Quantifying Partitions of a Stationary State Universe

The Poisson equation was at issue in the centuries long debate about whether an infinite stationary state universe would collapse under its own weight. It describes the behavior of a classical gravitational system; an analogous equation describes behavior in general relativity. Einstein ran afoul in his analyses because Poisson's equation is not just an equation; it is the formulation of a 'boundary value problem'. The equation applies within specified boundary conditions of the system under consideration. Newton had argued that no boundary to an infinitely distance assured there would be no collapse. But Einstein and Hawking modeled an infinite spherical universe as circumscribed by a spherical boundary, albeit at an infinite distance in the limit. But their model features an inside and an illegitimate outside of the universe.

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 of increasing size on the left in figure 1 showing attempts to increase it without limit), there is an equally, increasingly large adjacent spherical region which is also 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 where gravitational collapse would begin. All gravitational forces at every point on the smaller sphere cancel so there can be no collapse in a uniformly dense infinite universe. It is Einstein's and Hawking's model, not Poisson's equation, that is incorrect.

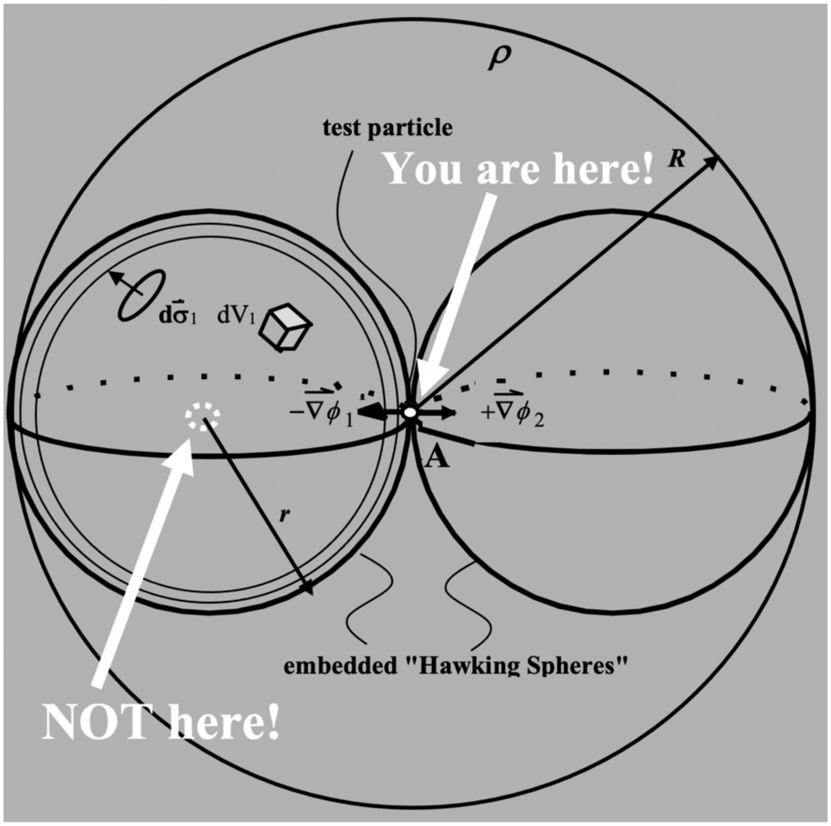


Figure 1: Using the Poisson equation to model a stable uniform-density infinite universe

Certainly gravitational collapse into stars, galaxies, and galaxy clusters is observed. Over (and under) densities certainly will and do occur for various reasons throughout an otherwise uniformly dense universe. In over densities gravitational effects will produce contraction into gravitationally bound systems as shown in figure 2. But such over densities do not precipitate overall collapse.

Notwithstanding emphasis placed on it, gravity is not the only 'force' to be considered in analyses of variations on the distributions of matter in an infinite universe that is uniformly dense at the highest level. Thermodynamic considerations must be taken into account as well. Any volume of particulate matter at a temperature above absolute zero experiences an outward pressure that would, if unconstrained, force continued outward expansion in accordance with the traditional ideal gas thermodynamic formula:

$$P\,V = n\,k\,T$$

where P is thermodynamic pressure, V is the volume within the boundary surface, n is the number of the particles of gas within the volume, so the average particle density is n/V. The parameter $k = 1.38 \times 10^{-16}$ erg sec is Boltzmann's constant and T is the average temperature of the gas within the volume in units of kelvins K.

