accurately portrayed for the protractors in figure 2. Thus, a requirement exists for a *relative* metric even in the case of uniform motion. Every observer has an inalienable right to Euclidean normality with “relativity” working the mathematical problem of a natural coordination when observations are to be compared. And the laws of physics are indeed invariant in this scheme just as they were shown to be in special relativity. This should not be a surprise since it is actually not that austere a constraint. In Einstein’s general relativity a nontrivial metric is used where "non-Lorentzian" coordinate frames involving "diffeomorphic" transformations are involved. In observational relativity this requirement is acknowledged up front as an inevitable requirement *in general* for observers in relative motion – even ‘uniform’ relative motion.

As was shown earlier with respect to the computation of the spacetime interval, the relative metric is an integral part of any computation presuming to invariance between observers. Scalar quantities (*real* numbers) derived from a mathematical theory of phenomena according to any credible philosophy of science, must be invariant for any observer. The conditions on that dictum are quite liberal. So wherever there are vectors or more complex mathematical structures involved in a theory, their values will typically differ among observers, but values determined from these constructs as *scalar* *quantities* must remain invariant among all coincident observers. That is the whole rationale for going to tensor mathematics.

At one point in his illustrious career Einstein acknowledged that reality might be such that alternative theories could equally account for observed phenomena and that such degeneracy might persist even after all conceivable discriminating observations had been made. The criteria used for selection of theories including invariance of the laws of nature with regard to observer dynamics might be insufficient in itself to select a correct theory of relativity. In this vein after having established invariance for observational relativity, the author ponders whether it is just another way of *looking* at relativity, or if it might perhaps be the only *correct* way of looking at it? Clearly fuller extension of considerations beyond those applicable to a restricted domain of uniform relative motions might further narrow what could be considered the *reality*. There are many additional questions to be asked and answered before that point however.

It might not seem to make a whole lot of difference other than avoiding some metaphysical baggage clearly demanded by the special theory and avoided by observational relativity. But there is more at stake than that. Or maybe we should say that *that* in itself involves more than meets the eye. As we proceed to more general motions we will see that addressing observed *geometrical* differences rather than presuming differences in measuring instruments may no longer be optional. In generalizing relativity Einstein proceeded by accepting "equivalence" between gravitational free-fall along geodesics and inertial (uniform) motion. Gravitation became an overwhelming attraction – or distraction, depending on how you look at it – of his generalization of relative motion. Thus, a strictly mathematical regimen became amalgamated with the stuff of nature and practitioners began to believe once more with Plato that nature really is a projection of mathematics. The author sees this as a dangerous trend.

Rejecting Action at a Distance in Itself Resolves the Problem of the Precession of the Perihelion of Mercury Even without Einstein's General Relativity

"…What would happen if the Earth were suddenly dropped into place, at its proper distance from the Sun? How would the Sun 'know' that the earth was there? How would the Earth respond to the presence of the Sun?…But the Sun would not 'know' that the Earth had arrived until there had been time (Faraday had no way of guessing how much time) for the Earth's gravitational influence to travel across space… and reach the Sun."[1]

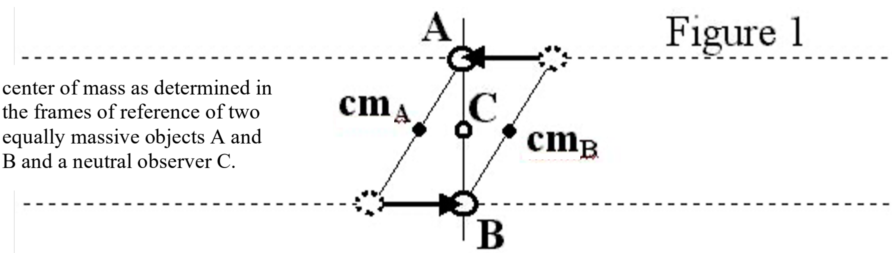
Newton's action at a distance involving instantaneous transmittal of forces was problematic from the first. If one is to eliminate action at a distance from the classical equations acknowledging that it takes time for forces of interaction to be transmitted between objects but retaining Newton's other concepts of a centrally directed gravitational force, one is faced with a dilemma – the elliptical orbits will precess. But once this has been taken into account by the gravitational force, general relativity is not required because the precession implied by removing action at a distance accounts for observations without further emendation.

Much of the simplicity that Newton was able to incorporate into his laws of nature might seem necessarily to have become obfuscated if action-at-a-distance does not apply, however. We encounter, for example, the situation of the "central" force being directed, not along the line of centers of two massive objects, but offset at an angle in a direction to which there would seem to be no source for a force. If the transmittal speed of the potential energy that drives the force is equal to that of light in a vacuum, then the angle of relativistic aberration determined by the relative velocity of the objects would determine the "line of sight" to where each object would *appear*. This then would serve also as the realized direction any associated force. This has the merit, of course, of both objects experiencing the force to and from the direction at which the other object *appears*, even if not where it *is*. But the framework in which this is true is *not* an inertial coordinate frame;

[1] John Gribbon, ***The Scientist***, Random House, New York, 2002, p. 423. In reference to a presentation made by Michael Faraday to the Royal Institution on 19 January 1844.

it is an accelerating frame of reference – at least with respect to the location of the center of mass of the two objects as it is usually accounted. Newton's laws of motion had, of course, been accepted as applying exclusively with respect to such inertial frames of reference.

Determining the center of mass of the two relatively moving massive objects is problematic from the start. Without action-at-a-distance, wherever there is relative motion there will be alternative perspectives caused by the direction from which the light (or force in this case) arrives, which will be in the direction to which the object *had been* located when the light (force) was emitted – *not* to where it is located when it arrives. This "aberration" will result in assessments of the center of mass being at variance. Look at the system of two equally massive objects depicted in figure 1. Since the minimum separation of their two straight line trajectories as drawn from a third perspective of an observer C half way between them (defined so as to provide symmetry) is non-zero, aberration distorts their assignment of a center of mass to the system (i. e., CM_A, CM_B, and CM_C) as shown. About which of these points will the objects orbit?



center of mass as determined in the frames of reference of two equally massive objects A and B and a neutral observer C.

In figure 2 we have drawn the circular orbit of radius R of what could be a planet p about a star S. Of course, the planet would be moving at the astronomically high speed of 0.449 times the speed of light, c to produce this much aberration. The darkened circle S is drawn where we conceptually envision the star to "be" and S′ is drawn where it would appear from the vantage of the planet in its path about the star (assumed to be much more massive than the planet so the center of mass of the system is approximately that of the center of the star). The planet's orbital speed was merely chosen in this case to accommodate the planet completing one orbit in exactly 14 times the length of time it takes the force field to travel from the star to the planet so it could be easily visualized. (However, if the realities of actual planets being unable to achieve viable orbits at distances compatible with this speed is a drawback to the reader in understanding what is at issue here, then assume the integer 14,000, or 140,000, or an irrational number for that matter; it really makes no difference to the point of this article.) So if we evaluate the status of the situation 14 (or 140,000) consecutive times during the course of an orbit as shown, we see that in a reference frame stationary with respect to the center of mass, the orbit of the planet whether about the *actual* star or about the *apparent* star is the same! See panels a and b of figure 3. However, in the latter case (panel b) the orbit is out of phase by one fourteenth (or one hundred and forty thousandths) of the orbital period such that p_1 is to S as p_2 is to S_2', etc.. (Also S as well as p orbits S' in this case.) This relationship of p_i being to S as p_{i+1} is to S′, etc. will be the same no matter what the relationship of the speeds v and c as long as the separation of p_i and p_{i+1} is R v/c, but if c is not an integral multiple of v, there will be a change in the phase shift from one orbit to the next that is proportional to the residue.

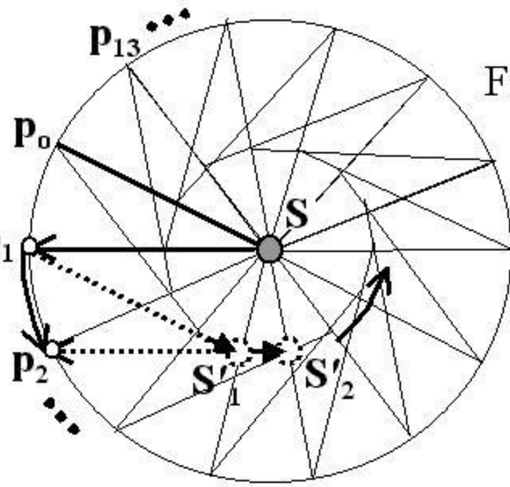


Figure 2

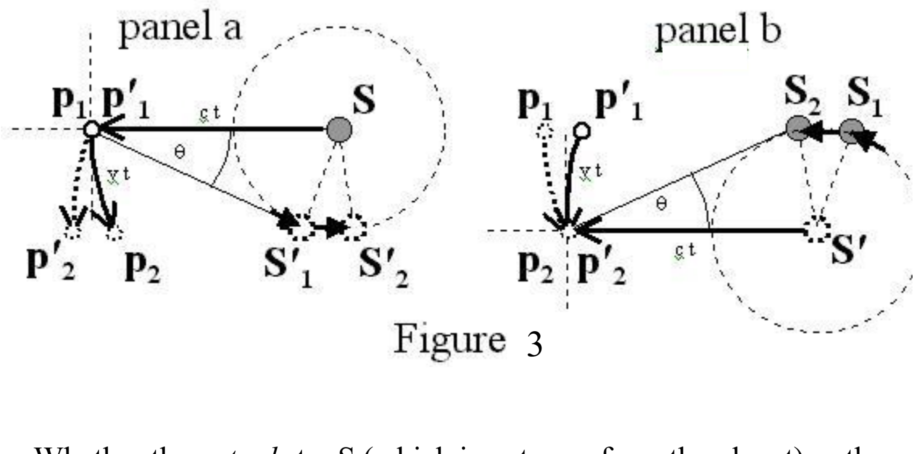


Figure 3

Whether the *actual* star S (which is not seen from the planet) or the *apparent* star S’ (that *is* seen) is envisioned as orbiting *also* (at the radius R v/c) about the center of the planet's orbit may seem of little import since the planet's path will be the same in either case. Of course, there are major epistemological differences in these perspectives. One tends to care little whether mere ephemeral conceptual constructs gyrate in strange ways to accommodate mathematical models, but for an *actual* star to orbit a void point other than the center of mass of the system from the perspective of comoving surrounding systems might seem to involve some travesty of thought. It is, after all, only in the accelerated frame of the ephemera that the unseen but "actual" star orbits. However, it is only in *that* frame of reference that our familiar concept of an inverse square law force "actually" applies. So, after all these mental gyrations, where are we? Maybe this just seems to work because we are dealing with a circular orbit here rather than the more general conic elliptical orbits. How would this alternative to action-at-a-distance play out with an elliptical orbit?

The answer is that the elliptical orbit (as seen from the comoving surrounds of the star) would involve the precession of an otherwise stationary closed elliptical orbit, whereas the elliptical orbit solution about the appearance of the aberrant star for which the central force equations apply would not precess. And this brings us to the famous test of Einstein's general theory of relativity with regard to the precession of the perihelion of Mercury by 41 seconds of arc in a century, which is unaccounted for in Newtonian mechanics. We are repeatedly reminded that the phenomenon is finally resolved by general relativity with the determination having been made by Schwartzchild of the appropriate gravitational metric tensor from which to determine the Ricci tensor, Ricci scalar, and stress-energy tensor from which the result can supposedly be computed. Needless to say, "That ain't necessarily easy for neophytes!" It is much easier, in fact, to merely acknowledge that it takes time for forces of nature to travel through space and determine the relative locations of the interacting bodies at appropriate times as shown above. *That* makes sense!

In looking up the data on the precession of Mercury's perihelion to check out the viability of all this, I ran across a very learned article published in arXiv.org:physics/0510086, January 20, 1906 by Jaume Giné on the internet[1], which exhaustively describes the history of such efforts as mine and extols the efforts of a German school teacher named Paul Gerber who in 1898 proposed just such an approach. It resulted

[1] http://www.citebase.org/cgi-bin/fulltext?format=application/pdf&identifier=oai:arXiv.org:physics/0510086

in accounting for only 14 seconds of arc and not the entire 41. However in analyzing those results Giné was able to show that using the round trip time instead of the one way force interaction time as suggested by the collaboration of Wheeler and Feynman on absorber theory in 1945, that the entire phenomenon is thereby completely accounted. See figure 4 taken from the reference.

In the diagram of figure 4 the retardation parameter τ is equal to what we would have referred to as R v/c^2 above. And the fact that the two pie-shaped segments differ in the second panel in figuring the round trip delay is that the orbit is not assumed to be circular as we did for didactic purposes in figure 1. In Giné's article he does not associate retarded potentials directly with the special relativistic aberration phenomena, but this association is inevitable.

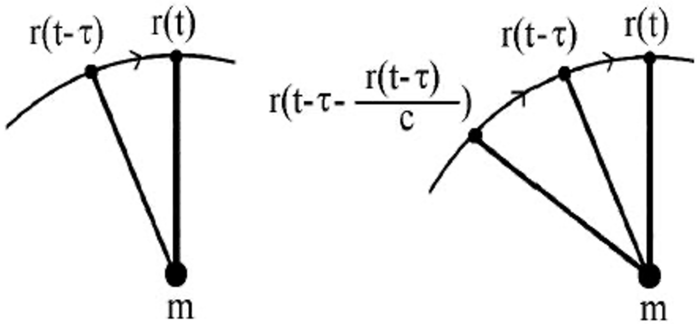


Figure 4

The retarded position of the test particle.

To update my own analyses as Jaume Giné did for Paul Gerber, the relationship would have to be made between p_i being to S as p_{i+2} is to S′, etc.. What this says in interaction terms is that the force "signal" sent out by S is in response to a complementary force signal received from p, so that the force received by p from S will be in response to where p was located two intervals back. It should be obvious that this makes sense once action-at-a-distance is done away with.

So, although I feel somewhat scooped (albeit narrowly by only one hundred and eight years), it is refreshing to know that, however rare, perspicacity has always lurked around every corner. And there is some, however, vestigial memory of the right answers to real problems.

written June 4, 2006

Skepticism with Regard to an *Astrophysical Trend*

"If our friendship depends on space and time, then when we finally overcome space and time, we've destroyed our own brotherhood."

– Jonathan Livingston Seagull[1]

Once again a friend has driven me to abstraction – a recurring situation for which I am repeatedly in his debt. (I guess that is a major criterion for entry into my *inner circle* of friends.) His articles place philosophical issues in a context that I find not only titillating, but damned unnerving at times as well. My search for irreversibility in microscopic interactions that have always been considered completely reversible by virtually everyone was spurred on as an objection to his counter claims. I am very grateful for the opportunity to have sought (and I flatter myself in believing that I actually *found*) the source of irreversibility in the usually negligible Doppler shifted energy losses of the photon exchanges by which collisions between molecular constituents of substances are effected. The many hundreds of enjoyable hours of investigation into irreversibility were in direct response to the stimulating discussion of 'the astrophysical trend'.[2] I must say that I truly believed I had handled the 'hardest' problem that had been posed by his article. Thus, I considered the total scope of my efforts to have been an adequate disputation (if not total refutation) of this notion of the inevitability of dire long term 'trends' in our universe's behavior as a whole. These *apparent* trends included, of course, that the universe must necessarily be winding down, and that photons generated in the heat of interaction while our universe is still interesting are being more or less 'sucked out' into a vast chill in which the universe is evidently conceived as being immersed. If most modern cosmologists are correct, the universe will indeed, as Robert Frost opined as alternative, "end in ice" – only *colder* with individual atoms continuing to separate themselves endlessly. Although there is still a heated contingent that "favors *fire*". The author here argues instead for a 'cosmocentric' equilibrium that avoids both these drastic extremes.[3]

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1 Richard Bach, ***Jonathan Livingston Seagull***, Avon, New York (1970), p. 87.

2 Frank Luger, "Conceptual Skepticism in Irreversible Energetics," ***Gift of Fire*** (a private journal of the Prometheus Society), #119, October 2000, pp. 10-24.

3 This comment is, of course, an ironic reference to Dr. Luger's subsequent article that addressed the same trend, i. e., "Anthropocentrism vs. Cosmocentrism – groping toward a paradigm shift". See for example ***Reason and Rhyme Anthology***, 2007, Vol. 1, pp. 164-173..

It is fashionable in physics nowadays to consider the Big Bang as the origin of everything otherwise unaccountable in physics and in this regard the *Astrophysical Trend* was perhaps a trendsetter. Preoccupation with deducing from a presumed origin of the universe what formerly would have been determined by more inductive means only after extensive experimentation and observation is a bit presumptuous if you ask me. This backwards perspective (what I consider to be looking down the wrong end of telescopes) has given rise to extreme extravagance in physics: Searches for heavier particles whose failures only precipitate proponents insisting that the particles do in fact exist but they must involve higher energies and if this superstring, brane, or mini black hole cannot be detected by current instruments then it must be because it is even larger than we suspected – excuses *ad infinitum*. This disrespect for accurate predictions and the results of experimentation is rampant in physics today. But my friend seemed to go even further in suggesting an accomplice to the Big Bang: “The Big Bang," he said, "would thus provide the ‘push’ while the cold nonreflecting space would serve as the ‘pull,’ for expansion-contraction processes…' [4] "

There are other places in his writings where the allusion to the 'pull' of *cold outer space* is employed. This fiction results from a flawed theoretical model refuted by the facts of a hot plasma known to facilitate our view of the universe out to 10 or 15 billion light years…so far. Intergalactic space is *not* cold or the low levels of dispersed hydrogen and helium would have absorbed the light by which we witness the cosmos. Conservative estimates of its temperature are between 10^3 and 10^6 K, but to effect such complete stripping of electrons it may well be even hotter. In fact it is as hot as the interiors of stars we observe – just much less dense. Virtually all electrons must indeed be 'stripped' to effect the transparency of our view notwithstanding islands of Lyman α forests where protogalaxies form. Certainly this data was not available in the sixties when this ‘astrophysical trend’ was introduced.[5] To be fair, the current view is that there was a time after ambient temperatures from the Big Bang cooled to about 10^4 K (noted by Dr. Luger as the temperature for electron capture), and then, after stars had formed, the intergalactic medium was reheated by the resulting radiation. I would argue this but it is unnecessary in this context. The lesser argument stands – where is this cold sink for radiation? But it is not clear to me in what sense

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[4] *Op. cit*. Frank Luger, p. 22.
[5] [See for example, J. V. Narlikar, Proc. R. Soc. London A270, 553 (1962).]

Dr. Luger even sees *cold outer space* as contributing to local physical process.

There is also, as he points out, the need for links to explain why entropic phenomena apply at the local level on a time-scale for which any evolution of the universe is irrelevant. This is *the* problem, not just an irrelevant corollary of the problem, it seems to me. The other way around is physics on its head.

Recently I found that my friend had not been convinced in the slightest by my arguments, nor apparently had my efforts to establish a sound submicroscopic basis for irreversibility given him pause to even reconsider his position or attempt refutation of my hypothesis. In a more recent e-mail he opined that:

"The evidence for arrows is so overwhelming that I don't know where to begin, and there's little point in boring you with elaborate lists. A simple intuitive example that springs to mind is the surface temperatures of the Sun, which range from an inner one over a million degrees, whereas the outermost 'layer' is maybe a few thousand degrees."[6]

The facts associated with there being vast variations in temperature and density throughout the multifarious domains of our universe were of course not news to me. It was only when he then succinctly asked, "*How could such a steep gradient be possible without cold outer space?*" that I realized what was at issue between us – the scope of the philosophical dilemma with which we wrestled.

The age-old problems of philosophy will never go away; conjectures that attempt to solve them will only cause these truly meaningful problems to be reformulated with successively more relevance accruing as time goes by, but forever nagging at our heels nonetheless. So with a renewed understanding of the nature of the gulf between us, i. e., the consequences of irreversibility originating at the *bottom* or the *top* of our reality, I decided to begin again with renewed vigor to attack the horns of the Parmenidean dilemma – Heraclitus's river that is always the same yet always different.

So I will now proceed with my current understanding of how irreversible changes in variations of characteristic aspects may persist even in a continuously stable universe that never collapses, does not expand indefinitely, nor run down as a grandfather clock in need of some grandfatherly figure to rewind it.

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6 Private e-mail communication from Frank Luger to Russell F. Vaughan dated Sun, 17 Nov 2002.

Certainly to accurately assess whether a trend exists one must *sample* suspected behavior over time and space with samples that can be justified as *representative* of phenomena for which the trend is presumed to apply. To this end one must have a valid model of the behavior of the system being sampled. This is exemplified by the shortcomings in the perspectives of two blind men who argue the nature of elephants from their own happenstance tactile-limited experiences with a hind leg, trunk, or tusk. So in a real sense one should have a working global knowledge of what is being sampled *before* averring too sanctimoniously to have comprehended its inherent nature, let alone, its 'trend' into the undefinable future. Of course when the system under test is the entire universe one can run into unique modeling problems.

Hawking defined what I have referred to in the next essay as a "Hawking sphere" and then claimed that it could appropriately represent the pertinent gravitational characteristics of an entire 'infinite' Newtonian universe. He erred by misrepresenting such a universe as having an inside and an outside which is patently absurd. The terms 'universe' and 'infinite' by definition preclude the void 'exterior' from which collapse derives in Hawking's derivation. Similar categorical reasoning errors have precipitated many of the erroneous notions including universes beyond the realm of *our* universe as though ours were a mere galaxy, and other absurd notions. Einstein had, of course, as Hawking knew, proceeded from just such assumptions:[7]

"*As I have shown in the previous paper, the general theory of relativity requires that the universe be spatially finite. But this view of the universe necessitated an extension of equations with the introduction of a new universal constant λ, standing in a fixed relation to the total mass of the universe (or, respectively, to the equilibrium density of matter). This is gravely detrimental to the formal beauty of the theory.*"

I personally think it ludicrous to presume that one's methodologies and theoretical model might appropriately dictate requirements on the *actual* universe that one is attempting to model as suggested in Einstein's remark. This is a much more egregious error than what Einstein considered to have been his "greatest error" in the above

[7] A. Einstein, "Do gravitational fields play an essential part in the structure of the elementary particles of matter," repuplished in ***The Principle of Relativity*** – a collection of original papers on the special and general theory of relativity, Dover, New York (1952) p. 193.

quotation. We must limit our models to valid descriptions of *actual* phenomena from which to extract invariances and explanations and accept them only to the extent that they *are* valid descriptions, if we would have the entire universe acquiesce to such pronouncements. One easily falls prey to gibberish otherwise.

In Heraclitus's analogy of the river one must model much more than the solid banks of the river itself and the fluid that flows between, if one is to resolve the paradox of identity in flux. It takes more than the addition of mountains, foothills, and valleys through which tributaries flow into the river, and more than models of the occurrence of seasonal rain and snow if one is not to eventually have it run dry or fill the seas to overflowing. The evaporation of water is what cycles it back to the river's source.

