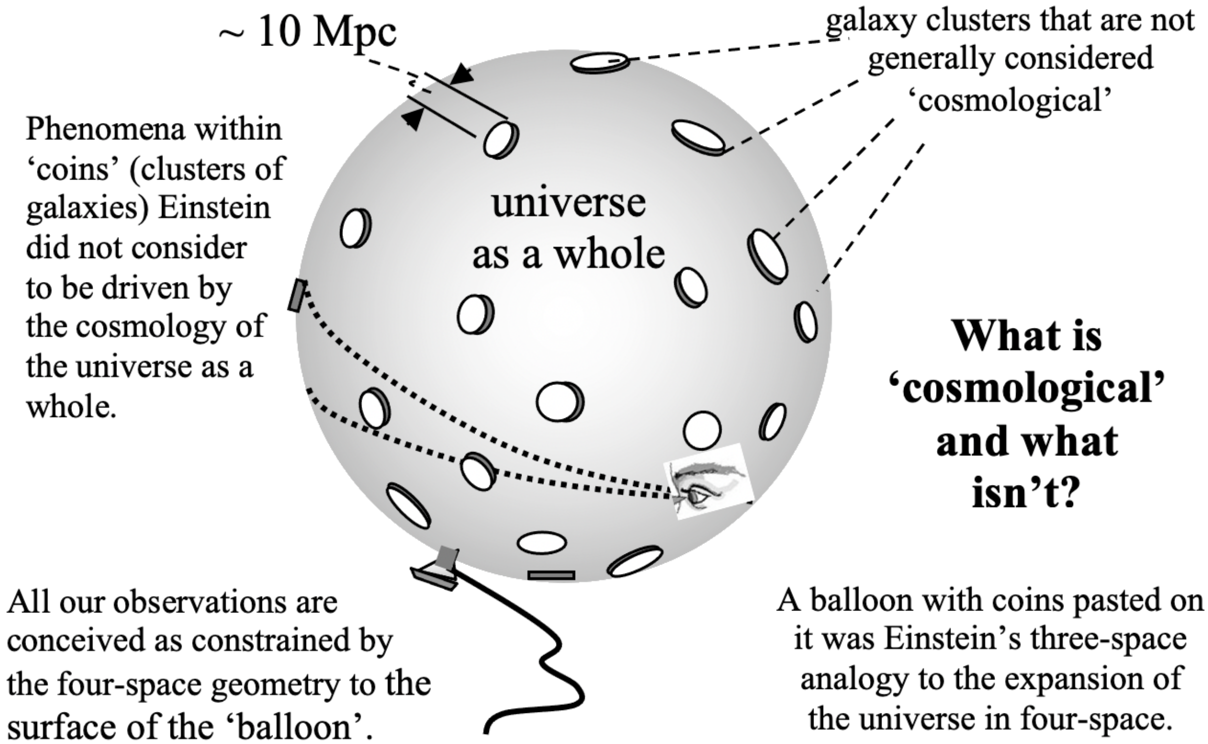
Evolution of Gravitational Models Toward a Model involving a Stationary State Universe[1]

Sir Isaac Newton envisioned an infinite universe exempt from gravitational collapse. Einstein was convinced on the other hand that Hubble's discovery interpreted as expansion was all that forestalled demise. His model of an infinite universe was an indefinitely enlarged spherical region of uniform density; he used Poisson's equation to demonstrate its collapse. That depiction has not been relinquished by cosmologists. A lambda fudge term that Einstein acknowledged as his most egregious error has been requisitioned as the density of supposed dark substance. But he was wrong in his characterization of an infinitely extended universe. Any three-dimensional model of the universe, whether finite or infinite, as an expanded sphere of a given density implies an illogical 'outside' of the universe with an outer surface at which collapse must begin – otherwise it won't. In his simplistic characterization, we would be at the center of a non-Copernican reality. He settled on the three-dimensional universe as a surface in four dimensions a shown in figure 1.



Whether the universe is continuing to expand or deflating became a preoccupation for a time. An initial inflationary period had to be embraced, but now as though there had been a renewed breath by the creator, the expansion of the balloon is seen as having been more recently accelerated.

Figure 1: Einstein's early conception of a four-space universe with galaxy clusters as nonexpanding coins on an expanding surface

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1 A 'stationary state' does not imply a static or refuted 'steady state' model; it is a stable thermodynamic state.

Einstein's and Hawking's model, not Poisson's equation, was incorrect. There is no 'outside' of an infinite universe. However large the three-dimensional sphere one chooses to represent an infinite universe (refer to the ones on the left in figure 2 increasing without limit), there is an equally increasing sphere adjacent to it, which is still a part of an infinite universe. All the rest of an infinite universe (both inside and outside the larger sphere) is symmetric about that central point of contact of the two smaller spheres, so all gravitational forces cancel at every such point and there would be no collapse.

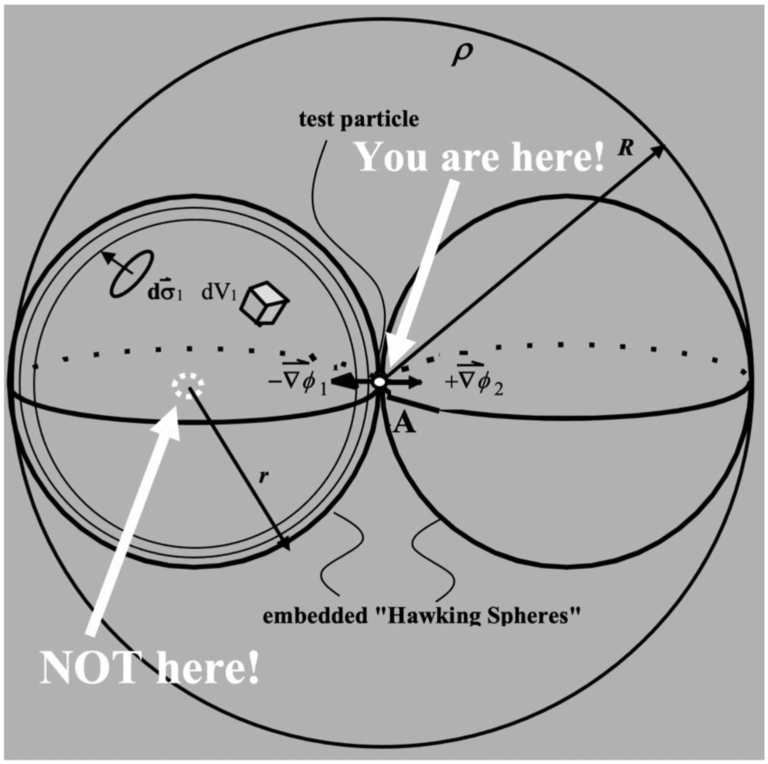


Figure 2: Using the Poisson equation to model a stable uniform-density infinite universe

If the left-hand sphere in figure 2 were somehow to have been filled with a higher total density of matter without affecting the surrounding uniform density, it and regions surrounding it would begin to collapse inward forcing a larger and larger exception to uniformity. If instead that sphere was empty without affecting the surrounding uniformity, then the void would expand indefinitely outward due to outward gravitational force on the particles at the boundary increasing the size of the hole. But if there is a level at which the universe can be considered uniformly dense, the realities of hydrostatic pressure, preclude both these extremes.