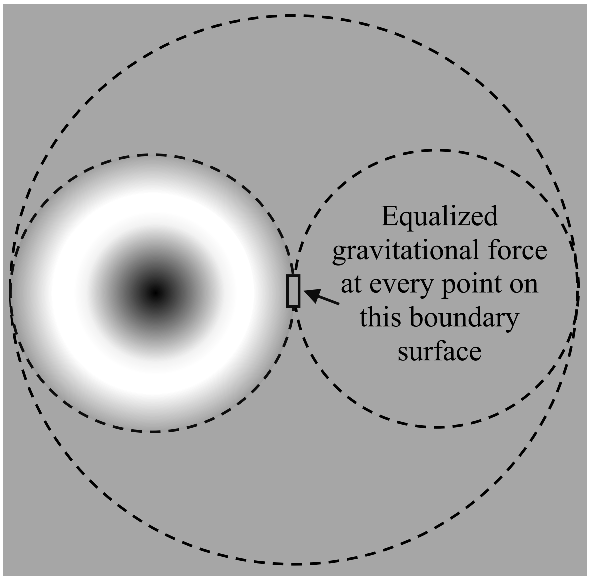


Figure 2: Applying the Poisson equation to modeling variations to uniform density.

This outward thermodynamic pressure at the surface associated with the force $\boldsymbol{f}_{\mathrm{P}}$ in figure 3 would be countered by the gravitational force $\boldsymbol{f}_{\mathrm{g}}$ of the matter contained within the volume as was assumed by Einstein's initial conclusion of a collapsing universe without counterbalance. This gravitational force would increase the local density, raising the kinetic temperature, and thereby further increasing the balancing outward pressure.

The *Jeans criterion* for collapse takes both these forces into account in assessing conditions throughout the volume for overall stability. The Jeans Collapse Criterion is a specification of the situation in which these two forces are equal and opposite. If a region of gas is compressed within a region of radius R_{J} defined as the Jeans radius the gravitational force of the enclosed mass will exceed the outward pressure causing the gas to collapse further.

$$R_J = \sqrt{\frac{15\,k<T>}{4\pi\,G\,m_H < \rho(r_{\mathrm{J}}) >}}$$

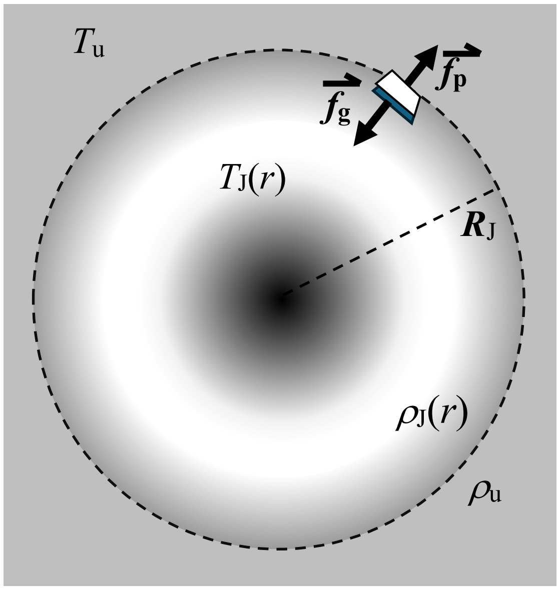
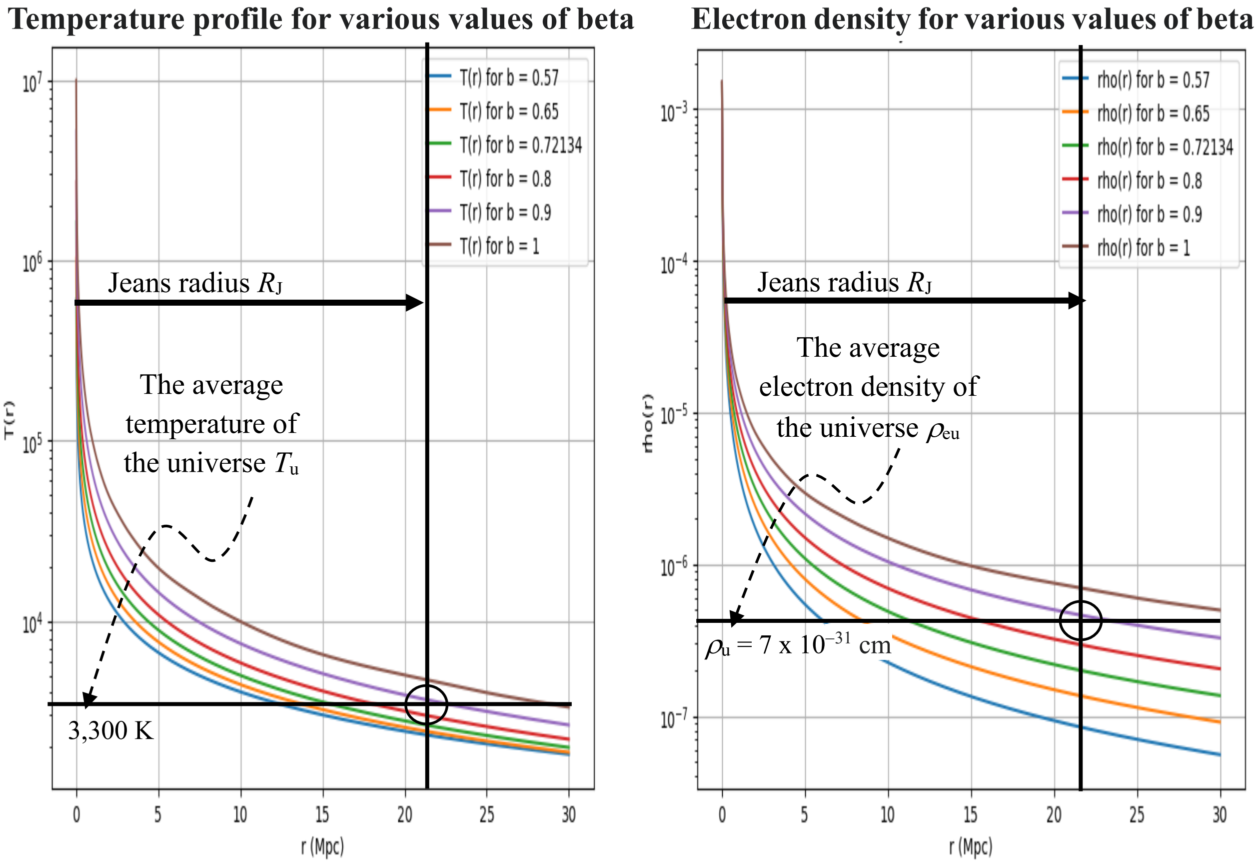


