Structure of Our Universe

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Abstract

By assuming that each point of the scalar field from which our universe arose is a fiber from a larger universe and that bosons can be represented by transverse vibrations and fermions by longitudinal, we can account for phenomena on both cosmic and quantum scales, such as the Poisson distribution of the centers of super-clusters of galaxies, gravity, and the creation of photons, electrons, neutrinos, and quarks, and the grouping of the latter in sets of three.

Keywords: early universe, scalar field, inflationary universe, random walk, photons, electrons, neutrinos, quarks, gravitational fields, entanglement, quantum tunneling, longitudinal and transverse vibrations.

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The Model

Entia non sunt multiplicanda prater necessitatem

We attempt in what follows to develop a theory of the structure of our universe that makes the minimum of assumptions, yet is consistent with observations. The theory is an extension of a model proposed by Good [2010] in which our present-day universe consists of a still-expanding scalar field in which there are isolated islets of ordinary-space, the super-clusters of galaxies.

Formally, we assume all of the following:

0. The laws of physics are the same everywhere. That is, the laws we observe to hold in the portion of the universe we can observe, also hold in the part we cannot.
1. Before our universe Ù came into existence, there existed an affine space U consisting of at least five spatial and two time dimensions.

Our universe of three spatial and one time dimension arose a point at a time via fibers from this pre-existing universe.

The wave equation of a pathway in the product space

U x Ù takes the form:

$$\psi[\vec{q},\vec{\tau}] = A\exp(ik_E X_E - \omega_E \tau_E)$$

where $\vec{q}$ (X_E, X_I) is a point in a D dimensional space-time, D > 6, with spatial components X_E in U while X_I represents the familiar 3-dimensional spatial coordinates of our own universe, and the components of $\vec{\tau}$ (τ, t) are the cosmic time parameter τ and the Minkowski local time parameter t.

The fiber bundle results in an exponentially expanding scalar field of constant energy density for which $k_I = 0$ and $\omega_I=0$.

2. The scalar field expands uniformly. That is, if s(ε) denotes a sphere of radius ε at time T about an arbitrary point p in the field, then after an interval in which the universe doubles in size, s(ε) will have radius 2ε, regardless of the location of the point p.[1]

3. Quantum tunneling after a random interval and at a random point in the scalar field results in expansion of a pathway into a Planck (space-time) volume of ordinary space averaging 10^{-34} cm in radius and 10^{-44} seconds in duration.

The energy of the degenerate pathway is now divided between the Planck volume and the external universe U, that is, the amplitude of the external portion of the oscillations is reduced.

$$\Psi[q,\tau,t] = A'\exp[i(k_E \cdot X_E - \omega_E \tau)] + h\exp[i(k_I \cdot X_I - \omega_I t)]$$

where A' < A so that the total energy is conserved.

The degenerate pathway may be viewed as a quantum loop in four dimensions or a string in D dimensions (D-4 of which are in U).

Development of a Degenerate Pathway

4. Expansion of these degenerate pathways proceeds in discrete units. While each of the two resulting pathways consists of a single Planck volume, the energy need not be equally divided among them.

The resulting pathways may or may not divide independently of one another.

Each successive division of a pathway results in a reduction of the energy retained by the individual pathways. Continued indefinitely, all the external-to-our universe energy of the pathway would be lost yielding only a 4-dimensional Planck volume of radius R and minimal energy V_o (the ground state) in our universe,

$$\Psi[q,\tau,t] = h\exp[i(k_I X_I - \omega_I t)]$$

But other processes are at work including all of the following:

i. Formation of photons

ii. Formation of quarks

iii. Formation of neutrinos

iv. Formation of electrons

Photons

5. We assume that when the energy transferred to our universe from an external pathway exceeds the minimum, it may be released immediately in the form of a photon, a transverse wave confined to a single plane within our restricted four-dimensional universe. Photons are both emitted and absorbed by the individual pathways. Photons also may be absorbed and emitted as a result of less-likely collisions with points of the scalar field.

Quarks

In developing a theory for the formation of quarks and, not incidentally, for gravity, one is obliged to satisfy two sets of observations, one on the Planck scale and one on the cosmic:

- Quarks occur in threes.
- While gravity appears to bind together the constituents of a super-cluster of galaxies only to see these constituents collapse

inevitably into one another, the super-clusters themselves appear to fly apart at light speeds.

6. We assume quarks are formed when a large amount of the external-to-our universe energy of a pathway is converted to a small magnetic field plus a mass or, equivalently, to a large amount of energy V in a Planck unit of degenerate space.

This volume would possess energy V far in excess of the ground state V_o in a volume of average radius R. As $[V]=[M]=[L^{-1}]$, the surrounding units will decrease in volume (of space and time) in an effort to equalize the energy density.

In order to minimize the overall distortion of space-time, masses would be drawn toward one another. As the distance r from a quark increases, the number of units affected increases as r^2, and the change in volume of each unit decreases as r^{-2}. In particular, two masses m_1 and m_2, a distance r apart would be drawn together by a force proportional to m_1m_2/r^2.

If our assumptions are valid, the gravitational effects of mass are exactly the same on the Planck- and macro-scales.

As compressing the surrounding space requires energy, the quarks group themselves so as to minimize the energy required, that is, so as to minimize their effect on the surrounding space.

We show now that an aggregate of three quarks will cause less distortion of the surrounding space than three disparate quarks.

Let n_1 denote the number of Planck units an isolated quark comes in contact with. Let r_1 denote the effective radius of each of the units.

$$n_1V_o/r_1^3 = V/R^3 \qquad (1)$$

and

$$n_1r_1 = 2\pi R. \qquad (2)$$

Without loss of generality, define the units of measurement so that V=1 and R=1.

