Quantitative Analysis of Atom and Particle Data Yields the Cosmological Expansion Rate in the Form of a Vacuum Instability *

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Abstract

The possibility that the Hubble expansion rate represents a vacuum instability is consolidated in the original framework of a geometry that inherently defines the shape of the hydrogen atom, vacuum fluctuations above the Heisenberg range, non-locality, and the electro-weak current. Calculations based on the Bohr atom yields the expansion rate $0.771 \times 10^{-26} m^{-1}$ while Λ_0 decay yields $0.767 \times 10^{-26} m^{-1}$. The Bohr atom is successfully factorized in terms of the geometry, which also defines a characteristic length associated with one-dimensional magnetic charge. The numerical value of the expansion rate can be identified with the electro-weak current by solving for the masses of the W and Z -bosons whereby a radial component of the former is at resonance with the $c\bar{c}$ family of mesons.

Keywords: Bohr atom, Λ_0 decay, W boson, Z boson, $c\bar{c}$ meson, Hubble expansion, Dirac string, quantum universe

1 Introduction to Theory

The instant of observation has a special significance in the quantum world since it accommodates the processes that cause the quantum observer to change from the ignorant state to the observed state. One approach to characterizing the instant of observation is to perform a Lorentz transformation of the inverse of the number-flux vector from a unit time prior to when the observation is made at time t=0 [1][2] to another frame of observation (barred) at its time $\bar{t} = -1$:

$$(q_0, t_0) = \left(\frac{\sqrt{1 - \frac{v^2}{c^2}}}{v} \frac{m^2}{s}, 0 \right); \qquad (\overline{q_0}, \overline{t_0}) = \left(\frac{1}{v} \frac{m^2}{s}, -s \right) \tag{1}$$

 Citation: Quantitative Analysis.. Proceedings of www.scienceandresearchdevelopmentinstitute.com , Quantum Physics & Cosmology # 13 (2010). Email: cerven@scienceandresearchdevelopmentinstitute.com In this 2024 edited version, corrections of printing errors, consistency, etc. are indicated by green and amendments by blue text. Amendments in the main text are only made in order to facilitate reading the manuscript and following the original logic. A 'Comments' section has been added with some recent perspectives on the original paper. The original unedited manuscript can be found here

$$(q_r, t_r) = \left(\frac{\sqrt{1 - \frac{v^2}{c^2}}}{v} \frac{m^2}{s}, s\sqrt{1 - \frac{v^2}{c^2}} \right); \qquad (\overline{q_r}, \overline{t_r}) = \left(\frac{1}{v} \frac{m^2}{s} - vs, 0 \right) \tag{2}$$

Here, m signifies the unit of length and s the *geometrized* unit of time using non-standard (not SI) notation in order to better keep track of the dimensions. Mass is also expressed in units of s. This system of equations defines two observers located at origo (un-barred) and at radius distance from origo (barred observer). The latter observer is capable of observations along the momentum axis, $\overline{\Delta q}$, and of measuring the unit of time while the observer at origo only is aware of time and recognizes an angular velocity v. The two observers are space-like separated [1] which causes the geometry to be merely reminiscent of but not equivalent of a circle. The interval of observation in the barred frame is characterized by

$$\overline{\Delta q} = -vs \tag{3}$$

and

$$\overline{\Delta q}\overline{q} = -m^2 \tag{4}$$

where $\overline{q}$ is the radius along the momentum axis.

There is no time axis in the momentum frame since any storage and retrieval of information about prior quantum events would imply that the system changes once again, thus defining another instant of observation. The same applies to any information that would allow the quantum observer to determine an angle of rotation relative to the outer world. Therefore, the quantum observer sees a one-dimensional, instantaneous world. All influences from perpendicular spatial axes that would be evident to an observer aware of a 3 or 4-dimensional world are embedded in the resultant vector located on the momentum axis. In contrast to the momentum observer, the un-barred observer at origo recognizes an angular velocity, which implies selecting a tangential direction and the awareness of orientation in space.