Of course uniformity at the detailed local level of our universe is unrealistic to say the least. Random variations are required of any realistic dynamic model of the universe; that would produce over and under densities in the uniformity. One of the more egregious of Einstein's errors was in depicting an exclusively gravitational universe. Any adequate model of the universe must include thermodynamic considerations with its ideal gas law for which a stable uniform mass density would be associated with uniform temperature and pressure. Realistic situations of higher temperature and pressure in a denser clump would produce a low-density moat with pressure limiting infalling matter from its outer regions, stability ultimately resulting. A void would be filled in by diffusion due to pressure from the outside until a spherical declivity was filled in enough to counter the outward gravitational force. And unless matter were to have been inserted or extracted from the general uniformity, hydrostatic equilibrium would be maintained with uniformity established at a higher level of granularity. In either of these cases there will be a gravitational clumping toward the center of a left-most spherical region surrounded by a less dense region out to where uniformity is realized at the interface to the sphere where counter forces cancel. This is because all symmetrically organized forces external to the two smaller spherical regions nullify each other. This is shown in figure 3 with typical functionalities of density, temperature, and pressure of galaxy cluster domains functionally coordinated at hydrostatic stability. Variable density regions will expand until average density is reduced to the average uniform density and pressure values, with cancelation of forces at the boundaries with a compact Voronoi tessellation of space as illustrated suggestively in figure 4.

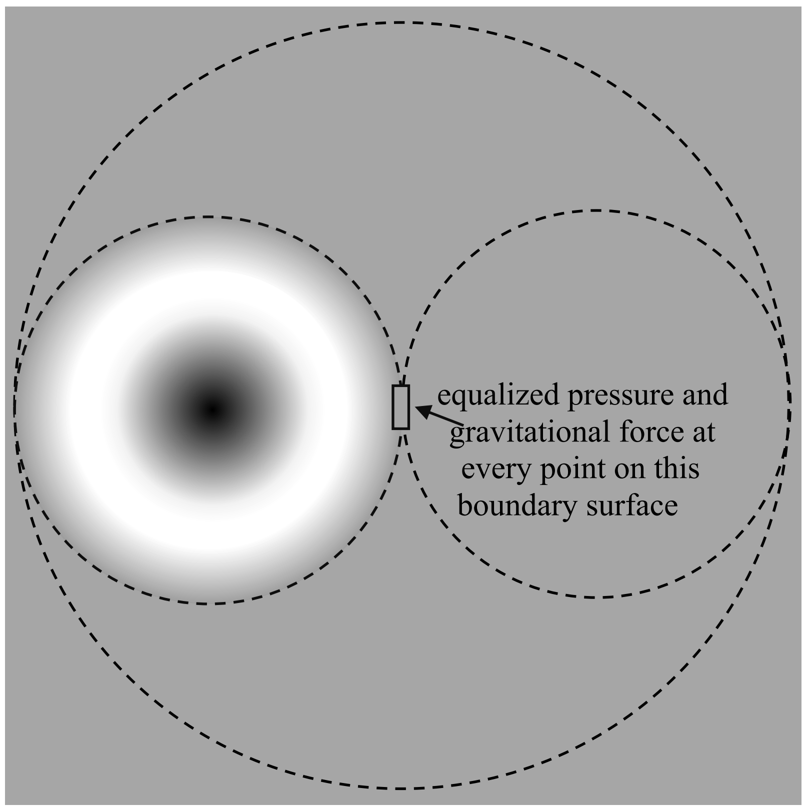


Figure 3: Applying the Poisson equation to modeling variations to uniform density.

In over densities temperature as well as mass density, and therefore thermodynamic pressure become orders of magnitude higher than for the universe at large. In excess of 99.99% of the baryonic matter in the universe is in the plasma state. It is these gases that largely comprise the over densities with some gravitating into proto galaxies an stars of swirling gases. There is an order of magnitude more baryonic mass in intergalactic plasma than in all the stars of the galaxies that orbit about the centers of such over densities, but these are the objects we observe through the otherwise transparent hydrogenous plasma. The massive galaxies are distributed by the same hydrostatic pressures resulting in the 'galaxy clusters' at the cores of these domains. They contain tens, hundreds, even thousands, of orbiting galaxies about a dense central core region as shown in figure 5.

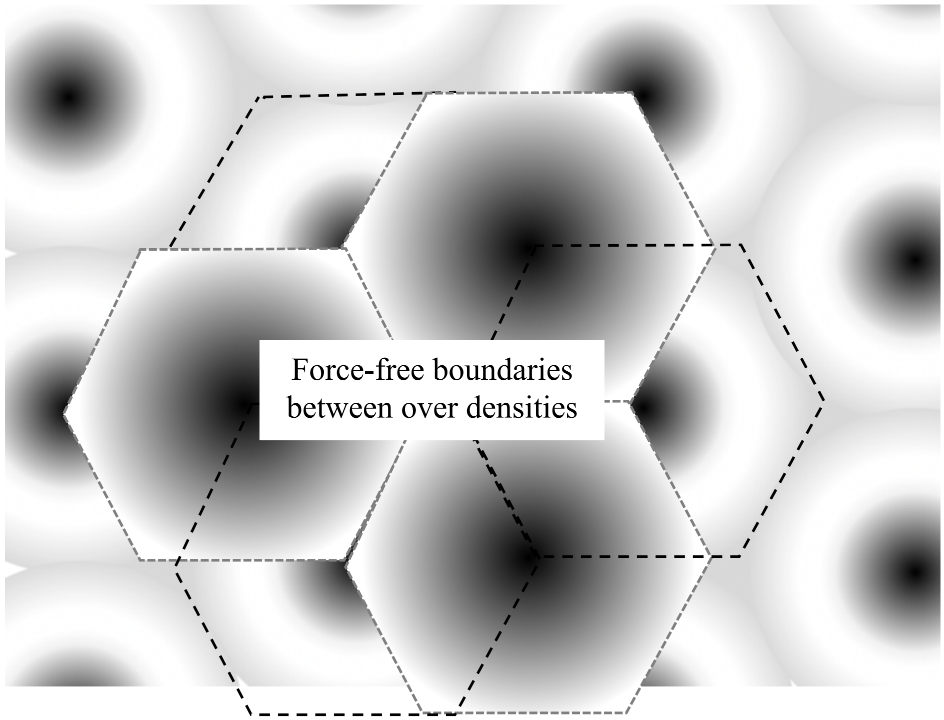


Figure 4: A single layer in densest compression of galaxy clusters with force-free boundaries between clusters at a single level

