10:th Anniversary of the Discovery of the Bohr-Dirac Quantum Universe *

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Dec. 12, 2011

Abstract

A brief review is made of the Bohr-Dirac Quantum universe, first discovered in 2001. This universe has one primordial atom per unit length. Its apparent Hubble expansion rate, its age, and its baryonic matter content are derived from the Bohr atom, which takes the form of the Dirac monopole. These results constitute cosmological evidence of magnetic poles. The apparent deceleration or acceleration of the universe arises because emission of radiation from matter takes place on the background of the geometry of the universe. An oscillating unit length at the horizon generates the cosmic background radiation. The edge of the universe is non-local and hence indistinguishable from the local universe but the latter has evolved for as long as the universe has existed. These geometrical results make the closure problem in standard cosmology obsolete. The interconnectedness between remote and local involving time provides for time-energy uncertainties as an alternative to matter-antimatter fluctuations for generating baryonic mass. The theory supports the existence of currents and magnetic fields at the horizon, which may provide for yet another kind of matter creation. Even though the theory is quite distinct from Big Bang Cosmology several numerical results agree, for example the apparent Hubble expansion rate, the age of the universe, and the proportion of baryonic matter.

Keywords: Bohr-Dirac Universe, Quantum Universe, accelerating universe, matter quantization, magnetic monopole, hydrogen ground state

1 Introduction

This year marks the 10:th anniversary of the first paper leading to the discovery of the alternative cosmology of the title propounded by this author and a brief consolidated review seems justified. In this cosmology the universe spans between a local quantum observer who is capable of measuring one-dimensional line increments and a non-local observer who only can measure time. The geometry is applied to the Bohr atom in the ground state factorizing out a line increment which is interpreted as the apparent Hubble expansion rate the inverse of which gives the radius of the universe and indirectly, its age, all in quantitative agreement with contemporary Standard Cosmology. The factorization yields from the Bohr atom a mathematical form equivalent of the Dirac monopole consistent with matter

 Published on the Internet on Dec. 12, 2011. Citation: 10:th anniversary.. Proceedings of www.scienceandresearchdevelopmentinstitute.com , Quantum Physics & Cosmology # 17 (2010). Email: cerven@scienceandresearchdevelopmentinstitute.com

quantization of one atom per unit length. Also astrophysical observations can be interpreted in terms of the geometry, for example the apparent acceleration of the universe and the cosmic background radiation. Applying the geometry to the universe may lead to a conceptual revision of our current world picture especially with regard to the closure problem and the singularity problem encountered in standard cosmology. In order to help the reader follow the arguments herein the 2004 paper 'Space-time dimensionality of plain physical observation' [1], which is a summary of the 2001 Wigner Symposium contribution [2] appears un-edited in its entirety in Appendix I. Since this is still non-standard cosmology all papers have been published at the author's Internet homepage rather than in the commercial science media.

2 The Quantization of Matter in the Universe

As shown in the summary of the theory (Appendix I) it is the inverse of the four-velocity along the x_1 spatial coordinate that when Lorentz-transformed to the local (barred) frame causes the universe to materialize. The universe spans between a material one-dimensional momentum observer in the barred frame and another observer in the un-barred frame, in which measurements are perpendicular to the momentum frame and non-local as judged by both observers. In the present case,

$$\bar{q}\ \overline{\Delta q} = -m^2\ , \tag{1}$$

where $\bar{q}$ is interpreted as the radius of the universe, $\overline{\Delta q}$ is the apparent Hubble expansion (rate) in the current epoch of the universe's history (and for reasons explained in Ch 4, also in other epochs), and m is the unit of length. This result and the use of the inverse of the four-velocity suggest quantization per unit length. Mass is measured in the units of time. By analogy with the de Broglie equation,

$$\frac{\lambda}{h}\ p = 1 \tag{2}$$

where λ is a wavelength of matter waves and h is (the plain) Planck's constant. Eq. 1 can be written

$$\frac{\bar{q}}{-m^2}\ \overline{\Delta q} = \bar{q}\ \frac{1}{\bar{q}} = \frac{1}{\overline{\Delta q}}\ \overline{\Delta q} = \frac{1}{\overline{\Delta q}m}\ \overline{\Delta q}m = 1, \tag{3}$$

offering possibilities to quantize per unit length, per unit line increment, or per unit radius. Concrete evidence of matter quantization is obtained by starting with the Bohr equation of the ground state of hydrogen, $a_0 = 4\pi\epsilon_0\hbar^2/(m_e e^2)$ [1], factorizing out

$$\frac{a_0}{\hbar}\ \alpha m_e c\ \left(= \frac{a_0}{\hbar}\ v_e m_e \right) = 1 \tag{4}$$

which is in the form of Eq. 2 and 3, and then further factorizing out a line increment, $\overline{\Delta q}$ which is interpreted as the apparent Hubble expansion rate,

$$H = \overline{\Delta q} = \sqrt{\hbar}\ \pi\ \frac{\alpha}{e\ c} Ampere\ . \tag{5}$$

The details of this derivation appears in [3]. Eq. 5 can be arranged into a form equivalent of Dirac's quantization scheme for magnetic charge [4] [6] [8][2], namely