Figure 3: Gravitational and thermodynamic forces active in the structure-producing processes of the universe

This Jeans radius is the dimension of a spherically symmetric region where counter forces are equal, and the size of the region will remain stable. In a hydrogenous plasma the average mass of the particles is $m_H = 1.67 \times 10^{-24}$ gm, the average density $<\rho(r)> = n\, m_H / V(r)$ and $V(r) = 4/3\, \pi\, R_J^3$. To balance gravitational forces, the average mass density of the encapsulated stable over density $< \rho_J(r) >$ must equal the average mass density of the universe as was shown in figure 2. This density is on the order of $\rho_u \approx 10^{-30}$ gm/cm^3 although this value depends on assumptions about dark matter. The gravitational constant is $G = 6.674 \times 10^{-8}$ cm^3/gm sec^2. Thus, we obtain:

$$R_J = 1.22 \times 10^{24} \sqrt{<T>}\ \text{cm}$$

The average temperature throughout the region within the Jeans radius must equal the average temperature throughout the universe if the universe is to remain in balance thermodynamically as well as gravitationally, which it must. There are considerable reasons to conclude that this temperature is bounded by $10^3 < T_u < 10^4$, not least of which are observationally validated plots of temperature and density throughout galaxy cluster over density regions. See plots based on the beta model of galaxy cluster plasma gases data in figure 4 where the radii are in units of Mpc = 3.07×10^{24} cm and electron density rho(r) = $\rho_J(r) / 1.673 \times 10^{24}$.



Temperature profile for various values of beta **Electron density for various values of beta**

Figure 4: Temperature and density profiles in galaxy clusters for various values of beta

These values of temperature and density are ballpark values, but they are collaborated by other observations and analyses described in various papers on the author's site. It is interesting although coincidental that the standard cosmological model posits the origin of the CMB at a surface of last scattering at a temperature of about 3,300 K; this value is also compatible with the origin of the CMB in the author's scattering model. This value results in following value of the Jeans radius:

