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A Steady State Better Explains a Metrically Expanding Universe and the Vital Interplay of Entropy and Gravity

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Abstract

Current ideas of the Origin of the Universe favour a Big Bang (Standard Cosmology SC) rather than some Steady State (Infinite Time) variant. Despite that, the SC as it stands is unsafe because each claimed support for the SC has a feasible alternative. In addition, profligate Universe-wide destruction of hydrogen still leaves it in excess. The concept that inertia is due to Lorenz force resistance from the Zero Point Field predicts that gravitational fields will always repel surrounding space and explains metric expansion of the Universe. Dark energy is simply Gravitational Inertia Recoil. Expansion proceeds at a rate exactly matching a hypothetical insertion of protons e.g. by gamma ray photofission. This suggests a novel Steady State relation between Entropy and Gravity that drives maintenance and growth of the Universe.

Keywords: Big Bang; Expanding Universe; Infinite Space; Infinite Time; Steady State

Introduction

Answers to the riddle of the Origin of the Universe have been divided by the radically different ideas of an original singularity occurring some 13.9 billion years ago followed by enormous expansion (Big Bang Hypothesis or Standard Cosmology, SC) versus various versions of a Steady State Theory. These propose no beginning.

Modern cosmological opinion seems firmly gelled around the SC. Despite this López-Corredoira [1] presents a very long list of unresolved problems with the SC while Narlikar and Padmanabhan [2] find similar issues with both Big Bang and Quasi Steady State models, it is unnecessary to explore these further here. We show below that there are feasible alternatives for each claimed support for the SC, too many in aggregate to leave the SC safe as it stands. We therefore systematically explore their significance via the lens of more recent insights and detail alternatives and solutions.

Claimed Supports for The SC

The overall problem

- First, the Universe exists therefore there must be a prior time when it did not. FALLACY: Science has trouble with concepts of Infinite Time. Also, there is something Counter-intuitive about Time, see below.
- Second, Hubble's Law. Since galaxies are moving away from each other, they must have been more compact before. FALLACY: They are not moving away space is just being inserted between them see below. The same reservations about the nature of time also apply.
- Third, the CMB is a leftover from an earlier much hotter epoch. This is conjecture that lacks evidence the CMB is better explained by photon emission from the known crystallisation of hydrogen in space, see below.
- Finally, the SC predicts the observed distribution of light and heavy elements especially the surprising preponderance of helium. But helium will accumulate in the long term (say 10^{11} years) since it is less consumed than hydrogen, and random supernovae can produce the heavy elements, see below.

In sum, each alleged support has a feasible alternative and is therefore unsafe. The Standard Cosmology as it stands is accordingly itself unsafe.

Funny Things about Time

Entropy and Precognition/Presentiment

Entropy: Rovelli, [3] argues persuasively as an astrophysicist (and philosopher and poet) that Time actually does not exist, being only Newton's construct to explain the inexorable rule of thermodynamics that Entropy must increase, or at least never

decrease. Thus Time's arrow merely reflects a succession of events determined entirely by Entropy's flow. We return to this pivotal topic in the last section.

Precognition/Presentiment: There exists a large literature showing that, in the words of one participant, "there's something funny about Time that we don't understand". Many carefully controlled experiments show that conscious awareness can predict certain outcomes (precognition) with a measurable degree of certainty, and others that unconscious awareness (presentiment) can do the same [4-6]. Spontaneous occurrences (in dreams, in mediumistic situations, in waking life) may be recorded as synchronicities [7].

The question is whether this aspect is intrinsic to Time itself or simply a result of human interaction with it. This question is more than semantic: the interaction of conscious attention is shown to be critical to the Quantum Measurement Problem in collapsing the wave function to form elementary particles. In particular, 'delayed choice' double-slit experiments by Radin, et al. [8] appear to show that the collapse effect seems to reach backwards in time [9], or else that the mind does not exist in ordinary Space-time in the first place (Radin's words). The last could also be said for the examples in the previous paragraph.