One must complete the loop in any valid model if one is ever to have a chance to understand an equilibrium situation. Without completing such logical loops, equilibrium will always be seen as an impossibility. I see it as no different with the *astrophysical trend* to which Dr. Luger defers. Certainly gradients and change are essential to our nontrivial world, but that does not preclude cosmological stability. Certainly there are gradients of temperature in the universe just as there are gradients associated with the flow of rivers, but that does not in itself suggest either that rivers will all one day run dry nor that the oceans will overflow in a material manifestation of Olbers paradox. There is more subtlety in heaven and earth than that. Olbers had not the slightest conception of magnitudes involved in either the separations in space nor finite lifetimes of stars or he would not have conjectured as he did, and others would not have wasted so much time on this supposed paradox.[8]

It is no surprise that open loop models of rivers might run dry. In resolving irreversibility at the submicroscopic level it was necessary to extend Einstein's blackbody radiation model to close another major loop. The model then had to be extended to incorporate complimentary mechanical aspects of the system as well, to show that although any

8 We have that 10^{10} years is a reasonably long average lifetime for a star, and 10^{23} light years is the average distance of a line of sight to encounter a stellar object with the densities of stars encountered in our universe. Thus if we represent a "sky cover ratio" X, defined as average night time intensity along a line of sight divided by what it would be if directed directly at the sun. We obtain the likelihood of a line of sight encountering a bright star as $10^{10}/10^{23} = 10^{-13}$. This is only an estimate good to within a factor of a few thousand. So that, $10^{-16} < X < 10^{-10}$. In contrast, at mid day the sun provides a total sky cover ratio of about $3x10^{-4}$ so that the night sky is predicted to be about a billion times darker even if the universe were infinite. And so… one does not require sun glasses to enjoy the splendors of the night sky! We just happen to be situated in a 'warm spot' in the universe.

and every individual process dissipates energy, that energy goes *somewhere* and energy from *elsewhere* can keep the system going – yes, even indefinitely.[9] So it is definitely conceivable for there to be gradients of change in perpetuated systems, but it cannot, as Dr. Luger would quickly counter, be assumed as a foregone conclusion. This is particularly so when identified processes such as a 'big bang' and 'black holes' are claimed with some credibility to be, respectively, an exhausted one-time resource and irreversible sinks of the energetics that drive the whole system.

However, the presumed characteristics of these two processes as currently modeled are too obviously contradictory to allow such presumptions to limit discussion. According to virtually any version of the standard model of cosmology, we are either just within, or have just recently escaped from, the Schwartzchild radius of the ‘black hole’ that is (or has been) our entire universe. So either black holes are *not* singularities into which matter is sucked endlessly to a mathematical point never to escape as established theory predicts or the 'big bang' never happened. Take your pick. Lewis Carroll and a healthy "conceptual *skepticism* in irreversible energetics" would not allow one to rashly embrace both such conflicting models after a hardy breakfast.

One must incorporate a valid model of *every* known process consistent with assumptions of all others within the system before one has a *valid* model of the system itself from which to declare the “alpha and omega!" Glibly imposing requirements on a universe that happens quite defiantly to *exist* without regard for our conjectures is totally absurd. This is particularly the case if we are to avoid naïve presumptions of limited open loop models of the entire universe.

We can reach no valid conclusions without completeness, and this does not bode well for increasingly popular ‘theories of everything’ (TOEs) that have been hawked by Hawking and his lessors recently. With outstanding questions of such magnitude concerning the nature of the primary processes of our universe, we must emphasize observation. The overwhelming scope of our ignorance should certainly humble theorists. It seems to me, however, rather to have emboldened those who should know better to greater and greater levels of pugnacity. So I will not attempt to stick out my own big TOE to be

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[9] Because of the Doppler shifting in the exchange photons that effect the collisions of material particles, if we reverse particle velocities involved in an interaction and try it again, the situation does *not* reverse. We've lost energy in the form of escaping radiation and in doing it again [in reverse], we'll lose some more. This escaping radiation may be absorbed within the boundaries of the defined 'system,' but unlike atomic matter that can be confined, it may escape into or beyond boundaries of any jar or laboratory. Unless the amount of radiation from outside the boundary makes up the deficit, there will *be* a deficit.

stepped on here. I will rather content myself with labeling as presumption any suggestion that currently observed ‘trends’ imply that the metaphorical river is ineluctably running dry.

Would an Infinite Newtonian Universe Really Collapse Under Its Own Weight?

"Newton realized that, according to his theory of gravity, the stars should attract each other, so it seemed they could not remain essentially motionless. Would they not all fall together at some point? In a letter in 1691 to Richard Bentley, another leading thinker of his day, Newton argued that this would indeed happen if there were only a finite number of stars distributed over a finite region of space. But he reasoned that if, on the other hand, there were an infinite number of stars, distributed more or less uniformly over infinite space, this would not happen, because there would not be any central point for them to fall to.

"This argument is an instance of the pitfalls that you can encounter in talking about infinity. In an infinite universe, every point can be regarded as the center, because every point has an infinite number of stars on each side of it. The correct approach, it was realized only much later, is to consider the finite situation, in which the stars all fall in on each other, and then to ask how things change if one adds more stars roughly uniformly distributed outside this region. According to Newton's law, the extra stars would make no difference at all to the original ones on average, so the stars would fall in just as fast. We can add as many stars as we like, but they will still always collapse in on themselves. We now know it is impossible to have an infinite static model of the universe in which gravity is always attractive." – Stephen Hawking, ***A Brief History of Time***, p. 5.

There is a sophisticated, however erroneous, way of looking at the problem of gravitation which supports the conclusion that gravity would necessarily implode an infinitely-extended, uniformly-dense universe using Newton's laws. If one considers only the gravitational phenomena associated with larger and larger spherical balls of uniformly dense matter, one finds that the net of all forces active on a particle within such a ball increases in proportion to its distance from the center. This is in essence the counter argument Hawking put forward to contradict Newton's original argument that although a finite ball of matter would eventually collapse, an infinite one would not. Hawking extended the argument applicable to such finite spherical balls by considering the addition of matter in spherical shells without limit to approach an infinite size; from this he concluded that collapse of such an infinitely-extended, spherically-symmetric universe was inevitable. He based his conclusion, however, on the suspect premise that an infinite universe could be likened to a material sphere for which there exists a definite boundary beyond which no material substance would exist at all. A sphere possessing such an ultimate dividing surface between material being and nothingness I will refer to as a 'Hawking sphere'.

For a finite spherical universe, the force on a particle would increase linearly as it approached this 'edge' of that universe. Collapse would proceed dramatically from this boundary of the Hawking sphere in toward the center. It would, therefore, be forces near the periphery of any such ball that would be at issue in considerations of the validity of this argument in the limit as the radius of the sphere goes to infinity. So let us look at the situation from that perspective: How would the forces of collapse on a particle of mass m at the periphery of such a sphere differ if the sphere itself were immersed in an infinite extension of the same uniform mass density ρ of substance out beyond this 'periphery', as against the condition of a Hawking sphere? Is that not the real difference between a finite, however extended, and an infinitely extended universe?

We must agree with Hawking with regard to what the forces would be if the immersion were into a void. The force on a single particle of mass m would simply be:

$$F = -\, 4/3\, \pi\, G\, \rho\, m\, r,$$

where G is Newton's gravitational constant and r is the distance of the particle from the center.

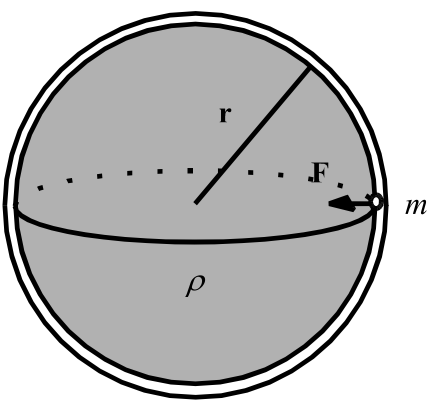

Figure 1: "Hawking Sphere"

But is any of that argument really relevant? Who has the authority – or audacity – to posit such an external void to an infinite universe?

With extension of substance out beyond this ‘periphery’ we have a very different symmetry to deal with. In figure 2 it can be seen that a particle at location A, at a distance from the "center" of any such sphere would experience a force F_1 in that direction from A, but a precisely equal counter force F_2 must, therefore, act on the particle that would nullify F_1. All the rest of the matter in the universe is symmetrically distributed with regard to A, so that all these extraneous forces would cancel in any other direction in space as well. So the gravitational forces of all the matter in the entire universe cancel in every direction in this case.

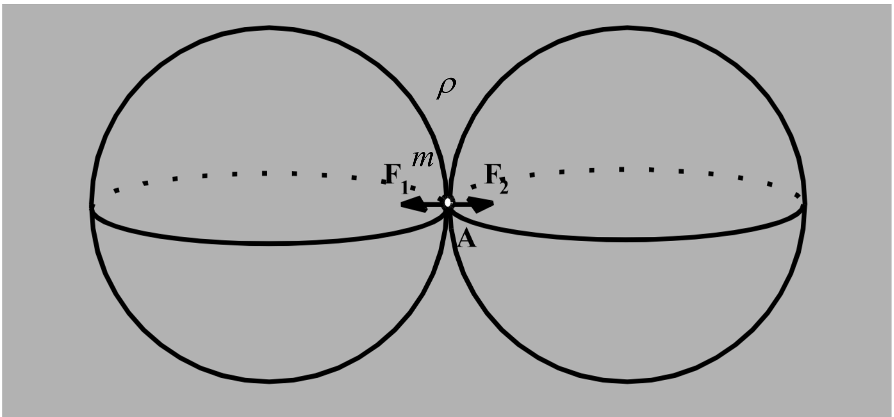

Figure 2: Hawking Sphere in an Infinitely Extended Uniformly Dense Universe

Naturally when we speak of an infinite ‘universe’ we do not speak of an entity for which there is an ‘outside’ – is all there is; that is what it *is*. So a Hawking sphere is an artifact of analysis that cannot be applied to such a universe as a whole. Newton seems to be the winner of this debate between the greats of different centuries. But what about fluctuations in the uniform density of matter in an infinite universe, could these accumulate to produce a general collapse?

Since we are now embarking on considerations of local variations that do not affect overall density of the universe, the same conclusion much be reached. However, there are several ways in which such variations might be manifest without altering the global density of larger scale measures of the universe. Let us consider the case in which ‘lumps’ are merely particles at a higher level of granularity. We will also consider the case in which a fluctuation involves a dense region surrounded by a dearth of material. At some distance from the center of such a fluctuation the enclosed matter will contain the same amount of material as a Hawking sphere of the same dimension. These two cases are shown in figures 3 and 4. The previous case suggests the possibility of fluctuations beneath the uniform density as shown in figure 5. Finally, as shown in figure 6, there is also the case involving holes or scarcities of matter distributed throughout an otherwise uniform density that act to reduce the effective density of the whole.

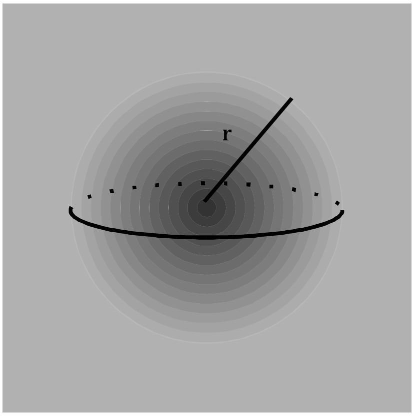

Figure 3: Density "Lump"

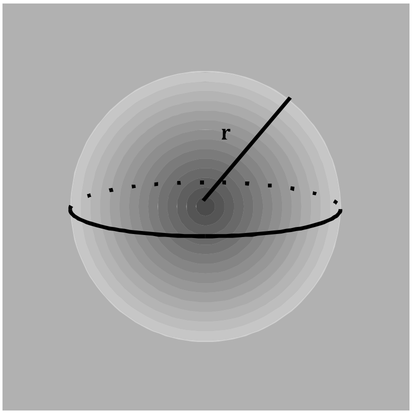

Figure 4: Density Fluctuation

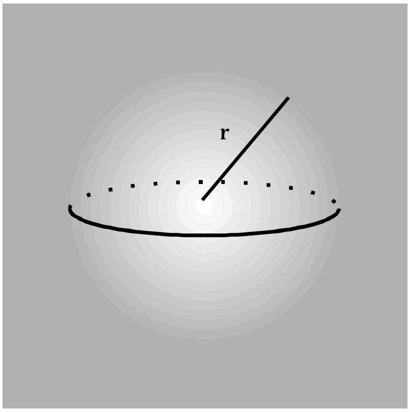

Figure 5: Scarcity Fluctuation

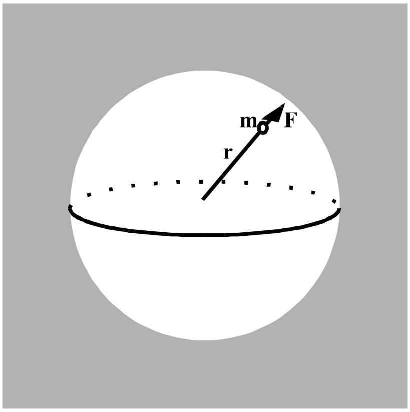

Figure 6: "Inverse Hawking Sphere"

We will consider the final case first since its understanding involves techniques essential to understanding other forms of variation in a uniform density. In this unique case we will be dealing with what might be considered an "Inverse Hawking Sphere" since it is what would result from having removed a Hawking sphere from a uniform non-zero density universe.

By reasoning from analogy it easily follows that the force on a particle at the center would be zero. Anywhere else within the hole and out to the edge of such a hole would be outwardly directed, away from the center and otherwise equal in magnitude to the force that would be experienced at that relative location if it were a Hawking sphere surrounded by a void. In other words,

$$F = +\, 4/3\ \pi\ G\ \rho'\ m\ r$$

There would also be a force exerted on any particle located outside the hole just as there would have been for a Hawking sphere that had been immersed in a void. If R were the radius of such an inverse Hawking sphere, by analogy again it is easy to see that the force would be equal and oppositely directed, i. e.,

$$F = +4/3\ \pi\ G\ \rho'\ R^3\ m\ /\ r^2$$

It would be an 'anti-gravitational force', if you will. Notice that we have used ρ' here to represent the uniform density of the material outside the hole. The reason for this is that to maintain the overall density of ρ at the global level, we must have that:

$$\rho' = \rho\ \left(1 - 4\rho'' / 3\pi\ \ R^{3} \right)^{-1},$$

where ρ'' is the mean density of such holes throughout all space and R is the mean radius of the inverse Hawking spheres.

Next, with regard to density fluctuations, let us look at the situation at the edge of a spherically symmetric density fluctuation. In dealing with this form of fluctuation in an otherwise uniformly dense material substance, we assume that there exists some radius about every fluctuation for which the total mass included in the enclosed sphere of that radius is equivalent to that of any other such sphere of material involving the uniform density. Beyond such a boundary there can be no net force caused by such fluctuations, whether the fluctuations are positive as in figure 4 or negative as in figure 5. These encapsulated variations could move about within the global context experiencing no forces from other fluctuations (positive or negative) until and unless they collided to form more major fluctuations of the same basic type.

Finally we come to "lumps" of over density. The simplest form, of course would be a "hard" lump of uniform – but greater – density than the uniform background. In this case it would act very like a Hawking sphere with an apparent density equal to the difference in densities. More generally it could be either a "lump" or "depression," where the latter would behave as a modified inverse Hawking sphere instead. The appropriate density of lumps required to effect the "uniform" density of the universe could be computed using a minor variation of the formula provided for inverse Hawking spheres above.

A more difficult case for normalizing the density involves lumps and/or depressions for which finite containment boundaries are less straightforward to assess, as for example, an exponential declivity that theoretically persists to infinity. In such cases the mean density of the abnormalities over any appreciable volume of space must be used to assess total enclosed mass by integrating over the enclosed volume and then dividing by the volume. It is obvious that only these more complicated extended lumps and depressions interact with matter beyond fixed boundaries; the force of these interactions must necessarily diminish as a power of distance greater than two. So remote variations in the uniform density will have virtually no impact on the behavior of the universe as a whole and certainly not on any alleged propensity to collapse. In order for collapse to occur, a variation would have to assume some global proportion that violates the condition of a uniform density.

In all the considerations above we have ignored forces other than Newtonian gravitation. In particular, thermodynamics and relativistic effects, which by any accounting would provide major modifications to this analysis. However, thermodynamic effects can never cause collapse! The forces would always be outward other than to fill in holes. The associated general relativistic effects for a uniform low density (flat spacetime) universe involve the area of Einstein's "greatest error" which is related to this discussion and which we will discuss further in another essay. At any rate Hawking did not argue that angle in renouncing Newton's conclusion that an infinite universe would not collapse, so it seems clear that as far as the bounds of this argument, Newton wins.

A Simple Rule To Befuddle Great Minds

There is a corollary of the '*divergence*' theorem for which Newton supposedly deferred publication of his *Principia* for twenty years in search of a convincing proof. This simple but problematic rule for inverse square law forces has continued to befuddle many of the greatest minds of our time, still distorting didactic treatments of cosmology. Briefly, it states:

"...a point inside a spherically symmetric distribution of mass at a distance r from the center is attracted as if the mass inside the sphere of radius r were at the center; the mass outside this sphere exerts no net force."[1]

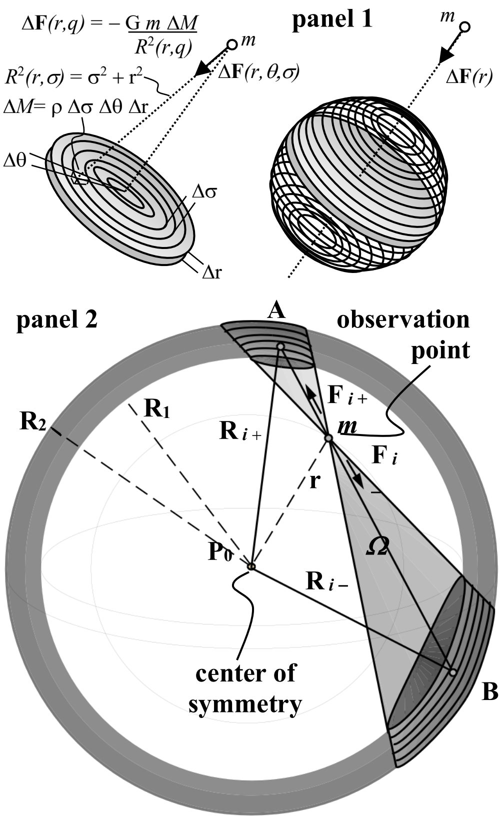

Figure 1: Aspects of the divergence theorem

To prove the first aspect of the corollary quoted above is simply a matter of integrating component forces from loci of circular discs of constant density throughout the extent of the internal spherical distribution. (See top panel of figure 1.) The second aspect involves the determination that all forces cancel within any solid angle *Ω* subtending areas on both sides of concentric spherical surfaces $|R_2|>|R_i|>|R_1|$ whose respective areas are related as the squares of distances to opposite sides of the external shell:

$$(R_{i+} - r)^2 : (R_{i-} - r)^2$$

where R_{i+} and R_{i-} are vectors of equal length $|R_i|$ but are directed at points on opposite

---

1 Symon, Keith., ***Mechanics 2nd Ed.***, Addison-Wesley, London, (1961) p.262. In this article we will content ourselves with discussing the theorem in terms of associated forces which does not get into the origin of the name of the theorem in a more general derivation. That treatment will be addressed in a subsequent essay.

sides of the sphere. The force from each infinitesimal element in opposite directions of the solid angle will relate respectively as:

$$(R_{i+} - r)^{-2} \;:\; -(R_{i-} - r)^{-2}$$

Thus total forces F_{i+} and F_{i-} from the two skull cap areas at A and B on opposite sides exactly cancel each other out for every shell layer. This remains the case as the solid angle increases to encompass all directions in space and all radii – even as $|R_2|$ approaches infinity.

There are awkward subtleties in the wording of the last clause of the statement of the theorem above that can get one into trouble in extrapolating beyond assumptions, however. It should be emphasized that "*the mass outside this sphere exerts no net force*" must *not* to be taken to imply that additional mass distributions that do not possess the same symmetry as, for example, that shown in figure 2 where a massive object outside the spherical shell *would*, in fact, exert a force on any test particle within the enclosed sphere. That is because forces on the test particle are vectorially additive. This is, of course, why the theorem works at all since it was required that we sum the forces F_{i+} and F_{i-} in order to demonstrate a net force of zero in figure 1 panel b. So the lesson of figure 1 panel b (and the statement it exemplifies) is not properly taken as implying that all externally directed gravitational forces are nullified on test particles inside a spherical distribution of mass. It is merely a demonstration that the sum of all forces originating at the various points within that symmetrical distribution cancel.

This is in contradistinction to static electrical forces on a charged particle within a charged spherical conductor. In that case the electric field is constrained to zero by *conduction* at the sphere itself, and whether it were charged or not (and even if the charged conductor were symmetrical or not – as long as it remained a closed surface), nullification would result by reason of conduction alone. An electric field does not penetrate a conducting shield because induced currents nullify the force at the conducting surface. There is no direct analogy between such electrical phenomena and the gravitational situation we are discussing. Some people have been confused by the superficial similarity with the electrical phenomenon discovered by Joseph Priestley in 1765. We won't go into aspects of electromagnetic theory involved in electromagnetic shielding, acknowledging at the same time that there *is* a legitimate application of the divergence theorem to electrostatics where conductors and currents are not present.

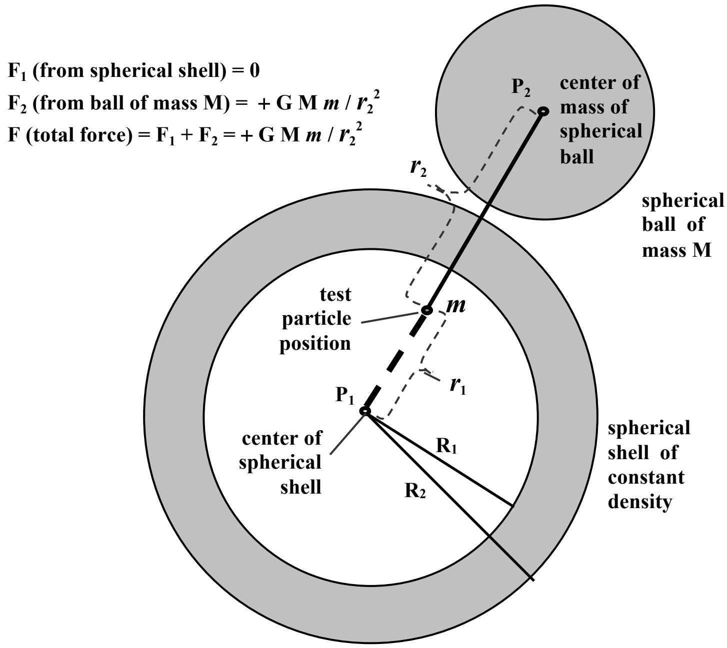

Figure 2: Demonstration that the divergence theorem does not accommodate gravitational shielding

Although homogeneity does indeed seem a reasonable assumption for an infinite universe and is well confirmed to as far as observations have been made, an appropriate center of symmetry must always be at the test particle upon which forces are being evaluated. For example, a sheltered hole in a universe without a bounded exterior surface – i. e., *one without a surrounding void* – will inevitably be asymmetric with regard to any test particles used in detecting such an effect unless it happened to be at the very center of the hole. Any presumed universal symmetry, other than an observer's own, would be an invalid contrivance from his perspective. Any argument concerning symmetry of a (homogeneous) universe of infinite extent must pertain to the position of any test particle. It is easily shown that, in this case when all symmetries have been taken into account, the effects of the larger portion of the hole on one side will 'outweigh' other considerations, and this closest environ of the test particle – will exhibit the largest (albeit a negative) effect.