[1] a_0 is the radius of the Bohr atom, the distance from origo where the electron is orbiting on average, ϵ_0 is the permittivity of vacuum, $\hbar$ is the reduced Planck constant ($\hbar = h/2\pi$), m_e is the mass of the electron, and e is the charge of the electron. (v_e is the average velocity of the orbiting electron). Abbreviations used in this paper include BBC (Big Bang Cosmology), SRT, GRT (special and general relativity theory), MKSA (meter-kilogram-second-ampere system of units = SI (Sisteme International), CBR (cosmic background radiation), c (velocity of light in vacuum), s (geometrized unit of time, not MKSA-second), m (meter)

[2] SI-units are not used in the referred paper, see also [7]

$$4 \frac{e\ c}{2\alpha} \frac{1}{\overline{q}} = \sqrt{\hbar}\ 2\pi\ Ampere\ \ s^{-1} \tag{6}$$

where Eq. 1 has been used to obtain the radius of the universe. Hence, a unit curl of current (right hand side, 2π) gives rise to 4 particles of quantized magnetic charge (left hand side) whereby one is free to interpret the particle as an electron [6] [8] or perhaps any other charged particle as well. The four particles are essentially equivalent of one atom if half of the unit circle generates antimatter and the other half generates 2 particles of opposite charge, which is required to make a neutral atom. Tracing half the unit circle as in [6] [8] generates half the number of particles. Eq. 6 is perfectly consistent with the geometry laid out in Appendix I. The left hand side expresses the magnetic charge which generates the one-dimensional Dirac string (herein as seen by the barred observer) whereas the right hand side expresses the curl (herein as inferred by the velocity perpendicular to the barred observer's direction of observation, cf. Eq. 13 and 18 in Appendix I). The physicality of the unit curl of current indicated by Eq. 6 has recently been corroborated by the discovery that electromagnetic radiation is generated when the vector potential changes direction in the yonder frame, following two perpendicular paths whereby time is perpendicular to the momentum frame [9]. Some astrophysical observational evidence of currents and magnetic fields in the early universe has recently emerged [10] [11].

In addition to these theoretical results some numerical approaches provide further evidence that there is one particle per unit length in the early universe. This evidence is based on the numerical values of the radius of the universe, $1.30 \times 10^{26} m$, and the apparent expansion rate, $7.71 \times 10^{-27} m^{-1}$, obtained from Eq. 5 and Eq. 1. In the present geometry the Hubble apparent expansion rate (which is taken to be linear, caused to appear nonlinear by observational distortions, cf. Ch. 4) adds up to a unit length on the cosmological horizon beyond which would be $v > c$. This remote unit length defines not only the absolute cosmological horizon but also the age of the universe. It is at this far away unit length that the universe appears for the first time. Here, an unbiased search for primordial matter focuses on the Λ_0 particle which decays into protons, neutrons, and electrons in a proportion capable of at some point of time generating hydrogen and helium in proportions estimated for primordial matter in standard cosmology. It turns out [4] [5] that one such particle per square length measure at the cosmological horizon would generate by half-life decay enough energy per unit time to cause the universe to oscillate at $7.67 \times 10^{-27}\ m^{-1}$ [3] [4], which is almost equal to the value obtained from Eq. 5 [3]. Since half the energy goes into the apparent expansion and half of it remains at the horizon the rule of one particle per unit length holds.

Since this theory sets out to provide an all-inclusive framework for interpreting the atom and the universe, and given the evidence of one particle per unit length mentioned above, the finding that the energy density of the cosmic background radiation (CBR), $3.44 \times 10^{-58}\ m^{-2}$, is so close to half the energy of an electron, $3.38 \times 10^{-58} m$, is not to be taken a coincidence. By analogy with the half-life decay of the Λ_0 particle the energy associated with the CBR would have been released to become measurable while an equal half would have remained at the horizon such that the mere numbers once again support the notion of one particle per unit length. Moreover, simple calculations [4] show[4] that half an electron per cubic meter corresponds to half a proton per cubic meter based on the radius of

[3] The close agreement between these numbers, first observed in 2001, was the reason for inserting the factor π into Eq. 5 prior to defining the connection with Eq. 6

[4] From ref. [4]: The matching baryon number is obtained as follows. The radius of the universe (which is the inverse of the local (Hubble) expansion rate, $7.714 \times 10^{-27}\ s^{-1}$), $1.296 \times 10^{26}\ m$ is interpreted as its total geometrized mass or energy and divided by its classical volume, $4\pi\overline{q}^3/3$ to obtain its density, $1.420 \times 10^{-53}\ m^{-2}$. Subsequently dividing by the mass of any particle that one considers primordial yields the expected baryon number density in the early universe (from which contemporary atomic nuclei have evolved by nuclear fusion). For example, choosing the proton yields $1.420 \times 10^{-53}/1.242 \times 10^{-54} = 11.43$. It is then necessary to rely on BBC for the fraction of the total density that corresponds to baryons, which currently is estimated at 4.6 %. Hence the number of protons per unit volume that corresponds to the 0.51 electrons/m^3 equivalent of the CBR is 0.53.

the universe of Eq. 5 and Eq. 1, based on the geometrization of mass as in general relativity theory, and based on the notion of 4.6% baryonic mass taken from Standard Cosmology. These calculations will now be corroborated using a self-consistent approach but first recall a distinct piece of evidence of the one baryonic particle per unit length -rule obtained by examining the half-life of the neutron [4]. Namely, when plotting the linear proportionality between length and time inherent in the apparent Hubble expansion rate one finds the radius of the proton ($\approx 10^{-15}m$) versus the half-life of the neutron close to the plot.

