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THE PROBLEMS OF THE 'STANDARD' MODEL OF COSMOLOGY AND THE SOLUTIONS ARISING FROM SANTILLI'S THEORY

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Abstract

What is often described as the 'Standard Model' of cosmology is much less certain than the Standard Model of particle physics, much less supported by experimental evidence, and much less coherent. A number of ad hoc 'fixes' are introduced to incorporate such phenomena as the large-scale flatness of space-time, the rotation curves of galaxies, and the apparent acceleration in the expansion of the universe. The whole theory would be unsustainable if a non-expansionary explanation of the cosmological redshift should emerge. Santilli's prediction and observation of the isoredshift from a physical theory with applications beyond the point particles and waves in vacuum to which Einstein's relativity theory is restricted requires us to look again at the possibility that other versions of cosmology may be more coherent, and that theories of the physical phenomena involved (like the author's own) can be developed independently of any particular cosmology at all.

Keywords: relativity, big bang cosmology, isoredshift, isonilpotent quantum mechanics, gravity, dark energy, microwave background radiation

1 Introduction

Einstein's special and general theories of relativity, of 1905 and 1915, have always had problematic aspects, not because they yield incorrect results, but because they have often been accompanied by incorrect physical interpretation. This has had an impact on both physics and cosmology. In the case of SR, the problematic aspect, as Santilli has demonstrated [1-2], is the assumption that it applies outside the *exterior* application to point particles and waves in vacuum. As soon as we have a medium or extended object, certain assumptions of the theory are no longer valid within the 'interior'. One of these concerns the 'velocity of light' (c) as a maximum attainable speed. Indirectly, this has an impact on cosmology, as Santilli's work has shown.

In the case of GR, the cosmological impact is more direct. Part of the reason for this is Eddington's presentation of the theory as a *revolutionary development*, making a significant break from what had happened previously [3]. This meant that the relationship of GR with previously theories was never properly established, and the physical meaning of the theory was lost under an all-embracing mathematical formalism. The understanding was created that the concept of gravitational force had been entirely superseded by a purely geometrical theory of Riemannian space-time. The revolutionary rhetoric also led to something close to an Einstein 'religion'. All discussion of any interpretation or development of SR or GR was (and is) likely to generate an automatic hostility, even though we know perfectly well that neither theory can be considered the final word on its subject. No other aspect of physics has achieved this status. Everything else is open to questioning and development. The idea that any aspect of physics is untouchable has led to a failure of physics at the foundational level.

Of course, though Cartan later showed that any physical field theory, including Newtonian gravity, could be represented in the same way [4, 5], we have never really accepted that the curvature concept was just a representation, and not a revolutionary change that had to be made. In fact, the 'revolutionary' aspect in some ways stemmed from a misunderstanding of how Newtonian theory actually operated. In Newton's *Principia*, the two-body problem of, say, the Moon's orbit round the Earth, has an easy solution – an elliptical orbit produced by an inverse-square force at one of the foci. However, the presence of a perturbing body, say, the Sun, produces complications which are too difficult to solve analytically. Newton's method of dealing with such perturbations is instructive. He looked for a *varying coordinate system* in which the elliptical orbit would be preserved [6]. This, to me, is not significantly different from the curved space-time concepts of GR. The added thing there was that the *observation* of the gravitating bodies could only take place at a finite speed – a fact known to Newton and his contemporaries, because that is precisely how the finite speed of light was actually discovered.

If Newtonian theory was to be carried through to its limit, this finite observational speed would have to be taken into account, and, as light itself is subject to gravitational attraction, then an additional change in a coordinate system, *used for the purpose of observation*, would be required. Of course, in Newton's time, the effects would not have been measurable and so could be disregarded for practical purposes. However, subsequent investigators began to predict a series of effects relating to *c* and gravity, using purely Newtonian methods. Whether or not, their particular investigations produced results that were actually correct, the principle was established, and correct results can be derived in this way. The important aspect of this is that nothing in GR requires us to believe that the space that we observe in cosmology is *anything but intrinsically Euclidean*, although to explain physical forces in mathematical terms and to make sense of our observations of objects moving in space, it is convenient to use coordinate systems which are not purely Cartesian. We now have 'mainstream' evidence that this is precisely the case. Because this was not fully understood after 1919, cosmologists also, when confronted by unexplained observations, felt obliged to indulge in the revolutionary rhetoric, and to *expect* solutions that were discordant with previous views.