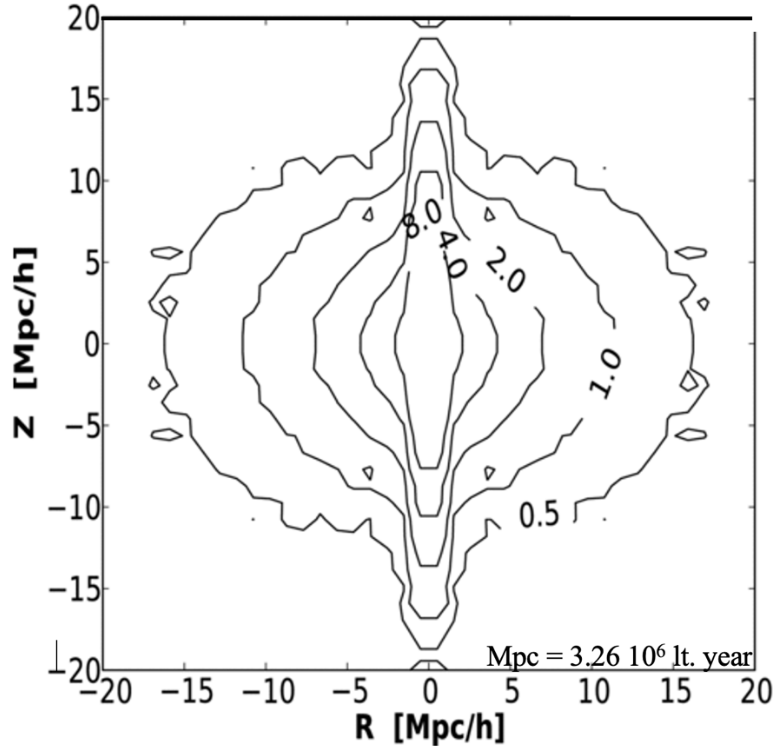
$R_J \cong 22$ Mpc

$M_J = 1.29 \times 10^{78} \times 7 \times 10^{-31} / 2 \times 10^{33} = 4.52 \times 10^{14} M_\odot$

In units of solar mass $M_\odot = 2 \times 10^{33}$. It is noteworthy that the masses of galaxy clusters fall within the range:

$10^{14} M_\odot < M_J < 10^{15} M_\odot$

The stable over densities are the observed galaxy cluster cells, structural components at the largest scale of a stationary state universe with their lower level collapsed eddies of plasma gases becoming host galaxies for stars. They exhibit broad redshift variation of their galaxies as shown by White, et al. in figure 5. This variation is not just a reflection of virial motions but an inherent dependence on plasma density of galaxies orbiting about their centers. They are not all the same size but are very nearly so as clearly suggested by BOSS data of galaxy surveys. Notice the similarity of dimensions in White's observations to our determination of R_J. That their numbers of observed galaxies vary so broadly has more to do with cell alignment and their variance in redshift when observing through them than on the allocation of galaxies in each cell.



"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 5: Galaxy cluster cell (aka 'dark matter halo') redshift-space correlation function

At the borders between cluster cells the requisite universal averages of temperature and density are realized. There is a Voronoi tessellation of space as each cell abuts adjacent cluster cells with zero force boundaries. This involves a closest 'packing' in space, whose two-dimensional organization is very much like that shown in figure 5. In three dimensions, these force free boundaries that entomb the cluster cell would for identically sized cells constitute twelve-sided rhombic dodecahedrons. Each face is the face of another cluster cell rhombus forming a cuboctahedron of 13 cells, both solid shapes capable of completely tessellating space. These structures are shown in figure 6.