We define a 'cluster cell' as the region of space dominated by a single galaxy cluster. This domain is called a 'dark matter halo' by current cosmologists in deference to the additional mass presumed to be required if redshift variation through the cluster results from Doppler shifts due to orbital velocities. But this additional mass (if it exists) would have to be distributed exactly as is baryonic matter although much more massive to effect greater orbital velocities to which they attribute the extreme redshift dispersion through clusters. The thermodynamic aspect of baryonic matter is not applicable to dark matter, which is conceived as strictly gravitational, incapable of the usual thermodynamic pressures of baryonic matter that results from thermalization processes involving matter-radiation interactions. It is reasonable, therefore, that in this article we consider alternative causes for redshift dispersion in cluster cells, concentrating on observable aspects of such domains.

Virgo is a giant, 2000-galaxy 'super' cluster that is centered about 20 Mpc away from the Milky Way. (An Mpc is a Mega parsec equal to 10^6 parsecs or 3.26 x 10^6 light years.) Virgo contains some 50 nearby smaller groups of galaxies that suggests that they all form one enormous, cluster of clusters that is called the Local Supercluster. This suggests that there is some higher-level systemic grouping of clusters, which is certainly born out in galaxy surveys. Recent surveys show a clumping of galaxies at distances separated by an increasing redshift but a constant associated distance of separation on the order of 100 Mpc. This apparent ripple effect is obvious in larger surveys that we will discuss later.

Intergalactic gases extend well beyond the typical orbital radii of galaxies orbiting near the centers of clusters. The gases are largely comprised of hydrogenous plasma. The centers of clusters are on average separated by on the order of thirty Mpc. Density and temperature profiles vary with highs in central core regions and values at the midpoint between clusters less possessing less than the overall averages of the universe.

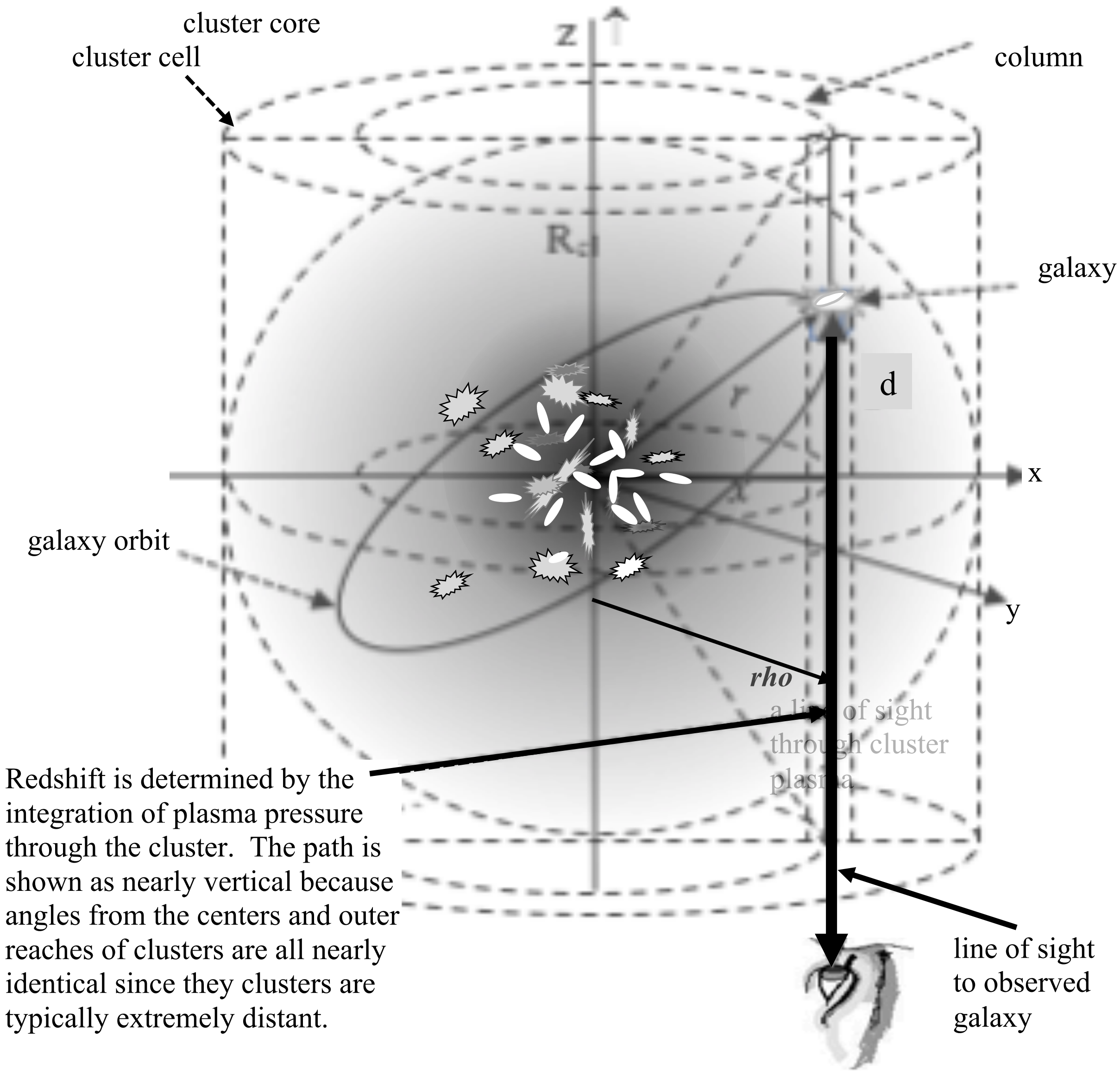


Figure 5: Accumulated plasma density through a galaxy cluster domain

The β model of galaxy cluster cells accurately describes observed hydrostatic phenomena in these domains (otherwise denominated 'dark matter halos'). There is a core radius parameter r_c that defines the central region of the cluster where a vast majority of galaxies reside and beyond which the density profile for both the galaxy number density and plasma electron density steeply declines. These densities in the β model are given by the equation:

$$n(r) = n_0 \left(1+(r/r_c)^2\right)^{-3\beta/2}$$

Here, n(r) is the number density of galaxies or electron density (depending on scale) at a distance from the center of the cluster r; the central density n_0 determines the scale; r_c is the core radius beyond which the density becomes negligible; and β is the parameter that controls the steepness of the density profiles. Typical values for r_c vary depending on the size and type of the galaxy cluster. The value is typically on the order of a few hundred kiloparsecs (kpc) to about a megaparsec (Mpc). For some massive and well-studied galaxy clusters, r_c might be around 100 kpc to one Mpc. At the boundaries between domains the overall baryonic mass density will have dropped well below the universal average of on the order of 10^{-31} gm/cm^3, which corresponds to a free electron density of on the order of 5 x 10^{-7} electrons per cubic centimeter.