Given the numerical evidence of one baryon (primordial atom) per unit length described above and the emphasis on the unit length in the geometry (Eq. 1, Appendix I and Chapter 3 below), Eq. 4, where the factors on the left hand side cancel out to give unity (based on geometrized units), may represent the present geometry in a general sense. Strictly applying the geometry to Eq. 4 may clarify this[5]. The factors in parenthesis in Eq. 4 represent its classical interpretation as applied to the electron and its orbiting velocity wherein $\alpha = v_e/c$. The modern interpretation of α [13] is that of a coupling constant for the electromagnetic force, such that the v_e/c form in parenthesis may be ignored for the present purposes. Furthermore, an explanation of the occurrence of the factor $2\pi\alpha$ in Eq. 4 is avoided here in favor of strictly applying the unit length geometry. It is well known that the electron orbiting the proton is to be regarded as a non-local electron cloud until it interacts with light (like, for example, attosecond pulses). A non-local 'object' does not have a size. The proton though, has a size that easily can determined by scattering. Its radius is $1.414 \times 10^{-15}m$ [14]. As explained in Ch. 3 below, the geometry of Appendix I yields that, similarly to the case of the atom, the universe itself includes a non-local segment at its outermost edge. This sets the scene for evaluating whether or not Eq. 4 may have some general significance in terms of this geometry. Even though the proton is distinct from the electron in the quark-gluon picture it does have a mass and a charge, just like the electron. Thus, there seems to be nothing that prevents from applying Eq. 4 to the radius of the proton or to its mass and solving the other factor. This approach yields the result that the geometry requires 20.4 non-local masses equivalent of a proton on the surface of the proton's classical spherical extension to satisfy Eq. 4. (Coincidentally this result is almost exactly cancelled by ignoring the factor $1/(2\pi\alpha) = 21.8$.) In other words, the plain geometry (whereby any influence of GRT cancels out of Eq. 4) indicates that only $4.9\% = 1/20.4$ of the non-local mass is in the form of a baryon. Hence, the missing-mass problem in standard cosmology may have a very simple solution if one fully reevaluates the implications of the Bohr ground state in this geometry.

3 Conceptualizing the Universe

A detailed quantitative analysis of the universe must refer to a geometry governing its constituents. The standard choice is that of a Cartesian coordinate system of 3 spatial coordinates distorted by a fourth time coordinate as prescribed in special and general relativity theory. This leads to a world picture in which the observer and the object may occupy any coordinate in four-dimensional space-time and all space-time coordinates are to be regarded as equivalent when referring to the global (as opposed to local[6]) appearance of the universe. Since the Hubble expansion rate is taken literally this mechanistic world picture leads to the famous closure problem regarding the extension of the universe and the problem of the incredibly enormous energy of the singularity at zero time. In contrast to SRT and GRT applied to cosmology there exists in physics many systems where any two coordinates may be strikingly non-equivalent. The atom is the most obvious example with its spherical geometry constituted by electrons orbiting around the nucleus. In theoretical physics Gauss' theorem and

[5]A similar strict application of the present geometry to electromagnetic radiation has previously made it possible to exclude several alternative forms of Maxwell's equations in favor of a physical description in terms of the vector potential [9].

[6]the universe might look different from the center of a pulsar, for example

Stoke's theorem both deal with integrals that vanish except at a boundary leaving the coordinates non-equivalent with regard to the physical process measured while, for example, the Dirac delta function highlights one point of space only. These four examples are all at variance with the notion of equivalence of any two space coordinates in the world of physics. The precedence suggests the possibility of a safe disembarkation from a coordinate-invariant world in cosmology.

Also the present geometry (Appendix I) represents a case of non-equivalence of the coordinates of two observers. Here, an observer is only allowed two perspectives, either that of the quantum observer (barred frame) who is capable of measuring one-dimensional line increments equivalent of momentum or that of an observer who only measures time increments (un-barred frame). Since the latter is unable to locate in space with the help of line increments (measuring rods) it is evident that the geometry defines non-locality in a broader sense than that which is established for light signals. The non-locality is an important conceptual element in this model of the universe. In fact, the non-locality is three-fold. 1. The un-barred observer, in being incapable of measuring line increments, lacks the means of defining a spatial coordinate, hence any un-barred observer is to be regarded as non-local relative to any other un-barred observer. In the empirical world this is particularly evident for very distant celestial bodies (closer to the unbarred observer at the horizon) whose current location can not be told because too long time has lapsed since the signal telling about their existence was emitted. The same applies to closer celestial objects although their trajectories may reveal their present location with high probability. In principle though, any object disappears into obscurity relative to the prior moment when it communicated its presence *via* a light signal, most objects retelling about their presence over and over again. 2. The barred and un-barred observers are space-like separated (Eq. 16 in Appendix I). This means that they can neither communicate with electromagnetic signals to obtain information about each others' frames nor can they locate each other in space. The non-locality of the two observers relative to each other can also be understood intuitively since they perform measurements that are perpendicular, the line increment $\overline{\Delta q}$ or the orbiting velocity v (cf. Appendix I).