Accordingly, humanity is not in a good position to construct hypotheses based on its perceived nature of Time.

The Redshift

Despite problems with the redshift, the Universe is definitely expanding and the rate has been getting faster

The concept of an Expanding Universe was inferred from the apparent redshift in spectra from distant galaxies, defined by the Hubble constant. Following the idea of a Big Bang it is natural to think that Inertia will keep matter flying out once in motion. But there has been no central focus and the Expansion is a metric expansion, meaning nothing is 'flying out': space is just being stretched or inserted following the analogy of an ant on the surface of an inflating balloon.

The only direct evidence for expansion remains the Hubble redshift but there are other ways that a redshift can occur:

a) Gravitational attraction effects analogous to the change in clocks in GPS satellites,

b) Photon energy is reduced over long distance by collision with intergalactic H,

c) or by travel through plasma, if originating inside a star.

The anomalous behaviour of quasars [10] is alone enough to doubt the whole concept of expansion derived from redshift.

Thus many problems existed with the Hubble redshift-expansion concept. In 1998, mainstream Cosmology was finally persuaded by two independent studies by Riess, et al. [11] and Perlmutter, et al. [12] that the Universe is indeed expanding, and even that its rate is accelerating. Type 1a supernovae (white dwarfs) have a fairly standard brightness that allowed comparisons of their redshift with dimness (distance); this showed that in fact they were receding, and furthermore the younger supernovae were receding faster. So recession was validated and the rate had increased over time. This led to Nobel prizes for Perlmutter, Riess and Schmidt in 2011.

The redshift has actually nothing to add to the SC and vice versa but a great deal to do with a Steady State. We return to this crucial topic in the final section.

The Problem with the Cosmic Microwave Background (CMB)

The cosmic microwave background (2.72K) is entirely explained as photon emission from grains of solid hydrogen warmed by crystallisation of hydrogen molecules according to the First Law of Thermodynamics

Cosmology readily accepts the pre-existence of some conjectural and unknowable background field in which some anomalous singularity occurred causing a massive, explosive creation event termed, for lack of a better, the Big Bang. Its acceptance as the Standard Cosmology (SC) has become firmly a part of Establishment thought.

Discovery of the Cosmic Microwave Background radiation (CMB) in 1964 by Penzias and Wilson [13] radically changed Cosmology in the second half of the 20th century and was recognised by the Nobel Committee in 1978. The CMB had notable properties: it was free of spectral peaks (perfect black-body radiation) and was spread evenly over the sky (although tiny deviations were later found).

Many theories for the structure and origin of the Universe have been proposed over several millennia [2], current survivors being either variations of the SC centred on the Big Bang hypothesis, or the Quasi Steady State model. The Big Bang theory did not actually predict the CMB but at least allowed it, helping it later to become the preferred option, while the original Steady State theory did neither.

The Coincidence: Hoyle, et al. [14] were exploring initiation of star formation by condensation of solid hydrogen on graphite dust grains while developing a Steady State theory. It turned out that if the heat of evaporation of solid H_2 had varied by only 25% formation of crystal nuclei would be prevented (another fine-tuning of Cosmic rules). In a remarkable coincidence, hydrogen was found not to condense in space unless the background temperature existed just where it actually did, i.e. experiment had shown that hydrogen crystal nucleation at the low gas densities found within a galaxy (10^4-10^5 molecules/cubic metre) could not occur above 2.6-2.8K: higher temperatures needed higher densities. The temperature of the CMB was then known as ~3K, later accurately measured at 2.72548 ± 0.00057K by Fixsen [15].