Let us determine the force on such a particle located somewhere within the hole in an otherwise infinitely extended homogeneous universe: R_2 is drawn in figure 3 so as to circumscribe everything that is asymmetric with regard to the particle. $|R_2| = |R_1| + r$, where R_1 is the radius of the hole. Everything outside this sphere of radius R_2 will therefore exhibit no net force. Within this we have the hollow bubble centered at P_0, a filled ball with a dimple of the same radius as the hole – centered at P_1. There is the circumscribing volume within the spherical radius R_2 that surrounds the two overlapping smaller spheres. The particle is situated at the center of the larger sphere, midway between the centers of the interior spheres, with the overlapping discus-shaped volume centered at the particle. The problem is to determine the forces produced by the material situated within the two spheres centered respectively at P_0 and P_1, since *all* other volumes are clearly completely symmetric from the perspective of the particle. Furthermore, we know that the actual gravitational effects of the hole itself must be null. This leaves the effects of the uniformly dense but dimpled ball only conceptually distinguished from the rest of the homogeneous universe. The most difficult aspect is the empty discus-shaped dimple that is illustrated as a dark area.

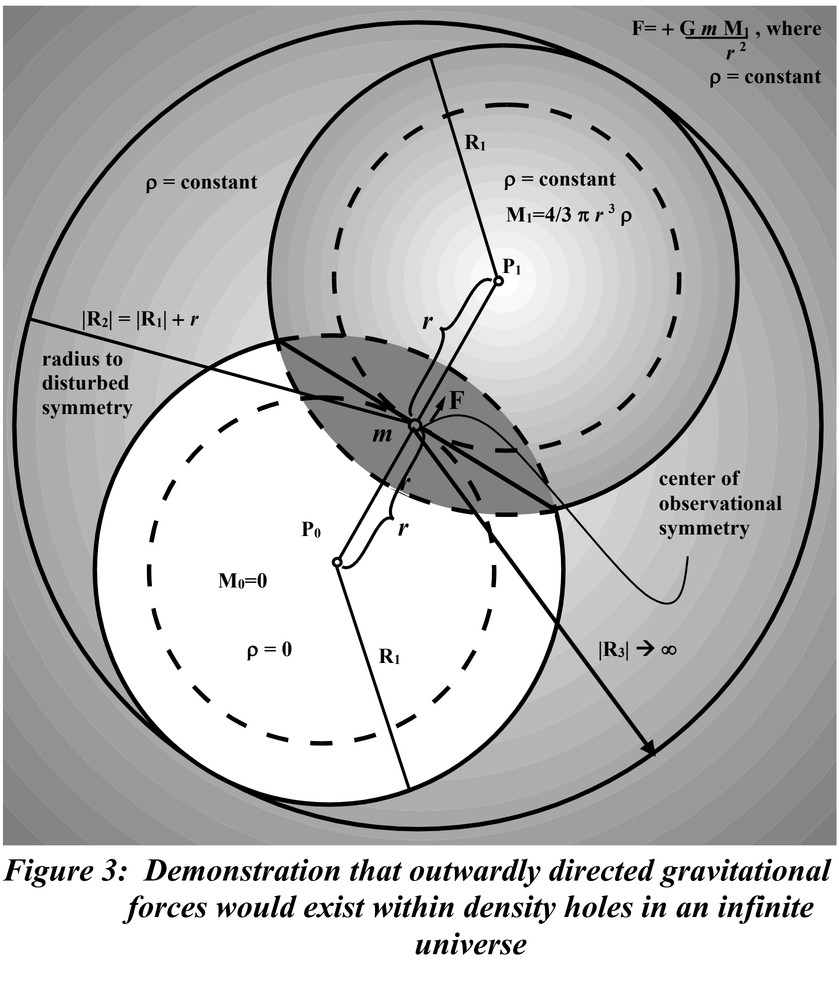

Figure 3: Demonstration that outwardly directed gravitational forces would exist within density holes in an infinite universe

An interesting conclusion with regard to the gravitational effects of this discus shaped volume centered at the particle is that by symmetry its effect must vanish, i., e., the test particle is situated right at its center. And since that effect must therefore vanish, the total effect of the force at the distance r away from the center of the hole will be unaffected by whether that entire discus is filled with the uniform density or totally devoid of material. Since this is true, we can solve the net force problem with the discus-shaped volume either filled or empty. The result is independent of whether the ball or the hole is 'dimpled'. The net gravitational force from the void centered at P_0 is zero in any case. However, in determining the effect of the complementary symmetric sphere filled with material, it is easier to see the result by assuming this discus-shaped volume to be filled. Thus, we can cancel the forces from a *complete* spherical shell of uniform density between the radii of *r* and R_1 centered at P_1 using the divergence theorem, to find that the force due to the total amount (including the entire filled discus) of material inside the radius R_1 centered at P_1 is just the force given by the first aspect of the divergence theorem, i. e., that due to material within the radius *r* of P_1. Since the net effect of the forces from all areas within the discus itself is zero by symmetry, that volume can be voided without affecting the result. Thus, the net effective force produced by the presence of the hollow bubble *inside* of radius *r* in a uniformly *filled* universe, is the same as would be realized by a filled volume of the same dimensions *outside* of *r* in an otherwise *empty* universe. This force is outward from P_0 (since it is toward P_1). Any particle within such a voided volume would experience an outwardly directed force. So any tendency to fill in the void from the outside would be countered by gravitational forces tending to expand the hole until the overall equilibrium density was achieved. If, on the other hand as example, the geometry of figure 3 were augmented by inserting a spherical lump at P_0 of radius less than r whose mass was just equivalent to the total displaced mass of the entire bubble, then the edge of the bubble surrounding the lump would be stable although the mass at the surface of the lump itself would experience forces to further condense. So a universe of globally uniform density might indeed develop bubbles and/or lumps, but only in conjunction with one another in maintaining the large-scale average density and *not* in imploding or exploding the universe itself. So don't panic!

A strange dynamic is demonstrated here: If ever a bubble were to arise in an otherwise uniformly dense universe, the bubble would expand precipitously pushing matter outward with its growth in a manner directly complimentary to how a lump would collapse *until* (and it is key that it is *only* until) the net density within the total collapsed/exploded volume (including the peripheral developments) produced a net density equal to the global average density of the universe as a whole. This highlights the original problem of its application to Einstein's cosmological considerations that we will discuss in the next article: In essence the problem in Hawking's argument with Newton was to assume that the 'average' density of the universe that was assumed valid out to an exterior of all shells was not valid beyond that – that in fact, it was zero beyond that. (See the first density profile in figure 4 below.) So the universe can be made to implode in upon itself or to explode with equal ferocity depending upon assumptions employed with regard to the density at infinity. Importantly, infinity is *not* a distance that can be reached so as to posit a difference at that distance!

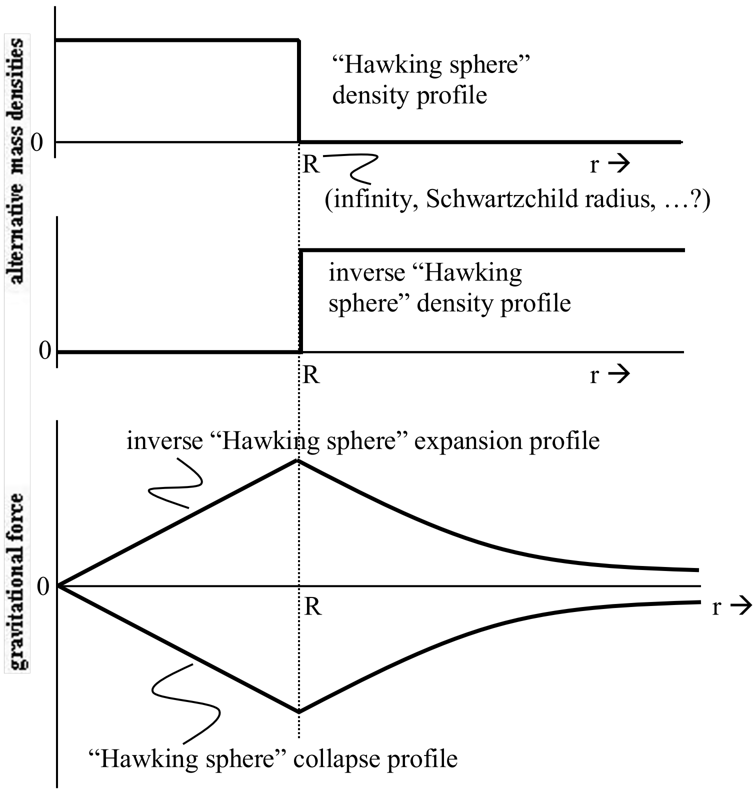

Figure 4: Density and corresponding force profiles for "Hawking" and inverse "Hawking" universes

Newton, Einstein, Hawking, and most of the luminaries in both intervals between, have applied the straight-forward proof of the divergence theorem beyond the validity of its assumptions.

Conflicting conclusions employing the divergence theorem derive not from the application of the theorem, but from considerations beyond the scope of the theorem, i. e., the model of the distribution to which the theorem is applied. It comes down to invalidity in conceptual presumptions regarding construction techniques appropriate to 'building universes'. This is precipitated by the misconception that one could (even in principle) *build* a universe 'in' a void as against *describing* what can be *observed* of a universe without limits! In a universe surrounded by a void the theorem would indeed hold, of course, and it would pertain to a catastrophically imploding universe. Clearly the universe depicted in figure 3 involves a symmetry that from the perspective of the particle does *not* involve cancellation of gravitational forces. It is the determination of effects realized at the location of the test particle that is a proper application of a mathematical theorem to a physical situation. The same organization with the hole filled and the rest of the universe empty would have given the result obtained by Einstein's and Hawkings' construction, but that is a very special case, no less so than would be a hole in an otherwise filled universe. In any case, it is *not* a good springboard for a general theory. Global symmetry about a point can be restored by acknowledging those asymmetries that exist within a radius of say R_2 as shown in the figure and individually solving for dynamical effects produced within that radius. Within this radius about which global symmetry pertains there may be additional symmetries for which forces can be seen to cancel each other as we have shown. Even within remaining asymmetries there are local symmetries that assist in determining the forces that do *not* cancel.

Devotees of science will not be deducing further proofs to shore up the positions of the great names in science, but asking themselves, "How might this be refuted by measurement?" For *that* is the way of science! It is thought by many, the author included, that half of the baryonic matter in the universe is invested in its vast intergalactic regions and half in denser galactic structures. One of the very few reasons to believe in the existence of "dark" – non-baryonic – matter is that spiral galactic rotations are too swift in their outer regions. The author believes that other explanations of such anomalous observations will ultimately be discovered.

Newtonian gravitation should probably typically not be applied directly to physics on any grand scale of course, although all evidence points to the geometry of our universe as described even by Einstein's general theory as being characterized by a 'flat' spacetime continuum. But in any case in addition to mass density, dynamic pressure also plays a principal role in cosmological analyses. However, the divergence theorem does remain central even here. Homogeneity and isotropy of mass density and pressure on large scales, i. e., beyond local asymmetries, must be maintained by such other factors. In fact, the over-whelming stability of the universe on grand scales is perhaps the ultimate proof of homogeneity. Einstein's recognition that, when erroneously applied, the theorem fails to assure stability gave rise to a twiddling with equations that he later regretted as his "greatest error," but one which practitioners still ply in fudging to get desired answers. Current cosmologists fail to realize just how fundamental that error really was.

The assumptions of the divergence theorem are insufficient in themselves to address situations of mass density distributions that do not vanish in the limit – i. e., infinite homogeneous non-null cosmologies that would be appropriate to Newton's argument as described in the previous article.

It is application of the theorem to Einstein's 'static model' – a didactic entry to general relativity to be discussed in a subsequent article – that is at issue. The dispute involves an inappropriately-centered symmetry. With Newton (and the rest of us), Einstein had accepted that the universe is most probably symmetric and, in fact, homogeneous at the largest scale. But he also inadvertently assumed a void beyond a bounded surface.

How Much Difference Can It Make?

The previous articles have pointed out flaws in the reasoning upon which so much of current cosmological thinking is based. But how much difference does it make? What would the corrected analyses predict as a refutable alternative?

On large scales there is reason to believe that the universe is indeed uniformly dense, but significantly there are huge variations accommodating the galaxies of which our Milky Way with its 150 billion stars is somewhat typical and entire clusters as well as super clusters of these colossal objects. So how could these come about naturally within any conceivable scheme of homogeneity?

We mentioned several themes of variation in an earlier article, but here we will attempt to show how excesses and depressions in density might form and grow into larger structures. With the thermodynamics of the plasma which constitutes most of the known (observable) universe, slight variations in density over quite small regions might develop such that, for example, a minor bubble in the uniform density would occur. This would involve a spherical shell of inflated density as shown in figure 1 to account for the matter that is removed from the bubble, of course. So what forces would be attendant to such a development?

In the figure we show such a development together with the separate symmetries appropriate to solving the problem. Background symmetry is identical to that discussed earlier with regard to an inverse Hawking sphere. The associated force experienced within the hole increases linearly with distance from the center of the hole and is directed outward. Outside of the hole in such a configuration the force continues to be outwardly directed, but diminishes as the inverse square of the distance from the center of the hole. (See figure 4 in the previous article.) But now there is an additional force due to the denser shell to be considered, and again as appropriate to any field theory, forces experienced at a point are simply additive.

The symmetry of any inflated density shell that develops would naturally be expected to be centered about the center of the hole since the background symmetry suggests equal outwardly directed forces from the center of the hole. The maximum force will be experienced at the edge of any such bubble, so material at the edge of the bubble will be forced outward with the greatest force forming a denser shell, with material further out from the bubble experiencing more minor forces, there being zero force out past whatever ridge develops. In figure 2 the effect of a constant density shell that extends to 1.2 times the radius of the bubble is shown. The constant density in the shell is just the material removed from the hole. So such holes would gradually increase in size until such time as another structure was encountered by the expanding shell of the bubble.

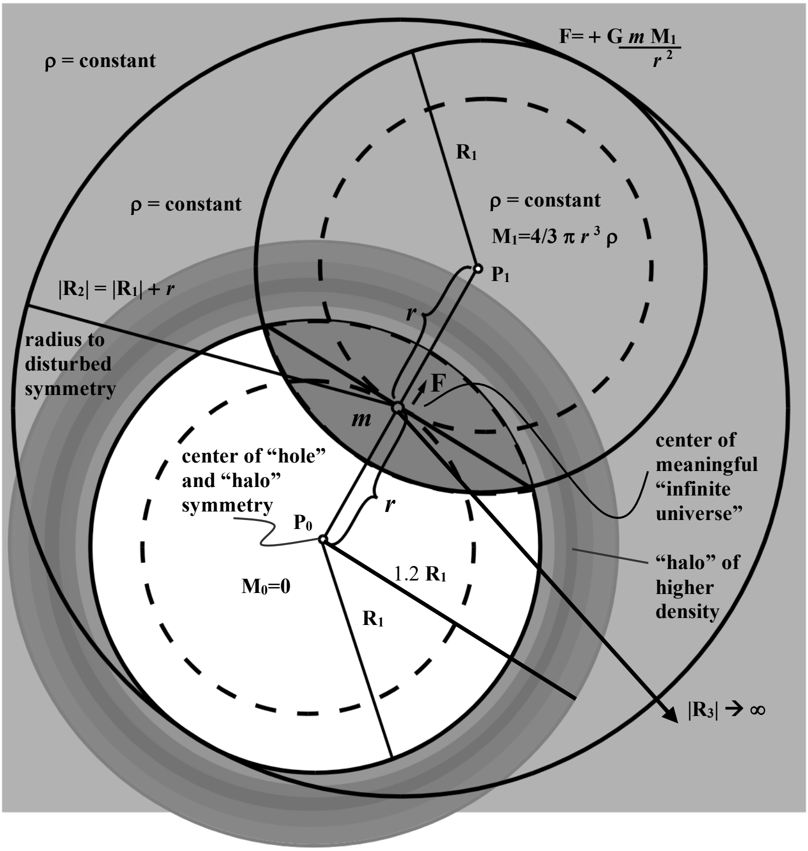

Figure 1: Bubble with a shell

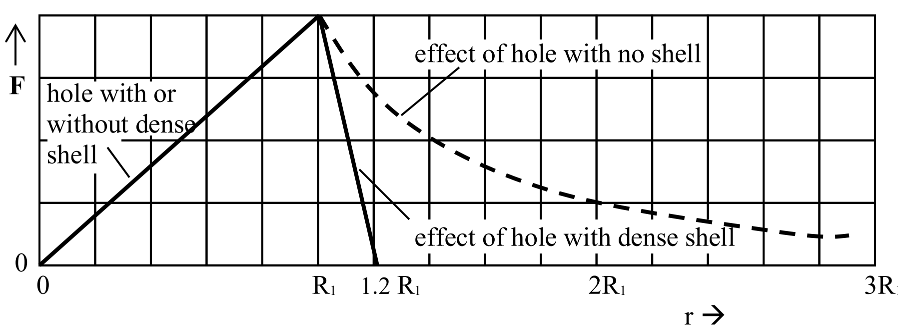

Figure 2: Forces experienced in and around a bubble with no net change in the average global density

If the bubble were formed by the material accreting to the center for whatever reason, the effect would be as illustrated in Figure 3, where the accretion has been to within a radius of 0.3 times the radius of the bubble. The difference from the effect of an isolated sphere surrounded by a void is not all that major except for material out near the surface of the bubble where the force would go to zero except for whatever thickness may have resulted at the surface, which would then produce a sharper edge to the force.

That something similar might be an operative phenomenon in a diffuse low density substance is demonstrated by a cross section illustration of our solar system and its associated Oort cloud and Kuiper belt Trans Neptunian comet spawning grounds. See figure 4.

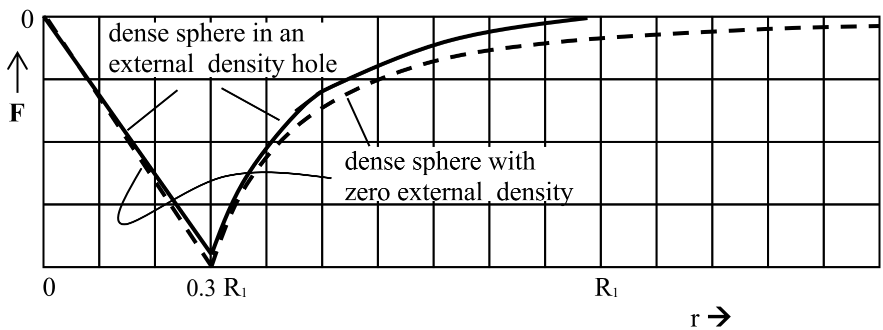

Figure 3: Forces experienced around declivity with no net change in the average density

It is also of interest to acknowledge the very minor perturbations in the trajectories of the Pioneer 10 and 11 space probes which, once they escaped the immediate gravitational confines of the sun and major planets experienced unexplained gravitational forces. The unexplained forces were on the order of one ten billionth that of the sun at the positions, but they were at the time less than ten percent of the way to the Oort cloud that is thought to contain the makings of 10^{12} comets. Of course the force was toward the sun rather than outward, but the Kuiper belt with it 10^{10} objects also would contribute to inwardly directed forces. It will be interesting indeed to see what forces are experienced when probes approach and pass the Oort cloud.

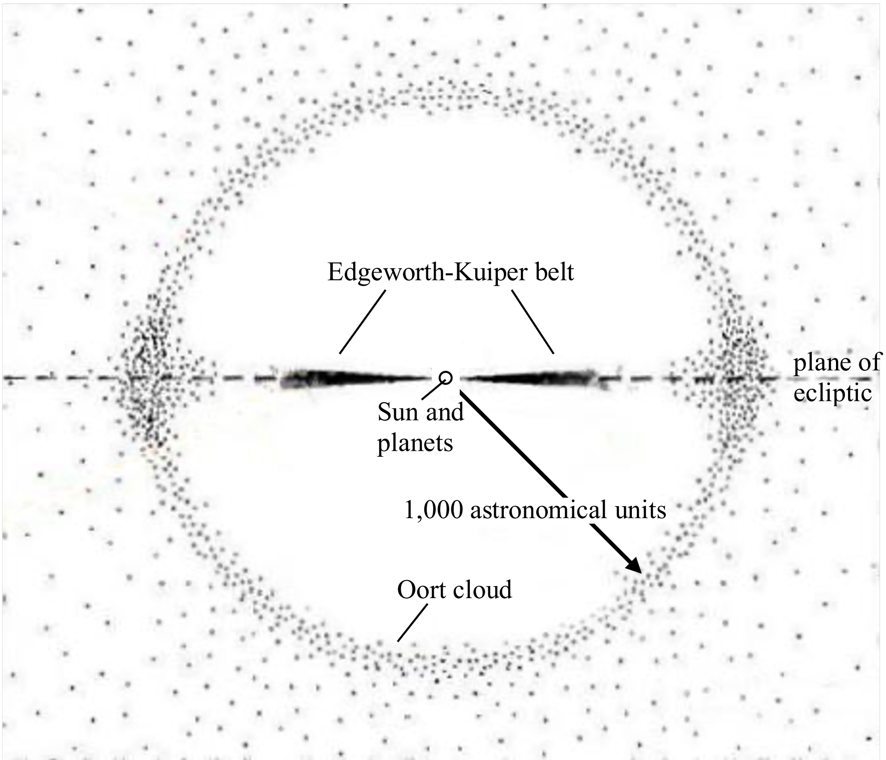

Figure 4: Cross section of the 'bubble' surrounding the solar system

Exploring Einstein's "Greatest Error"

In discussing the "cosmological considerations of the general theory of relativity"[1] in 1917 Einstein made reference to Poisson's well-known equation as applied to gravitation. In particular:

$$\nabla^2 \phi = 4\,\pi\,K\,\rho$$

where the second derivative of the gravitational potential energy is equated to a constant times the mass density as appropriate to inverse square law forces. He noted that there is an apparent incompatibility of this usual formulation with Newton's theory in as much as it requires that the density become zero as the extent of the volume to which the equation applies becomes infinite if the gravitational force is not to also become infinite. This is certainly mathematically true.

Clearly, the equation is incompatible with there being no net force ($\mathbf{F} = \nabla\phi = 0$) on matter in a uniformly dense universe as Newton was wont to accept as the reality of our universe, but which Einstein and others have disputed as being an erroneous view on Newton's part. (The reader should read the preceding essays which discuss the issues of this so-important argument.) If we solve Poisson's differential equation for the potential energy of a uniform distribution, we do indeed obtain:

$$\phi(r) = 2\,\pi\,K\,\rho\,r^2$$

which, of course, increase without limit as r becomes large.

