Reflections on the Origin of the Cosmic Background Radiation in the Quantum Universe *versus* Big Bang Cosmology [*]

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Abstract

The origin of the cosmic background radiation (CBR) in the 'Quantum Universe' is analyzed by reference to big bang cosmology. In the quantum universe, the CBR arises at the cosmological event horizon, equivalent of a relativistic event horizon, which obliterates the isotropy problem and the closure problem in classical cosmology. The quantum universe can not be smaller than one unit of length. At this size it contains one electron and one baryon based on a) the analogy between CBR and the electron inherent in its peculiar geometry and b) the missing mass -problem borrowed from standard cosmology which sets the baryon density at 5 % of the mass density. In the history of the universe as deduced from a kind of equivalence principle applied to the CBR it appears to have coalesced from space-like separated fractions that at the outset each contained the equivalent of one electron and one baryon.

Keywords: CBR, cosmic background radiation, quantum universe, Bohr atom, Hubble expansion

1 Overview and Results

In [1] the Standard Model of Cosmology the cosmic background radiation starts at the moment of formation of atoms from ions, the 'decoupling', and forms an optical event horizon that expands at the velocity of light. It is interpreted as caused by the thermal motion of material atoms. Since it is isotropic to within $\pm 10^{-4}$ [1] over the entire cosmological horizon the question arises how the primordial matter could equilibrate its thermodynamic state over such supraluminal expanses, this is the so called 'isotropy problem'. However, thermal motion is not the only agent that can bring about blackbody radiation. It can arise at the event horizon of a small black hole [2] for example, or by decoherence [3]. Any kind of formation of thermal radiation that implies a nonlocal process would obliterate the isotropy problem in cosmology. A geometry that has an event horizon has the potential to accomplish this because even if there is a one-to-one correspondence between events in the local and

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[1] The abbreviations used are CBR for cosmic background radiation, BBC for big bang cosmology, c for velocity of light, $\hbar$ for Planck's constant, k for Boltzmann's constant, s for geometrized unit of time, m for meter, J for Joule

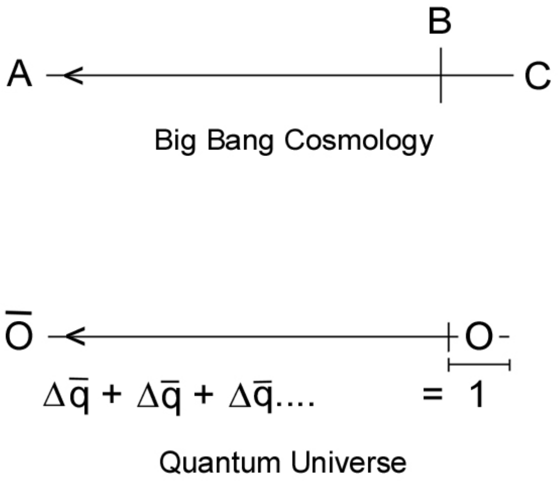

Figure 1: Representation of the universe according to Big Bang Cosmology (upper half of the drawing) and according to the Quantum Universe picture (lower half) as described in the text. The upper axis has dimension time (age of the universe) while the lower axis represents the radius of the universe $(= \bar{q})$

the yonder frame there is no light signal transmission that could make the yonder process appear local.

Event horizons are usually associated with strong gravitation and black holes but any geometry that comprises a space-like separation between two frames of observation will generate a relativistic event horizon. This series of papers is focussed on one particular such geometrical object, constructed by performing a Lorentz transformation of the inverse of the number-flux vector at the beginning and the end of a time interval of observation [4] [5]. In this geometry the local observer sees line increments in the direction of observation while the space-like separated non-local observer infers a tangential velocity, features that are conjectured to be relevant for the geometry of the atom and that of the universe.

The two cases of the CBR in classical cosmology and the quantum universe emerging from the geometry in refs. [4], [5] and [6] are illustrated in Fig. 1. In classical cosmology (upper half of the drawing), the Terrestrial observer at A sees CBR arriving from its source point B, the optical event horizon, while events in the interval B-C are hidden from observation because of the opacity of ionized gas and electrons. Any neutrinos created in the Big Bang (like in supernova explosions) would similarly arrive in a steady stream at A, delayed relative to the CBR by their slower velocity. The classical interpretation of CBR divides the universe into an observable part A-B and a not observable part B-C which hides physics that has not so far been seen in laboratory experiments (like inflation). Furthermore, the interval B-C has the character of a time axis capable of hiding proportionally more matter and galaxies until at time $\bar{t} = 0$ at the point C the density of the universe is infinite. If intepreted as a space dimension however the axis may continue to the right of C as determined by the evolution and the possible 'closure' of the universe. In principle, there is no natural absolute event horizon limiting the spatial extension of the universe in Standard Cosmology.