The temperature profile in the β model is given by the equation:

$$T(r) = T_0\ (n(r)/n_0)^{\beta}$$

T_0 is the temperature at the center of the cluster. These temperatures range as high as 10^9 K and are typically in the range 10^7 K < T_0 < 10^9 K. There is an X-ray spectrum associated with the cluster core regions of cluster domains. At the boundaries between domains the temperature will have dropped below the universal average of on the order of 10^3 K.

The hydrostatic pressure in the β model is given by the usual thermodynamic expression:

$$p(r) = k\ T(r)\ (n(r)$$

where k is Boltzmann's constant.

A 'redshift correlation function is associated with cluster domains more typically called dark matter halos that is associated with fingers of god phenomena, but it is accurately modeled as a plasma gas pressure distribution in the β model. It is given by the equation:

$$Rs(r) = C\ p(r)$$

where C is a constant that is on the order of 2 x 10^3 in units that leave Rs unitless.

There is a radius R largely defined by the boundaries between clusters as was shown in figure 4. The radius is typically between ten and twenty Mpc. This radius is more rigorously defined as the radius at which the average baryonic density of the entire cell is equal to the baryonic mass density of the universe.

The effect of beta on the hydrostatic pressure is illustrated in the plots of figure 6. A complete set of parameter plots for a hypothetical cluster domain is illustrated in figure 7; a 3-dimensional plot of electron density shown in figure 8.

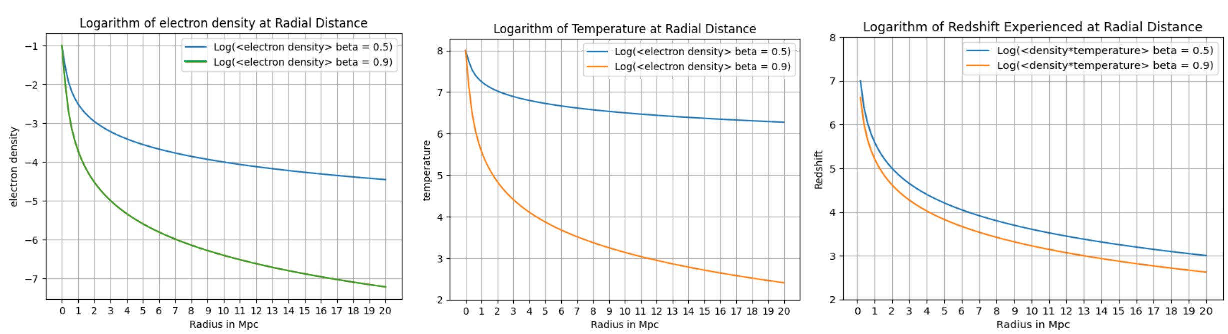


Figure 6: Impact of beta value on electron density, temperature, and redshift

Space is fully occupied by galaxy clusters cells as suggested in figure 4; there are zero-force boundaries between them where thermodynamic pressure cancels gravitational force, but there are no complete voids – no expanding empty space. These clusters are not packed together totally at random, nor yet like eggs in an egg carton with space between and piled atop each other for which total volume would be 1.9 times the volume contained in the more spherical regions of cluster cells. The galaxy cluster cells are compressed distributions within cuboctahedral groupings with variations in the tessellation of space to be sure. For representative cluster cells the configuration in column C of figure 9 is what hydrostatic equilibrium would produce.

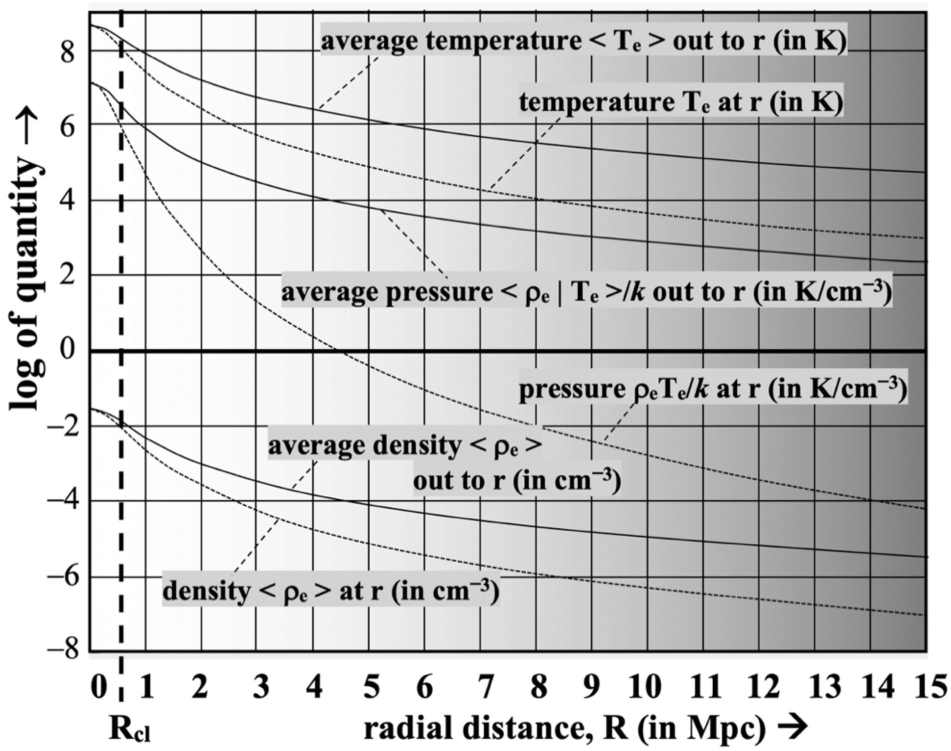


Figure 7: Typical temperature, density, and pressure in the beta model of intergalactic plasma gases in a galaxy cluster cell as functions of the distance from the centers of the cells