These findings stand as observed facts obtained by measuring actual temperatures with appropriate thermometers; they were not derived from some theoretical parametric. Ishimoto, et al. [16] confirmed the crucially important observations, ingeniously and

reproducibly producing freestanding cylinders of solid hydrogen 10 mm diameter and 5 or 10 mm high (~34 or ~68 mg) at very low pressures. Their sublimation rates (times to lose 1 mg H_2) were negligible (>10^4 days) at 3K, measurable (200 days) at 3.5K and rapid (~43 min) by 5.0K.

Hoyle, et al. [14] attributed the CMB temperature to absorption of starlight ultimately from H_2 fusion to He, but the accident that only enough starlight photons were absorbed to achieve exactly the right temperature was not explained. Also, despite the very small target offered by each grain (1-10 microns radius), target theory e.g. given by Nomiya, [17] vs. starlight photon flux was not considered.

Big Bang theory allowed the CMB as a residual glow from a very hot origin. But it failed to explain the very low temperatures of the CMB; it had also to assume a high redshift to bring frequencies down to microwave levels. Yet as there are no spectral lines in perfect blackbody radiation no redshift could actually be shown, and so there is no evidence for this conjecture.

An Explanation: On re-reading Hoyle, et al. [14], it became clear that this paper was actually describing a thermodynamically reversible heat-pump system, an important point seemingly overlooked for fifty years. The authors calculated the heat of vaporisation of solid H_2 to be ~260 cal/mole at ~3K, Carnot's principle tells us that condensation of solid H_2 must also release ~260 cal/mole at ~3K, since no other work has been done. This energy will be cumulative and stored for a time in the H_2 grain, which may also include a foreign core (e.g. metal whiskers or graphite), and if stable can only equilibrate with its ambience by radiation (photon emission).

The time of emission of the photon is quantum mechanically uncertain and its net energy content will depend on what previously has happened to its grain, which is similarly uncertain. Hence its temperature is likely to lie in a range ~3K rather than any fixed value. The entropy of this condensation is not finally increased until the release of this photon. As the exchange is purely low-intensity thermal no electron orbital shifts are involved and so the radiation will be pure blackbody in character. Such a system is a Self-thermostat as long as there remains an excess of free hydrogen: an increase in temperature will slow hydrogen condensation, and a decrease will favour it.

Is a Heat-pump answer to the origin of the CMB quantitatively feasible? The value 260 cal/mole calculates to 6.79431 x 10^{21} eV per 6.02252 x 10^{23} molecules (Avogadro's number), or 0.011281 eV per H_2 molecule condensed; 10^4 photons of the CMB equate to 6.626 eV (or 11.68 eV, depending on the definition of spectral radiance) so that 1 average CMB photon carries 0.0006626 or 0.001168 eV.

Therefore, the energy released by condensation of 1 molecule of H_2 (0.011281 eV) is equivalent to 17.03 or 9.68 average CMB photons, i.e. enough to produce the observed radiation. This concept raises a testable prediction: there should be a relation between hydrogen gas concentration and CMB frequency photon emission from solid hydrogen crystals.

The view of the CMB from earth is likely to be dominated by such energy distribution within regions nearby, such as our own galaxy. Yet tiny deviations (1/100,000) do penetrate the glow from more distant sources and the anisotropies of the CMB correspond to faraway areas of higher mass density in the Cosmos. This clear observation is inexplicable as an afterglow from some Big Bang and provides prima facie very strong evidence of actual emissions of CMB photons from those distant sources.

Conclusions: Such a prosaic snapshot of this seemingly unavoidable energy balance sheet may disappoint some but has the advantage of being extremely simple - high school science in fact. The condensation of solid hydrogen, which we have no reason to believe has stopped in the Cosmos, can alone account for the CMB together with its isotropic distribution and energetic properties, especially its observed temperature: in fact it appears to be a thermodynamic imperative. Such a scenario does not necessarily displace the SC but the fact that it must occur confuses calculations from the quantitative values of the CMB. If there were indeed an afterglow from a Big Bang, then it would have to be a small superposition on the inevitable thermodynamics.