2 The development of big bang cosmology

Essentially, GR is only a theory of space-time curvature, in effect, of coordinate transformations. To make it physically meaningful, it has to invoke the Newtonian potential. Soon after the GR field equations were put forward, Alexander Friedmann announced 3 solutions for different densities, expanding, contracting and stationary [7, 8]. This, however, has nothing to do with GR, as such – just the Newtonian component. It is a question of density, not of curvature. The idea that GR can 'predict' the evolution of the universe in some special way is totally spurious, but it has been used to link GR inextricably with big bang cosmology.

Modern cosmology begins with the discovery of Hubble's law (1929), and the establishment of a linear relation between the redshift of distant galaxies and their measured distances [9]. The redshift was almost immediately interpreted as a Doppler effect, suggesting that the galaxies were moving away. Lemaître took this to the extreme of postulating a 'primal atom' (1930), from which the universe emerged in a 'big bang' [10. 11]. Significantly, Lemaître was a priest. It was natural for him to look at a beginning which had some relation to the abrupt beginnings of scripture. Only Zwicky (1929) suggested an alternative to expansion, proposing that the redshift was a signature instead of 'tired light', a loss of energy due to scattering' [12].

As we have indicated the expanding universe equations are nothing to do with GR.

$$H^2 = \frac{8\pi G}{3}$$

is just the equating of kinetic and Newtonian potential energy

$$\frac{1}{2}mv^2 = \frac{GMm}{r}.$$

Milne and McCrea showed in 1934 that you didn't need Friedmann's solutions to get the same answers, just standard Newtonian gravity [13].

The big bang theory was the only one available for some time after 1930. It wasn't until 1948 when an alternative view was proposed. The Bondi-Gold-Hoyle 'steady state' theory suggested matter being created as the universe expands [14, 15]. However, despite its name, this is not really a 'steady state' theory, because it is still based on expansion. It is nevertheless always presented as the alternative to big bang cosmology and, significantly, it has monopolised the name. In fact, it became a 'straw man', usefully occupying the 'alternative' ground. There was little interest in nonexpansionary theories.

The crucial year was 1965, when Penzias and Wilson detected microwave background radiation. It was interpreted immediately as a relic of the big bang [16], and Penzias and Wilson were awarded Nobel prize with extraordinary speed. It has been claimed that Gamow had predicted it from the big bang theory, and Gamow was one of the first to recognize the now widely accepted meaning of the Penzias and Wilson results, but Gamow's prediction (50 K) was very different from the observed value [17, 18]. In fact, Eddington had calculated the temperature of space based on the density of starlight at 3.2 K as early as 1926 [19]. The theory that emerged seemed to require the rapid expansion of the universe from a point of infinite density and temperature. It required the *creation* of space and the *creation* of time. Immediately, there was a fit made to existing data to work out the 'history' of the universe. The successive phases were then treated almost as if they were separate 'evidence' for a big bang. The same thing happened with the abundances of elements and other phenomena.

The nature of the big bang singularity caused problems. At one time it was believed that this was indeed a point (the 'primal atom'), a sort of reverse singularity to the black hole. But this seemed to require a mediaeval privileging of some centre, when the theory demanded that there was no centre. So it must require everywhere to be the point. Due to the influence of GR, it was also generally thought the universe was finite and curved. In the modern version of the big bang theory, the singularity is not a point. The expansion occurs simultaneously all over space. It seems that we have an expansion from an infinite space, even though space has to be created. Also, an infinite density becomes a finite one, reducing over time.

The usual answer to the question of how the big bang actually happened puts it down to quantum fluctuations. But from the beginning there was a problem with the observed uniformity and isotropy. It was realised that relatively slight fluctuations would result in massive nonuniformities and isotropies, and could not explain the relative smoothness of the cosmic microwave background radiation (CMBR).

3 The current state of cosmology

Even today there are the only two pieces of real evidence for the 'standard' model of cosmology, redshift and CMBR, and these are not very strongly connected in a mathematical theory. The second is not derived strongly from the first as we might expect in a rigorous theory. The original big bang theory had at least two major problems, which required a drastic solution. One was the flatness problem. Using the Friedmann-Lemaître-Robertson-Walker metric for the expanding universe and starting at the Planck time, even a small departure from the critical density for flatness would increase significantly with time. After just a few minutes, the proposed time of nucleosynthesis, the universe density could not have departed by more than one part in 10^{14} from its critical value to make it compatible with the universe we see now. The second was the horizon problem, based on the fact that, in Einsteinian relativity, no information can travel faster than light. In this context, if the universe is 13.7 billion years old, then certain regions could not have been in causal contact and have the same temperature at the beginning. A universe in which radiation or matter dominated up to the time at 300, 000 years, when photons decoupled from matter and the universe became transparent (the epoch of last scattering), would produce an observable particle horizon only over about 2 degrees of the sky.