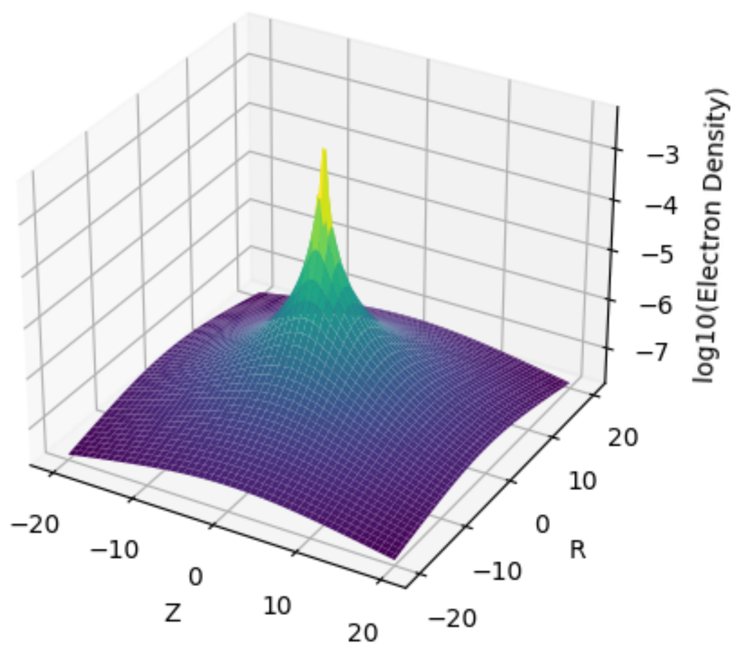


Figure 8: Plasma electron density in a galaxy cluster cell

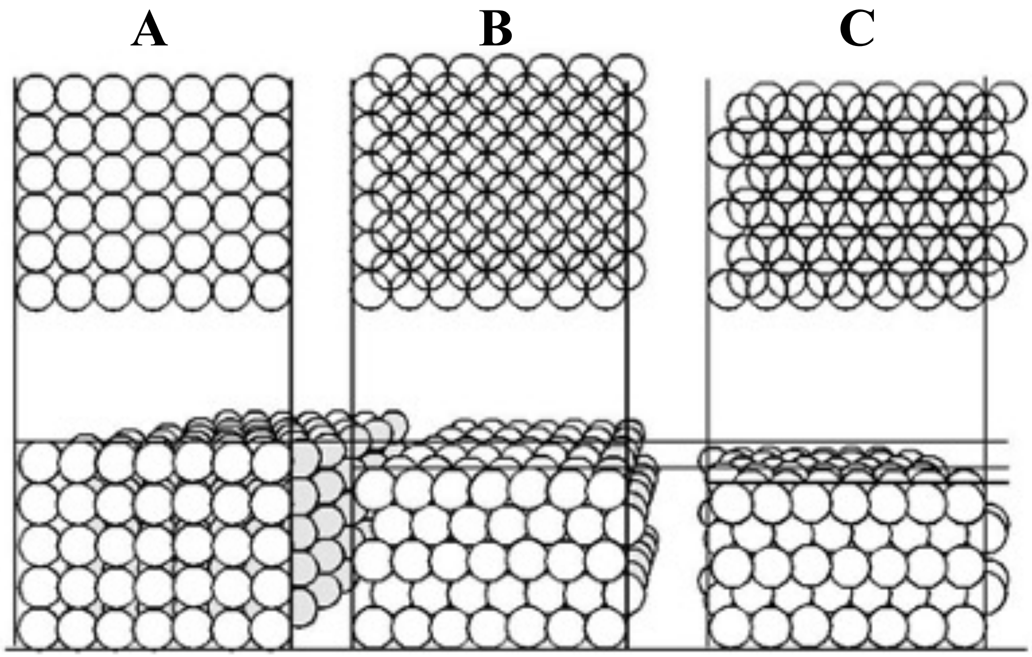


Figure 9: Structural tendencies of compactness

A cuboctahedron is a polyhedron with eight equilateral triangle faces and six square faces. It has 12 external vertices, and its name comes from the fact that it can be seen as a cube (with eight corners) and an octahedron (with six corners) combined as one. The cuboctahedral structure is a fascinating geometrical arrangement that has had various applications with significance in mathematics, crystallography, architecture, and other fields. Octahedral tessellation involves arranging thirteen spheres in such a way that the composite structures fill space without gaps or overlaps, forming an overall pattern like that shown in panel C of figure 6. Each sphere is a part of thirteen unique cuboctahedrons, with no sphere unique in itself. These features are applied in crystallography, materials science, and molecular modeling. As applied to cosmology we assume spheres to correspond to representative galaxy cluster domains. Of course, all cluster domains are not the same size, but the structure provides a place to start at obtaining numbers to compare with astronomical observations on lines of sight up through multiple galaxy cluster domains.

Initially we consider an orientation of the cuboctahedrons such that a horizontal middle layer of domains constitutes a hexagon with a seventh domain in the center as shown in the center panel of the seven golf balls in figure 10. The top and third layer in the cuboctahedron, are triangular structures of three balls that initially we consider as anti-aligned; these are shown at the top left in figure 10. In this diagram we show vertical lines-of-sight up through compactly structured cluster cells, having passed through one cluster core, will pass through another one three layers later along a light propagation path. So extreme properties of cluster cores are realized at most every three layers, i.e., but peripherally thrice per cuboctahedron. Looking vertically upward through the middle layer of the structure, cluster cores appear more closely associated than they would be the case if only centers on the same layer were considered. The middle and right-most panels of figure 10 show the relative layout of three layers of the thirteen core regions. In figure 11 the averages of column density and incumbent redshift in lines-of-sight passing through these three layers.

Each triangular column has an equally spaced cluster core at each corner that is characteristic of what is observed in looking up though galaxy clusters; it is not just a view through single cluster.

But the view through the cross section of a single cluster core, repeats itself every three layers involving effects of the six closest peripheral cluster cores. The numbers of galaxies and plasma electrons encountered by lines of sight through the hexagonal over densities shown in figure 4 that comprise single cluster cells, involves partial effects of six more cluster cores – three above and three below. Those effects can be partitioned into six identical triangular column volumes shown at the far right of figure 10. The observed effects are modeled as three-layer column averages corresponding to universal averages.