However, standard cosmology has provided evidence that the CBR has a remote origin beyond distant galaxies which carry an imprint of acoustic oscillations and cause secondary effects on the

CBR while it approaches the Earth [1]. If that is so, it must have its origin at a cosmological event horizon of some sort since otherwise it would place the Earth at the center of the universe and all other locations off center (by reference to the internal spherical segment of CBR generation), which is unlikely. In order for any observer at any location in the universe to find himself at the center of the universe the CBR must be generated at an event horizon equivalent of the cosmological horizon and this horizon must have the same significance for any observer in any epoch of the universe's evolution.

Against this background of classical theory the focus will now be set on the geometry described in [4], [5] and [6] (Fig. 1, lower half). Here, two observers $\bar{O}$ and O are space-like separated by a distance $\bar{q}$, which is interpreted as the spatial radius of the universe. One observer, $\bar{O}$, performs measurements in a single dimension, the momentum axis, whereby the observed state at $\bar{t} = 0$ is characterized by a line increment $\Delta\bar{q}$ per unit length relative to the prior time $\bar{t} = -1$. This line increment is $0.771s^{-1}$ per unit length where s is the geometrized unit of time [6]. The line increment is interpreted as a vacuum instability rather than a literal expansion of space like in BBC. The line increments per unit length sum up until at the cosmological horizon $\Sigma\Delta\bar{q} = 1$. Hence, the cosmological horizon where the CBR has its origin is a relativistic event horizon a) since $\Sigma\Delta\bar{q}/s = 1 = c$ where c is the velocity of light (beyond which point $c > 1$) and b) since the space-like separated observer O meets $\bar{O}$ at $\bar{q}$ to define the geometrical object comprising the universe. The event horizon [2] impinging on the quantum observer $\bar{O}$ has spatial extension over the entire 3-dimensional cosmological horizon in contrast to that of a black hole, which is point-like. In this geometry, the observable universe is floating in a causality cloak wherein a yonder observer infers a tangential velocity but is unable to perform other than time recordings (cf. [4] [5]). Only the local observer can measure momentum and length changes but is unable to see any rotation (because of space-like separation from observer O).

The x-axis in the lower part of Fig 1 has the character of a spatial axis even though its length is proportional to time by the velocity of light. It represents the universe compressed into one dimension based on the following interpretation of the CBR: The density of CBR at the apparent center of the universe at $\bar{O}$ is proportional to the surface generating it $\bar{q}^2$ times the magnitude of the mechanism generating it, a function of $\Sigma\Delta\bar{q} = 1$, but again inversely proportional to $\bar{q}^2$ on account of its dilution in the wave front. Even if the quantum observer were able to add CBR contributions from all angles of the concave origin of the sky this is cancelled by the convexity of the wave front to the effect that a one-dimensional representation like in Fig 1 is adequate for describing the process. Because of the equivalence of any observer, any location on the line from $\bar{O}$ to O is associated with the same density of CBR at the equivalent moment of time but every new observer would, of course, redefine his position to that of $\bar{O}$. A similar (although more debatable) reasoning can be applied to the overall energy density including the baryon density since each location near the concave celestial horizon produces gravitational force proportional to $\bar{q}^2$ and this force declines in the local frame proportionally to $1/\bar{q}^2$ which is a constant when an arbitrarily located observer redefines his location and origo anywhere between $\bar{O}$ and O in the drawing. The same applies to the sum of all spherical segments contributing to the overall energy density by radiating force in both directions from an arbitrary location on the x-axis, which adds another constant contribution of equivalent mass density to the one-dimensional representation of the universe in Fig. 1. The geometry only allows an observer to take the position of either $\bar{O}$ or O.