From (1), we see that $r_1 = (n_1/V_o)^{1/3}$ and from (2) that $n_1 = (2\pi)^{3/4}V_o^{1/4}$.

The center of mass of an aggregate of three quarks may be assumed to be at the center of a sphere of radius 2R or 2 in our revised units and to possess energy 3V or 3.

$n_2V_o/r_2^3 = 3/8$ (3)

and

$n_2r_2 = 4\pi.$ (4)

So that $r_2 = (8n_2/3V_o)^{1/3}$

and $n_2 = 2^{3/4}\,(3/8)^{1/4}\,(2\pi)^{3/4}\,V_o^{1/4}$

$= 2^{1/2}\,(3/4)^{1/4}\,(2\pi)^{3/4}\,V_o^{1/4}$

$< 3\,(2\pi)^{3/4}\,V_o^{1/4}$

the number of units in direct contact with three isolated quarks.

As we have assumed that quarks possess an oriented magnetic field, any aggregation need be coplanar and can assume one of two possible configurations, one in which the magnetic fields lie within the same plane so as to cancel one another as in neutrons, and one in which they form a single field at right angles to the plane occupied by the quarks as in protons.

Antiquarks

Antiquarks are 180 degrees out of phase (in our universe) with quarks.

Antigravity

At the boundary between the continuous scalar field and the discrete Planck volumes, the energy inherent to the volume V_0 can only be equalized with that of the scalar field by expansion of its volume. As the distance r from the boundary increases, the number of volumes affected increases as r^2, and the change in size of each spatial unit decreases as r^2.

Neutrinos

7. We assume neutrinos are formed when some of the external-to-our-universe energy of a pathway is converted to increased amplitude of the

vibrations in all four dimensions of our universe including time. Thus, there is only an infinitesimal probability of other particles colliding with a neutrino at any fixed point in time.

Electrons and Positrons

8. Electrons and positrons are formed when some of the external-to-our-universe energy of a pathway is converted to increased amplitude of the longitudinal vibrations in the three-spatial dimensions of our universe (mass), some to an electric field, and some to kinetic energy.

When an electron and a positron collide, their mass is converted into energy in the form of photons, their external-to-our- universe vibrations cancel, and two Planck volumes in the ground state are left.

When a mass-possessing particle comes into contact with a point of the scalar-field, it is repelled by the tension of the point, which is proportional to the energy of the pathway. There is no offsetting gravitational attraction as the component of mass of the scalar-field in our universe is infinitesimal.

Discussion

Is this model supported by observations?

I. Assumption 3 implies a Poisson distribution of super-clusters of galaxies. A Poisson distribution arises only if events (such as the genesis of a super-cluster) in non-overlapping intervals of time-space occur independently of one another. "Filaments" and "The Great Wall" are natural consequences. For if P_1, P_2 denote the Poisson probabilities of one, two events respectively in the same region of time-space, then $P_2 = P_1^2/2$.

A Poisson distribution of the super-clusters of galaxies was first reported by Neyman and Scott [1952] utilizing the limited data then available from ground-based telescopes. Recently, Good [2013] analyzed the data from the SDSS survey main and Luminous Red Galaxy (LRG) samples collected by Liivamagi, Tempel, and Saar [2010] and confirmed that the super-clusters do have a Poisson distribution.

The recent discovery by McDonald et al. [2012] of a quite-young cluster of galaxies also would appear to support the present model.

III. The description Weinberg [1993] provides applies to the first three minutes of development of every degenerate pathway, and thus of the first three minutes of every super-cluster of galaxies. Unfortunately, the resultant smear described in Good [2010] would occupy only a few light minutes and would be unlikely to be seen from Earth.

IV. If our assumptions are valid, the gravitational effects of mass are exactly the same on the Planck- and macro-scales. That is, in an effort to minimize the distortion of the surrounding space, any two masses m and m' separated by a distance r will be subject to a force proportional to mm'/r^2 attempting to pull them closer together.

V The present model viewed in conjunction with Good [2010] calls for gravity to be limited to the confines of each super-cluster of galaxies. It is easy to verify that Einstein's theory of general relativity applies when derived a super-cluster at a time. The present model does not entail a cosmic constant and predicts in accordance with current observations by Reiss et al. [1998, 2004] and Perlmutter et al. [1999] that while the galaxies within a super-cluster will be drawn continuously closer together, the super-clusters themselves, separated by a still-expanding scalar field, will continue to be forced ever further apart.

VI. The principle force affecting a rotating galaxy is the expansion of space or anti-gravity resulting from the presence of the far-larger scalar field. As noted in Good [2010], the degenerate pathways occupy only a fractal portion of our four-dimensional universe. Thus, the rate of rotation within the galaxy should be independent of the distance from the center of the galaxy.

VI. Electrons and positrons are formed in large, approximately equal numbers. The arc-sine law tells us that if one type or the other is present in excess originally, as a result of pair-wise annihilation only that type will be present in a given super-cluster albeit in much smaller numbers. As mass possessing particles cannot penetrate the scalar field, some super-clusters may contain only matter and some only anti-matter.

VII. The theory of the gravitational force presented here is consistent with observation. In an effort to minimize the distortion of the surrounding space, any two masses m and m' separated by a distance r will be subject to proportional Gmm'/r2 attempting to pull them closer together.

VIII. The phenomena of entanglement may be the result of physical entanglement of the wave functions of particles in the external-to-our universe dimensions.

IX. We made reference to quantum tunneling in our third assumption, defining it there as the result of the transfer of vibrational energy from dimensions external-to-our-universe to our universe's dimensions. Cannot the same quantum tunneling which is responsible for our sun's light as well as numerous other phenomena be attributed in turn to the transfer of mass out and then into our universe along pathways external to it?

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