To resolve this problem, if only as a 'foil' for the resolution he had in store for the general theory, he conjectured that there might be a universal constant λ, defined such that Poisson's equation could be replaced with the following:

$$\nabla^2 \phi + \lambda\,\phi = 4\,\pi\,K\,\rho$$

The solutions of this equation for a uniform density ρ_o is $\phi_o = -4\,\pi\,K\,\rho_o / \lambda$ everywhere. He proceeded to apply the similar kluge to his general theory which he later acknowledged as his "greatest mistake"

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[1] Einstein, A., "Cosmological Considerations of the General Theory of Relativity," ***On the Shoulders of Giants*** – edited by Stephen Hawking, Running Press, London (2002) pp1248- 1257.

but which cosmologists continue to reincarnate as solutions to mismatches between theory and actuality.

This is a situation where we sometimes get so caught up in sophistication of symbolism in mathematics that we forget to check the isomorphic physical reality – the association that is the only justification for any symbolic *representation* at all. Poisson's equation derives from Gauss's integral theorem that is associated with the divergence theorem discussed in the previous essays. This integral theorem states that:

$$\iint \nabla\phi \bullet \mathrm{d}\sigma = \iiint \rho \, \mathrm{dV}$$

This expresses in mathematical terminology that the sum over an entire closed surface (such as that of a sphere) of the outwardly-directed perpendicular component of the force field associated with the enclosed mass density distribution is equal to the total amount of mass enclosed by the surface. If the density is uniform throughout the enclosed sphere, it would correspond to what was referred to earlier as a "Hawking sphere." Certainly the perpendicular component of the force field $\mathbf{F} = -\nabla\phi_1$ due to the portion of the uniform distribution in the left-hand Hawking sphere shown in figure 1 is the same at every point on the sphere. However, similar relations apply to $-\nabla\phi_2$ due to the mass distribution on the on the right which is required if we are to maintain symmetry about a test particle on which the field is exerted at A. Both values $\nabla\phi_1$ and $\nabla\phi_2$ can be determined using mutually exclusive portions of the mass distribution that maintains the proper symmetry about the test particle by this procedure, and their sum by the rules of field theory is therefore the legitimate solution at point A. So the total force field $-\nabla\phi$ at point A must be zero when we insist on the legitimate application of Poisson's equations to the symmetric parts of this problem. And the *proper* way to extend such considerations to the limit of an infinite universe is to let R (not just r) go to infinity. This gets us away from the scenario of our universe being a gigantic black hole, etc..

At any rate, Einstein was persuaded that the universe was indeed very uniform at distances large with respect to our own galaxy and its immediate environs such that a uniform density seemed a reasonable assumption. That assumption seems even more valid now that hundreds of billions of galaxies have been observed. But he was also convinced that the universe must be finite to keep velocities of distant galaxies within bounds, and that conviction we must question – not for reasons of Hubble's hypothesis which persuaded him to disavow his position, but for physical and mathematical reasons.

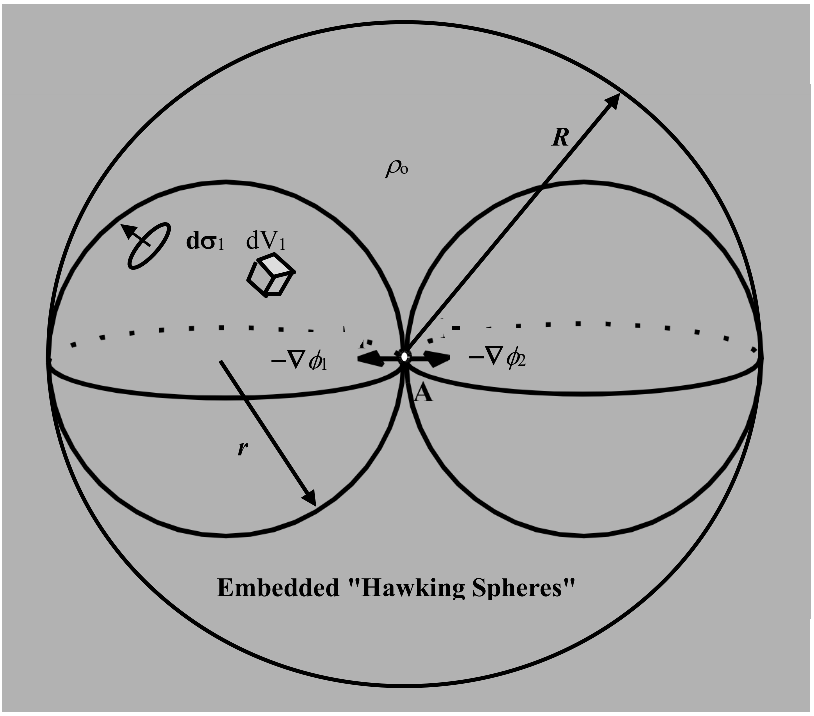

Figure 1: Applying Gauss's integral theorem to embedded Hawking spheres

Hubble's hypothesis did seem to have come to Einstein's rescue with regard to the universal constant λ such that, assuming an extreme initial velocity of the matter at remote distances, one could suppose that gravitation was indeed operative at these extreme ranges in bringing the velocities of distant galaxies into check. Of course it would have been as reasonable to have assumed the same initial velocity had occurred in the even more distant past that had finally been brought under subjection. In either case it puts us at a non-Copernican position in spacetime. But he hadn't, and so it was Hubble's hypothesis of expansion of the universe that effectively did away with any need for λ in Einstein's mind, especially in a finite universe. So he acknowledged that it had all been a bad mistake – that he should have let his equations guide him without fear that the world might not follow.

Hubble's constant provided a means for assessing gravitational values of cosmological significance including the average density and radius of the entire universe.

Although the critical density and its derivation are cornerstones of what general relativity and current cosmology are all about, it is a simple concept and there is a correspondingly simplistic, non-relativistic, derivation of its value: The derivation begins with the classical concept of 'escape velocity' from a massive body such as earth and proceeds to considerations of distant objects receding at extreme velocities as a part of the expanding universe hypothesis. The collective mass of the universe is hypothesized as the retro force keeping expansion from getting out of hand. Of course this derivation does not get into the strange initial conditions or their origin.

In classical physics the kinetic energy of an object of mass m that is moving with velocity v is $\frac{1}{2} m v^2$. The gravitational potential energy ϕ of an object of mass m at a distance, r, from the center of gravity of a spherical mass distribution of total mass M is:

$$\phi(r) = - G_m M m / r.$$

G_m is Newton's gravitational constant. An object will escape the gravitational field of the distributed mass if its kinetic energy exceeds the absolute value of the gravitational potential energy by which it is bound such that:

$$\frac{1}{2} m v^2 \geq G_m M m / r.$$

Kinetic energy will be converted into gravitational potential energy as it proceeds further from the center satisfying the energy conservation law. If the two forms of energy happen to be equal then the object would stop at a very great distance with essentially zero velocity and zero potential energy.

It is virtually the same calculation for distant galaxies whose escape from the attraction of all the other galaxies and intergalactic media in a finite (Hawking sphere) universe that is in question. Will they stop, turn around, or fall back to swirl with the other galaxies until finally they dissipate their energies and collapse into a gigantic black hole? If there is just enough material in the universe to stop the galaxies then perhaps the universe will go on forever expanding ever more slowly. That is the current thinking.

According to Hubble's law the approximate velocity of a distant galaxy is proportional to its distance, $v = c H_o r$, where $c = 3 \times 10^{10}$

cm s^{-1} is the speed of light, H_o is about 5 x 10^6 Mpc^{-1}, where Mpc refers to "mega par sec" or 3.26 x 10^6 light years. So the kinetic energy of a galaxy can be written ½ m $(H_o r)^2$. The mass of all the material inside a sphere of radius r is given by $M = 4/3 \pi r^3 \rho$, where ρ is the average density of the universe. Substituting these two expressions into the inequality provided above produces:

$$\tfrac{1}{2} m (H_o r)^2 \geq G_m (4/3 \pi r^3 \rho_o) m / r$$

By simplifying and rearranging to solve for the critical (equality) situation, we obtain:

$$\rho_o = 3/8 c^2 H_o^2 / \pi G_m$$

which depends only on universal constants so it would seem to qualify also as a universal constant. It is approximately 5 x 10^{-30} gm cm^{-3}. An estimate of the mass of galaxies has been obtained by determining the approximate number of stars per galaxy (on the order of 10^{11}) and multiplying by the average mass of a star, or by observing the dynamics of orbiting parts of galaxies which is determined by mass. By adding the masses of all galaxies seen in this region and dividing by the volume of space involved in this survey one obtains an estimate of ρ_o. As larger and larger regions of space are included in such surveys the mean density seems to approach a figure of about 10^{-31} gm cm^{-3}. Certainly there is some fairly large degree of uncertainty in this value because it is based on a series of estimations.

The mass of an object can be determined by its orbital velocity about another object. When applied to the motions of individual galaxies within large clusters of galaxies using the virial theorem we can estimate the mass of the cluster by the radial velocities reflected in the Doppler changes in wavelength of known emission lines in the radiation from the various galaxies. Similarly the orbital velocities of stars within a galaxy are used to assess the distribution and total mass of the stars within galaxies. A mass to luminosity ratio for galaxies allows luminosity data to be used to supplement mass estimates. The results imply an 'actual' density of the Universe that is about 0.3 times the critical density, which in turn implies that galaxies will not escape the gravitational forces of all the other galaxies. There are known discrepancies that lend some credence to 'dark matter' theories, of course, which some believe ups that percentage to nearer 100 percent.

Knowing ρ_o is tantamount to assessing the Schwartzchild radius R_o of the entire universe. The calculation uses the same inequality used above, but with a photon of light as the escape vehicle. We obtain:

$$R_o = H_o^{-1}$$

Virtually all of current concepts of cosmology are intimately tied to this concept of a critical density from which one can supposedly obtain a size for the universe, an age of the universe, etc..

So what's to doubt?

Let's just list a few of the objections to the certitude given this little bit of cosmic mysticism. They will not necessarily be listed in the order of the significance the author places on them:

1) There are the inconsistencies encountered in observed data – stars in our own galaxy older than the supposed age of the universe, too early giant elliptical galaxies, and other too early structures throughout the universe.
2) Supposed requirements for 'dark matter' to support the virial theorem calculations with regard to inter and intra-galactic dynamics.
3) Evidence for acceleration (rather than deceleration) of expansion on which the whole calculation is based – revitalizing Einstein's "mistake".
4) A general willingness to entertain Einstein's "biggest mistake" or any other alteration of time-honored laws of physics or universal constants just to make these calculations work.
5) Theoretical inconsistency with black hole theory since the universe by these calculations has been a black hole for most of its existence but is now apparently emerging from that ultimate lethality, in contradiction of notions put forward by the same theorists in the context of black holes rather than universes.
6) The current understanding that gravitational forces are transmitted via gravitons in analogy to photons transmitting electromagnetic forces, suggests that these must also be limited to speed of light travel and involve wavelengths and frequencies proportional to the momentum and energy transmitted. This would certainly be associated with redshifting in accordance with Hubble's hypothesis with an associated diminution of both with distance. So that to presume unabated gravitational forces at extreme distances seems unrealistic.

7) The calculation is based on an arcane model of the universe as discussed earlier by this author with regard to inappropriate application of the divergence theorem to all space.

The first six of these are more or less nitpicking. The seventh addresses underlying assumptions of the theory of cosmological gravitation, general relativity, and virtually all current thinking in cosmology. There is no reason to believe the underlying assumption should be considered valid for the universe as a whole. Presumed validity in this domain is based on precedence and the reputation of those who have previously accepted the assumption, perhaps most notably Einstein and Hawking.

The Pushing of Distant Stars

"...we have discussed centrifugal forces. According to Newton they indicate the movement in absolute space. According to Mach and Einstein they indicate the movement relative to the distant masses of stars."[1]

This is not an attempt to inform you of some subtle aspect of Ernst Mach's philosophical ramblings nor even necessarily to promote a principle that he so ably introduced, the coloring in of which quite took the fancy of Albert Einstein and other twentieth century physicists and cosmologists. It is rather a light hearted challenge to oft repeated adages concerning the *pull* of distant stars that tends to yank one off roadways when attempting to negotiate sharp curves at high speed in the middle of the night.

It seems more like they are *pushing* to me.

Inertial mass has been shown by Etvös's experiment and others more recently to be quite equivalent to gravitational mass as Newton, Einstein and others have presumed. I think by now we ought to just accept that as a fact. Also at the outset, let's just accept that gravitation throughout our current universe – except, of course, in the immediate vicinity of black holes or neutron stars – can be handled quite adequately using classical Newtonian theory. We live in the closest thing imaginable by even the greatest minds and astronomical instruments of our time to what Einstein referred to as a flat universe. If the general layout of the universe should ultimately prove to be otherwise by a few slots in a googol, it will still be too close to quibble for our purposes here.

So, for this exercise gravity can be characterized as an inverse square law force for which the divergence theorem applies. If you have forgotten (or never knew) what that particular corollary of one of Gauss's more famous endeavors is all about, I'll explain briefly the implications to which I refer: It is that if a body can be characterized by a distribution of mass that is spherically symmetric, then the gravitational force on another particle of matter at a distance r from the center of that distribution will just be given by $F_G = G\ m\ M\ /\ r^2$, where G is the gravitational constant equal to 6.7×10^{-8} dyne cm^2 / gram, m is the mass of the particle, and M is the total mass of the symmetric body of matter within the radius r. Of course this applies to any inverse square law force and it need not be quite so restricted as I have

[1] Max Born, ***Einstein's Theory of Relativity***, New York, Dover (1962) p. 349

simplified it here. Furthermore, if one happened to be inside a nebulous body of symmetric density distribution much larger than r, say R = 1/H_o, then the force could still be represented as just $F_G = - G\, m\, M(r) / r^2$ totally independent of the total radius R and mass M(R) out past where the particle is located. The point of all this is that the effect of all matter further from the center than the particle should have no effect on the total gravitational force experienced except as I've explained in another article. This proof would remain valid even if the universe were infinite. Of course, in that extreme case there must be symmetry and the center of that symmetry must be *recognizable* and *make sense* or arguments leading from it won't make a lot of sense either as I explain elsewhere.

Inertia – that 'equal and opposite reaction' of which Newton was so fond – is also characterized quite simply. If the velocity of a particle were to be increased by some amount Δv over a period of time Δt, then the particle would experience a force $F_I = - m\, \Delta v / \Delta t$, directed in the opposite direction from the increase in velocity. The particle mass, m in this expression is assumed to be the same as its mass in the gravitational force equation above. Special relativity, of course, changes the expression somewhat to $F_I = - \Delta(m\, v) / \Delta t$, but since Δv will be small and Δm even tinier in any test case of which we are capable, let's continue with our no-quibble policy.

Mach's principle suggests that the inertial force is due to the 'distant stars', so it must presumably pertain to their gravitational attractions on us. There just don't seem to be any other forces that act at such great distances on neutral matter other than for one of Einstein's greatest mistakes that we need hardly mention here. So let us assume without quibble a nominal finite (but large) spherically symmetric three dimensional universe with time added like an old fashioned supplement. To make it easy, assume we are very near the center but at a large distance from any appreciably massive bodies so that it all looks fairly uniform and the same in all directions. Then we are in a situation in which we experience no net force from the universe around us. All the conceived forces applied by the distant stars cancel out according to Gauss's theorem – *unless* we become too active. But how could our status quo with regard to such massive objects so many, many, many light years away possibly change so dramatically and instantaneously by our merely applying a minor impulse (Δv) on this little insignificant speck somewhere in the middle?

Consider, however, that the entire symmetric universe around us suddenly takes on an entirely different appearance when we experience acceleration. Relative to our situation of just a moment (Δt) prior to that experience, a portion of the universe has veritably jumped out in front of us! Yes, it really has: This is the effect called aberration that was predicted and verified long before special relativity came along to modify it only slightly. Distant stars and the odd trillion or more galaxies – that had been directly overhead and beneath us, as well as those directly left and right of us – are now situated at an angle slightly in front of us as shown in figure1 below. The sine of the angle through which they will have moved is,

$$\text{Sin}\ \alpha = \Delta v/c$$

Because of relativistic aberration. Other astronomical objects that had been behind us will now have moved up to take their places like so many lemmings eyeing the infinite sea. There are now more stars in front of us and less behind. Aren't there? And yet, by all accounts, we experience a net force pulling us backward – in the direction from whence we came – where there are now *less* distant stars than there had been before we experienced the acceleration. So tell me, does it seem to you like the distant stars – now predominantly in front of us – are *pulling* as everyone professes to believe, or *pushing* as I intimated above? I rest my case on that frivolous issue.

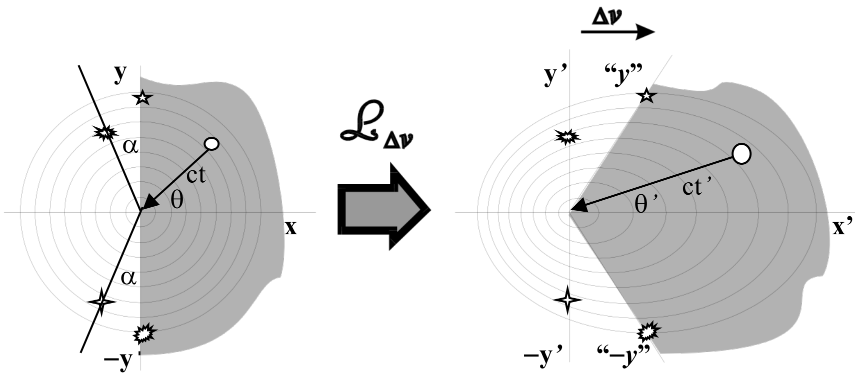

Figure 1: The universe seems to jump in front of an accelerated observer

I know some of you are trained in the appropriate sciences and cannot let this *pushing* phenomenon just pass without some clarification. To understand how this works, try to visualize that in Δt seconds we will have altered our position only by the short transport distance Δv times Δt, which can be made arbitrarily small without thereby reducing our acceleration which is their ratio. Relative to the *distant* stars we will certainly not have picked up much parallax by our brief acceleration. Virtually the entire difference in our purview is due to aberration caused by our almost instantaneous change in velocity – *not* an appreciable change in our position relative to our former perspective of *their* positions. After all, it happened the very instant we began accelerating. Of course the stars have *not* moved – but they will have moved for us in virtually every respect that matters. Consider that whatever influence they have over us must proceed along our lines of sight to them and that those lines of sight may have changed quite drastically over a miniscule Δt seconds. Gauss's brilliant analyses that depend so intimately on spherical symmetry would no longer seem to even apply as illustrated in figure 1, nor therefore do the effects of distant regions of the universe cancel as in our former status quo.

However, the inverse square relationship of gravitational forces assures us that the forces pulling us to the rear, where distant objects are now mapped closer to our position by the Lorentz transformation will more than compensate for the added population to the fore. So to be accurate, one would have to say that the "*closer* of the *distant* stars *behind us* are actually *pulling* us harder in this case rather than that the more numerous but now more distant ones in front are *pushing*." So let's just drop that rhetoric.

I would have liked to end this on such a clever note, but it isn't as straight forward as one might like it to be. It never is.

It should be possible to calculate these gravitational forces which no longer cancel for a uniformly dense universe of radius R_o and density ρ to assess the implied impulse. But first we'll illustrate the calculation in which, without acceleration, all the forces cancel, we employ the cosine of the angle to the designated region relative to the acceleration direction to assess the positive and negative gravitational forces from each bit of matter in the universe, obtaining:

$$F_G = 2\pi \int_o^{R_o} \int_o^{\pi} G\, m\, \rho\, (\cos\theta) \sin^2\theta \; d\theta\, dr = 0$$

For the altered situation, the impulse realized over a tiny time interval Δt will be that effected by an increase in velocity of Δv. The distance to each infinitesimal unit of volume will now be $r' = c\,t'$ rather than $r = c\,t$, where $c\,t' = \gamma\, c\, t\,(1 - \beta\cos\theta)$ is the Lorentz transformed distance; c is the speed of light, β the ratio $\Delta v/c$, and γ is the factor $(1-\beta^2)^{-½}$. We also have that $\sin\theta' = \sin\theta / (1 - \beta\cos\theta)$ and $\cos\theta' = (\cos\theta - \beta) / (1 - \beta\cos\theta)$ from aberration formulas. We will also need to take into account an additional factor of γ in the accelerated mass. The impulse will be:

$$F_G = 2\pi \int_o^{R_o} \int_o^{\pi} G\, m\, \rho\, \gamma^2 \, \frac{(\cos\theta - \beta)\sin^2\theta}{(1 - \beta\cos\theta)^2} \, d\theta\, dr$$

$$\approx - \left(\pi^2 G \rho R_o / c \right) m\, \Delta v$$

But, since we wish to attribute this result to inertial forces, i. e.,

$$F_I \, dt = - m\, \Delta v,$$

we run into a rather serious problem. In order for Mach's conjecture to be viable, there is a constraint on an expression of what are considered to be universal constants:

$$\pi^2 \, G \rho R_o c^{-1} \rightarrow \sim 1$$

However, when we assess this with the best obtainable values of each parameter on the left we get a result of on the order of 10^{-20}. Something is definitely wrong here, either we are forgetting something…or there is something at work here that we have never adequately understood. Certainly this is disconcerting

And what about there not being any force remaining after one takes the foot off the accelerator? *That* is not taken into account by the preceding analyses either. What is the proper understanding of that?

So you see Mach's principle is just not very polished as principles go. A push here, a shove there maybe – what more can one say? Maybe now we know why everyone knows *about* Mach's principle but nothing of a quantifying nature has ever been done with it.

Reopening the Book on Black Holes

The ugly specter of a black hole is somehow quite enchanting to physicists in this new millennium, in part I suppose this is because they mirror conditions perceived by many as pertinent to our ultimate womb and doom – a narcissistic perspective that has seemed to beckon physicists for well over forty years now. That the geniuses of Hawking and Penrose have been greeted with such enthusiasm is due in large part to priorities they have assigned to these elusive objects of their unique insights – insights involving the inner workings of what have been perceived as seething vortexes of matter. But the most salient features of black holes can easily be understood by virtually anyone – even those with minimal backgrounds in the sciences. Black holes had been anticipated hundreds of years ago by a member of the clergy who stated in his paper presented to the Royal Society back in 1783 that escape velocities from an extremely massive object could exceed the speed of light under prescribed conditions. Thus, a lowly holy man augured prophetically that "all light emitted from such a body would be made to return towards it."[2]

For a particle of mass m to escape from a massive body of mass M, the kinetic energy imparted to it must involve a velocity larger than the 'escape velocity' v_s in order to overcome the negative gravitational potential energy such that:

$$\tfrac{1}{2}\, m\, v_s^2 \geq \mathrm{G}\, M\, m / r,$$

where G is the gravitational constant 6.7 x 10^{-8} erg-cm/gm^2, r the distance of m from the center of gravity of the object of mass M when it possesses the velocity v_s. Since the upper limit on achievable velocities is that of light, we have:

$$r_s = 2\, \mathrm{G}\, M / \mathrm{c}^2.$$

where, c is the speed of light, 3.0 x 10^{10} cm/sec, and r_s the *Schwarzschild radius* to the 'event horizon' from within which even photons of light could not escape. This formula derives from classical analyses as shown, but is compatible with Einstein's gravitational model. Thus, if an object were sufficiently dense, it would be invisible.