The representation of the universe in Fig. 1 allows the CBR generation at the cosmological horizon extending towards the observer O to be treated like a linear oscillator. Since $\hbar\nu = 2.612 \times 10^{-70} << kT = 1.38 \times 10^{-23} \times 2.725 \times (J \rightarrow m) = 3.11 \times 10^{-67}$ where T is the temperature of the CBR, Rayleigh-Jeans' law may be used for obtaining the energy density. In its classical derivation it comprises one contribution from a linear oscillator and another one from a reflecting hot cavity (cf. e.g. [7]). In

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[2] The word 'event horizon' is used here in the restricted sense of event signaling mediated by electromagnetic radiation.

classical hot cavity physics there is always a contribution of 4π from the surface angle of the reflecting hot cavity and one factor of 2 for the polarization of light into two planes. In the case of the CBR however, there is no reflecting wall and the classical Rayleigh-Jeans' law,

$$U(\nu) = \frac{8\pi\nu^2}{c^3} kT \tag{1}$$

is 'de-amplified' by the factor 4π and transforms into

$$U(\nu) = \frac{2\nu^2}{c^3} kT \tag{2}$$

where kT is the energy per particle. Suppose that photons were entrained to the oscillation frequency $\nu = 1$ at the cosmological horizon. This would imply that the boundary between the observable universe and its surrounding causality cloak has unique properties relative to other distances $< \bar{q}$ from $\bar{O}$ where $\Sigma\Delta\bar{q} < 1$ and where no CBR is generated. Then, for example, throwing in the empirical number density of CBR photons, $4.11 \times 10^8 m^{-3}$[8], of average energy $kT = 3.11 \times 10^{-67} m$ into Eq. 2 would produce a CBR density of $2.56 \times 10^{-58} m^{-2}$, close to the empirical value, $2.60 \times 10^5 eV/m^3 = 3.44 \times 10^{-58} m^{-2}$, allowing plenty of time for the photons to equilibrate to the most probable frequency distribution (and, hypothetically, to stretch in an expanding universe) while a) emerging from the event horizon and b) traveling across the universe. The photons do not themselves have the frequency $1/s$ but they equilibrate with the oscillator.

In contrast to BBC the CBR in the Quantum Universe is a structural part of the universes geometry. Since the CBR is not generated by thermal motion but rather in the absolute relativistic event horizon adjacent to a non-local frame of observation the isotropy problem may be considered solvable in the framework of this cosmological model.

There is evidence from CO rotational excitation that the CBR was hotter in the early universe [9] but the observational fit to the theoretical curve based on measurements by different research groups (Fig. 5 in ref. [9]) is not as convincing as the thermal distribution of CBR once was before it became consolidated by satellite measurements. The cooling of CBR is of paramount importance in BBC since it is used for calibrating the time scale of the universe's evolution by reporting about the atom dynamics 300000 years or so after the big bang. Whether or not it cools down is not so important in the Quantum Universe, which is, at least at the outset, essentially a static universe where any of two observers records what happens during one interval of time only. The quantum observer may perform a second measurement at a later moment but will then redefine the universe's geometry. Namely, a quantum observer located closer to O than in Fig. 1 derives the same amount of CBR since it is defined by $\Sigma\Delta\bar{q} = 1$ which is invariant with respect to the radius q. In order to acquire a history, which the universe must have had [3], two lines of reasoning converge on a plausible solution.

One approach is to try to extend the universe beyond its horizon at distance $\bar{q}$. In order for the geometry to be valid irrespective of epoch the observer faintly discernable at the edge of the universe as now seen from here must have computed a shorter distance to the non-local frame at the time the light was emitted. In such a case it is not allowed to add a second equally long distance to conclude that the universe extends twice as far as seen now from here. If, at the edge of the universe as seen by that observer, $\bar{q} = 1$, then $\Delta\bar{q}/s = 1$ and it is impossible to extend the universe beyond its current radius. While the distant observer's horizon expands at the same rate that the signal approaches (in order to clear causal space) his location becomes increasingly uncertain and more subject to speculation than

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[3] Whether or not there exists an absolute universal time for reference by the local observer is debatable. Many complex systems evolve on a characteristic time scale peculiar to each system. This time scale depends on the system chosen for reference. The constancy of the velocity of light may provide a time scale, but only by reference to a distance (for example $\Sigma\Delta\bar{q} = 1$)

measurement. [4]