The solution was one of the most *ad hoc* and unsatisfactory aspects of the so-called Standard Model of cosmology. A very short period of rapid and exponential inflation, it was proposed, had produced a flat distribution and a universe at the exact critical density [20]. Later observation showed that the universe was indeed flat and Euclidean to an incredible degree [21]. According to inflation theory, the universe, at an early epoch before matter became dominant over antimatter (by an unknown process called 'baryogenesis'), must have been dominated. This epoch produced an exponential expansion, explaining why regions which are now separated by distances outside each other's event horizons could have had causal contact at previous times. Quantum fluctuations (which were effectively scale invariant and Gaussian) in the early universe must have been responsible for observed structures now. During inflation, the spacetime expansion was so rapid that all curvature was quickly lost and the density became the critical value required for flatness.

The assumption has always been that, at the beginning, there was zero actual matter, only energy. (The presence of energy means that a big bang can't start from *nothing* as often proclaimed.) It then split into *almost* equal amounts of matter and antimatter, but matter was slightly preponderant. The antimatter was annihilated leaving a small amount of matter. No explanation has been able to account for the asymmetry. CP or time-reversal violation, as so far observed, certainly can't explain it – as it is mesonic, and so doesn't change the matter-antimatter relation. In addition, inflation is impossible without such a process.

Other problems also have no obvious solution. Dark matter is an old problem, noticed already by Zwicky in the 1930s, but it came to the fore only after the 1960s revival of big bang cosmology [22]. Zwicky found that the dynamics of clusters of galaxies seemed to require extra mass. Subsequently the same problem was seen in individual spiral galaxies. Here, the curves for velocity against radial distance flatten as though a halo of invisible matter exists outside them. However, if dark matter exists it is certainly a strange form of matter, coupling only to gravitational fields. It is also odd that it should only exist outside spiral galaxies, rather than in them. In addition, no candidate for dark matter has shown up so far in particle accelerators.

According to current data, ordinary matter takes up only about 4 % of the mass of the universe, dark matter is about 22-26 %, the rest is dark energy. This creates another problem. Dark energy was first invoked when redshift measurements, using type Ia supernovae as standard candles, appeared to show an outward acceleration, in addition to the Hubble velocity of recession. Mathematically, it has the same form as Einstein's cosmological constant (Λ), originally invented to stop the universe from collapsing. However, it is famously 'not even wrong' in being 120 to 123 orders of magnitude too small to be predictable from a quantum vacuum.

In effect, there has never been a big bang *theory*, only a big bang concept. The theory requires a massive number of bolt-on quick-fix remedies. Some problems have no answer at all. The theory has no successful predictions. Where predictions have been made, they have turned out to be wrong. For example, the big bang theory has had to change from a point-like origin (primal atom) to an infinite one. It has had to change from a finite curved universe to an infinitely flat one. It has had to incorporate dark matter and dark energy. It has had to propose a special period of exponential inflation. Everything 'coincidentally' seems to point to the exact requirement for the critical density at the present era, even though the present era is not 'special', according to the theory. It has major problems with entropy; there was not enough at the beginning to account for the entropy of the universe at the present time.

It is also considered acceptable to build assumption on assumption as problems arise. Speculations has become 'mainstream' science excluding possibly more productive approaches. Many of the claims made for matches between theory and experiment are highly suspect and in some cases definitely falsified. Even some naïve questions seem to be impossible to answer. For example, if the big bang happened everywhere at once, where was *where*? Then there is the question of why we actually *observe* expansion at all? Why isn't every part of space expanding down to the spaces between smallest components of matter? Why is it only the space connected with gravity and not that connected with the electromagnetic force? How can there be faster than light expansion beyond Hubble radius?