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[2] `Although John Mitchell was indeed a member of the clergy he was also a polymath of no mean talent who had given up a post as professor of geology in Cambridge in 1764. (John Gribbon, ***The Scientist***, Random House, New York, 2002, p. 293.)

That is, if it were smaller than its Schwarzschild radius r_s, it could not be observed other than by external effects of matter being dragged to its doom and a minor associated effervescence. Let us ignore for now the ability to 'observe' it by means of its gravitational 'field,' i. e., how do these fields escape if electromagnetic ones cannot? How fast do gravitons move? Etc..

Thus, Newton's formulation of gravity in which forces act through the center of mass of an object reduces the complexity of calculating the Schwarzschild radius of an event horizon from beneath which no light can escape to mere child's play. The minimum mass that is required by evolving stellar masses if they would attain unto this status is similarly easy to determine as we will see. It is about two solar masses. We now know also from Hawking's and Penrose's extensive work that there are no particular subtleties with respect to black holes; they must all be 'standard' inasmuch as distinguishing characteristics outside their 'event horizons' can only be their unique mass and angular momentum – net charge not being much of a possibility. (Thus, "Black holes have no hair" is every bit as sophisticated as, but certainly no more so than, the statement, "There is no free lunch.")

But despite such dispassionate determinations of their simplicity there is still a tremendous amount of conjecture pertaining to internal structures – or lack thereof – with popularized conceptions promoted by those who should know better dictating an associated spacetime singularity. That general relativity, whose equations cannot even be solved for trivial planar cases, implies that spacetime may be "pinched off" in the vicinity of a black hole is a factal of which I will deny myself other than an amused awareness (for reasons to be discussed in more detail below). From the outside, however dark, a black hole is just an object. There persists this notion that having once sunk beneath its Schwarzschild radius all its mass would have been swallowed into a single mathematical point never to return, although we have been told by the same individuals that our current universe emerged (or is just about to emerge) from beneath just such a shroud. It's hard for me to distinguish just what should be believed before breakfast. From such fanciful theorizings come fantasies of "worm holes," Einstein-Rosen Bridges, "quantum foam," and time machines. Notwithstanding these absurd (Oh, did I say "absurd?") presumptions, Hawking has shown that given 10^{85} years (regrettably somewhat less than a picturesque googol) black holes would eventually effervesce back into visible matter. And as usual, I'm skeptical – not of the effectuality of his effervescence which seems reasonable mind you, but of a need for it in this case.

We are all aware of the frequent news flashes claiming repeatedly to have confirmed the existence of black holes. It is claimed that there are giant black holes at the centers of many distant galaxies and even our own Milky Way. The galaxy M87 is thought to possess a black hole at its center with a gravitational pull three billion times that of our sun. These "messy eaters" have become the engines of choice for the prodigious energies generated by quasars, etc. Statistical estimates place the number of black holes resulting from collapsed neutron stars at as many as 100 million in our Milky Way galaxy alone. With respect to the news flashes, there is considerable reason to believe that black holes do indeed exist. But on logical grounds I currently have very serious doubts – outside the scope of mathematical games played with general relativity – about their being associated with singularities in spacetime as popularly envisioned. Let us consider that notion.

There is, of course, the minimum mass requirement for astronomical objects that proceed down the thermonuclear ash ladder based on thermodynamic pressures and simple gravitational collapse considerations. There are observationally confirmed stopping off places in the collapse of matter into its densest states. In a penultimate state, an entire massive star may be comprised of a single nuclear blob of juxtaposed protons and neutrons surrounded by an atmosphere of electrons. This structure is known as a "white Dwarf." Quantum solutions such high Z (proton count) 'Hartree atoms' would provide an extremely wide range of orbits for degenerate (as in Pauli exclusion principle) electrons. The inner shells would be constrained well within even their own Schwarzschild radii while the outer shells would be virtually free of gravitational attachments altogether. Such stars are thought to be particularly stable because electron degeneracy that precludes the particles occupying the same angular-momentum-space-spin attributes, would preclude their being packed more tightly such that they would then have to share mutually exclusive allotments as in the shell structures of their more mundane atomic counterparts. Neutron stars are those that fall through this rung on the downward spiral staircase by virtue of exceeding the Chandrasekar threshold of 1.4 solar masses. Exceeding this limit suffices to allow gravity-induced pressures to exceed electron degeneracy forces by increasing temperatures such that thermonuclear reactions that merge electrons and protons into neutrons occur, so that the star plunges to the next rung on the ladder. If the stellar mass is less than about 2.0 solar masses the surface of the neutron star will remain above its Schwarzschild radius. Such neutron stars are now well-known as "pulsars." Those that have been observed have radii of about ten kilometers just safely larger than their Schwarzschild radius of approximately five kilometers. However, stars more massive than this threshold will eventually virtually disappear. Their collapse is envisioned by many, however, as hounding them like Bill Clinton's tireless detractors even beyond invisibility. But how can that happen when the mass density must now be determined by neutron degeneracy? It is conventionally thought that a similar process to that whereby electron degeneracy is eventually overcome by gravitational pressures would eventually force neutron stars also to succumb. But this would not occur as soon as the neutron star sank beneath its event horizon – these phenomena are certainly not directly coupled.

For modeling purposes calculations of gravitational collapse phenomena can be simplified by unrealistic assumptions involving constant densities such that any macroscopic region of a neutron star would have the same density. As compaction proceeds in search of a new compressed equilibrium under such (unrealistic) assumptions, the object would more or less continuously reach higher and higher densities. This process is perceived as proceeding "beyond" the neutron star stage once a black hole is created with an associated abandonment of the conservation of baryons as the trapped heat from the increasing pressure cannot be released. Assumptions appropriate to a neutrino-quark gas are what are inferred and in this form the indivisibility of major atomic components is seen as having finally been lost. In this case the density profile is intuited to proceed down the path to singularity. Collapse would force density toward infinity more rapidly than the radius tends toward zero. The tremendous gravity would turn surface mountains into submicroscopic ripples, smoothness, then oblivion. One might argue thus that for matter comprised of point particles distributed evenly as in a gas in a spherical gravitational well there is no reason why, if degeneracy gives way to the ineluctable pressures of gravity, sufficient matter should not collapse indefinitely. So singularity might seem to be inevitable such that black holes would become point particles of extremely large mass – the Big Bang happening in reverse! Such fantasies of thought engage even the brightest notwithstanding the established facts to the effect that whether black holes collapse to singular points or hover forever just beneath their event horizons could never be scientifically distinguished unless there were some possible consequence that could be observed – that there isn't. But singularities are the stuff of dreams for string theorists who anticipate so many large point particles they don't know what to do with them all. That the truth might forever be shrouded from falsifiability by experimental and even theoretical means has never been an obstacle to such theorists; it may even subconsciously be acknowledged as an advantage. But let's just consider the simplified model of matter involving uniform distributions of infinitesimally small point particles. How legitimate is it?

It is true that the divergence theorem legitimizes the assumption of all symmetric mass distributions acting *as though* (but certainly not *as in actual fact*) operating through a *single point* at the center of mass of the distributed body for gravitational consideration. It is also true that the Schrödinger equation that nailed down the behavior of electronic matter did assume *point particles*, but that treatment used little more than broad analogies. It turns out that solution of these equations involving the very same *point particles* results in their inevitably being *smeared out* as mere probability clouds with absolutely no credentials for existence at a single point at any particular time. The validation of these solutions by experiment is legend. But despite success in the laboratory, the derivation of the equation itself and the assumptions that went into it remain entangled in hocus-pocus. Notice also in this regard that although it assumed that attractive forces of the nucleus act through a single point this is *only* in the sense of the divergence theorem, and that in cases with more than a single proton it obviously cannot actually *be* a single point other than as the abstracted center of mass. So… so much for those lame arguments. If particles are, in fact, as most theorists maintain, *point* particles, one might ask why protons and neutrons do not ultimately just collapse into their own gravitational potential wells. Their Schwarzschild radii are on the order of $r_s = 5 \times 10^{-19}$ cm, but that is one hell of a lot bigger than a *point* particle and would provide a very dangerous environment for a particle that dashes about violently within strict confines! It would be like a man in an Edgar Allan Poe nightmare with a manhole-sized abyss in the middle of his dark cell – simply a matter of time. The answer to this dilemma is simple if one accepts data from the real world. The theoretically and experimentally inferred radii of their associated clouds exceed 10^{-13} cm. They are alas, despite theoretical arguments to the contrary, like neutron stars of less than several solar masses, everyday planets, people, baseballs, and M&M's, just too damn big to fit within any such confinement as their own event horizon!

Mass and charge are concepts that are not all that well defined other than with respect to their effects on apples and cat's fur, and I will not make conjectures here other than in that same time-honored tradition. In figure 1 there is a set of curves representing the density of nuclear charge as a function of radius for a few garden variety atomic nuclei as determined by electron scattering methods appropriate to this endeavor. You will notice that all these nuclei are too big to fit into their Schwartzchild radii and I would wager that there is little danger of component quarks falling into theirs either. It is inherently reasonable to assume there are nearly identical distributions of mass and charge in such cases. There is, of course, a slight

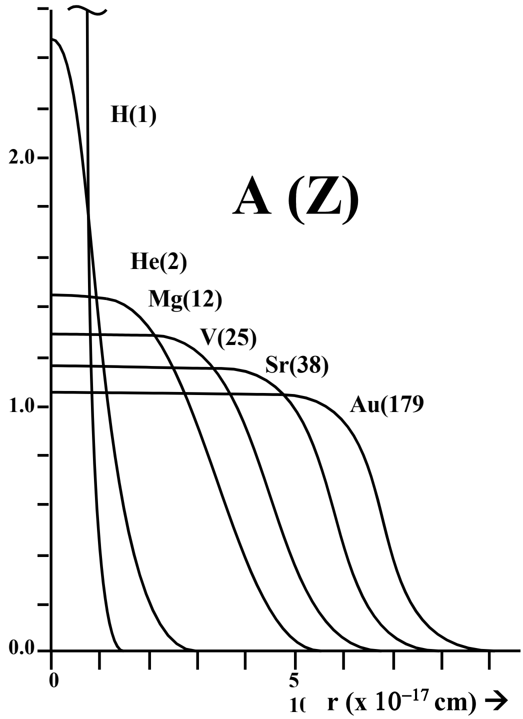


Figure 1: Nuclear charge densities

increase in the percentage of uncharged neutrons relative to protons with increasing atomic number, but otherwise the curves in figure 1 are much more like what one should expect for mass distribution of elementary nuclear particles than for the soup model described above. But again, when dealing with units of miles or kilometers such fuzziness about the edges would have been on the order of 10^{-20} smaller – in fact the mere “ripples" of which we spoke earlier. But before we talk too glibly of singularities, for which such fuzziness becomes huge, let's consider effects of such fuzziness on the ultimate collapse of matter into the abyss of its own black hole.

When electron degeneracy breaks down in the collapse into a neutron star and in proceedings thereafter (if there is, in fact, a thereafter), is it reasonable to assume that the generic aspect of a probability distribution associated with the building blocks of matter would be drastically altered also? And if the structure were to be so altered, who is to say that it would be to a distribution along the lines of a simplistic soupy model? Does it seem reasonable to anyone capable of coherent thought on the subject that Quantum organization would be abandoned at this point? Would God have thrown up his hands at that point and said, "Oh, I never thought about that?" I don't think so. Be aware that no one knows the correct answers to such metaphysical questions since we have no snap shots from the supposed *bang*, some time after which neutrino degeneracy is praised, but I don't think that matter in black holes would turn to soup. Occam's Razor would surely take a swipe at that assumption and I see no reason to fight such a weapon myself. There is a continuous record of soupy models of matter having repeatedly been replaced by previously unsuspected models involving a more organized structure as heady endeavors provided additional information about phenomena associated with submicroscopic matter. In particular, there would have been every reason to believe that a stable hydrogen atom would prove to be an utter impossibility. But nature has vehemently insisted on particle indivisibility that precluded an electron soup from spiraling into a proton soup and their two charges dissipating in a sayonara swan song as they disappeared altogether into however romantic a unity in an electromagnetic vortex. The forces were there for exactly that eventuality, but … it turns out that there are *other* forces than electromagnetism and gravitation that have precluded that.

How could tiny nuclei contain multiple protons whose inverse square repulsion would skyrocket these juxtaposed objects to the opposite ends of the universe? But of course the nuclear attractive and repellent forces involving lower levels of fundamental particles enforce comfort distances using forces of much higher order than an inverse square relationship to preclude such disasters. No one could have anticipated the nature of these additional forces until sufficient data was available. Now there's a concept! All the high powered deductive reasoning on then current models was laughably insufficient to scale these peaks of knowledge. It has been our scientific heritage that by employing inductive methods we do systematically scale such peaks, and ultimately smile down on our former ignorance. But there seems currently to be little inclination to such humility on that account or patience for just plain "finding out!"

It should be noted that nuclear forces although symmetric do not involve inverse square relationships and that, therefore, the divergence theorem that that has been so essential in the context of black holes doesn’t even apply in that domain. Certainly as a neutron star becomes more massive by accretion, more significant gravitational forces become increasingly pertinent to any quantum solution. However, it seems a bit rash to predict that a tiny force, that in domains for which we have actual data pertaining to it being smaller by a factor of less than 10^{-40} than another, should prematurely be declared the victor based on interpolations from the ultimate dearth of data. Never mind the fact that Bush's cousin and brother could achieve that result in Florida – that was third world politics. To assume that an inverse square law attractive force could suck objects into a singularity in the real world when those same objects repel each other by much more extreme forces is a bit…well…extreme!

Much more likely it seems to me is the possibility that increasingly massive stars would go quietly to that good night behind the curtains of their event horizons. As a neutron star's mass attained several solar masses, whether initially or eventually through gradual accretion, whatever associated increase in volume it achieved by adding particulate matter would be dwarfed by more dramatic cubic increases in the volume increases due to its increased Schwarzschild radius. So it would seem reasonable to assume that the object might indeed eventually sink beneath its event horizon. But it seems unlikely without further evidence that it would proceed from such a gradual demise directly to the hidden singularity too often propounded as a necessary consequence. Why would it? No one now, nor will anyone *ever*, have empirical evidence of what happens beneath an event horizon other than that of our segment of the universe, because alternative inner workings of black holes must forever remain moot points in accordance with the findings of Hawking and Penrose.

One thing seems certain and that is that there is so far no adequate justification to conclude that they must proceed in one fell swoop to a mathematical point rather than the externally equivalent alternative! As mentioned, their radii and all other features are fixed independent of their internal workings so why is it scientific to presume such an impossible situation when all possibility of evidence for that eventuality is foregone? This gets back to the meaning of the divergence theorem and the equivalence of any symmetric distribution to one in which all mass is concentrated at a point: That equivalence applies to inverse square law forces and even in that case does not confuse anyone with regard to our sun, earth, and moon possibly thereby being merely mathematical points assigned the given masses. Why is this so-related point so hard to understand?

The neutron star rung in the matter ladder may ultimately arrest collapse altogether – perhaps it's the basement floor itself or the trampoline beneath the trapeze of being! In some cases such an object's surface may actually indeed immerse into and beneath an event horizon, but the internal workings of the associated object itself need not undergo transmogrification on that account. It is my guess that it will remain the embodiment of the very same generic rung on the ladder notwithstanding its understandable new shyness. It is obvious that we know too little about neutron stars other than pulsar radiations we attribute to them. What is the structure of a neutron star – whether it involves 1.0, 1.4 or 5.0 solar masses? Whatever it is, it must involve a lump of neutrons whose organization is determined by quantum considerations pertinent to a fermi gas trapped in a tremendous gravitational well. Complimentarity suggests that classical expressions for energy of a neutron added to such an object of radius r must bear some resemblance to the corresponding quantum mechanically determined value. So $E \approx 4/3\ \pi\ G\ m_n\ \rho\, r^2$, where m_n=1.67x10^{-24} gm is the mass of a neutron with density 1.67x10^{15} gm cm^{-3}, which is not much more dense than typical neutron stars as one might expect. But now let's consider how a distribution of fermions is affected by increasing temperatures that would accompany additional gravitational pressure. As is typical of quantum solutions, the distribution becomes much broader by skipping energy levels and hopping into extended orbits as implied in figure 2. Only at the temperature of absolute zero Kelvin would such a gas be completely compacted within its minimum radius determined by E_f (the highest compacted energy level). At 10,000 K the distribution would be totally out of any bounds we could associate with complete compaction in any way similar to a soupy model restricted within an event horizon let alone presume it to have collapsed to a mathematical point. At hundreds of millions of degrees – reasonable temperatures for such ensembles – associated neutrons would exist throughout a vast cloud much larger than the event horizon. Nor would this involve impossibilities of faster than light travel; in quantum solutions there is no sense in which probabilities of being here or a light-year away involve the concept of 'escape velocity'. And since a high-energy neutron has a definite propensity for disintegrating and/or interacting with other matter no matter where it is found in the vicissitudes of its "travel," this scenario involves something totally *other* than being 'confined to a black hole'. These real world considerations are why the contents of such objects cannot be dismissed like debris shoved down a garbage disposal. High energy neutrons light years away from the center of the neutron star or black hole would disassociate atoms, create deuterium in collision with plasma protons, and ultimately create helium and traces of heavier elements far removed from the hole itself. The pertinent question is, "How could this *not* happen?"

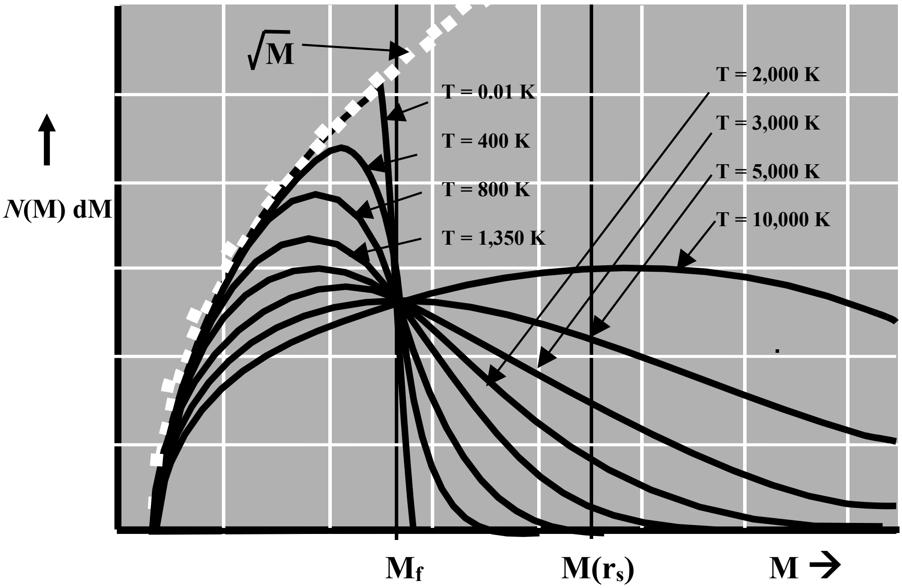


Figure 2: Significance of fuzziness in the mass distribution in a fermion gas of neutrons as would be realized in a collapsed neutron star

Being compressed to a Schwartzchild radius is *not* like reaching *Mach one* or *the boiling point*! There is no qualitative new torture awaiting matter at this coincidental (as against universal) threshold as popular thought insists. (For example, scientists are having one hell of a time determining whether our entire universe is beneath or has somehow crawled out from underneath such a shroud. If it made such a tremendous difference, why could we not tell? And if our entire universe escaped its own event horizon as data increasingly suggests to most that it must have a long time ago now according to the standard cosmological model, *how* did it get out?) Internal phenomena might very well reach a state (even if one anticipates some method of circumventing fermi gas restrictions) in which it becomes sufficiently energetic whereby internal eruptions (the next up the Richter scale from supernova) associated with quantum distribution phenomena occur. We may already have observed this at the centers of active galaxies – quasars or gamma ray bursts – about which we have had plenty of Jungian *inflationary* dreams concerning primordial origins. There is no reason to presume that such once-obscured matter might not reappear as a result of internal reorganizations that swells it first back beyond its Schwarzschild radius in a process that might afterwards explode the entire now visible contents back into luminous interaction. Such a process could free all of the trapped matter with no violation of any physical law – freeing the hot neutrons in one gigantic (although not *that*) big a bang from which the rest of all we know about the universe proceeds. There is nothing magical here. This would not involve the spewing forth of iron, gold, Europium, and Americanium or other heavy elements of a supernova, but the basic building blocks that have naively been assumed as only *initial* primordial prerequisites of the universe. "Cosmocentrism" propounded by Frank Luger may be actualized by such rising phoenixes – not everywhere all at once, but all black holes at some point in their maturity so as to maintain an infinite and eternal equilibrium between these sources and sinks of all material existence. It is enough to titillate and frustrate the fantasies of creationists of all ages and scientific persuasions.

I wish I could flap my lips to produce the mellifluous sounds of a Carl Sagan on one of those old Public Broadcasting System *Nova* programs my children used to deplore when I say the following because it's the awe-inspiring religious sense in which I feel it. Anyway, getting away from this epiphany, and whether with eloquence or a more characteristic bombasity, here goes: "Nothing says that a book, a mind, or even a black hole, having once been closed, cannot be reopened."

Afterward:

There would seem to be some level of hypocrisy for those propounding the origin of the universe from what they consider to be a singularity with a "big bang" when these same individuals insist on the penultimate death of the material universe into just such singularities. For example, Ed Seidel (NCSA and University of Illinois) states with regard to what he considers to be cosmic "decency laws" that what happens beneath Event horizons must in essence forever remain no one's business such that:

"All singularities within the universe must therefore be 'clothed.'

"But inside what? The event horizon, of course! Cosmic censorship is thus enforced. Not so, however, for that ultimate cosmic singularity that gave rise to the Big Bang."

That is not the introduction to an explanation, but the end of one. And this ultimately is the hypocritical lie to be told – where we find that what is good for the goose in *not*, in fact, good for the gander!

I was recently accosted that the universe could not possibly exist in a stationary state because of the multiple levels of fundamental particles. I asked how this logical structure could imply a temporal origin and was told in essence that many, if not indeed *most*, of these particles would have no role if it were not for the big bang where they could conceivably have had some play. It was as though my critic had perceived the universe as a staged production being somehow *directed*; and why would a playwright write a play with specified actors for some of whom there were no parts written. A theatre group that hired actors for which there were no roles would be a madhouse. In such case there should as likely be roles for which there were no actors.

I understood. I more or less agreed.

However, what did he not understand about the similarity presented by the possibility that black holes might ultimately spew forth matter back into the useful universe just as what is envisioned as having happened at a big bang?