The quantum observer's reference frame is not defined until the moment when the signal transfer takes place, at which time the geometry is defined. The quantum (momentum) observer then distributes the universe's matter along the direction of observation. The un-barred observer however, who is incapable of measuring line increments along the radius but performs measurements of tangential velocities, will associate the universe's contents with a circular or spherical geometry. Both are free to do so because the matter is essentially non-local. When looking back towards the horizon in the barred frame, each unit length accommodates a line increment per unit time which add up until at the radius of the universe $\Sigma\overline{q} = 1 = c$, and its absolute edge is reached. Here, any matter is entirely non-local, which implies that it is indistinguishable from the local primordial matter in the local barred frame of observation, albeit the latter has evolved and redistributed locally for as long as the universe has existed. Therefore, a local observer who watches the edge of the universe actually watches the local conditions subject to time evolution such that the closure problem in standard cosmology becomes obsolete. In other words, the horizon acts like a mirror that defines the physics of the local observer. Because of this interconnectedness between remote and local it is natural to apply uncertainty relations involving time spans as long as the age of the universe. This opens the possibility that our universe is made possible by Heisenberg type uncertainties involving energy and time rather than vacuum fluctuations of matter and antimatter. The latter tend to amplify the singularity problem of BBC because only a minute fraction of the point-like energy at zero time is thought to remain for creating the universe. The matter-antimatter problem in BBC has recently been reevaluated experimentally [12]

4 Astrophysical Observations

The observations which need to be interpreted in terms of this new cosmology can be divided into direct and indirect ones. Besides the numerical value of the apparent expansion rate a remarkable agreement between the present model and BBC is obtained for the age of the universe, calculated here from its absolute radius and the velocity of light, yielding 13.7 billion years. This is based on an apparent expansion rate linear with time, which is justified by the geometry described in Appendix I and ref. [2]. The apparent nonlinearity of the apparent Hubble expansion rate is very much in the focus of today's astrophysics research where absolute distances are inferred from bolometric intensities of light emitted from supernovae and gamma ray bursts [15]. For the present purposes a sample of these data have been extracted graphically from ref. [15] and replotted as a function of radial distance in place of z (redshift) using the formula $v = 1 - 1/(1 + z + 0.5\ z^2)$ (cf . [16]). (see Fig. 1). In the present model, v is proportional to the radial distance from the local observer towards the edge of the universe. Previously [17] it was discovered that the astrophysical observations indicating an apparent acceleration and deceleration of the universe might alternatively be explained by an equation of the type

$$R = \left(v - \left(\frac{tan^{-1}(v/c\sqrt{1 - v^2/c^2})}{\pi/4} \right) \right) R_U \tag{7}$$

where R is the radial distance from the local observer and R_U is the radius of the universe. The function graph of this equation has been plotted in Fig. 1 (yellow circles). The equation would imply that the intensity of light emitted from the supernovae (some bolometric measure, that is) is faded or amplified because of the geometry of the universe as laid out in Appendix I, apparently in the following manner: Since

$$\frac{v}{c\sqrt{1 - v^2/c^2}} \tag{8}$$

is the tangent of the angle by which an orbiting point seems to be delayed by an observer at origo [2] [7] the angle itself (numerator in Eq. 7) would be a function of the intensity of radiation coming out of the yonder (un-barred) frame of observation. It has recently been shown [9] that the geometry comprising two perpendicular directions as in Appendix I is compatible with electromagnetic radiation being generated by the vector potential changing orientation in the non-local frame along two perpendicular paths. The currents generating radiation would be parallel to the vector potential in agreement with the case of the matter, Eq. 6. The central idea leading to Eq. 7 is therefore that the radiation coming out of the matter of the celestial objects is generated on the background of the geometry of the universe. If the background is subtracted as in Fig. 1 the most remote objects will appear fainter whereas those at closer distance would illusively indicate acceleration in the universe's current epoch. The denominator in Eq. 7 determines the radial distance at which apparent acceleration turns into apparent deceleration. The choice of $\pi/4$ may be correct, for example, if the background is squeezed in some fashion and its influence on the emission from matter is referenced to the influence of the angle $\pi/4$ which has equal contributions from the unit circle. This idea is actually compatible with the notion arising from group theory that the three-dimensional world collapses into a two-dimensional one at infinite radius [18] [19]. In the present model this two-dimensional world corresponds to the unit length at the horizon as seen by the quantum observer and its perpendicular velocity inferred by the observer at origo. The oscillating line increment is of course immensely squeezed whereas the non-local velocity might be so.

In standard BBC the CBR is a residue of the thermal motion of atoms or molecules which becomes visible after 'decoupling'. Thus it has a remote origin and astrophysical observations indicate that it appears hotter at earlier times [20]. In the present theory though, it arises because of the geometry