Routinely, cosmology is used as a *substitute* for physics. Cosmological redshift, the microwave background radiation and the arrow of time are purely physical phenomena which are given *ad hoc* cosmological explanations without any attempt to understand them in terms of more general physical principles. Cosmology is 'archaeology', a description of what just happened to take place at different times, rather than physics, or a fundamental explanation of physical phenomena in terms of physical laws.

4 Santilli's isomathematics

Since the CMBR corresponds pretty closely with the Eddington calculation made before big bang theory, the key evidence is still the redshift. If the interpretation of this is wrong, then there is nothing to support the model. All other 'evidence' is a matter of fitting the data to work out the details given the initial assumptions. This is not independent evidence, though it isoften presented as though it is. There is a striking parallel with Kelvin's Age of the Earth calculation of 1862 [23]. According to Kelvin, the inexorable laws of thermodynamics said the Earth can only be 20 million years old. Geology and biology couldn't fit into this timetable. So much the worse for geology and biology, said Kelvin. Dissenters – and there were some – had no chance against Kelvin's authority.

However, there was something missing from Kelvin's calculations, something totally unexpected. This was radioactivity, discovered in 1896, and proposed as the Earth's internal source of heat in 1904. Could there be something missing also in cosmology? There is nothing wrong in putting forward a speculative cosmology. What is wrong is claiming that it is a 'standard model' on the level of particle physics and vilifying everyone who casts doubt on it. This is politics not science. The same happened, as we have seen with the Age of the Earth; Continental Drift was another significant example. Cosmology has too often sought superficial answers to fundamental problems. This is precisely why they appear so *ad hoc*. Essentially, cosmology doesn't give answers from within itself. We have to go to a deeper level in fundamental physics.

Santilli has shown that we have to go even further and reformulate mathematics first [24, 25], defining a new *isoproduct*:

$$AB \rightarrow A \otimes B = A\hat{T}B$$

$$[A, B] \rightarrow [A, B]^* \rightarrow A \otimes B - B \otimes A = A\hat{T}B - B\hat{T}A.$$

This requires a new unit

$$\hat{I} \otimes A = A \otimes \hat{I} = A$$

$$\hat{I} = 1 / \hat{T}.$$

The mathematical structure carries over into physics, defined by algebraic relations. It allows, in particular, for the more complicated states in interiors of extended objects and in anisotropic media. The *isotopic element* $\hat{T}$ is defined very generally > 0. It is not a fixed value and may be a function of many possible variable parameters. The time evolution of a system, which conventionally requires the application of the exponential e^{iHt}, where H is the Hamiltonian and t is time, now requires the more generalised form, e^{iHT*t}.

There are many physical consequences of this new mathematics. We can, for example, redefine Minkowski space-time using a new symmetry, Lorentz-Poincaré-Santilli isosymmetry [1, 2],

$$\hat{x}^2 = x^\mu g_{\mu\nu} x^\nu = x^\mu \hat{T}_\mu^\rho \eta_{\rho\nu} x^\nu .$$

In effect, this becomes:

$$\hat{x}^2 = \frac{x_1^2}{n_1^2} + \frac{x_2^2}{n_2^2} + \frac{x_3^2}{n_3^2} - \frac{c^2 t^2}{n_4^2} .$$

The n values (> 0) are the variables required for an anisotropic medium (the characteristic qualities of the medium), for example in the interior of an extended body. In particular c / n_4 will be a local speed of light, $< c$ or $> c$. So, the maximum possible speed is no longer c, as in SR.

5 **Isonilpotents**

Since the norm 0 nilpotent structure used in the author's own version of quantum mechanics is defined only by its algebraic operators and not by whether the coefficients are fixed or variable [26-39], we can put this into an isonilpotent form:

$$\left(\pm ik\frac{ct}{n_4} \pm \boldsymbol{ii}\frac{x_1}{n_1} \pm \boldsymbol{ij}\frac{x_2}{n_2} \pm \boldsymbol{ik}\frac{x_3}{n_3} + j\hat{x} \right)^2 = 0$$

$$\left(\pm ikE \pm \boldsymbol{ii}p_1\frac{c}{n_1} \pm \boldsymbol{ij}p_2\frac{c}{n_2} \pm \boldsymbol{ik}p_3\frac{c}{n_3} + jm\frac{c^2}{n_4^2} \right)^2 = 0 .$$

From this we can generate an isonilpotent operator for quantum mechanics:

$$\left(\mp k\frac{\partial}{\partial t} \mp i\boldsymbol{i}\frac{c}{n_1}\frac{\partial}{\partial x} \mp i\boldsymbol{j}\frac{c}{n_2}\frac{\partial}{\partial y} \mp i\boldsymbol{k}\frac{c}{n_3}\frac{\partial}{\partial z} + jm\frac{c^2}{n_4^2} \right).$$

As with the standard nilpotent expression, the operator creates the unique phase term on which it can operate to produce an amplitude which squares to zero for any fermion in any state, regardless of how many potentials or curvature terms it incorporates when the derivatives become covariant.