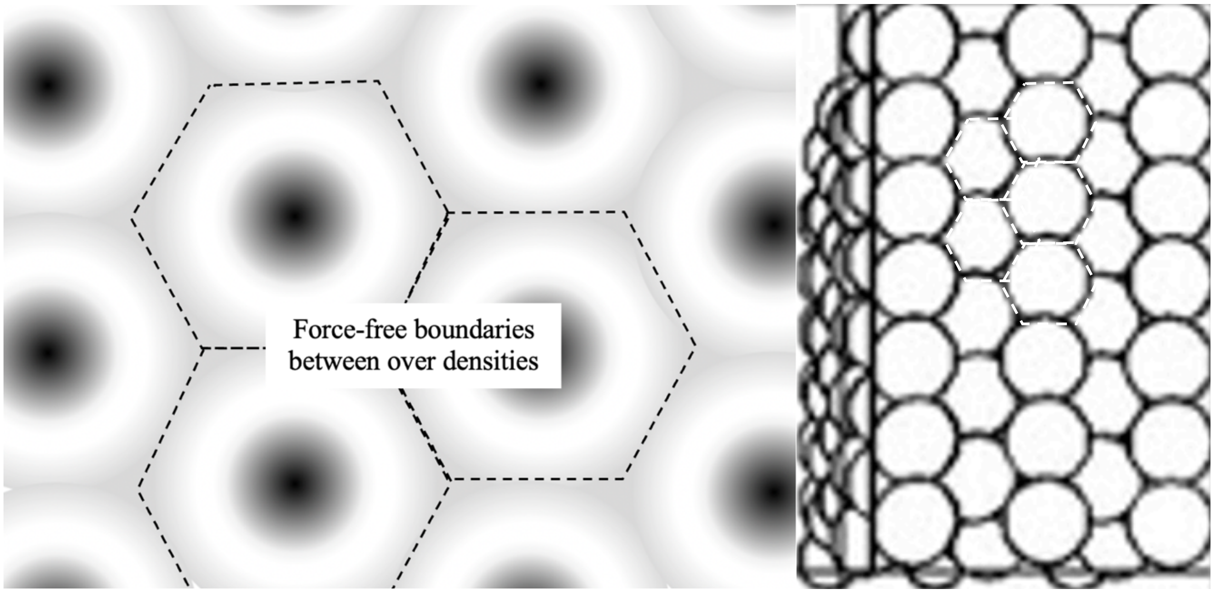


Figure 5: A single layer and densest compression of galaxy clusters with force-free boundaries between cluster cells at a single level

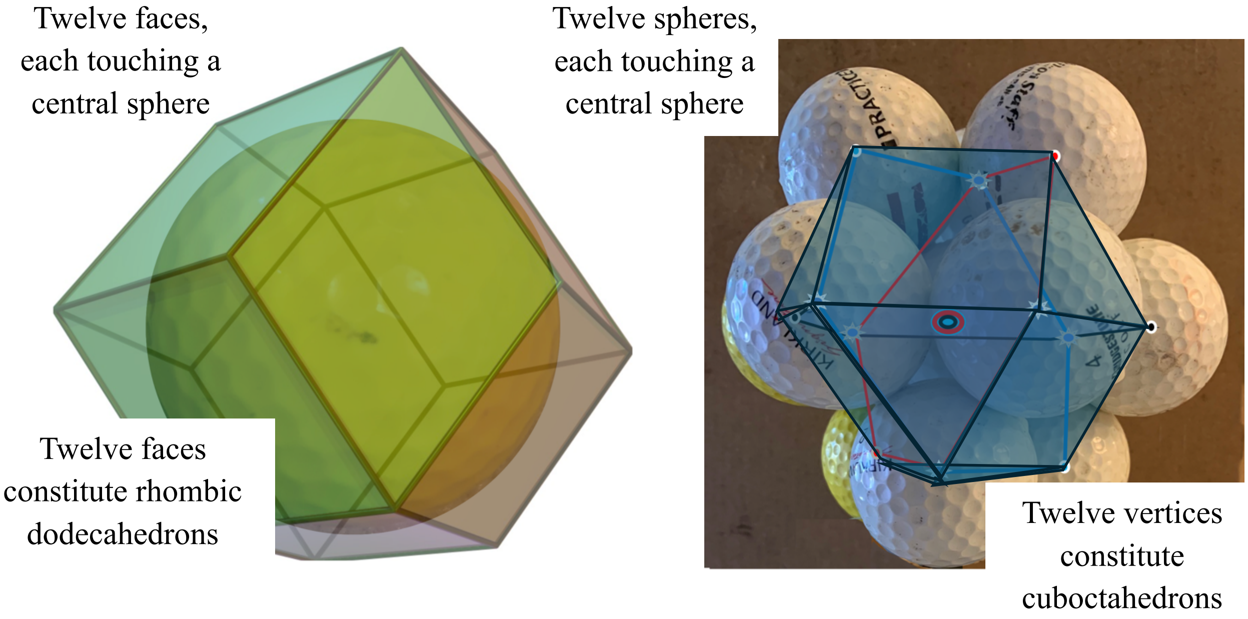


Figure 6: Applicability of rhombic dodecahedron and cuboctahedron structures

We have ignored the distinction between baryonic and 'dark' matter, not because it doesn't matter, but because it does. The distorted emphasis on gravitation as the primary determinant of cosmological effects resulted in introduction of unseen and non-electrodynamically interactive matter. That is because gravity applied to the only kind of matter that is scientifically understood would be insufficient to accounting for what we observe of the cosmos. The very definition of dark matter precludes its incorporation into any thermalization processes that counterbalance gravitational collapse because that process is driven by electromagnetic interactions with baryonic matter. It is thermodynamics to an even 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.

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 to representat galaxy clusters that in themselves were seen as having nothing to do with major cosmological issues including a supposed 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 in upon itself nor is it required as a cause of the observed cosmological redshift. Galaxy cluster cells contain all the secrets of the entire universe: the observed baryonic mass density, observed average kinetic temperature, 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/.