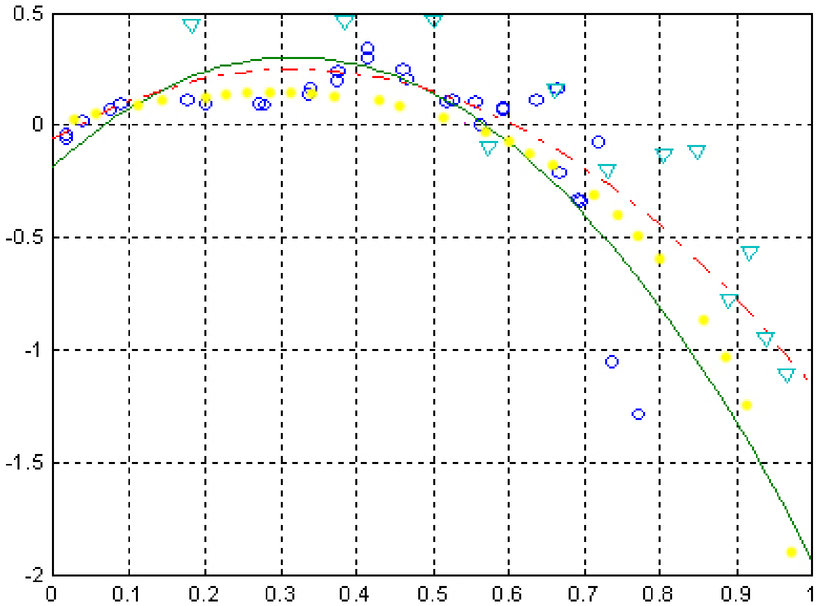

Figure 1: Cosmological distances based on redshift and bolometric measurements and Eq. 7. The observational data have been extracted graphically from a plot of distance decrement versus redshift in reference [15] and recalculated to radial distance towards the cosmological horizon based on the present cosmological model where radial distance is proportional to v, using the definition of z (cf. [16] and text). Circles and triangles represent observations of supernovae and γ -ray bursts respectively. The unbroken line is the 2:nd degree polynomial best fit to the supernova data, the broken line is that to supernovae and GRBs combined while the yellow (shaded) dots represents the continuous function of Eq. 7. The x-axis represents the radial distance where 1 is the absolute cosmological horizon. As for the observational data, the y-axis has the same units as in ref. [15] while it is the function value of Eq. 7 regarding the yellow (shaded) dots.

of space and time rather than particle motion. Compared to BBC it has a more remote origin at the absolute event horizon rather than at a horizon of visibility. Because of the inverse relation of $\bar{q}$ and $\overline{\Delta q}$ the unit distance at the horizon as seen by a remote observer (judged from the Terrestrial perspective) makes a larger proportion of the overall energy and it might therefore appear hotter. On the other hand, if measured in a smaller universe when viewed from the Earth in the current epoch the apparently shorter radius as calculated for the distant observer from here makes a smaller proportion of the total distance as seen from here. The former amplification and the latter de-amplification cancel when seen directly from the Terrestrial barred observer's perspective, as one would expect of a static universe which is eternally sustained by processes taking place in the remote unit length. Indirect evidence of the remote CBR coming from absorption spectra of distant matter involves the un-barred frame as well. A complete theory of the CBR based on the present approach would have to take into account Eq. 7 and the difficult problem of the history of the universe in the present model. However, preliminary results suggest that the observational data fit to a transformation of the energy of the CBR from the un-barred frame to the barred frame of the form

$$\frac{1}{\sqrt{1-v^2/c^2}} + \frac{v}{\sqrt{1-v^2/c^2}} \tag{9}$$

derived from Eq. 13 and 18 in Appendix I based on the assumption that the energy associated with the CBR transforms like $s = \bar{t}/\sqrt{1-v^2/c^2}$ where the first term in Eq. 9 would constitute the remote observer's contribution and the second term the Terrestrial observer's contribution. This transformation yields $CMB(v)$-plots similar to the would be choice of standard cosmology, $T_{CMB}(v) = T^0(CMB)\sqrt{(1+v)/(1-v)}$ cf. [16] [21]

Attempts at quantifying the CBR in the present theory have been made based on Raileigh-Jeans' law applied to the remote unit length oscillator. The BBC-CBR field of research also includes the CBR anisotropy and baryon acoustic oscillations.

5 Conclusions

In scientific research it is common practice to build a theory and hold it for true until irrevocably disproved by observation. In GRT applied to cosmology, however, the extent to which observation fails to support the theory has been given a special name, dark matter and dark energy, and it is admitted by researchers in the field that the nature of these are not known. This makes the 'dark' components searched for in the universe a good example of a common, risky and most often very fallacious human way of thinking, that of referring concrete things to a poorly defined abstraction. Although observation fails, the abstraction is maintained, like now in the literature refocusing on hot dark matter in place of cold dark matter, even though the abstraction itself (dark matter and energy) may possibly not be warranted. In the present case though, the abstraction is rather well defined (the geometry of the universe spanning between two observers) and the problem is to reinterpret the data to make them supportive. The results on matter quantization presented in Section 2 add substance to this cosmological model but also the ease of conceptualizing the universe's extension discussed in Ch. 3 are favorable compared to BBC. Furthermore, the promising preliminary results on how to reinterpret the apparent acceleration or deceleration of the universe's apparent expansion can be maintained. Preliminary results on the CBR have also been obtained while searching for a comprehensive theory.

Finally, whether or not one believes in the existence of magnetic charge has rather far-reaching consequences in the field of theoretical physics. Since the units of ec/α are [Ampere sec] $\times$ [meter/sec] time cancels out such that the number of length associated with c in the MKSA system of units becomes an integral part of the quantity of charge unaffected by the unit of time chosen. This means that geometrizing the units according to standard GRT procedures leads to loss of information, casting doubt over whether these procedures are justifiable. The numerator of c in the MKSA system is an invariant element of proportionality between electric and magnetic charge, it is *not* a reference for time based on the constancy of c in vacuum if one sticks to the magnetic charge. Perhaps the lack of experimental evidence in support of the existence of magnetic charge has caused it to be too much ridiculed in the past. However, those efforts have mostly focused on microscopic scales whereas the present evidence derives from cosmological scales.