The debate between the SC and a Steady State is ongoing and awaits new data, while this section simply points out an overlooked complication. But it makes one thing clear: the existence of the CMB does not per se compel us to accept a Big Bang origin of the Cosmos.

Distribution of Light and Heavy Elements

An equilibrated Universe yields an excess of helium and random supernovae can produce the heavier elements.

An attraction of the SC for proponents has been that it predicted the relatively high helium to hydrogen ratio found in the Universe today, and also the existence of substantial amounts of much heavier elements. However, Burbidge and Hoyle, [18] concluded that all elements have been made in stars in the expected way, although it may take 10^{11} years to achieve the present proportions. The heavier elements are only made by very high energy as in supernovae, which are fairly rare but do occur spontaneously in the Milky Way galaxy. Historically an average of about one every fifty years is observed, a rate interestingly confirmed by Diehl, et al. [19] from the Milky Way's content of the rare gamma-emitting aluminium-26 isotope, with a half-life of 740,000 years. This is long enough, and the rays sufficiently penetrating, to permit an extended survey of heavier metal production events.

Thus an acceptable alternative to the predictive power of the SC is also demonstrated for the distribution of elements.

Why has the Universe Not Already Run out of Hydrogen?

Supply and Demand of Hydrogen

It is plain that the Universe has been and remains quite profligate in its disposal of hydrogen: the desert sky at night is ablaze with distant furnaces, powered mostly by fusion of hydrogen to helium. Our Sun is about half through its lifetime of 10 billion years, and the galaxy of which it is a part is about 13.5 billion years old, almost as old as the Universe according to the SC. At least two older stars, the first comprising hydrogen only and producing almost only helium, and a second, much larger, must have preceded our Sun. This second star finally exploded as a supernova in order to leave the richness of very heavy elements found in the primordial Earth. It is not clear how these events are somehow squeezed into only 13.5 x 10^9 years.

The Sun consumes ~10^{20} kg H/year, and is regarded as a very average star in our galaxy of ~ 2 x 10^{11} stars. Thus our galaxy will consume hydrogen at ~10^{31} kg / year (there are some 2 x 10^{11} similar galaxies in the visible Universe but let us stay with our own galaxy).

The proton concentration within the galaxy was taken as 10^5-10^8/cubic metre, while inter-galactic space is believed to contain about 1 proton /cubic metre while Hoyle, et al. [14] accepted 10^2-10^3 protons/cubic metre. One cubic light-year of space =10^{48} cubic metres. The volume of the Milky Way galaxy is about 8 x 10^{12} cubic LY, or ~10^{60} cubic metres. This space outside the galaxy would contain up to 10^{63} protons but within the galaxy should contain up to 10^{68} protons. The Milky Way consumes about 10^{31} kg H/year or ~10^{58} protons. Therefore, our galaxy consumes its content of free H in 10^{10} years. According to the SC it has had 1.35 x 10^{10} years to do so, yet its content is still abundant.

Of course there is a huge volume of ambient space to draw on, and cosmology has recently found that our galaxy cluster, including the Magellanic Clouds, is in the midst of a huge halo of hydrogen. Thermal diffusion of protons would be minimal at ~3K, while gravitational pull, although tiny, is unremitting and cumulative. Over millions of years this could result in very high terminal velocities such that a light year may be crossed in only a few years, any hindrance only being other particles under the same gravitational vector.

Cosmologists seem quite sure that the Universe will never 'run out' of hydrogen - there is at present so much of it about. Their prognoses are based on a literal paradigm that the Universe must eventually end because Infinite Time is not considered, in the meantime, its fate will just follow a course dictated by the current hydrogen content.

The next section will include the effect of Infinite Time.

Two Unconsidered Implications of an Expanding Universe

Firstly, an expanding Universe is a necessary reaction to the gravitational action of stars in overcoming inertia of falling matter, a Lorenz force resistance generated by the Zero Point Field (ZPF). The ZPF (Space itself) will in turn be repelled under Newton's Third Law. This is the action expected of dark energy.