Certainly the high energy conditions under which these lower levels of fundamental particles have been discovered are realized inside black holes. So just maybe the neutron lumps transform to heavier but similarly structured matter as a next rung on the ladder of material being that retards the ultimate collapse – until it also reaches its own analogy to a supernova. Who knows?

There is a lot we do not know about gamma ray bursts other than that they seem to occur even at the extremities of the visible universe and to be associated with optical galaxies. Maybe these are the evidence of black holes erupting.

Cosmic Coincidence?

There seem always to be nearly insurmountable epistemological traps and barriers to overcome. We seem always to be peering down the wrong end of telescopes, until very occasionally by some accident of fate, we run off yelling “Eureka! Eureka!” like demented hippies in the backwoods of California. Our various highly evolved linguistic and mathematical skills get applied primarily to justifying the particular inanity that happens to be in vogue – never with actually changing paradigms. There seem always to be mathematical mappings of what *is* known of the unknowable depths of our universe to the shallow waters of our intellectual wading preference, but the veracity of such mappings is often warranted no more than formal propriety justifies aphorisms depicted in poesy.

Consider what we know of our universe with regard to its composition as a very diffuse but impure hydrogenous plasma, for example. Yes, as surely as to a first approximation we ourselves are mere bags of salt water, the universe is a hydrogenous plasma, both being pretty damn good approximations. With only this much firmly in our grasp, we must resist urges to charge off like rabid string theorists to find the big end of some telescope, waving at cameras and grabbing microphones on the way.

How diffuse? About 10^{-25} grams per cubic meter. So in sifting through a few cubic meters of universal debris at random you may find the odd proton, an electron to neutralize the concoction, and by-product neutrinos all whizzing about at significant fractions of the speed of light. The most obvious decomposition of this plasma being that apparently on large scales everywhere in the universe it is 76 percent hydrogen nuclei (protons) and 24 percent (by mass) helium nuclei (alpha particles) such that there are twelve hydrogen nuclei per each helium with mere traces of other isotopes.

At high temperatures helium nuclei are formed from hydrogen nuclei by nuclear fusion. (Of course at even higher temperatures protons which comprise the nucleus of hydrogen can be created from neutrons, and positrons, with neutrinos and associated ‘opposites’ dashing about, but let us ignore third tier observations.) All nuclear reactions are reversible with equilibrium percentages of each product determined by temperature. Those of us who still accept the conservation of energy – notice that most cosmologists do *not* – insist that *if* the 24 percent helium did indeed derive from primordially pure hydrogen plasma, then the energy released would not be totally lost.

This caveat holds to the extent that the universe is a closed system, which it would seem to this author to be by definition. This radiant energy, however thermalized, must therefore still be present somewhere in (and indeed, throughout) the universe.

Now if you go through the calculations, and they are very straightforward, you will find that the amount of radiation energy released per cubic centimeter by this reaction is quite precisely the amount of energy even now invested in the microwave background radiation. All fashionable cosmological theories take this to be a mere coincidence. They tell us that the *facts* of annihilation associated with an unknowable primordial imbalance in matter and antimatter right after a miracle happened resulted in that glut of energy which today is viewed as some sort of perversely understood *fact* of the universe supposedly *in reality* being only 3 degrees Kelvin rather than the many orders of magnitude higher temperatures observed everywhere we look. According to these theories the energy balance coincidence is just a strange happenstance of our being here *now* rather than somewhere somewhat similar a billion years ago or hence. With such a perspective my confusion might have been avoided. But I don't have it.

So how 'bright' should it be if this coincidental amount of radiation that we all agree is actually out there *is* actually out there? Well, let's think about that: On average every hundred cubic meters or so of the universe contains ample evidence of a few of these reactions having taken place. From our observation point the intensity from each reaction is diminished as $1 / r^2$ where r is the distance to each occurrence. We arrive at Olbers paradox with the number of cubic meters increasing as the square of the distance, r^2. Thus, we get to the crux of the paradox when we combine these two effects for the entire universe. But of course modern cosmology resolves such difficulties by demanding a finite universe of radius $R_o = 1/H_o$ where H_o is Hubble's constant. So we end up with a modest(?) intensity given by:

$$I \sim \int_o^{R_o} (1/r^2)\, r^2\, dr = R_o$$

So a finite universe and the Bang that justifies it are (quite literally) made for each other. But if the redshift-distance relation is accepted as the mere fact that it *is* rather than a grandiose deduction from conjecture, then to the accuracy of precise observations the relation is characterized by $r = R_o \ln(z+1)$, which theorists will tell you corresponds to an "Einstein-de Sitter Universe." Here we have distance given by the natural log of redshift, z, plus one, all divided by Hubble's constant. The effect of redshift is to reduce the frequency of radiation, thereby reducing its intensity by the factor $1/(z+1) = e^{-r/R_o}$. So that in an infinite universe we would have:

$$I \sim \int_0^{\infty} (e^{-r/R_o} / r^2)\, r^2\, dr = R_o$$

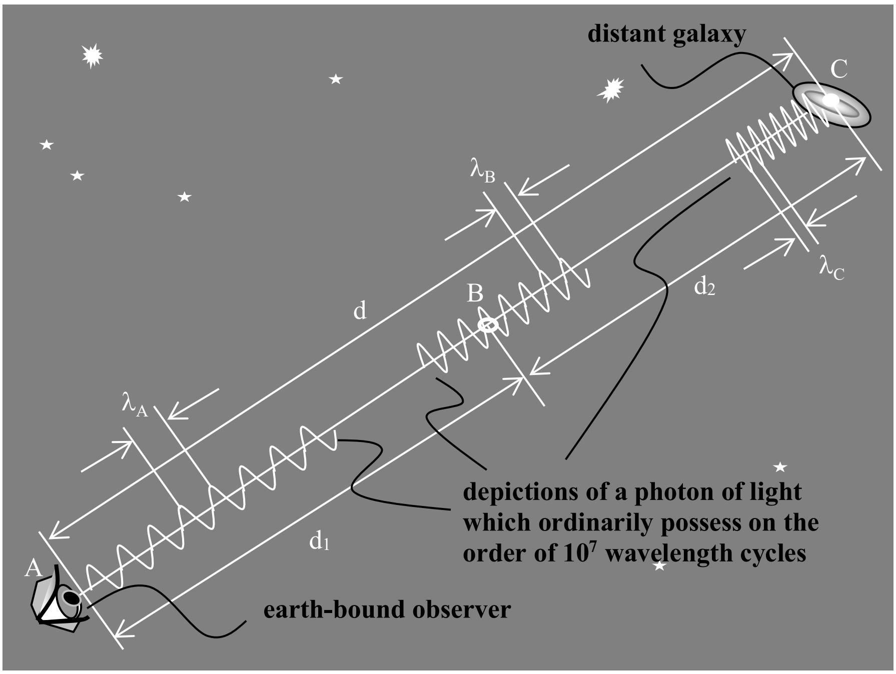
Thus, the same facts justify opposing theories if you're into that?

Of course cosmology involves a mass of observations concerning a broad scope of concepts, all of which must be understood in such a way that they agree before any comprehensive theory will ever even approach some sort of validity. But, as with the preceding, there seem to be more ways of looking at each fact than initially meets the eye. Einstein's gravitation equations don't address the obvious possibilities of gravitational energy suffering the depredation by redshifting while being propagated. But why not? Nor, of course, should 'Newton's iron sphere theorem' be taken as having any relevance once one realizes that the metaphor does not hold for a closed universe for which there is no inside-outside surface. Here too, therefore, *observed* gravitational effects of finite universes cosmologists favor can be matched or bettered by virtually identical ones involving indefinite extension.

Are all these mere cosmic coincidences? I don't think so.

The Significance of a Logarithmic Distance – Redshift Relation

There are some extremely compelling reasons why there should be a logarithmic functional form for the distance-redshift relation that plays such a significant role in observational cosmology; in fact, it is so compelling as to be virtually a logical necessity as the form of that relationship – whether that fact is generally acknowledged or not, which of course it is *not*.



distance-redshift phenomena

To adequately understand the rationale for this claim, let us look at what is involved in light being redshifted along a propagation path from emission to observation. Suppose there is an observer at point A for which a telescope on earth would suffice as an instance. And suppose that there is an ensemble of atoms in some star in a distant galaxy that we will refer to as point C that emits light of a specific wavelength associated with the spectra of the particular element involved. These atoms will emit photons of light, some tiny fraction of which are ultimately observed by the telescope at A. If there is a distance-related redshift in the spacetime where all this takes place, then the wavelength of the light λ_A observed at A will be related to the emission wavelength λ_C emitted at location C according to the redshift definition:

$$Z_{\overline{AC}} = (\lambda_A - \lambda_C) / \lambda_C$$

This is illustrated in the accompanying figure; it is true no matter what the separation between A and C. But for physical reasons $Z_{\overline{AC}}$ must be a continuously increasing function of the separation $\overline{AC}$.

So, let us define the redshift-related parameter $\zeta(d)$ as a continuous function of the separation $d = \overline{AC}$ as follows:

$$\zeta(d) \equiv Z_d + 1 = \lambda_A / \lambda_C$$

Since $\zeta(d)$ is continuous, we can choose A and C to have any separation and the relationship should still hold. Thus, we should be able also to place an observer at any point B along the light path from C to A, where $d_1 = \overline{AB}$ and $d_2 = \overline{BC}$, with the observed radiation exhibiting redshifts as follows:

$$\zeta(d_1) = \lambda_A / \lambda_B \text{ and } \zeta(d_2) = \lambda_B / \lambda_C$$

Therefore, over the total distance for which $d = d_1 + d_2$ the following relation must apply:

$$\zeta(d_1 + d_2) = \zeta(d_1) \cdot \zeta(d_2),$$

And as a necessary consequence of this relation, it follows that:

$$\zeta(d) = e^{\alpha d} = e^{\alpha (d_1 + d_2)},$$

where α is a constant (*Hubble's*) fudged to fit the data. And, therefore, of course:

$$d(\zeta) = \alpha^{-1} \ln(\zeta),$$

where ln( ) is the natural logarithm, and α^{-1} the oft-presumed *radius of the universe*.

The standard cosmological models embrace a broad class of disparate alternatives loosely united by adherence to Hubble's hypothesis and one form or another of Einstein's theory of general relativity. The Einstein – de Sitter model is but one of the simpler of these alternatives that exhibits a 'flat' spacetime, because of which it is frequently discussed for didactic reasons, although it is generally disparaged as a somewhat naïve candidate for serious consideration by current cosmologists. This short shrift seems ill-advised in light of the interesting fact that a key feature of the Einstein de Sitter model is that the distance-redshift relation for this alternative is given by the logarithmic form derived above – whose merits we have already extolled. Although the Einstein – de Sitter model is virtually never considered to be a viable contender for the ultimate cosmological solution, its implied logarithmic form for the distance-redshift relation is generally used by all serious workers in the field when analyzing data simply because it so closely fits the actual data as distances to observed objects increase.

Sometimes facts are even more compelling than theory.

Cosmological Questions Arising from Unique Conservation Relationships for Particles and Photons

Some time ago this author determined (with no ensuing fanfare of course) that far from thermodynamic irreversibility entering the laws of physics clandestinely via some obscure subtlety of statistics as most physicists have supposed for over a century, or more boldly as a side effect of a supposed primordial Bang as also frequently argued over the last three quarters of a century, it enters as a straight-forward consequence of a properly-derived kinetic theory of gases. An update is necessary to the kinetic theory which otherwise induces suicidal despair in those great minds capable of understanding the nature of such questions and who demand *legitimate* answers. As such an able mind, Boltzmann rightly discerned that it had to be in the individual interactions between material particles where irreversibility originates. But of course he could not have known that such interactions must, in fact, be mediated by *other particles* (namely, 'photons') constrained by *different* relationships between energy and momentum. His despair was legendary. And although lip service updates to his analyses have been accepted for many decades, the far-flung implications of actually *doing* it has continued to be bedazzle establishment.

A dramatic consequence derives from this very essential difference between the rather flexible atomic components whose interactions demand mediation and the hard-nosed mediators who do their bargaining for them, to which fact everyone who matters continues to be unaccountably oblivious. The incompatibility introduces an additional constraint on the conservation principles employed by the two types of objects.

In classical Newtonian mechanics we have that:

$$p = m_o v$$

and

$$E = \frac{1}{2} m_o v^2$$

respectively for momentum and energy, where m_o is the unaffected mass of the particle. Thus, we have the relationship of energy to momentum of:

$E = \frac{1}{2} p^2 / m_o$

However, in relativistic mechanics applicable to high speed particulate matter the conserved energy and momentum exhibit a different nonlinear relationship. This relationship is illustrated as the dotted curve in figure 1.

For conserved dynamic quantities of the mechanical counterparts the relativistic equations are:

$p = m[v]\, v$

and kinetic energy is now:

$E = m[v]\, c^2 - m_o\, c^2$,

respectively for momentum and energy, where the mass is no longer unaffected by motion and becomes a function of the relative velocity of the particle:

$m[v] = m_o / (1 - v^2 / c^2)^{½}$

with m_o now merely the *rest mass* of the particle. Thus, E(p) although still a nonlinear relationship as illustrated by the dark solid curve in figure 1 becomes very different than the classical case when velocities increase appreciably with respect to the speed of light.

Photons (very unlike their molecular component counterparts) are constrained by a precisely articulated proportionality between these same conserved quantities as follows:

$p = h / \lambda$

and

$E = h\, c / \lambda\,)$

respectively for momentum and energy, where h is Planck's constant and c is the speed of light, both defined earlier, and λ is the wavelength of the associated radiation such that we have the following direct proportionality that is illustrated in figure 2 as well as being superimposed on figure 1 as the lighter solid line.:

$E = c\,p$.

The quantized nature of photons (as the mediating particles) is what constrains these somewhat similar nearly-particulate entities to a strictly linear relationship as shown in figure 2. The units on the plots in figures 1 and 2 can be made equivalent by taking

$\lambda_o = h/\, m_o c$

This quantity is known as the 'Compton wavelength' of a particle. Of course the unit of momentum $m_o c$ is not linear with respect to velocity of an associated particle. Each such successive increment in a particle's momentum is associated with a velocity $v = (n/n{+}1)^{1/2}\, c$, for n=1, 2, 3,… such that already at p = 1 ($v \approx 0.7$ c) the classical formula $E = p^2/2m_o$ begins to fail appreciably as illustrated in figure 1. By p = 3 we have ($v \approx 0.93$ c) a nearly linear relationship already appearing between E and p. Direct similarity between particulate and radiational energy increases as higher and higher energies are realized.

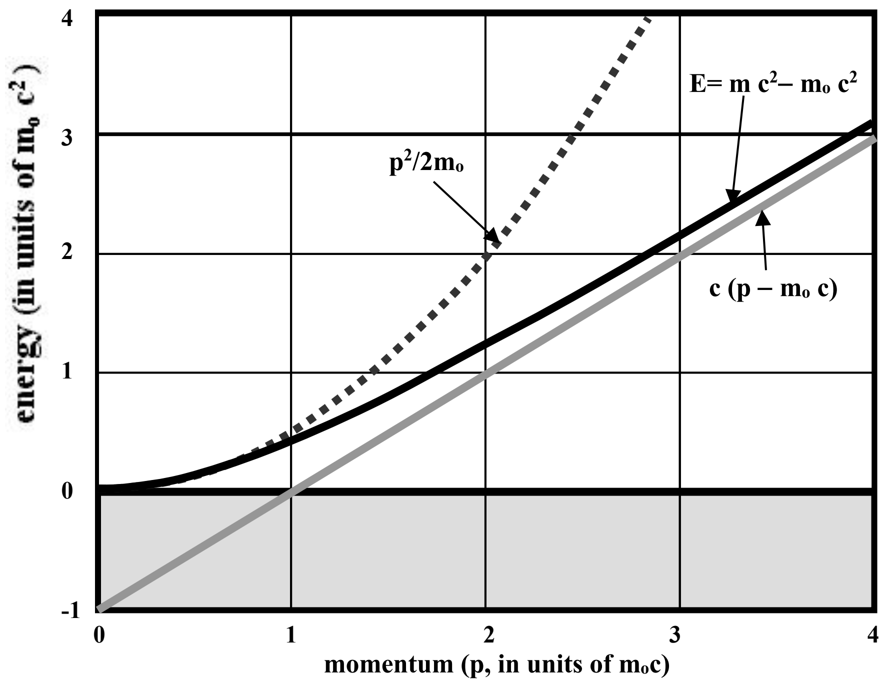


Figure 1: Various relationships between momentum and energy

Not only does this difference between mechanical dynamics and electro-dynamics produce the irreversibility of collision processes, it thereby also results in phenomena previously denominated 'causes'. This includes equilibrium conditions of modal number densities in the two partitions of the Maxwell/Boltzmann distribution, etc.. So in traditional explanations of the origin of redshift and cosmic background (microwave, as against the otherwise similarly distributed X-ray) radiation, the observed distribution could *only* have been produced in a plasma gas at one very particular moment in a big bang scenario. Thermal equilibrium between plasma ions and radiation would not have been sustainable over any non-negligible time period for which temperature and pressure continuously varied.

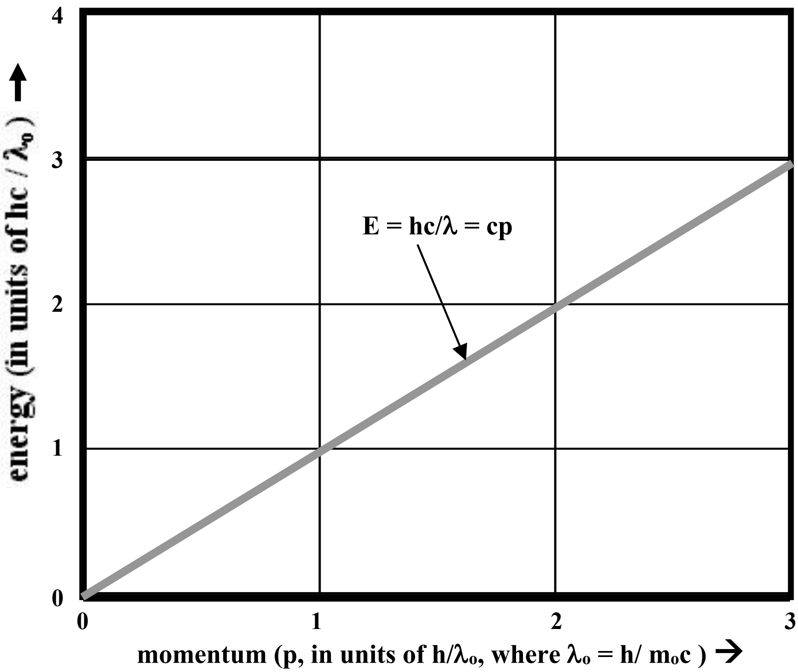


Figure 2: Relationship between energy and momentum of a photon

So we are left with the question, "What happened *before* and just *after* that moment?" Why are there no yellowing snapshots of *these* periods in the standard model's baby book of the universe? The grossly inadequate answer seems to be that radiation from *before* was scattered into thermal equilibrium with the gas, whereas after that moment the temperature characteristic had been instantaneously *frozen into* the radiation as a separate energy resource partition which then was available to emanate from a cooled surface of plasma just preceding its disappearance into molecules, stars, galaxies, and cosmologists which created an expanding void in which it could no longer be scattered to re-establish any semblance of a new equilibrium.

Well…that's what *they* say.

Short Stories Epilogue

The Strange Timing and Revocability of the Decision of the Andromedans to Attack Earth

We are all acutely aware that strange things play out in the fullness of time, but possibly the strangest involves the remote revocability of that fateful decision of the Andromedans to attack Earth.

There being some 300 billion stars in the galaxy which we variously denominate M31, NGC 224 and Andromeda, the name itself becomes somewhat indicative of the awesome capabilities realized by this one nation, indivisible under God throughout that giant island universe. But this article will not venture tangentially off into the political science fiction never-never land of the historical aspects of the origin and past of this species that may or may not conquer (or even have set out to conquer) the Milky Way Galaxy. The *decision*, Ah yes! that so aggrandized nod of the head in board rooms on even this humble planet, is once again the topic of the day. Consequences, although probably never a 'Boom!' to our stock market like that caused by the decision to lay off 40,000 IBM workers as a boon to investors, does have some quite interesting aspects, however, but again, we will leave that to speculation. It is the *timing* of the decision, independent of its historical perspective or eschatological ramifications, the mere assessment of *when* did, or will, that decision occur. Just trying to make sense of that tiny bit of minutia, before it is lost in endless debate of liberal artists and mean-spirited conservatives to be gobbled up by more profound issues surrounding the situation, is the object of this discussion.

Sir Roger Penrose is a rather interesting little man who raises the odd question from time to time. To my mind on page 201 of *The Emperor's New Mind*, one of the better formulated of these appears, not as a question actually, but as a description:

"*Even with quite slow relative velocities, significant differences in time-ordering will occur for events at great distances. Imagine two people walking slowly past each other in the street. The events on the Andromeda galaxy (the closest large galaxy… [about two million light years] distant) judged by the two people to be simultaneous with the moment that they pass one another could amount to a difference of several days. For one of the people, the space fleet launched with the intent to wipe out life on the planet Earth is already on its way; while* *for the other, the very decision about whether or not to launch that fleet has not yet even been made!*"

But that is a small part of the story of the epic decision. (I have no idea why Sir Roger chose to tell us so little). The Andromedans, having been a highly competitive nation for eons, had as a sporting gesture placed a *stationary* space probe at a position relative to the Earth that would result in its passing nearby our planet at about X years prior to the decision having been made on Andromeda. The probe was designed to jettison a message for Earth which would detail the date that the decision would be made to allow Earth several thousand millennia to prepare (very nearly the amount of time the Andromedans had had to prepare after having positioned the probe and initiated its time synchronization, up until launch time of the fleet, if that were to be the decision). It would serve Earth well in any case.

So as Roger's two men pass, they both are reading the report of the jettisoned message in copies of the same newspaper. Both men are scientists of a sort and so the report interests them, and although one never passes up any opportunity to show off his superior understanding of relativity (and in fact concentrates rather heavily on the precise value of X), both understand it well enough to realize that the probe although 'stationary' relative to Andromeda and, therefore, moving at about 200 miles per second with respect to them implies that in spite of the good faith intentions of the Andromedans and the fact that the report indicates the decision will not be made for another X years, it is in fact immanent! How immanent of course depending quite sensitively on the direction and speed of one's strolling at the moment. This subtlety was not overlooked by Sir Roger nor one of the two men.