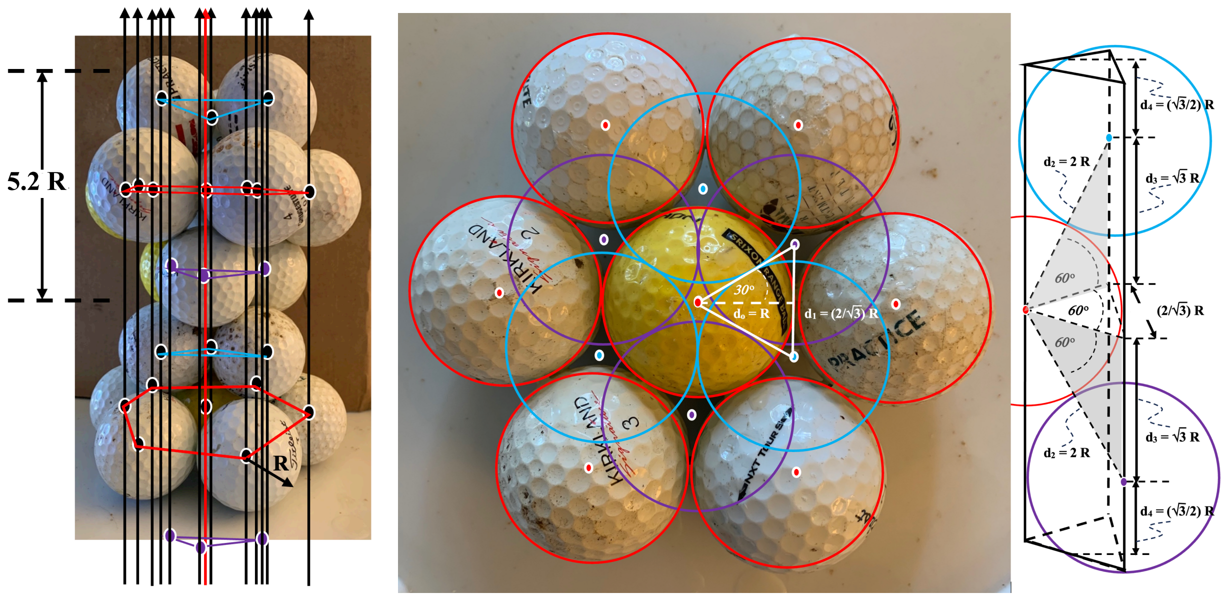


Figure 10: Tri-level structuring of density repeated every three levels at increasing distances.

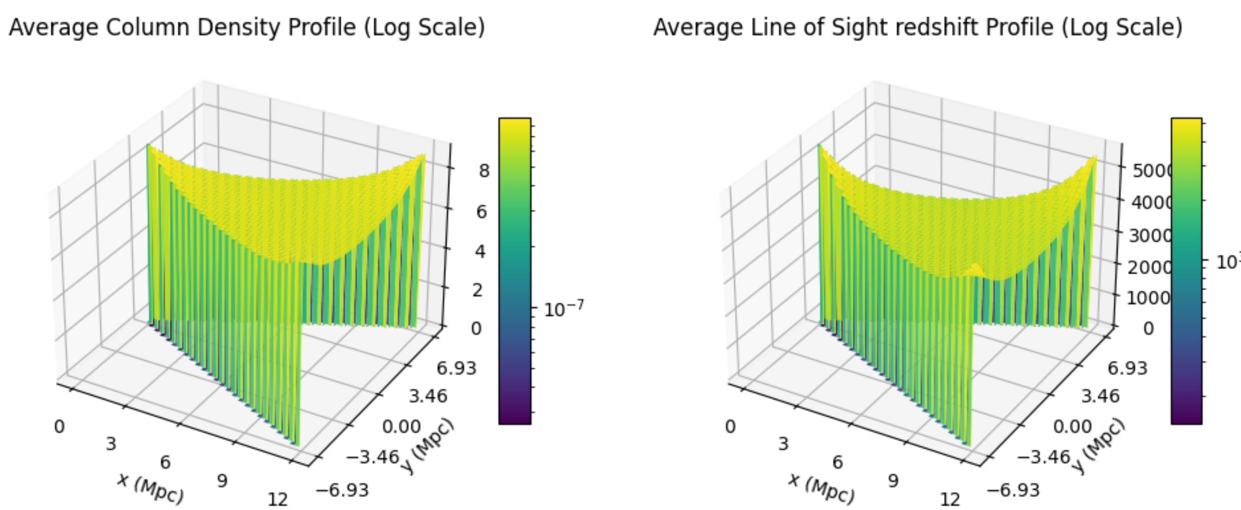


Figure 11: Tri-level triangular column density and encountered redshift profiles.

These plots were computed by numerical integration of the equations specified above for the beta model of galactic cluster phenomena. Parameter values used in these particular plots are:

n_0 = 0.2 electrons per cubic centimeter
r_c = 0.65 Mpc
β = 0.3
$T_0 = 1.5 \times 10^8$ K

All these values are realized in observed galaxy clusters. The plots above have average values that compare closely with universal averages. They are:

Overall Average Density: 3.8×10^{-7} cm^{-3}
Overall Average Temperature: 1,004
Overall Average Pressure: 4.6×10^{-15}
Average Line-of-Sight Redshift Inducing Pressure: 2093,

Other articles on this web site indicate that a value just over 2,000 for the average product of electron density and temperature throughout space has been shown to produce the equivalent of the observed cosmological redshift. Notice that the average of the product differs substantially from the product of the two averages that are shown.

There are other models that address aspects of different interpretations of the observations of galactic cluster phenomena. When the hypothetical role of dark matter is accepted, the Navarro-Frenk-White (NFW) profile is used to track virial mass, which is greatly reduced when effects attributed to vast amounts of dark matter are handled instead by the effects of plasma gas pressure. But there is also a "double beta" model in which plasma gas parameters n_0, r_c, and beta are duplicated with unique values to provide flexibility in represent a somewhat different functionality of the observables at shorter and longer distances from the center. Figure 12 shows plots using this model. At large distances from the centers of such structures, all models revert to a simplified r^{-3} power law functionality, with the mass within the spherical confines matching that of adjacent spherical confines at the universal mass density as was illustrated in figure 3.

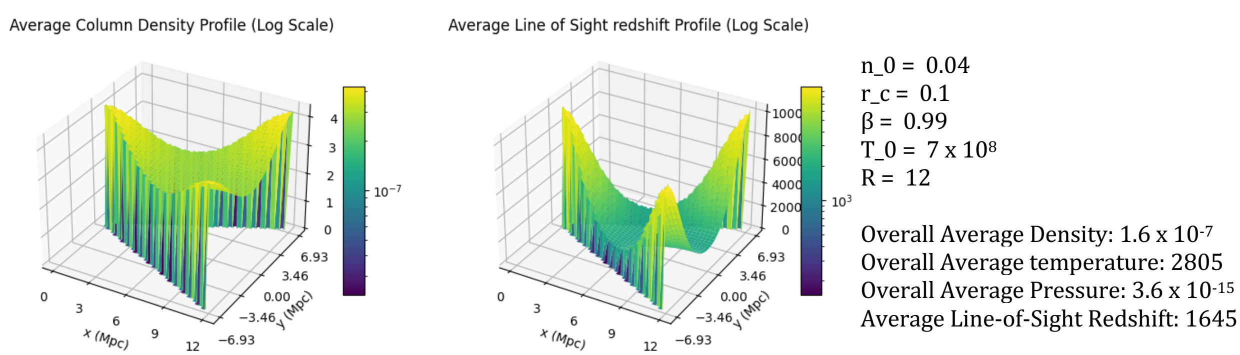


Figure 12: Column density and encountered redshift profiles for double beta model

Whether from virial motions of galaxies induced to greater velocities by dark matter or extreme electron velocities in hot plasma, it is clear that the effects of redshift in the vicinity of cluster cores are extreme. The significantly increased pressure that is correlated with redshift can be seen in figures 6 and 7, and at the corners of the plots in figures 11, and 12. In the latter cases the effects are multiplied by closes neighboring cluster cores in front and behind the cluster of record. The fact that these cores are closer in the one case and further in the other is of virtually no consequence because it is redshift and not distance per se that is observed. All vertical lines of sight passing through a cross section of an octahedron structure of galaxy clusters will pass through a triangular column like those shown in figures 10, 11 and 12 with three nearby cores. Furthermore, the pattern will repeat for every octahedron the light passes through.