This cosmological model addresses different problems than BBC (e.g. matter quantization into atoms) and makes some of the difficult BBC issues obsolete (e.g. the closure and singularity problems). Some other BBC problems can now be seen in a new perspective (e.g. matter creation). Since more and more pieces of data seem to fit in a workable fashion into this cosmology, the Bohr-Dirac Quantum Universe is becoming a realistic alternative to BBC. It may not be the case that cosmology has lost a century because of unduly focusing too much on GRT-BBC. In contrast, the numerical agreements between the present theory and BBC regarding, for example, the expansion rate, the age of the universe, and the fraction of baryonic matter are remarkable. However, since this theory integrates a greater variety of data (e.g. the atom and the vector potential) besides solving the closure problem in standard cosmology it has a chance of evolving into a more comprehensive and quantitative world picture.

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Appendix I

Space-Time Dimensionality of Plain Physical Observation (Published in 2004)

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Abstract

A local Euclidean reference frame, which forms the basis of physical observations, may be defined by reference to some space-like separated frame, in which case a constrained validity of the closure axiom may be implied. For instance, the inverse of the x_1-component of the four-velocity may be Lorentz-transformed to an Euclidean reference frame defined around $t = 0$ whose spatial extension is limited by c. In this geometry, local observations of radial increments are made perpendicular to an angular velocity in a space-like separated frame. The space-time dimensionality of this system is further investigated. Interesting applications seem to be contracting three dimensions on a cosmological scale to a single axis of observation, and the Bohr atom.

INTRODUCTION

The knowledge-theoretical dilemma of distinguishing between the perceived signal and the object itself was in the focus of the academic debate in the late 18:th century but its implications for modern physical descriptions have been taken lightly. For example, all of relativity theory is based on regarding the information carrier light as an approaching object even though it is not. The invariance principle in relativity theory leads to the well-known problems of defining the spatial limitations of the universe, its ”closure” in Euclidean space. Current standard cosmological models are all based on placing celestial objects in a 3-dimensional Cartesian coordinate system subject to relativistic frame invariance. Is the real world really an object looking like a Cartesian coordinate system? No. Atoms, which are the most stable form of matter, are round and electromagnetic radiation has three qualitatively distinct spatial dimensions harboring magnetic and electric vectors and momentum whereby the signal forms a wave front. These qualities are not inherent in the Cartesian coordinate system. Why then should the universe be an infinite object of right angles as required by the invariance principle enforced at each point in a Cartesian coordinate system? Obviously, there is no reason why it should be. In fact, the geometry of the universe is not known. The following is an attempt at finding a more natural geometry of the physical world where the Cartesian coordinate system is secondary to the qualities of the observers' frames and the latter inherently yield the empirically known geometry. For this purpose, the 200 year-old academic debate mentioned above is revived: Observations are one-dimensionally directed towards the signal rather than towards the physical object and the object itself is made space-like separated from the observer's frame.

RESULTS

Let two observers O and $\bar{O}$ located on the x-axis of a Cartesian coordinate system measure at time t the distance between respectively origo and a point q near the circumference of a circle. Let

$$q_0 = \frac{\sqrt{1 - v^2/c^2}}{v} \frac{m^2}{s} \ ; \quad t_0 = 0 \ , \tag{10}$$

where m is the unit of distance, s is the unit of time (sec is the SI-unit of time) and $c = m/s$ is the velocity of light. The circle is defined by analogy with the unit circle, $(\cos x)^2 + (\sin y)^2 = 1$, as

$${q_0}^2 + \frac{1}{c^2} \frac{m^4}{s^2} = \frac{1}{v^2} \frac{m^4}{s^2} \tag{11}$$

Then perform a Lorentz transformation to the barred frame such that the observer $\bar{O}$ measures

$$\bar{q}_0 = \frac{1}{v} \frac{m^2}{s} \ ; \quad \bar{t}_0 = -s \tag{12}$$

Define the barred frame to be the laboratory frame and evaluate q and t at a time later by one unit in the barred frame, $\bar{t}_r = 0$;

$$q_r = \frac{\sqrt{1 - v^2/c^2}}{v} \frac{m^2}{s} \ , \quad t_r = s\sqrt{1 - \frac{v^2}{c^2}} \ ; \tag{13}$$

$$\bar{q}_r = \frac{1}{v} \frac{m^2}{s} - vs \ , \quad \bar{t}_r = 0 \ . \tag{14}$$

The sign of the interval, $d^2s = d^2x - d^2t$ as calculated on each of the four coordinates, $q_0, t_0;\ \bar{q}_0, \bar{t}_0;\ q_r, t_r;\ \bar{q}_r, \bar{t}_r$,

$$d^2s_0 = \frac{c^2 m^2}{v^2} - m^2, \qquad d^2\bar{s}_0 = \frac{c^2 m^2}{v^2} - s^2 \tag{15}$$

and

$$d^2 s_r = \frac{c^2 m^2}{v^2} + \frac{v^2 s^2}{c^2} - s^2 - m^2, \qquad d^2 \bar{s}_r = \frac{c^2 m^2}{v^2} + \frac{v^2 m^2}{c^2} - 2m^2 \ , \tag{16}$$

shows that the observers are space-like separated for all velocities $v < c$ and units $m = s$ whereas in classical relativity, space-like separation follows when $v > c$.