The expressions automatically include $+ E$ and $- E$, matter and antimatter, two directions of time, matter and vacuum, etc., as required. From my point of view there is an opportunity to exploit iso-, geno- and hyper- extensions of nilpotent theory, in which the algebraic operator structure and nilpotent character remain while the coefficients (including the differentials) take on extended aspects. In nilpotent quantum mechanics and quantum field theory, the 'medium' (vacuum) is already part of the structure and formal aspects of this could be investigated.

The nilpotent structure, in fact, exists at all levels to define self-organization and has applications well outside of physics, as the definition of a universal rewrite system seems to indicate [35]. We can even apply it to pure numbers. In the spirit of Santilli's redefinition of algebraic and numerical units, we can use the fact that a pure unit version could be written:

$$(\pm ik1 \pm \boldsymbol{i}1c + 1c^2)^2 = 0 .$$

Here we are using the idea that the nilpotent incorporates the holographic principle that the entire information comes from the 'area' defined by space and time or two spaces. The solution for the constant relating the two spaces, c^2, is now the golden section or its inverse. This relates interestingly to Stein Johansen's derivation of natural numbers from Fibonacci numbers [40-42], and from my own derivation of the Fibonacci sequence and the logarithmic spiral from confining variations in 3-D space to the 2-D plane (as in the holographic principle and the nilpotent structure) [43, 44], in addition to the Santilli definition of $\hat{T}$ and $\hat{I}$.

6 The Santilli isoredshift

Santilli's theory also requires a new mass-energy relation (or isoequivalence law):

$$\hat{E} = \hat{m}c^2 = m_s \frac{n_s^2}{n_4^2}.$$

and a new Doppler isoshift law

$$\omega' = \omega / (1 + v_s n_4 / c n_3 \ldots)$$

which depends on direction in space (indicated by subscript s) in an anisotropic medium. A physical consequence of this is that there will be a frequency shift for electromagnetic waves in a transparent medium, without relative motion of the source, medium or observer. This has now been observed [45-48]. It also provides the explanation of a phenomenon with which we are all familiar, but which has so far received no satisfactory explanation, the redness of the Sun at sunset, where we can write for direction s:

$$\lambda_{irs} = \lambda_{blue} / \left(1 - \frac{v\, n_s}{c\, n_4}\right).$$

The confirmation of the isoshift as explaining the redness of the Sun at sunset yields a shift of up to 200 nm compared with the 10^{-6} nm expected from a conventional Doppler shift. Conventionally the redness is explained by atmospheric absorption (which would lead to blueness at the horizon) and scattering of sunlight by air molecules (which would be too small).

The Santilli isoredshift suggests that the cosmological redshift is not a Doppler effect due to the expansion of space. Interstellar and intergalactic space are media, stars and galaxies are extended objects, which should produce isoshifts. There are certain problems with the uniformity of redshifts, such as Hans Arp's long-standing evidence in which quasars and galaxies with different redshifts seem to be physically connected. To have an explanation of the redshift that is not a Doppler expansion could mean that there are major problems for the big bang theory. If we have an alternative explanation which is demonstrated by experimental verification, this means that there is a missing piece in the scenario, just as there was in the Age of the Earth controversy. If the redshift is *not* due to Doppler expansion, then the whole apparatus of big bang cosmology has no secure foundation. The redshift and the cosmic microwave background radiation then require *physics* explanations, rather than cosmological ones. Also, 'dark energy' and 'dark matter' don't need fitting into a cosmological scenario, where at present they cause major problems.