The significance of this overlapping is that by adding a fourth, fifth, and sixth layer, the density of the same pattern, which will be nearly the same, will be repeated precisely. With every additional three layers the density will increase by the very same amount and with the same distribution. It is a mere geometrical fact. Assuming the spheres are isometric with galaxy cluster cells, with densities at issue are spatially related redshift contributions, we have accounted for the ripples in galaxy survey data at about three times the average galaxy cluster diameter as is clearly demonstrated in observations. This phenomenon is real. Observations made through layers of galaxy clusters do indeed exhibit periodic ripple effects in galaxy density; these spherical ripples are centered at our location here in the Milky Way galaxy. This is an obvious feature in every galaxy redshift survey like that shown in figure 13. We know that the milky Way as a galaxy, no more than our sun as a star, our earth as a planet, or Seattle as a city, is the center of the universe. So, why does it look that way? Galaxy survey data can only look that way because of structural geometric aspects that cause it to look as though anyone from anywhere is at the center of the universe. The ripples appear in redshift surveys only because redshift is the way we measure distance: the periodicity of these ripples is spatial rather than specifically redshift phenomena. In redshift the separations are logarithmic. See the data presented by Sparke and Gallagher in figure 14 that demonstrates that galaxies appear to occur primarily in these concentric shells. The vertical dashed lines are separated by 52 Mpc, so the separation between high galaxy density is 104 Mpc, implying representative galaxy clusters must have a diameter of about 35 Mpc.

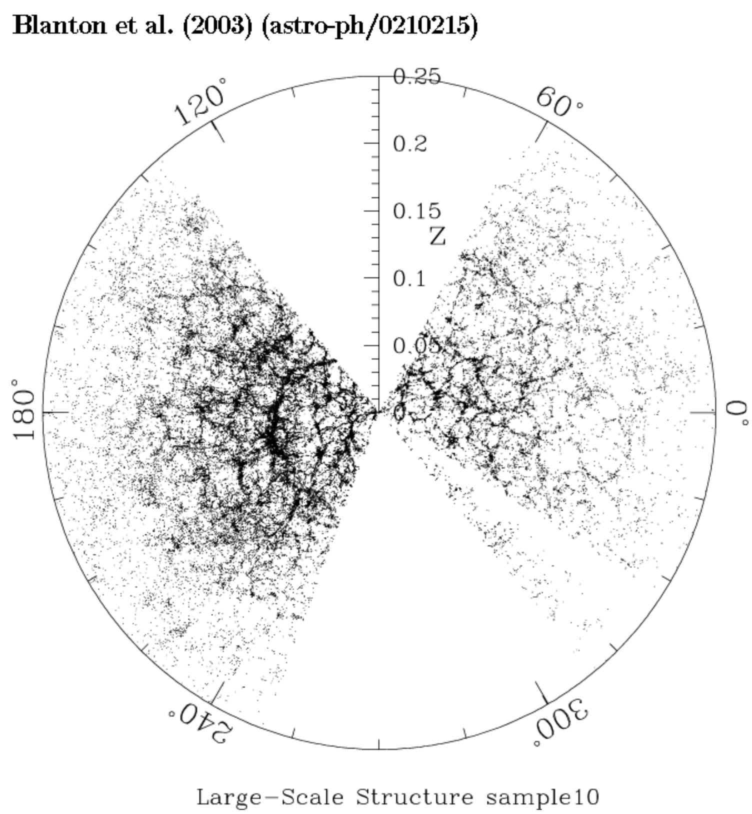


Figure 13: Distribution of galaxies in redshift surveys

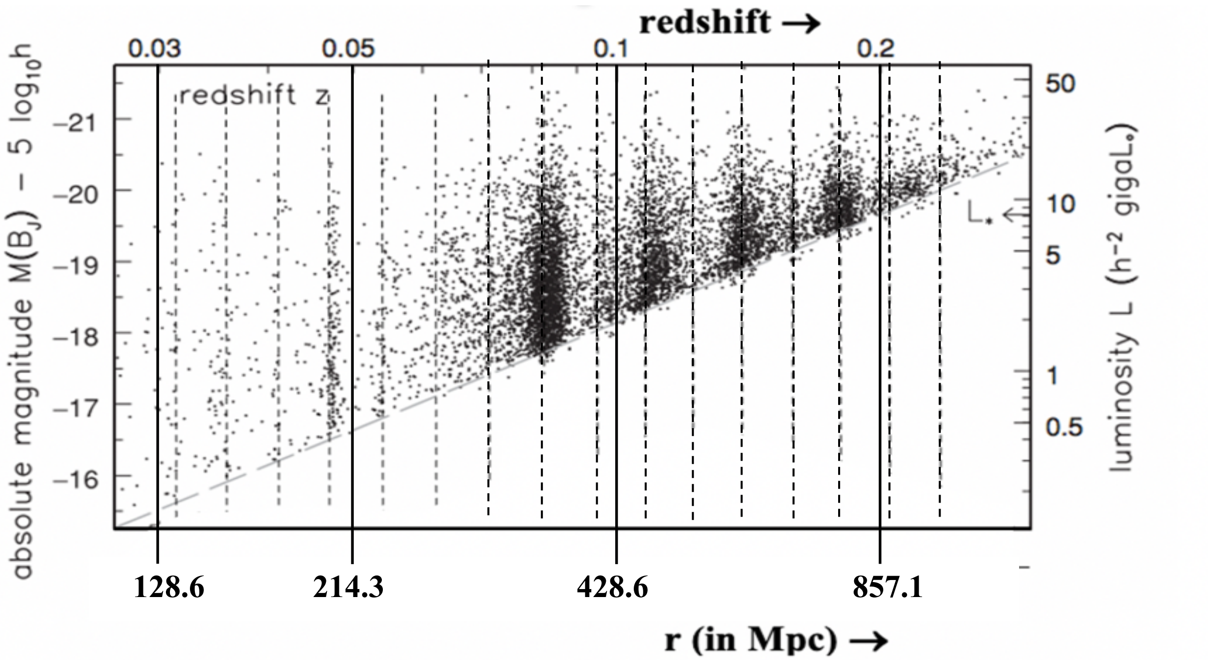
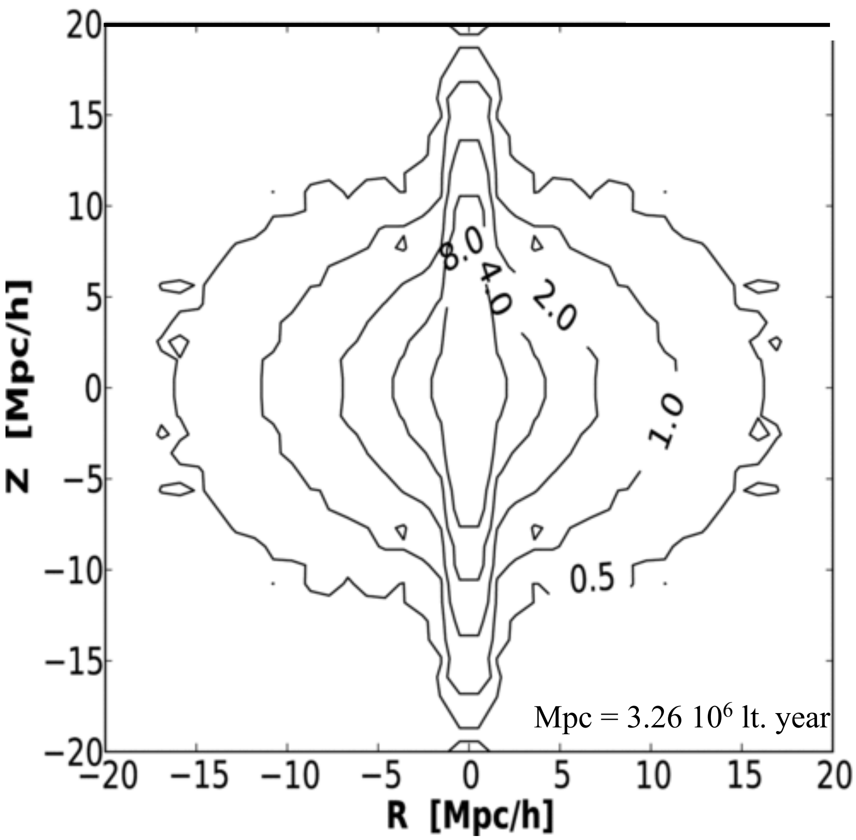