A small passage at the end of the report is interesting in that it indicates that the probe has evidently progressed considerably beyond the droids of human folk lore, it states that it would "bet on it!" A bit threatening to say the least! The men reach each other just as they each read this statement, the one saying to the other in passing, "I'll bet it happened!" The other quite resignedly says, glancing over at the former with the lesser knowledge of relativity, "I'm betting it won't!" The former stops still in his tracks, thinks for a moment, turns, and then steps out after the latter. In *his* universe, the space fleet may have inadvertently stopped and headed butt-first, back ass-wards back to Andromeda (that is, if the decision had been to proceed with the invasion in the first – or is it subsequent – place), but at any rate will now await the decision that had launched them several days earlier. It was a dastardly act for him as a mere mortal human being, hardly in keeping with the sporting spirit of the Andromedans, but at least it would give him time to reconsider his bet before the decision was *actually* made. Why had his friend been so sure? Certainly his fine knowledge of relativity would have assured him from the subtle timing of the message that Andromedans had known about relativity many millions of years ago. But what can one conclude from that? Nothing!

As he thought about it, he wondered. Now that the decision was to be made all over again, could the outcome of the decision process that was going on even as he contemplated it be any different than the one he had just revoked? Did a ruler of that great nation not even possess free will? Or does each and every decision have a preordained outcome being unveiled ceremoniously as a surprise at its appointed time in every Lorentz frame?

Stopping in perplexity, once again the Andromedan fleet took off heading toward the Milky Way, maybe even directly to planet Earth. Or did they? Maybe his momentary remote consideration had been cause enough for them to reconsider the pusillanimity of a preemptive strike – even against so disgusting a species as Homo sapiens.

Definitions and Illustrations Pertinent to the Andromedan Attack Problem

Special relativity involves concepts including *absolute* and *relative* past and future as against the everyday terms 'past' and 'future'. It also incorporates 'elsewhere' and 'else-when'. To portray these concepts the *space-time diagram* of figure 1 has been drawn for an observer suggesting areas and directions in four-space to which these terms consistently apply. A third dimension is omitted per tradition in this diagram to accommodate visualization of the fourth (time); conical surfaces (*light cones*) correspond to events connected to the observer via detection or emission of light. *Elsewhere* and *else-when* refer, of course, to that region of four-space which is currently isolated from – and inaccessible to – the observer, i. e., those regions outside his light cone. Nothing he does *now* can affect nor be affected by these events. This domain comprises, by any reasonable accounting, more than half (½) of everything that *is*.

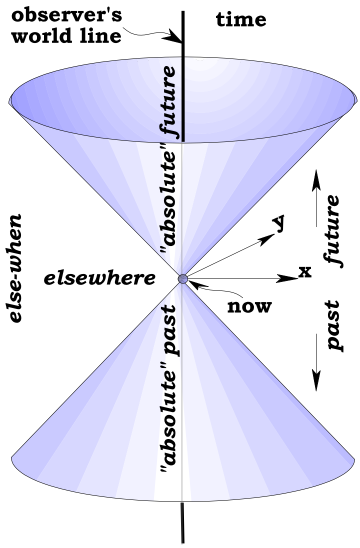


Figure 1: Spacetime diagram for defining denominated regions of four-space

Einstein's clock synchronization procedures determine clock settings at remote locations from the observer. Einstein elaborated the method of synchronization using the round trip transmission of light that assumes an identical speed for both segments of the path. This procedure produces the common sense result for relatively stationary clocks and retains compatibility with the Lorentz transformation when there is relative motion. The implications of the assumed isotropy of the speed of light are far-reaching. The concept of simultaneity is intimately tied to this assumption. The very concept of mutual simultaneity of two events at remote locations for two coincident observers has had to be sacrificed in the interest of consistency of Einstein's interpretation such that the timing of the decision on

Andromeda would seem to have been left in the lurch as shown in figure 2.

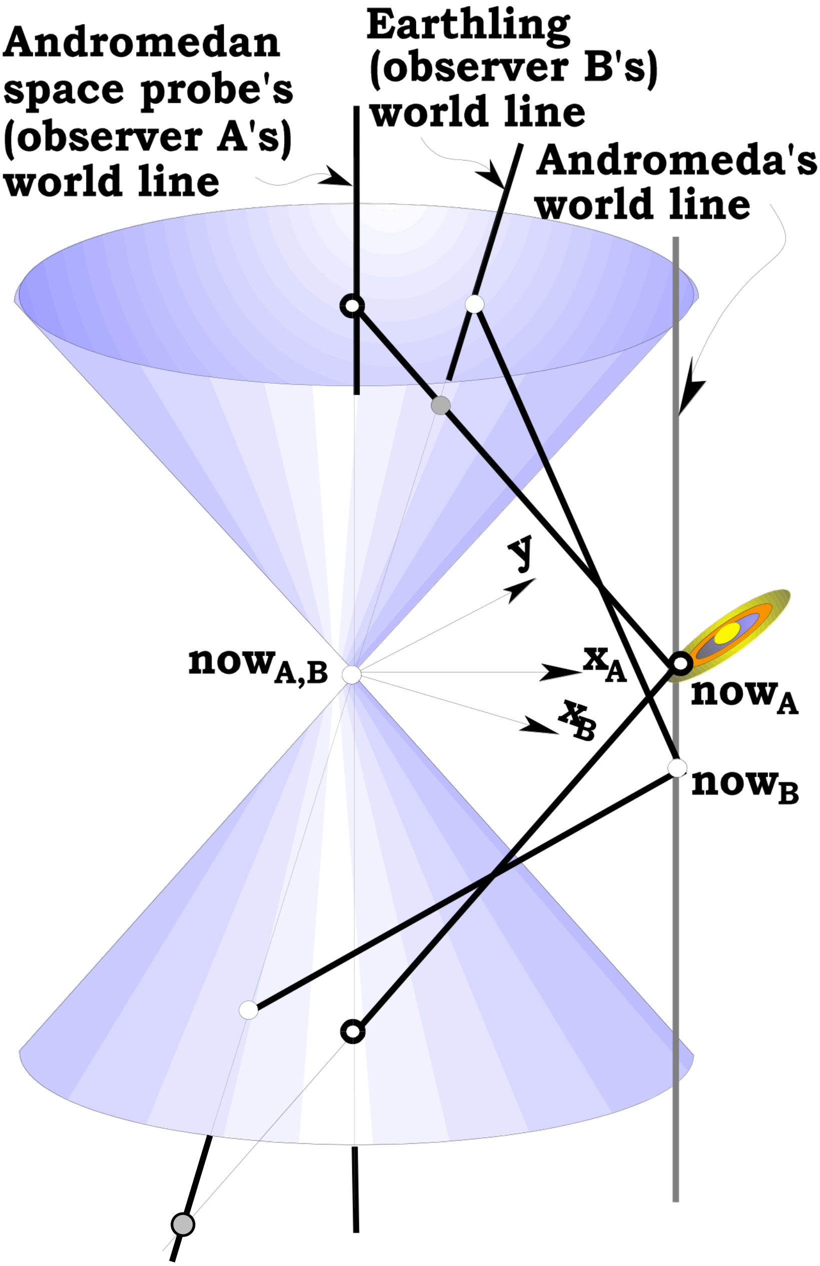


Figure 2: 'Now' in separate frames of reference

In Defense of the Andromedan Dilemma[*]

When I indulge fantasies by writing an article on a topic for which I am a layman, there is certain exhilaration in having someone well-respected in the field comment on that article. Nonetheless, it is a major disappointment when the response addresses preconceived notions of a misconception rather than the article itself. I feel such mixed emotions now because R__ has not responded to the central question that was raised. It involved a situation in which one of two individuals strolling down *Jesus Lane* – a quaint little street on the campus at Cambridge, England where Sir Roger Penrose frequently holds court – turns around to follow the other. Does the status of the Andromedan decision of whether to attack earth actually change from 'already decided' to merely 'imminent,' in the ego-centric frame of the individual who so turns?

It is as if having come for the funeral of a close friend with great expectations I am listening intently to a eulogy that has been hijacked for the paltry purpose of saving the souls of mourners instead of recounting the gallant deeds of the deceased. So why am I here? Does my soul need saving or am I just here to help carry the casket?

Disenthralling myself from such diversionary thoughts, let me respond to the problem R__ has phrased (without going so far as to deny that Andromeda *is* actually approaching earth at approximately 200 miles per second rather than receding at a beetle's[&] pace) so that a meaningful debate of concepts can proceed.

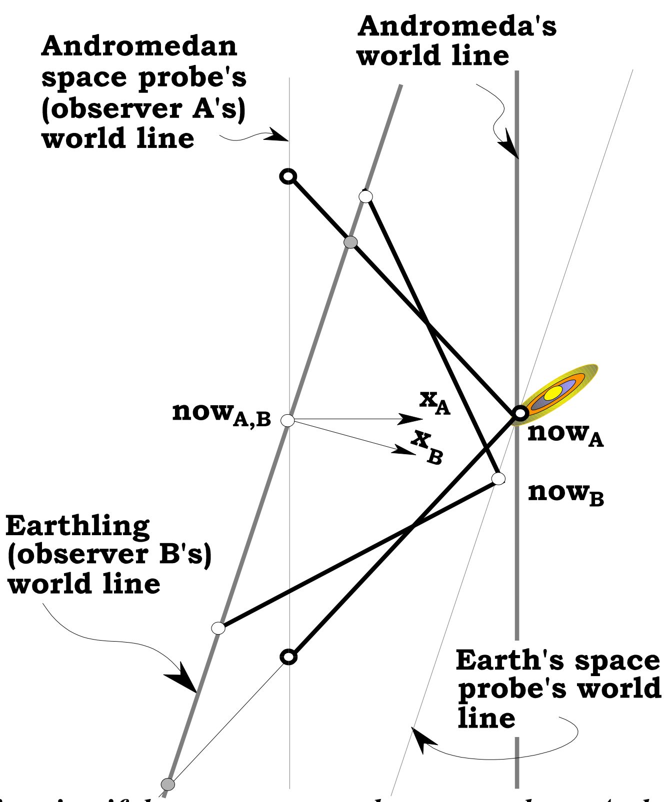
Pragmatism is often confused with relativity by laymen, less frequently by those intimate with either concept. When R__ states that, "it all depends what you mean by" the decision having already been made in one observer's frame of reference while it is still days from having been decided in the other, is he suggesting that there may be no more meaning to *factual* statements such as, "The Andromedan armada left their home base on February 23 of the year AD 1997," than one wishes to assign to them? No. I'm quite sure he is not. There is a specific and unique time at which any event transpires in any frame of reference; one cannot just will it to be one way or another. Of course coordination and synchronization of the various clocks that would

[*] The article was written in response to critical comments on the previous article by a friend who is a professor of mathematics and physics in England.

[&] "Beetle" is, of course, slang for "professor" on the Oxford campus where that friend received his PhD in physics. (I try to keep my allusions pertinent.)

disambiguate such statements between frames of reference are quite problematical as he points out.

But are conjectures concerning events within the region of *elsewhere* and *else-when* merely the subject matter of rhetoric and science fiction? Not at all. At every moment in time events occurring throughout the entire spatial universe are *elsewhere* with respect to that point on the 'world line' of the observer; the existence of events in the domain of *elsewhere* and *else-when* is certainly not doubtful nor of little consequence. Events which occur there do have an objective time and location of occurrence and, furthermore, the mere fact that an event is *elsewhere* for a given observer at a particular time does not imply that it has always been elsewhere nor that it necessarily will remain so. Epistemologically as tiny children we came to accept that objects existed even when they were outside of our immediate field of view. The same reasoning can assure us of events that occur *elsewhere* and *else-when*. A remote event from *elsewhere* may yet affect us in the future (as for example, an Andromedan attack) and, in fact, might very well have been affected by one or more of our past actions.



the situation if there were an earth space probe at Andromeda

Einstein elaborated a method of synchronization of clocks using a round trip light path that assumes an identical speed for both segments of the round trip that reverts to common sense for relatively stationary clocks and is compatible with the Lorentz transformation in any case. But how has this changed the conception of time such that inferred differences in how long ago events occurred may in some obscure sense be considered merely pragmatic?

I found R__'s "important note" concerning the possible use of projectiles other than light to be distracting but most interesting as red herrings go. In the first place, if we're talking truly elastic balls bouncing from a truly elastic surface, the balls will not exhibit the requisite *same* speed for the 'thrower' on both segments of a round trip if the elastic surface is in relative motion with respect to the original thrower of the balls. Catapults would require a unique mechanization in each frame if the *same* speed were to be realized on both legs of a round trip path, etc.. Photons are the only 'elastic objects' (stretching our imaginations a little) that could even conceivably change the magnitude of their momentum upon reflection without also changing speed. They (as legitimate heirs of Einstein's "rays of light") occupy pre-eminent positions in the special theory of relativity. In the second place, if another object type could be substituted that had a speed less than that of light, then if its speed bore the same relationship to the Lorentz transformation equations that light speed does – which I take his note to imply, the equations would be invalid for coordination of observers with greater relative speed even if less than that of light.

So how has special relativity changed the conception of time so as to suggest to R__ that measurable time interval differences might *be* whatever we mean by them? The very notion reminds me of a beatnik who, upon encountering an injured man lying by the road crying, "Call me an ambulance!" calmly says, "Ok man, you're an ambulance!" Perhaps it's the same chap whose funeral became such a travesty. But back to the main issue.

The problem here is not mere definitions and what we subjectively mean by this or that. Suppose that earthlings had been so sophisticated eons ago, might we then have had our own probe that would pass by Andromeda just as the decision was being made and the Andromedan probe passed by earth? "No," according to the special theory, two such remote events (i. e., the Andromedan probe passing earth and the decision being reached on Andromeda) cannot be set up to be simultaneous in both frames. At the instant of passing noted on earth as well as by the synchronized clock on the terrestrial probe destined to pass by Andromeda, the decision would not occur for two millennia as shown in the figure on the preceding page.

Strange? Ain't relativity wonderful!

Consistent? I don't think so. But maybe it comes down to "what you mean by" *consistent*!

Wrong? Very probably.

Deirdre and Alana Poe and Their
Tell Tale Hearts

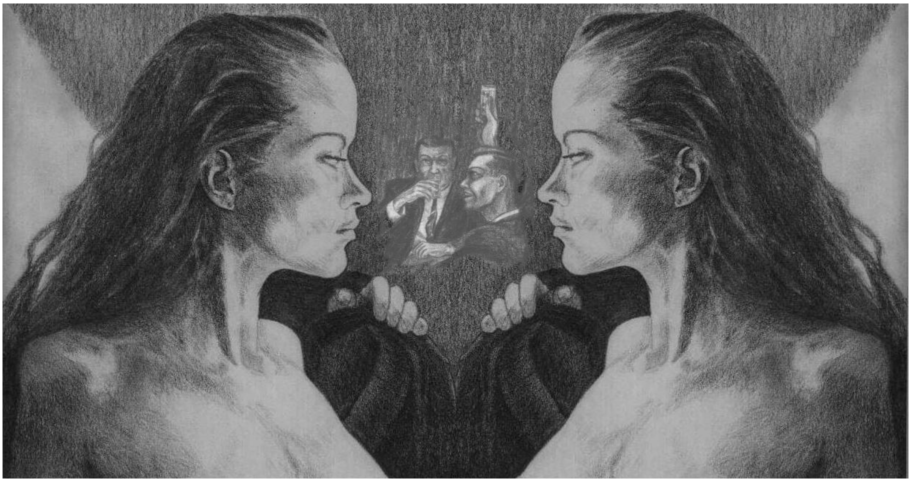
Two nicely-endowed identical twins – lovely girls – decided to strip relativity of its mystery by resolving once and for always the riddle of the 'twin paradox'. They began by spending considerably on a spacious user-friendly ion blaster equipped with exercise room, bathroom, makeup room, and other amenities so that the life style of the traveling twin could remain equivalent to that of her sister left behind. In addition, they spent even more to instrument themselves to the hilt – medical equipment costs being what they were in the US at the time. This involved specially developed brassieres with sensitive nonintrusive transducers in the left cups that could detect each heartbeat and powerful transmitters to broadcast each coded beep to the ends of the universe. In addition each maintained a receiver antenna for her own and the other coded beeps with readout of the cumulative heart beats of both twins. When the instrumentation was so well implemented that it no longer itched and could not be seen under a silk gown, they were satisfied.

Perhaps they were operating under false assumptions. For they had come to believe that without mishap or sickness identical twins should have identical numbers of heart beats in their lifetimes and that on the average they would have the same number of heartbeats each year. They tested this hypothesis for a couple of years early in their lives and found that whereas Deirdre had 31,600,029 beats between their 16th and 17th birthdays, Alana had 31,558,371. But then Deirdre had had her first fling somewhat earlier than Alana and they were gratified that between their 17th and 18th birthdays, Deirdre had 31,579,181 and Alana had 31,579,219. So the idea seemed to work fairly well as biological clocks go. By then the preparations of the ion rocket were completed and so, being totally uninhibited by God's not playing dice, they decided to draw straws. Deirdre drew the short straw so she would have to stay home and watch. They reset their counters to zero, fastened their bras, and with no more adieu Alana was off.

Deirdre watched with some alarm as her own counter ticked along at its usual rate while Alana's crept along, slowing ever so methodically so that at the end of one year it read only 27,932,420 and during the second year it registered only 23,684,400 more ticks. Deirdre was happy that during the third (and final) year of the outward bound leg of Alana's mission she had 23,693,767 beats. At this point Deirdre's readout said 94,737,600 whereas Alana's read 75,310,587. For the next year Deirdre worried because the number of heartbeats from her beloved sister did not increase as dramatically as she had hoped. But eventually it began picking up and by the end of the fourth year Deirdre was worrying about whether Alana's heart could hold up under the stress of the increasing toll of heartbeats.

The spaceship was sighted at an extreme distance some five and a half years after blast off and the sisters became ecstatic at the prospects of giggling together once again as they had when they were both young. Once they were in voice contact, they no longer watched their readouts as they had so assiduously before. Upon touchdown Alana stepped through the hatch opening and beamed as she said, “One tiny step for me and a giant one for womankind.” Whereupon the sisters embraced with giggles enough to make up for years of loneliness. Their beepers raced.

Luckily a couple of thoughtful – though somewhat insensitive – male geek scientists who had become fascinated with the story (and instrumentation, to say nothing of the attractive girls) ripped the bras off the women to stop the beeping and read the meters at this historic point. The bewildered boys looked from the now bare-breasted women back to their readouts, and back again, over and over again in excitement. They shook themselves and looked again; then they poured themselves drinks as though celebrating their having come of age and looked yet again… and again. Finally, in total disarray and confusion one of the men asked the other, "Does this mean there's more to life than just so many heart beats?"



“There is more to life than so many heart beats”

The other thought for a moment and said finally, "I think it means that if *life*, or *time*, or whatever you want to call it is measured as a number of significant events such as heartbeats, then covariance must apply and that quantity must be preserved across reference frames – but damn those twins are beautiful, aren't they? I think the younger one wants me," he added with a wink.

The twins held their breasts modestly and looked at the men and back at each other in utter disbelief and amazement. Rapidly their biological clocks pheromonally re-synchronized and began pulsing in unison.

"I've been away a long time," Alana said wistfully.

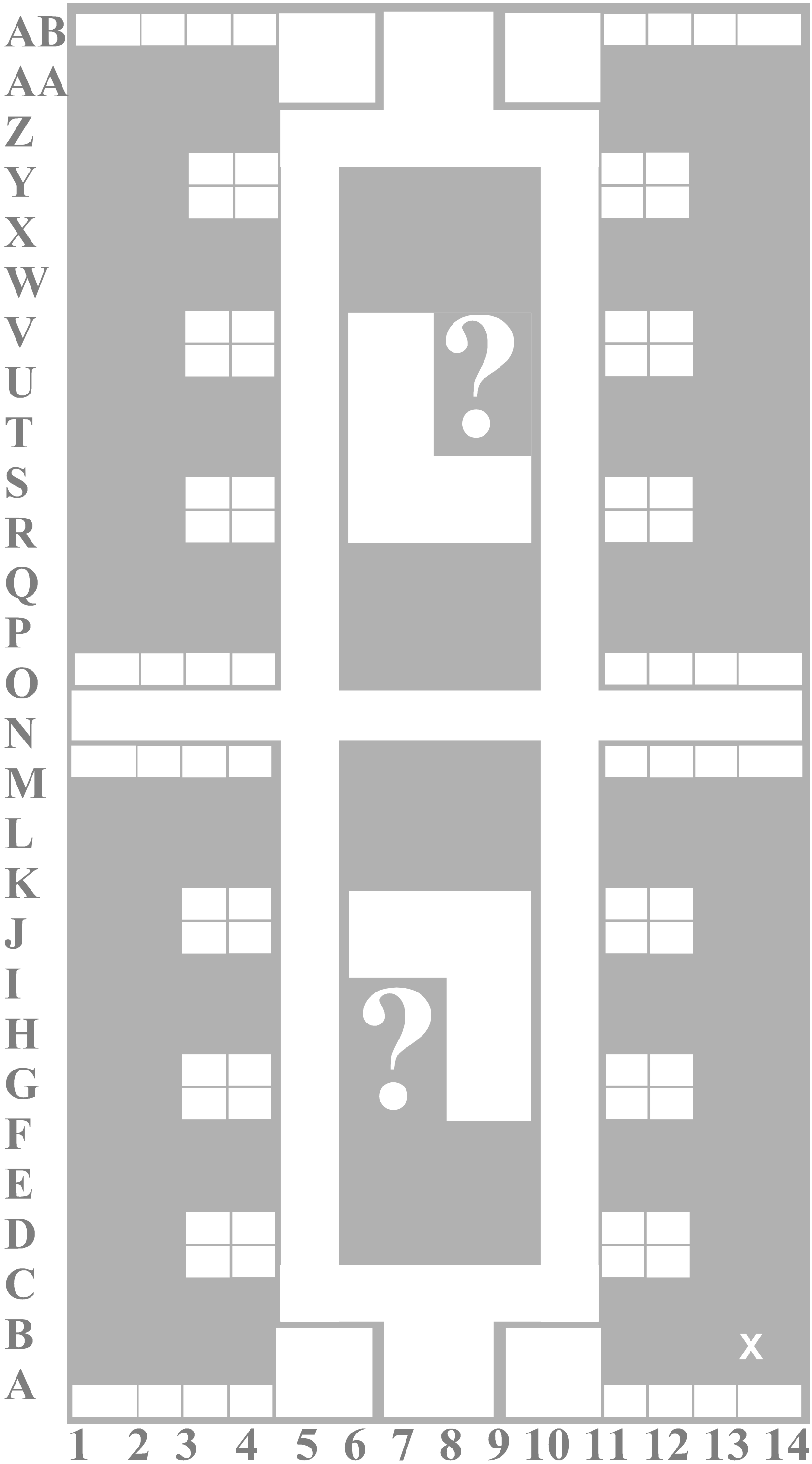
"But not as long as you've been *gone*," Deirdre stated as a final scientific wrap-up to the just-completed experiment, and then with much more enthusiasm she asked, "Which one do *you* want?"

Any Place
Can Be Another Place and Time

"All parts of the house are repeated many times, any place is another place. There is no one pool, drinking trough, manger; the mangers, drinking troughs, courtyards, pools are fourteen (infinite) in number. The house is the same size as the world; or rather, it is the world."[1]

Any organization involving the employment of 150,000 people in any one metropolitan area is naturally going to be subject to all manner of logical absurdity. I hereby do solemnly aver that The Boeing Company is undoubtedly one such unnatural organization and I, for my part, became somewhat adapted to life as a component of such logically perverse cellular automata. In thirty years of toil in such a labyrinth, one necessarily swirls through many eddies of the vortexes surrounding singularities of distorted logic. And although certainly one becomes inured to the vast majority of anomalous situations, becoming oblivious to the associated humiliations of rationality as the justly remunerated deserts of those who willingly massage resumes to resonate with ever-vacillating skill code preferences, there were a few occasions that were just too weird to be forgotten.