If the maximal causal speeds in the interior of stars, quasars and black holes is say $10c$, then 95 % of the universe's energy will be due to this. The dark matter explanation of rotation curves has always been problematic, as it depends on hypotheses of galaxy formation that may be quite incorrect. At the 2011 San Marino workshop, M. M. Everaldo de Souza showed that the formation of galaxies as growing rather than contracting could lead to the dynamical pattern observed, without requiring either dark matter or any violation of Newtonian dynamics [49]. Leong Ying has shown that nuclear reactions in stars may be responsible for cosmological redshift [50-51]. Calculations give the correct value for H. Eddington, as we have said, found that the energy density of starlight was equivalent to a space temperature of 3.2 K. Starlight comes from nuclear processes, and so the Ying calculation could relate the temperature of space to redshift in a way that has never been accomplished within current cosmology. If we suppose that H and the CMBR are related, then the 'coincidence' must be due to nuclear reactions being responsible for starlight. Hoyle also pointed out the similarities with the energy density of the galactic magnetic field and of cosmic rays. This suggests that there may be an equilibrium, steady state, process responsible for all these effects [35].

It is clear that we need to find explanations for fundamental phenomena which are firmly rooted in mathematics and physics, and not limited to an arbitrary and ad hoc cosmology which has no fundamental explanation. A theory of gravity and inertia, which I have previously presented [52], involves the generation of a 'medium' or vacuum structure, and leads to a series of explanations and predictions (redshift, CMBR, dark energy, and possibly dark matter), not specifically requiring big bang or any other cosmology. It would be interesting to see how isoredshift affects this.

7 Gravity reconsidered

Gravity-gauge theory correspondence and the nilpotent formalism are compatible with gravity being nonlocal (as its weakness might imply) and therefore instantaneous. Measurement requires local interactions at c, which is also affected by gravity. If this is incorporated into Newtonian gravity, a version of GR emerges in which the c-related effects are results of the process of measurement not the intrinsic nature of gravity. 'Aberration' effects will be generated, equivalent to fictitious forces, and they can be written down in the form of gravitomagnetic Maxwell equations. We can identify the 'centrifugal' component through an argument involving Mach's principle. This was done by myself long before the discovery of 'Dark Energy' [35, 53-58]. It produced a derivation of Hubble redshift which had no specific connection to cosmology of any kind. It also predicted an acceleration term of the same form and of a similar size to that found in 1999 [59, 60]. The Coriolis component has been invoked as the possible explanation of Dark Matter, the Pioneer anomaly, etc.

Mach's principle suggests that the inertia of a body – its mass or resistance to accelerated motion ($F = ma$) – is determined in some way by an interaction with the rest of the matter in the universe. If it is, then it must come from a 'magnetic' component. If the argument proposed is correct, then gravity will have a (fictitious) 'magnetic' inertial component and an acceleration-dependent inductive force analogous to that which occurs in electromagnetic theory:

$$F = \frac{G}{c^2 r} m_1 m_2 \sin\theta \frac{dv}{dt} .$$

Sciama (1953) considered the possibility of explaining Mach's principle using such an inductive force (in his model a real one) [61, 62]. The inertia of a body of mass $m = m_1$ attributed to the action of the total mass $m_u = m_2$ within the observable universe, specified by radius r_u, so making the inductive force equation equivalent to $F = Kma$, with K a constant. Our additional supposition is that the continuous mass-field we need for physics provides a standard by which we can define a unit inertial mass nonlocally for the entire universe, in the same way as the near-constant gravitational field **g** provides a way of defining a unit mass at the Earth's surface. We imagine that mass m_u defines a radial inertial field of constant magnitude from the centre of a local coordinate system, and, at the same time, use the principle of equivalence (equivalence of mass from inertia and gravitation), to equate this to the nonlocal gravitational field (Gm_u / r_u^2), which, independently of the local coordinate system, defines a unit of gravitational mass within the same event horizon. If we use isotropy to remove the angular dependence, we obtain:

$$\frac{Gm_u}{c^2 r}\frac{dv}{dt} = \frac{Gm_u}{r_u^2}.$$

We also obtain an acceleration

$$a = \frac{dv}{dt} = v\frac{dv}{dr} = \frac{c^2 r}{r_u^2}.$$

Integrating this with respect to r, gives

$$v = \frac{cr}{r_u} = H_0 r$$

where H_0 is Hubble's constant. The acceleration is now

$$a = \frac{v^2}{r_u} = H_0^2 r.$$

For nonlocal gravity, this acceleration will be a fictitious one, describing the effects on the coordinate system produced by using a Lorentzian space-time to model the instantaneous interaction. We have two forces; gravity (attractive) and this fictitious inertial repulsion. Combining them gives