The time interval

$$\Delta \bar{t} = \bar{t}_r - \bar{t}_0 = 1 \tag{17}$$

is an interval of observation located adjacent to zero (=present) time, which is taken as the allowed coordinate from where an observation can be made. The lapse of one unit of time in the barred frame is measured from origo as

$$\Delta t = t_r - t_0 = s\sqrt{1 - \frac{v^2}{c^2}} \ . \tag{18}$$

The lapse of a unit of time produces a line increment in the barred frame,

$$\Delta \bar{q} = -vs \ , \tag{19}$$

while the radial distance as calculated from the frame at origo remains the same as before,

$$\Delta q = 0 \ . \tag{20}$$

The sign of the line increment shows that the radius of the observed object decreases (cf. eq. (14) and (19)). This corresponds to the observer at origo computing a contracted radius $\bar{q}_0$ such that from eq. (10) and (12), $q_0 = \bar{q}_0\sqrt{1 - v^2/c^2}$. Hence, the geometry can be visualized as a circle space-like separated from a peripheral observer who detects it in the form of a line increment in the direction of observation (equivalent of a contraction of its radius) after the passage of one unit of time. In physics, line increments in the direction of observation are known from the Bohr atom and the cosmological expansion.

An important argument for abandoning the Bohr quantization scheme in favor of the Schroedinger-Heisenberg schemes in the first half of the 20:th century was that the rotation of the electron around the nucleus not could be detected. No classical evidence of rotation could be obtained and the counter-argument that signaling from space-like separated events is forbidden was never presented in the debate at that time. One may infer that a similar situation should apply if the present geometry were applied to the cosmological expansion: No classical evidence of rotation may be anticipated in that case.

To proceed with these applications, factorize the unit of distance, m, into momentum mass, M, expressed in units of 's' and velocity;

$$m = Mv = \frac{\bar{q}_0 v}{c} \Rightarrow M = \frac{\bar{q}_0}{c} \tag{21}$$

such that the classical definition of photon momentum, $p = E/c$, reads $\bar{q}_0 = \bar{E}/c$ and any point on the signal axis may have some momentum relative to the expanding cosmological horizon. Let the line increment, $\Delta\bar{q}$, and the time interval, $\Delta\bar{t}$, represent a fluctuation around respectively $\bar{q}_0$ and zero (cf. eq. (12) and (14)). Further, let the symbol $\bar{h}$ substitute for Planck's constant, $\hbar$, in the present geometry and formulate the uncertainty principle relating to momentum, $dx \ dp = \hbar$, as

$$(-vs) \ (m) \approx \bar{h} \ . \tag{22}$$

Then, a vacuum fluctuation is expressed as

$$\Delta\bar{E} \ \Delta\bar{t} = (-vm) \ s = \bar{h} \ . \tag{23}$$

For observations towards origo along the full extension of the radius, the magnitude of the line increment is amplified from $\Delta\bar{q}$ per unit radius to m (this may also be seen from eq. (12) and (19)),

$$\frac{-\Delta\bar{q}}{m} = \frac{m}{\bar{q}_0} \quad , \tag{24}$$

which yields the differential

$$\bar{q}_0 \; \Delta\bar{q} = -m^2 \quad , \tag{25}$$

whereby the velocity of light, m/s, limits the radial extension of the geometry to $|\bar{q}_0|$. A local observer may try and apply the Euclidean closure axiom to the line increment, $\Delta\bar{q}$, and use it for constructing a 3-dimensional space of infinite extension including visible and space-like separated regions beyond the apparent remote cosmological horizon. However, in the present case, the extension of space is limited by $v \leq c$ as required by $\sqrt{1 - v^2/c^2}$. The limitation of the validity of the closure axiom is only evident by reference to the space-like separated (invisible) frame at origo.

Because of eq. (19) and (20), observations directly relying on energy transfers on the momentum-signal axis can only be made from the laboratory frame at the periphery towards the origin of space and time coordinates. The observer at origo is non-local in the sense of performing all observations solely on the time axis (eq. (18)). He is unable to define a spatial coordinate system through observations, which would require repetitive use of some line increment or a measuring rod. However, a relation between Δt and $\Delta\bar{q}$ exists. From eq. (18) and eq. (19)

$$(\frac{\Delta t}{s})^2 + (\frac{\Delta\bar{q}}{m})^2 = 1 \quad , \tag{26}$$

such that by comparison with the unit circle, the non-local time is perpendicular to the axis of observation in the barred frame. This is different from classical relativity where time is measured with reference to the velocities of the objects and light moving along the x-axis and arbitrarily assigned a dimension in Hilbert space with a metric and an observation may be performed from anywhere in four-dimensional space-time.

In order to see if the non-locality of the frame at origo may have any concrete consequences, consider the mathematical form of the Sommerfeld equation describing the absorption-emission spectrum of the Bohr hydrogen atom with relativistic corrections;

$$E_{nj} = M_0 \; c^2 \; \left(1 + \frac{\alpha^2}{\left(n - k + \sqrt{k^2 - \alpha^2}\right)^2} \right)^{-1/2} \tag{27}$$

where E_{nj} is the energy of the emitted radiation, M_0 is the rest mass of the electron, $\alpha = v_e/c$ is the fine structure constant, v_e is the orbiting velocity of the electron, and n and k are quantum numbers. Then make an observation towards origo; $\bar{q}_0 = q_0/\sqrt{1 - v^2/c^2}$, and factorize in this expression from unity using

$$1 = -\frac{\bar{q}_0 \Delta\bar{q}}{m^2} = \frac{v s q_0}{m^2 \sqrt{1 - v^2/c^2}} = \frac{1}{(\quad)\sqrt{1 - v^2/c^2}} \; . \tag{28}$$

the empty bracket indicating a non-zero factor, to get

$$\frac{\bar{q}_0}{ms} m^2 = \frac{q_0}{c} \frac{m^2}{s^2} \sqrt{\frac{1}{\left(1 - \frac{v^2/c^2}{(\quad)(1 - v^2/c^2)}\right)}} \quad . \tag{29}$$