Figure 14: Luminosity of 8,438 galaxies near 13ʰ20ᵐ from the 2dF data shown in figure 1.19 (data missing below the diagonal is due to instrumentation limitations that results in less density at greater redshifts) –Sparke and Gallagher (2010)

What we have referred to as galaxy cluster cells are more typically been given the name 'dark matter halos', tying the 'finger of God' effect to a presumed cause. Galaxy cluster cells or domains would have been preferable to 'halos' to associate with the 'fingers of God' phenomena just to avoid the transference addressed elsewhere. But a rose is a rose is a rose I suppose and by any other name smells as sweet as they say. Research into the nature of the redshift that occurs in light passing through these domains has been addressed by Martin White, et al (2011) under the heading of 'halo occupation modeling'. The article provides excellent data even though certainly intended to justify a different possible cause of the effects of light transmission through such regions. Figure 15 (what was figure 4 in their paper) provides redshift contribution densities through a cluster as a "redshift-space correlation function". That correlation maps directly to the spatial distribution of hydrostatic pressure through the cluster cell. The column density of this quantity through a tri-level space occupancy of cluster cells in cuboctahedrons of compact space occupancy produces the redshift associated with transmission through 100 Mpc of plasma electrons in the plasma scattering cosmological model, with the lengthening of wavelength increasing redshift increments logarithmically as distance increases.

The dark circular arcs in figure 13 are not physical like the stone wall of China or Hadrian's wall or firmly fixed 'filaments'. They are artifacts of having to measure distances to galaxies in redshift, a spectroscopic effect that is dispersed with a three-layer regularity.

If thermodynamic aspects of galaxy cluster cells, including temperature, density, and pressure profiles of plasma gas, had been thoroughly investigated before the cosmology community had acquiesced to the Doppler/dark matter hypothesis of fingers of god phenomena, the last century of theoretical cosmology would have proceeded very differently. We would not be re-litigating Genesis. The debunked so-called 'tired light' theories of redshift accruing with transmission distance through material substance were disrespected in deference to the well-known recessional Doppler effect. Had the data shown in figures 7, 11, and 12 been available, someone would surely have noticed that the redshift effect was proportional to the integral of average hydrostatic pressure as photons pass through the high temperature plasma. It would have been ad hoc at that juncture since a mechanism for such an effect was not yet known. Nor of course was anything known about dark matter at the time –it still isn't – and yet it was (and is) embraced wholeheartedly even as 'tired light' models are disgraced. That was because Yakov Zel' dovich averred that there could be no possible scattering mechanism to support a tired light model, and no one of equal rapport countered with an equally dismissive comment that we might spend a hundred years without success, looking for an explanation of 73% of matter that no one understands. If both hypotheses had been evaluated contemporaneously, respectful comparative analyses would most likely have proceeded rather than embracing non-Copernican concepts of *creatio ex nihilo*, inflationary expansion at greater than light speed, a later accelerated expansion of the entire universe, etc, and quixotic quests to reinterpret general relativity and discover the illusive nature of dark matter and then dark energy. Quests proliferating quests. But… there it is.



"Figure 4.
Contours of the redshift-space correlation function, $\xi(R, Z)$, for our $0.4 < z < 0.7$ galaxy sample (see the text). Note the characteristic elongation in the Z direction at small R (fingers-of-god) and squashing at large R (super-cluster infall). [This] panel shows the results from the BOSS data."

–Martin White, et al (2011)

Figure 12: Galaxy cluster cell, aka 'Dark matter halo', redshift-space correlation function

We have come full circle. Initially there was Einstein's disagreement with Newton concerning the stability of an infinite universe. Then his analogy of an expanding balloon with coins stuck on it as representative of galaxy clusters that had little to do with major cosmological issues including an origin and expansion of the universe – created and emerging from nothing. But here we are. We find that expansion is not required to keep an infinite universe from collapsing upon itself nor is it required as a cause of the observed cosmological redshift. It turns out that the hydrostatic pressure that determines thermodynamic aspects of galaxy clusters accounts also for the baryonic mass density, observed average kinetic temperature, the, average kinetic and radiation energy density, and the cosmic microwave background (CMB) that characterize the universe. See related articles describing these realities under the heading cosmology papers on the author's web site at https://fred.vaughan.cc/scientific/cosmology-papers/ . It is thermodynamics to a greater extent than gravitation that is required in modeling the *real* stationary state of our universe. Entropy is not how it ends, it is rather the driving force that keeps it going – yes, even forever.