$$F = \frac{Gm}{r^2} - H_0^2 r = \left(\frac{4}{3}\pi G\rho - H_0^2\right)r.$$

Adding the inertial term to standard gravitational theory gives us:

$$\nabla^2\phi = 4\pi G\left(\rho - \frac{3H_0^2}{4\pi G}\right) = 4\pi G\left(\rho + \frac{3P}{c^2}\right) = 4\pi G\left(\rho - 3\rho_{vac}\right),$$

where the vacuum density is

$$\rho_{vac} = \frac{H_0^2}{4\pi G}.$$

This is equivalent to a 'dark' energy density or negative pressure

$$-P = \frac{H_0^2 c^2}{4\pi G},$$

and cosmological constant

$$\lambda = 8\pi G \rho_{vac} = 2H_0^2 .$$

If we define the critical density for a 'flat' universe as

$$\rho_{crit} = \frac{3H_0^2}{8\pi G}$$

we obtain

$$\frac{\rho_{vac}}{\rho_{crit}} = \frac{2}{3},$$

which is within the limits of current observations, though it was obtained twenty years before the first measurements.

The 'vacuum' or 'inertial' component of the universe's energy (the so-called dark energy contribution) appears to be 2 / 3 of the total or 67 %. Current estimates of the experimental value are of order 70 %, but with large errors, both systematic and statistical. The force law involving this component suggests a linear increase with distance ('Hooke's law'), exactly as assumed in dark energy calculations. It also has the classic mv^2 / r form expected of centrifugal force. The calculations preceded the observations by about 20 years.

The argument can be extended to a derivation of CMBR, here massively abbreviated. The complete derivation is in the San Marino presentation, 2011 [52]. The noninertial frame will produce an inertial or fictitious acceleration, and the accelerating virtual (vacuum) charges will radiate, according to the Larmor formula, at a rate

$$\frac{dE}{dt} = \frac{2}{3}\frac{e^2}{4\pi\varepsilon_0}\frac{a^2}{c^3}.$$

On integration, the total energy density radiated for a uniform continuous distribution of virtual charge becomes:

$$\frac{3}{4\pi r_u^3}\frac{1}{144}\frac{r_u^2}{r_e^3}\frac{e^2}{4\pi\varepsilon_0} = \frac{1}{192\pi}\frac{e^2}{4\pi\varepsilon_0 r_e^3 r_u}.$$

If we equate this to aT^4, we obtain first-order values for the would give a value for the Hubble radius at 1.224×10^{26} m and the Hubble time at 1.293×10^{10} yr. The Hubble time is currently quoted as the 'age of the universe' at 1.37×10^{10} yr, with an error of at least 0.1×10^{10} yr. We look forward to seeing how much isoredshift will alter the values for Hubble's constant, etc., and perhaps produced improved agreement. The main purpose of such arguments is to show that physics is capable of creating explanations of the Hubble redshift, dark energy, etc., without being fixed to a particular cosmology. Even if a cosmology is suggested by them, it is important to show that the physical explanation is the primary one.

8 Conclusion

Many problems have arisen with what has often been called the 'Standard Model' of cosmology. Apart from its relatively unsuccessful record at predicting new physics, and its inability to accommodate evidence such as 'dark matter', 'dark energy' and a flat Euclidean universe at the critical density without additional ad hoc assumptions, it is primarily based on only two significant pieces of primary evidence: the cosmological redshift and the cosmic microwave background radiation. If a convincing alternative explanation should be found for either or both of these then there will be no longer be any compelling reason to persist with a theory that has so many other intrinsic difficulties and predictions. However, whether or not this cosmology or some other is finally adopted, the requirement at the present time is for a *physical* theory that will explain fundamental physical phenomena, rather than a mere historical account of the development of the universe presented as something that just 'happened'. Santilli has presented physicists and cosmologists with a challenge with the prediction and observation of a new form of redshift, arising from a physical theory with applications beyond the point particles and waves in vacuum to which Einstein's relativity theory is restricted. Any cosmological applications of this effect and others predicted by Santilli could have significant implications for the way that current data is used in support of 'Standard Cosmology'. It is possible that they might also lead to an improved fit to data of the author's own predictions derived from a theory of gravity as a nonlocal correlation. In addition, the creation of an isonilpotent operator for quantum mechanics, using Lorentz-Poincaré-Santilli isosymmetry suggests a way in which the author's nilpotent theory can be extended to encompass a description of fermions in an extended medium.

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