where v^2/c^2 is perpendicular to the axis of observation (cf. eq. (11)) in the complex plane and the empty bracket harbors the torsional momentum quantum numbers of eq. (27). q_0/c is equivalent of rest mass (cf. Eq. (21)). The first two factors on the right side thus correspond to those of eq. (27). The term on the left side has dimension frequency times distance squared whereby the relation $\Delta\bar{q}\ m = \bar{h}$ is evident from eq. (19) and eq. (22). Then scale down from cosmological size to the unit radius using eq. (24) and accordingly divide the left side by $\bar{q}_0^2$ to get an interval of observation, $\Delta\bar{q}$, corresponding to the signal on the left side of eq. (27): The magnitude on the left side is made smaller by a factor of ${\bar{q}_0}^{-3}$ upon transforming from cosmological to atomic size. It may be concluded that eq. (27) and eq. (29) are equivalent up to the quantum numbers but distinguished by scaling of the magnitudes. Thus, if the signal axis is capable of transmitting information about the universe then the primordial hydrogen atom is capable of appearing along with it. The gravitational center of the universe is non-local in the empirical sense that contributions from all directions cancel at any point and the results therefore seem to indicate that this non-locality is made manifest through the existence of (hydrogen) atoms in a frame lacking spatial measures.

In contrast to the hydrogen atom for which exact experimental data long have been established, the geometry of the universe is not known. However the present non-standard approach to cosmology may be evaluated using known numerical data for the apparent expansion rate and other cosmological observables. This is somewhat beyond the scope of an investigation of the plain geometry but is nevertheless highly relevant in any discussion of the Euclidian closure axiom. Hopefully, applying the geometry in various pertinent contexts will yield numerical correspondence with standard cosmological models.

In principle, the expansion rate should be the inverse of the radius of the universe (eq. (24)), from where its matter density may be obtained by conversion from geometrized units. In one particular non-standard approach [1], the energy produced by Λ_0 decay tangential to the cosmological horizon is equated with the line increment as described by

$$\Delta\bar{q}_{length\rightarrow energy} = \frac{E_{\Lambda_0}}{2\ c\ \tau}\ 2\pi\ r_u \quad , \tag{30}$$

where E_{Λ_0} is the energy of the particle, τ is its half life, and $r_u = \bar{q}_0$ is the radius of the universe, which yields $\Delta\bar{q} = 0.7668 \times 10^{-26}\ m/unit\ radius$. In another approach, the geometry is applied to the Bohr atom with radius $\bar{q}_0$ using the scaling $m_e \propto \Delta q$ described under eq. (29) whereupon the condition $\Delta\bar{q}\ m = \bar{h}$ yields (with e indicating the elementary charge)

$$\Delta\bar{q} = \sqrt{\hbar}\ \frac{\pi}{2}\ \frac{2\alpha}{e\ c} \times Ampere \tag{31}$$

and the value $\Delta\bar{q} = 0.77145 \times 10^{-26}\ m/unit\ radius$. When further applying eq. (24) and integrating line increments per unit radius until the herein described limitation of Euclidean space is reached, the age of the visible universe appears to be $13.7 \times 10^9\ years$, which agrees in the 3:rd digit with the value recently calculated by the Wilkinson Map Project [2,3]. This result and the fact that the expansion rates are within acceptable limits of current estimations indicate that the present geometry is capable of providing a workable approach to cosmology.

It is noteworthy that not only physical objects are accommodated by this geometry. The signal transmission *per se* is also represented. Electromagnetic radiation is known to be composed of electric and magnetic vectors perpendicular to the signal propagation (as in the frame O, which also is capable of representing polarization and a non-local wave front) while the momentum appears in the direction of propagation (the frame $\bar{O}$).

DISCUSSION

This report describes a geometry, which is closely tied to physical objects and observations. The objects, which are atoms, are represented by a space-like separated frame having circular shape and a rotational velocity whereas the observer perceives the signal coming from the atoms in a one-dimensional frame of observation - the laboratory frame. The observation is made during a short interval of time located around zero. This interval is related to the classical quantum fluctuation described by the uncertainty principle. During the discrete observation of a signal, a radial contraction towards the remote is measured in the laboratory frame, which is pertinent to the electron jumps taking place in the Bohr atom. Since signaling from space-like separated objects not is allowed, the geometry naturally explains why there is no classical evidence of the electron's rotation around the nucleus. Depending on numerical calibration, the line increment towards the remote may also be relevant to the cosmological expansion rate. The geometry yields a one-dimensional universe perceived in the direction of observation towards the signal whereas the objects themselves are space-like separated. If applied on the cosmological scale, the atoms constitute evidence of the non-locality of the gravitational center of the universe, because they appear in the same non-local geometrical construct distinguished only by scaling of the magnitudes. The non-locality of the space-like separated frame at origo can be shown from the fact that it lacks spatial measures in the direction of observation. Measurements there are instead performed on a time axis estranged from classical relativity a) because it is inherently perpendicular to the axis of observation rather than being arbitrarily assigned a dimension in Hilbert space with a metric and b) because observations only can be made from zero time and not from arbitrary time coordinates in four-dimensional space-time. During the observation, a discontinuous Lorentz transformation of this object is performed to the laboratory frame. As a result, two or three spatial dimensions in the object (depending on polarization) become represented in a single spatial dimension in the laboratory frame - the signal axis.

Literature Quoted in Appendix

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