Secondly, the Universe is expanding at exactly the right rate to accommodate the volume of protons needed to replace its known content of hydrogen.

The Redshift section above has shown unequivocally that the Universe is expanding. How can that be so?

Newton's Third Law: The famous fall of Newton's apple may have led him to his Theory of Gravity but at the same time it also seemingly violated his Third Law of Motion - and nobody noticed! Haisch, et al. [20] proposed that inertia is no more than a Lorenz force electromagnetic resistance to acceleration in the ZPF. When a proton 'falls' out of its original cubic metre towards a star it loses potential energy and gains kinetic energy. The only reason for keeping its place was its inertia. Overcoming that inertia by gravity accordingly involves a Lorenz force reaction from the Zero Point Field, which will be equal and opposite.

And so provided there is matter falling into a gravitational centre it will always be accompanied by an equal and opposite reaction from the Zero Point Field, i.e. Space itself, which means it is repelled. *Thus Space will always tend to be repelled from a working gravitational centre*, another view of the Yin and Yang of Entropy and Gravity (see below). The Redshift is Entropy at work.

A metric expansion of the Universe is in fact a dramatic validation of the Haisch-Rueda-Putnam proposal. The repulsion of space occurs in all directions, as does gravitational attraction but exempts bodies that are gravitationally tied. Thus the action of Gravity falls off with the square of separation while the action of ZPF repulsion does not; the repulsion is somehow deferred to the outer limit of gravitational attraction. The ZPF in effect makes space a 'Thing' that can be acted upon. This is a testable prediction; in fact, it may already be an established fact [21,22]. The ZPF, or the quantum vacuum virtual plasma, plays the role of dark energy in providing Gravitational Inertia Recoil, the basis of an expanding universe.

Proton insertion? Recent estimates for the Hubble constant (expansion rate of the Cosmos) average ~70 km/sec/megaparsec. While this sounds fast it is in fact extremely slow: each megaparsec stretches about 70 km/sec, so each km stretches by only 2.2 x 10^{-21} /sec, or ~ 10^{-14} /year. Space behaves as if it has essentially flat geometry, meaning conceptually that space is not curved and extends in three dimensions linearly even if locally distorted by the matter and energy in it.

As mentioned, intergalactic space is currently believed to contain about 1 proton/ cubic metre, although Hoyle, et al. [7] accepted 100-1000 protons/ cubic metre. The diameter of a proton is ~10^{-15} m. One metre of space expands by 10^{-14} metre a year, or ~10 proton diameters, and so the physical insertion by some means of 10 protons/metre, ~1000 protons/cubic metre/year or 1 proton/ cubic metre every 8-9 hours, would exactly account volumetrically for an expanding universe. This figure also fits very well with the accepted hydrogen content of intergalactic space.

The closeness of this coincidence is emphasized in view of the small dimensions and their huge range of possible variation.

A possible source of protons to replace losses by migration, crystallization or fusion is creation by cosmic radiation. The energy of a proton is nearly 10^3 MeV. There is ample radiation flux of photons >10^3 MeV, particularly in the beam of a Blazar or other Active Galactic Nucleus (AGN aka Black Hole) or from quasars. Is it possible that a collision of such a photon with a proton could preserve enough information to produce two protons from one, by a process similar to the known photofission or photodisintegration? This is a testable prediction.

A photon does not have mass in the normal sense. Electromagnetic radiation provides a way to transmit energy over Infinite Space (given Infinite Time) that bypasses the influence of Gravity. But the instant its energy is converted into something that does have mass, gravitational centres somewhere else will have to recoil from space to an amount that is equal and opposite. So in effect an insertion anywhere of anything that has mass will be precisely geared to and *could be deemed actually to cause the expansion of the Universe!* The observation that expansion happens to coincide precisely with the replacement needed to keep proton numbers constant provides some validation of these ideas.