Much as with analogous naturally occurring fungi, structures continually emanated outward from the 'Little Red Barn' where Bill Boeing first glued silk to strut. (That barn is now, in fact, a feature in the large Boeing Employees Aerospace Museum – or so I'm told. I've never actually been there myself.) In the mid to late sixties this frenzy of expansion to saturate aerospace markets resulted in the expropriation of vast acreage in one of the most fertile river valleys in the world – the former Green River produce farming belt in Kent, Washington, USA. Cabbages, carrots, broccoli and corn gave way to a spread of large engineering and electronics manufacturing buildings, all denominated "18-xx" for reasons (if indeed there were any) of which I am oblivious. There were conspicuous omissions at that time. I think the 18-24 was the first one built, followed by the 18-23. Construction proceeded over the next few years until there were the 18-10, 18-21, 18-22, 18-26, 18-28, and of course, the 18-04 and 18-05 Siamese "twins," in all of which I worked or dined over the years beginning with occasional stints in the 18-24 back in 1965. The too-obvious naming gaps and areas of pre-construction gravel that would litter the campus for many years reflected the great optimism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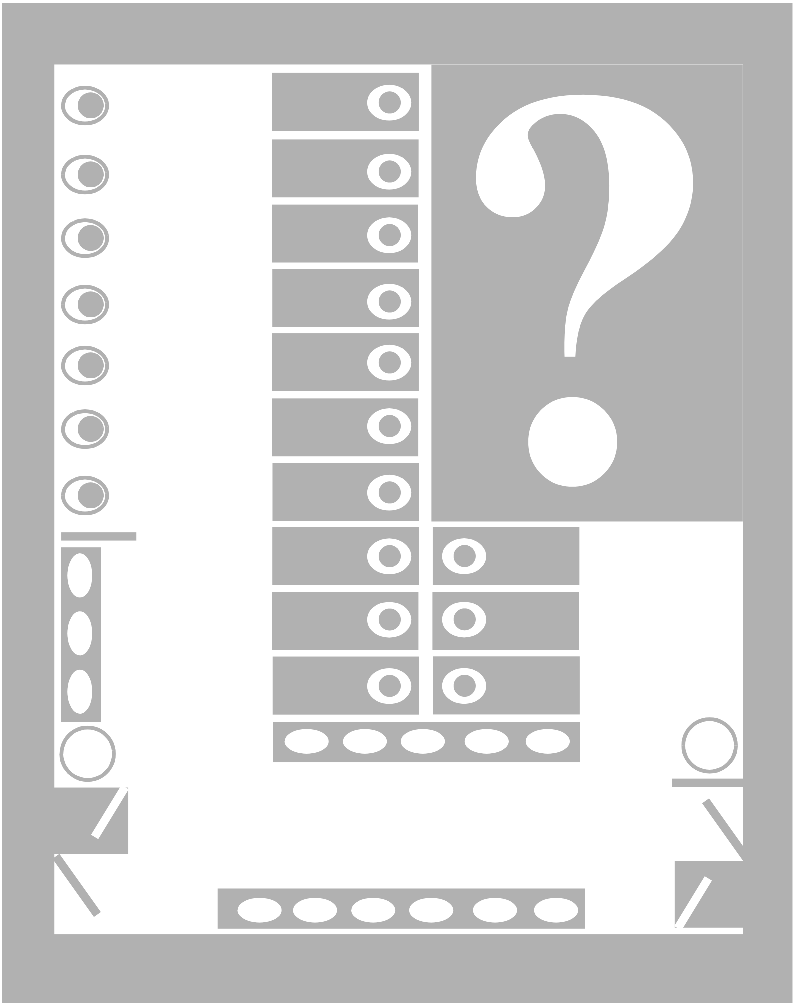
of the aerospace industrial leaders of the sixties and early seventies and Boeing's preeminence within those emerging markets. When that optimism faded with the cut backs in the Apollo program and the cancelled SST in the Nixon years, one knew that something had gone seriously awry. But eventually grandiose plans for a "Grand Tour" of the outer planets, many highly classified "black box" projects whose objectives could only ineffectually be doubted by congress in secret session, and Reagan's fantasized "Star Wars" restored some semblance of optimism to this overall scheme. So that an 18-42, 18-43, 18-60, and 18-61 (the facility from which I ultimately escaped at retirement) as well a few others were built whose specific denominations I do not recall because of having had too little intercourse in them. Then in the 80's with the end of the "cold war" some graveled plats were graded down and landscaped into lawn with trees or converted to paved parking lots, acknowledging finally an abandonment of earlier plans altogether. Surrounding this complex was, of course, the proverbial meshed wire fence topped by curls of wire with razorblade barbs. A couple of turrets of armed guards were situated on each of the four sides of the complex who inspected badges of all employed at each entry and exit – a rather homey place for engineers really – typical of the aerospace defense industry throughout the US in those cold war years.

All of the first generation buildings on this industrial campus shared a common "look and feel" so that the frequent moves of projects from one facility to another were less obtrusive than they might have been otherwise. At the time of the strange situation described here, I was employed in the 18-05, second floor – the building's interior being comprised of two identical floors with stairwells at both ends and in the middle. The building was symmetrical in every way: up and down, left and right, and one end to the other. There were two long hallways running the length of the building and a much shorter cross-aisle at the ends and in the middle. On the bottom floor, there was a set of doorways at the ends of the building and at the center on both sides at the ends of the extended center aisle. On the outer walls of both hallways were doorways into the various engineering bays. These would generally be labeled with plaques that stuck out from the wall above the door with alphanumeric place holders such as "2B-12" followed by some descriptive group title such as "Illuminator Stability Control Electronics," for example, where I worked at the time. But on the inner side of each hallway were the doorways to general support facilities including large conference rooms, printing facilities, project security, and other administrative functions required by all projects from time to time. And here also could be found drinking fountains and the latrines – one set for each end of the building at the midpoint between the center and end hallways. The men's rooms were all L-shaped, to accommodate – I supposed – the smaller demands of women's rooms back in those days, which filled out the allotted rectangular space for the function. The men's rooms could be entered from either hallway with separate doors on both sides for entry and exit – these were unmistakable with emergence inside and out being inset into the wall so that on no occasion did I ever witness a collision. On the end wall of each latrine closest to the center of the building and just on your left or right as you entered was a long mirror and full row of some ten or so wash bowls with soap and towel dispensers between. On the opposite shorter wall was also a long mirror and row of wash bowls, but only about half as many since around each end of these was access to hidden toilet stalls. Only three stalls were situated on the right hand side to accommodate whatever mysterious functions and facilities were allotted to women beyond that far wall on "top" of the short right side of the "L." Whereas on the left side there were ten or more stalls with seven or eight urinals across from them, that wall then being finished with another mirror with three wash bowls and one set of entry/exit doors. You may think I have concentrated on this a bit too heavily, but this layout is central to the story.

The engineering facilities of 18-05 building incorporated “bays” of desks to house its hapless engineers, about a hundred to a bay with aisles between with very occasional movable five-foot partitions. (That was back before "cubicles" came into vogue, but somewhat after the times when it had been customary for new graduates from universities to write home, "I share a semi-private office with my boss," usually omitting "…and several hundred other engineers.") Managers' offices and associated secretary and desk to guard that office were all situated at each end of each bay, about four or five to an end wall and two or three to the shorter separations between bays. There was some accommodation for desks and an aisle for inter bay traffic around these shorter blocks of offices, with the whole scheme repeated quite a few times half the length of the building. The outer walls had very large windows (although venetian blinds were usually closed as an idiosyncrasy of the mentality of the engineers sitting near them who feared exposure to the sun long before the ozone hole was a public concern) with small separations between them to provide structural integrity for the building.



One could locate a conference room or specific engineer for consultation – should that ever be required – in this regulated array of thousands of humanity quite simply. It was facilitated by a grid of numbers and letters starting at the lower Northeast corner of the 18-05 or analogous positions in other buildings. These numbers ranged from one to fourteen in the "Oh Five" building and the letters continued from A through Z and hence on up to AA and AB to accommodate an infinite extension should that ever be required. So there was a 14 by 28 grid which one used variously to describe his/her position in the overall scheme of things. Thus, did I sit at a desk over which – within three or four desks one way or the other – hung a small metal flap painted with a "B-9" sign. The offices and smaller conference rooms were labeled with names such as 2D-8, etc. whose decoding was rather obvious. So it was easy enough to find a meeting or person anywhere in this matrix – should the need arise. A rather nice setting for the regulated mind of an engineer really.

My project – or rather, the project to which I had been assigned – took up perhaps a third of the West side of the second floor of the 18-05. The function within this group of the project that I happened to be supporting at the time occupied perhaps ten desks near the North end of the building. Our manager occupied one of the lesser offices along the end wall; he had one small window, no rubber plant, and a lone picture that hung on his wall by the door. It was bad art by any standard and thankfully, therefore, quite small all befitting his hierarchical status. The proverbial blackboard hung opposite his desk with a table with six chairs butted up against the front of his desk between.

But it is important to realize that I could have been located anywhere in any of several of the engineering buildings in the Kent complex and virtually all the foregoing description would have remained unchanged except for one letter or number here or there. This is particularly the case for the 18-04 building which is (as I have repeated and now insist on its being) an identical twin of the 18-05 – actually, a "Siamese twin" in this case since these two are more or less "joined at the hip" as they say. The North doorway (top, in this case, as well as bottom) of the 18-05 is replaced by a glassed-in causeway that continues into the extended East cross-aisleway of the 18-04.

I was at work going over some numbers in the reams of printout returned from my latest UNIVAC 1107 computer simulation run when Susan called out, "Fred, Bob wants to see you." So I got up and walked the small ways to his office behind Susan's pretty body, sat down at one of the chairs around the table and asked, "Yeah?"

"Susan, will you get Fred and I some coffee," Bob yelled out, to which as reply Susan left her seat coming back very shortly with two cups of coffee. "How's the illuminator pointing algorithm coming?" he asked.

I said, "Good. Once we get the gimbal and INS geometry firmed up I'll just plug in the numbers and it should work fine. I'm quite a bit ahead of schedule actually."

"I thought you would be," he said. "You know they've been having some problems on the BRUTE program," he added with only a brief pause. "Ray called again this morning; he's pretty frustrated. I think if you went over there for an hour or two to give them some pointers it would save them a lot of heart ache."

"Yeah, ok," I responded expressively again. "Those guys don't seem to have a clue," I revealed based on having chatted at lunch with some of the engineers on that project.

"They're located at N-4 on the first floor of the ‘Oh Four’, you know," to which "Yeah" was more than adequate as response.

I finished my coffee and handed my empty cup to Susan on the way out. "Thanks," she said and I replied years prior to guilt, "Yeah, thanks!" looking back. I cleaned up a few scattered papers on my desk and went out and down the hall to the men's room. By the time I left our bay my thoughts had reverted back to my own current private obsession – those I had had on the way in this morning – inertia, what is it? Not just in the sense of a brief description or formula, but *what the hell is it*? What is its logical origin? How does it relate to gravity and/or acceleration and spacetime in a metaphysical sense? What difference can a slight increment in velocity make that is so essential to the very nature of reality itself? Could an Einstein-Rosen bridge be effected by acceleration alone?

Coming out of the men's room I turned into the familiar bay to return to my desk with my thoughts reverting now to the simulation. But things looked strange. Susan wasn't there! I had never seen the secretary that sat there now. I looked at my own desk – it was occupied by someone who seemed completely at home, but it wasn't I! I shook my head and walked back out to the hallway to get my bearings. Yeah, this was the right place, but... Oh yeah! I was on the first floor; I turned and went up the familiar stairs and came out at the doorway 2B-12. I went in. Managers were gathered in front of one of the offices – the one that should have been Bob's. I knew none of them. I looked around the bay. I knew no one! Not a single soul of what must have been nearly a hundred had I ever seen before. Suddenly I panicked. I walked out into the hallway again and looked up at the sign above the doorway like I had never done before. It read: "Economic Forecasting." I stared at it; it rang no bells, and it had not changed when I peered again. I walked down to the next doorway and looked in. I had never seen any of these people before either. I began to sweat. I retraced my steps back to the end doorway. Whatever craziness was happening persisted. The girl who should have been Susan looked at me now as though I were a stalker. People passed me in the hall and looked at me as though they too were perplexed by my very existence. Suddenly it dawned on me that I must have walked out the wrong side of the men's room – I had done that before when I had been preoccupied in thought. So I walked back down the hallway, drank a gulp from the fountain, and went back into the men's room from which I had exited so recently, proceeded directly out the other side and thence down the extreme length of the other hallway and into the corner bay (ignoring the fact that it was inappropriately labeled 2Z-6) – still there was no one I recognized although I had seen of couple of these people somewhere. My panacea having failed, panic returned.

I fled down the stairs, down the hall to the center hallway, and ran out the door to the right. ("Running," like "throwing missiles," was one of the things listed on the back page of the Boeing phone book for which one's employment could be terminated, but there was something more terrifying than that going on here.) Things still seemed a little strange even out of doors, but I did fleetingly see my friend Russ. He asked, "What are you doing here?"

"I don't know," I said honestly and rushed on past him and the guard at the gate who looked at me with indecision as though I might be the reason he had been stationed there all these years and wondering whether to apprehend me or not. He missed his opportunity as I was now out the gate and to the car. But it wouldn't start. The damn thing wouldn't start! So I bent over around the wheel and searched under the dash for the wires that (if crossed) would trick it into motion – I had never done that before but it was easier than I had thought it would be with a jack knife. I guessed I had been taught by an expert; Bill had once told me when I asked how he had gotten the stolen cars to start: “Look under the dash back behind the ignition. Once you get back there, look for two red wires. That’s the standard color. When you find ‘em, cross ‘em!” It started! It was that easy.

I drove the length of the parking lot too rapidly and out past the main guard shack where the guard was motioning for me to slow down as I passed, and then onto Orilla Road. I thought the car handled a little differently than usual as I turned right onto East Valley highway proceeding to downtown Kent, onto the freeway on ramp and down to the highway 18 interchange, one clover leaf from right to left and out through Auburn. At the top of the hill in Auburn there was a momentary epiphany: Where have I been? How did I get here? Where am I going? But it passed with recognition that I was indeed proceeding toward my home by the only route I ever took. Then the longer interval toward Enumclaw unraveled before me; a left at 416th, a couple more turns and I was finally home. Everything looked the same. I got out of the car still a bit wary and walked to the house. In the back door I saw the shape of a receding woman – about the size of Kay, but definitely *not* Kay. The hair was very gray and thin; she was old, a little stooped. As she walked away into the living room she said in a cynical but somewhat familiar tone, "Are you home already, Fred? It's barely noon!" Was this a portent? I turned and walked out of the house as on those occasions when upon entering the house Kay had asked, "Where's Sean?" Whenever that had happened (and there had been more than one such occasion) I did an immediate about face without comment and retraced my route the twenty some miles to the baby sitter to pick up Sean and return. I have been a bit absent minded on occasion when concentrating on the nature of the multi-pole forces between neutral molecules of matter, for example, rather than my immediate obligations. But this time there was no sense of having forgotten anything and my thoughts other than the brief hiatus at the top of the hill had been quite mundane. The world had just suddenly turned strange and it was definitely not responding to treatment. I had not even marveled that the car was still running when I got back in it. As I drove back thinking about what had transpired I remembered that I had gone into the men's room only to exit onto an entirely repopulated planet with alien faces – except for my friend Russ. But he had not seemed surprised about anything but my behavior. I thought about that fact for a while. Russ worked in the 18-28 on the far side of the "0h Four;" maybe he was going to lunch when I passed him; he probably was going to lunch. It must be lunch time.

By then I was on highway 18 turning onto the freeway heading North toward Kent and the pull of inertia captured my thoughts just as it had earlier in the morning when I had cornered on this slope of the clover leaf. What does a small incremental change in velocity infuse into a situation? I mused all the way to the Kent plant till I came to the area of the parking lot where I usually park. My car seemed to already be there. I stopped behind it and stared at the license plate; the number seemed familiar even though I could never actually bring myself to remembering license numbers. But then what was I driving? I parked and reached to remove the key; there was no key. Oh yeah! I shook my head and left it running.

I showed a disinterested guard my badge and proceeded to the 18-05, up the stairs and into the bay without even recognizing the plaque that declared "2B-12, Illuminator Stability Control Electronics." Susan was where she should have been. She looked up with some surprise upon seeing me. "Where have you been?" she said. I just shook my head and looked at her as she appended, "Bob wants to see you!

I walked into Bob's office somewhat apprehensively although by and large things were much better than they had been – at least there *was* a Bob. All he said was, "Good job!" and "Sit down!" I wondered what he could be talking about, but soon enough he added. "Ray called and said that you saved them weeks of work finding that flaw in the timing of their control system and he also said that your suggestions really simplified their overall approach." He was smiling. And somewhere deep inside me the stream of "past" disconnected and admitted the insertion of a new segment that had been ripped out and had floated freely in the "elsewhere" until now. It was as though, having retyped a page that after transcription made no sense, one had found the offending repeated phrase that had resulted in the skipping of the several lines of text between occurrences. Without the information in that interval, the entire page – in my case the entire world – made no sense at all. I remembered the offending "phrase" now and with it the missing spacetime interval had just popped into place. After having completed our discussion of BRUTE's algorithm problems, I had gone to the men's room before returning to my desk thinking (as I recalled now) of the nature of Einstein-Rosen bridges. That was in the 18-04 building first floor North hallway as it turns out of course, and subsequently I had conceived myself as having exited into the 18-05 second floor West hallway into which I had entered earlier thinking exactly the same thing. The grammar was fine but meaning had been lost.

"But where have you been?" Bob asked with some humorous innuendo which just then brought me back from another reverie. "Ray called me two hours ago. He said he'd been trying to find you to give you his personal thanks. What'd you do, take a nooner only sooner?" He winked and laughed at his own little joke as usual.

"No. I guess I just went to the men's room and came out in Disneyland," I said hiding truth behind truth as I usually do, and I got up and walked out of his office with a renewed confidence lost too damned many hours ago. It was a trick I had learned from my mother's inquisitiveness: Just tell the truth with a little ironic smile and she'd never believe it. I don't know about Bob; he followed me out of his office placing a hierarchical hand on my shoulder and shaking his head, but smiling as one does at the incomprehensible side effects of the things we like best.

Before long it was Miller time and I headed once more for home. The other car was still running when I got out to the parking lot. It was actually a little bit different shade of blue and a different model number than mine I noticed by direct comparison, but quite similar. After untwisting and retwisted a couple of prickly wires, I got into my *own* car. It felt better and it started as soon as I turned the key. I wondered whose car I had taken for the joyride and how proud Bill would have been if he had been alive to tell. I figured the owner of the car would be happy enough when the guards found it for him even though in another lot across the complex with a little less gas. They might shake their heads for a while, but they'd get over it without going into big time forensics. How many times had I gone out to my car and after some searching, sheepishly walked all the way across the complex to where I had parked it that morning? I still wondered about the old lady I had encountered at home; would she still be there? It occurred to me enroute that it had probably been Kay's mom who had come up from California to visit on surprise, but where had Kay and her father been – and how had she gotten there. But sure enough, I saw that Kay's parents' car was indeed in the driveway as I drove in. When I walked in the door, Kay was there to greet me with a kiss as my usual world works. "Mom says you came home at noon and left when you saw her. Naughty boy! What was going on?"

"What?" I said emulating surprise. "Mom! How are you? Dad, hi!"

"Fred! I know that was you!" Kay's mom scolded as she did when I ate too fast, swore too much, or expressed a liberal view. "I told Kay about it as soon as she and Dad got back from the store so don't try to fool *me*."

"You're just getting old," I mocked, toying with her disbelief. “Time does strange things to people,” I said. God it was good to be back home again. But it seemed to me that in another time and place Jorge Borges must have known all about such phenomena. Maybe it was he who had sat so confidently in the "B-9" position of the 18-04 building, writing: "I hope he will take me to a place with fewer galleries and doors. What will my redeemer be like?, I ask myself."[2]

Notes:

[1] J. L. Bourges, "House of Asterion," ***Labyrinths***, New Directions Publishing Corporation (1964), p. 139.

[2] *Ibid*., p. 140.

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R. F. Vaughan has chosen the name of the fictional character, Ray Bonn, from his novel ***Not July*** as a pseudonym for the author for several of his scientific publications including ***The Aberrations of Relativity***

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by Ray Bonn and Lesa Sorensen

In addition to confusion with regard to exactly what entropy is, current scientific explanations of the associated irreversibility and the ineluctable increases in entropy are complicated, unsatisfactory, and completely incorrect. This problem is so impenetrable in fact that in over two centuries of notable attempts by the greatest scientific minds there has still been no explanation that is credible. The ubiquitous increases in entropy seem, however, to only affect the happenings at the macroscopic level of our everyday existence for which no process is completely reversible. Processes that are irreversible like those we witness every day with the naked eye are ipso facto those for which entropy is increased. But there has seemed to be no origin of this dire trend at the submicroscopic level where the answers to virtually all of the difficult problems of physics have been resolved.

In resolving irreversibility at the submicroscopic level it has been necessary to augment Boltzmann’s kinetic theory beyond two types of interaction and to more fully elaborate necessary constraints on the emission and absorption of radiation in Einstein's quantum theory of radiation. It is in the interactions between these domains where irreversibility enters. It has been incumbent upon us to close major loops left open by the scope of their analyses. Boltzmann could not have foreseen the impact of mediated interactions involving quantized photons, nor certainly relativistic effects.

A comprehensive model has had to be developed to incorporate complimentary mechanical and radiational aspects of a thermodynamic system. The mediated interactions between molecules that do not involve direct collisions always reduce the relative velocity of the interacting molecules, which is very entropic behavior. In this way, individual submicroscopic processes ‘use up’ otherwise useful energy and increase entropy even at the submicroscopic level.

Yet another form of interaction involving both radiational and particulate dynamics is the scattering of radiation by arrays of charges within a thermodynamic system. 'Forward' scattering in particular has traditionally been considered to involve conservative forces that do not alter the energetics of either the ensemble of particles or the radiation field. We show that this too is an over simplification whose correction has profound consequences of irreversible behavior, producing what have been considered 'cosmological' effects. The major loops that must be closed in this regard involve the origin of the ubiquitous hydrogenous intergalactic plasma with 24% helium by weight and the supposed disappearance of mass (and information) in black holes. There is increasing evidence that black holes do indeed erupt spewing forth hydrogenous plasma to again produce the 24% helium in generating the gamma radiation that after prolonged redshifting caused by irreversible scattering becomes the microwave background radiation. The blackbody temperature of a redshifting medium does not reflect the kinetic temperature of the particulate matter by which that radiation is scattered.