The other approach to cause the instantaneous universe to have a history is by applying the equivalence principle to the CBR: The CBR, which is generated at the relativistic event horizon in the Quantum Universe picture is a structural part of it and must therefore have been present throughout its history. Using the representation in Fig. 1 (lower half) this corresponds to reflecting the CBR at the point $\bar{O}$ back towards O such that throughout the history of the universe any point on the line between $\bar{O}$ and O equivalently has two contributions of CBR, one directly from O and the other receding from $\bar{O}$. Then, the thermal distribution can only be measured at $\bar{O}$ since at any other location on the line $\bar{O} - O$ it is twice that value (suggesting that laws of nature only are valid for observers who consider themselves at the center of the universe). In order to achieve energy conservation in cases where $\bar{q}_t < \bar{q}_{tu}$ (t_u= current age of the universe) there has to be several observers $\bar{O}$ (several fractions of the universe) space-like separated from each other *via* the non-local frame(s) O at those earlier times such that $\Sigma\bar{q}_t = \bar{q}_{tu}$. None of these fractions of the universe can be smaller than $\bar{q} = 1$ since $\bar{q} < 1 \Rightarrow \Delta\bar{q}/s > 1 > c$, which is different from BBC where an infinite density in a very small volume at $t = 0$ is propounded. Furthermore there is no steady coalescence of fractions of the universe in BBC, something that would be possible to evaluate based on secondary effects on the CBR. Since $\bar{q} \geq 1$ and since the line increment is invariant on the cosmological horizon where $\Sigma\Delta\bar{q}/s = 1$, the unit length acquires a special role in this geometry; it represents a quantum of volume.

Based on the two approaches outlined above it is thus possible to delimit the universe's extension in the present cosmological model, which represents an alternative approach to the 'flatness problem' in BBC including the problem of the universe's possible 'closure'. Besides the extension problem, the infinite energy at zero time represents another weakness in BBC. Not only must all the contemporary energy of the universe have been concentrated in a small volume but all the matter and antimatter that annihilated to leave a residue of matter by 'symmetry breaking' must also have been there at the same time or shortly before (possibly in an even smaller volume). Confronting such formidable 'problems' it is not surprising that the opinion sometimes is expressed that the strongest argument in favor of BBC is that there is no alternative theory. However, the Quantum Universe does provide an alternative. In it, the matter is not created, it is rather sustained by the oscillating geometry of the universe and that of the atom, which is seen as the reason why the apparent expansion rate can be derived from the hydrogen atom and from single particle decay per unit surface at the horizon [6]. If that is correct and given the shell-like appearance of the universe in this geometry, what would the CBR of observed energy density $3.44 \times 10^{-58}m^{-2}$ correspond to on the unit length if not an electron of energy $6.764 \times 10^{-58}m$? [5] To find out if this also holds for the baryons consider the energy of the universe in this model, which in geometrical units is the inverse of the line increment, 1.30×10^{26}. Divide by the volume of the universe $4\pi\bar{q}^3/3 = 9.123 \times 10^{78}m^3$ to obtain the energy density $1.42 \times 10^{-53}m^{-2}$ and divide again by the energy of the Λ_0-particle (which is unique among the elementary particles in that it is capable of providing the bulk primordial element composition by decay (cf. [6])). This gives the apparent baryon number density $9.62/m^3$. At this point it is necessary to borrow the missing mass -problem from standard cosmology, which identifies only about 5% of the apparent mass density as baryonic (0.046 of the critical mass, cf. [10]). One obtains an observed baryon number density of $0.44/m^3$ which is to be compared with the electron density of $0.51/m^3$ above. When applying the reflection at $\bar{O}$ discussed above that is required for equivalence, both the electron and the baryon density become close to unity. This is of course independent of the meter since any other standard length would cause the particles to be measured in other units as well. For example, if the meter kept in Paris were 5 times longer than it is then the weight of the particles would be 5 times less and the

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[4] Although not dealt with here this may require that there is a second shell of radius $2\bar{q}$, devoid of matter and gravitating energy where the CBR may recede.

[5] No signal from the binding energy of the hydrogen molecule, $2.65eV$ is yet expected in this cosmology

number density would be invariant. Since the same baryonic error factor of roughly 95% emerges both in BBC and the quantum universe it must have its roots in how gravity is interpreted, which reflects in the evolution of the universe in BBC and the geometrization of the units in the quantum universe. Nevertheless, there is sufficient evidence here to conclude that by understanding the atom one can also understand the universe. The importance of high energy physics in astrophysics is not limited to various particle showers but also includes the geometrical structure of the universe and how it is built up and stabilized by elementary particles. The results may also contribute to a comprehensive perspective on various calibration issues in contemporary particle physics and astrophysics.

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