If so, then the function of an AGN is seen as collecting, converting and in effect excreting galactic waste, in a form recyclable by the rest of the Cosmos. Emitted photons travelling at light speed in Infinite Time will proceed in their timeless Present until they collide with some target on which to offload their stored energy. This applies even to photons of starlight, so nothing is wasted in Infinite Time.

Proton insertion would be the very powerhouse of the Universe. From it all aspects of that Universe flow naturally, the stars, a viable Steady State and all the requirements for life to develop.

The essential complement to this powerhouse is the Yin and Yang of Entropy and Gravity. Gravity works to reverse entropy gained locally. A star such as the Sun is a store of low entropy providing energy for local events to do work that in turn grows entropy locally. This allows a local ebb and flow of entropy, events that must follow a sequence we know as Cause and Effect, or Time. Entropy and Gravity form the Bellows of the Universe, sucking in Disorder and exhaling Opportunity, all driven by the powerhouse of hydrogen.

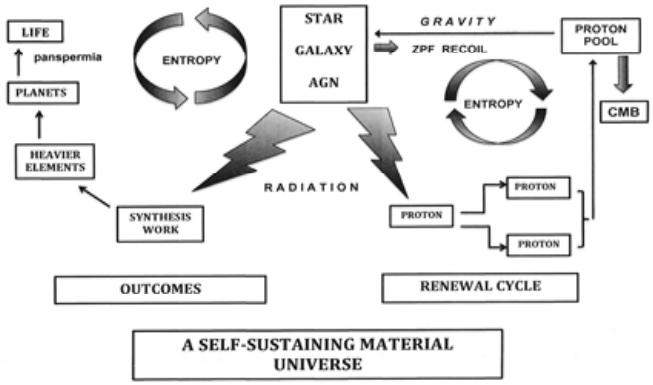

Figure 1: Summary of the Cosmic Plan outlined here.

Discussion

These concepts provide a plausible Steady State alternative to the SC. Whether it is ultimately viable remains to be seen; one notable question is the presumption that protons could 'pop up' in space. A feasible process is suggested involving proton duplication by cosmic gamma rays.

This hypothesis essay makes three testable predictions.

1. There should be a relation between hydrogen gas concentration and CMB frequency photon emission from solid hydrogen crystals.
2. Collision of a high-energy photon with a proton should be able to produce two protons from one by a process similar to the known photofission or photodisintegration.
3. There should be a demonstrable repulsive force between Space and an appropriate test article analogous with the anomalous thrust obtained using classical magnetoplasmadynamics via the quantum vacuum virtual plasma reported by Brady, et al. [22].

A yin-yang relation between Entropy and Gravity means that one cannot exist without the other, like light and shade. This is a Chicken-and-Egg situation that implies the absence of a beginning, a Steady State that has always been. It is also an observed fact of our Universe as we can actually see it going on. In contrast, the SC represents a colossal gain in Entropy from an unknowable source, and Gravity cannot come into play until matter has formed. The actual evidence for the SC has been systematically shown above to be unsafe.

"A perfect cosmological principle" is hypothetical fiat or dogma, not necessarily able to accommodate the enormous complexity conferred by the fixed constants of the Cosmos [23,24] or justified by any suggestion of data. It is contradicted by the anisotropies of the distant CMB, which is patently imperfect.

There is no a priori reason to exclude some form of evolution, or even variation. Apparent anomalies such as distant radio galaxies, acceleration of expansion and the highly bizarre nature of quasars, are not obliged to have a veto, just explanations waiting to be found.

The material Universe stands revealed as a well-oiled perpetual motion machine, endlessly recycling energy ultimately derived from the quantum vacuum virtual plasma of Infinite Space and Infinite Time.

In this writer's opinion the aggregate of evidential support for a Steady State massively outweighs that for the SC, despite the intellectual challenge of Infinite Time.

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