The geometry described is relevant to the real world as exemplified by an atom and the universe. In the former case, the interval of observation of an excited atom is characterized by a change of radial distance of the electron orbital from the atomic nucleus at origo as seen by a peripheral observer performing measurements in the signaling photon's momentum frame. In the case of the universe based on Standard Cosmology, a peripheral observer who watches in any arbitrary direction expects, in principle, to see signals coming from a non-local origo and perceives a line increment, the apparent cosmological expansion. Such geometrical features accommodating an interval of observation are not inherent in the Cartesian coordinate system or its non-Euclidian relatives like GRT[1]. The geometry described also accommodates a non-local frame since phenomena that are not in the momentum frame are not perceived at all by the quantum observer. Non-locality is usually associated with signals in the electromagnetic field (e.g. [3]) but it seems also necessary for a system to have in order to compute weighted probabilities (e.g. path integrals) before the system responds. Furthermore, the un-barred observer in Eqs. 1 - 4 measures a static universe where q_0 does not change (energy conservation), neither does the velocity v, nor does the line increment, $\overline{\Delta q}$. Hence this geometry inherently defines an instability of one-dimensional space where the length $\overline{\Delta q} + \overline{q}$ seen by the barred observer instantly relaxes back to a prior state $\overline{q}$.

Since the geometry described naturally accommodates so many features of the real world that have been proven in more detailed contexts in modern physics it seems worthy of examining more closely in

[1] general relativity theory

a quantitative manner. Xxx This was first done based on the Bohr formulation of the hydrogen atom [4] [5] and Λ_0 particle decay [1].

2 Calculations

Hydrogen is the commonest element in the universe. In diluted form it is, in practice, stable, and, as evidenced by nuclear reactions taking place in stars, it is primordial. The primordial, most stable matter in the universe is expected to be connected somehow to the space-time of the universe itself. The Bohr radius of the hydrogen atom in its ground state was originally derived by equating the Coulomb force between the orbiting electron and the proton with the centrifugal force on the mass of the electron, yielding [2]

$$a_0 = \frac{4\pi\epsilon_0}{e^2}\frac{\hbar^2}{m_e}. \tag{5}$$

In order to examine the relevance of the present geometry to the Bohr atom, Eq. 5 is rearranged to

$$(a_0\alpha m_e)\left(\frac{e^2}{4\pi\epsilon_0\alpha}\right) = \hbar^2 \tag{6}$$

and factors of the form of eq 4 are sought to be identified. The first parenthesis contains the factor a_0 which is interpreted as an oscillation of length perceived by the barred observer (first term of eq 4) whereas the geometrized mass corresponds to a steady length (second term of Eq. 4). By division with $\hbar$ and multiplication with c the first parenthesis turns into a dimensionless unit $(= 1)$ number based on an analysis of the 'frame signature'(cf. [6]) of the units (Table I and Appendix I),

$$D\left(a_0\frac{\alpha m_e c}{\hbar}\right) = \left(\overline{a_0}\frac{\alpha\widetilde{m_e}}{\overline{\overline{\hbar}}}\frac{\overline{m}}{\widetilde{s}}\right). \tag{7}$$

Table I

Momentum Frame $^{-}$	Nonlocal Frame $\sim$
length (m)	time (s)
momentum (m)	mass (s)
power (W)	force (N)
magnetic charge ($\overline{C}$)	electric charge (C)
electric potential ($\overline{V}$)	electric flux (C)

Table I. Frame signature of the commonest physical units (see Appendix I for a more comprehensive tabulation). An observer in the barred frame ($^{-}$) is only capable of measuring units that appear on the one-dimensional signal axis. Measurement of other units is unavailable to the quantum observer. These units are non-local, denoted by $^{\sim}$, in the sense of the barred observer. A local measurement distributed non-locally becomes non-local giving the rule $^{-}/\sim \;=\; \sim$. The measurement of two interdependent non-local units require that they become local giving the rule $\sim \;\sim\; = \;^{-}$

$$\left(a_0\frac{\alpha m_e c}{\hbar}\right)\left(\frac{e^2}{4\pi\epsilon_0\alpha}\right) = \hbar c \tag{8}$$

and by geometrizing m_e

[2]Bohr radius, a_0 =5.2918 $\times 10^{-11}m$; fine structure constant, $\alpha = 7.2974 \times 10^{-3}$; rest mass of electron, $m_e = 6.764 \times 10^{-58}m$; Planck's reduced constant $\hbar = 2.612 \times 10^{-70}m^2$; permittivity of vacuum, ϵ_0

$$\Big(1\Big)\left(\frac{e^2}{4\pi\epsilon_0\alpha}\right) = \hbar c. \tag{9}$$

The second composite term is factorized as

$$\left(\frac{\alpha}{\epsilon_0 \pi c^2}\right)\left(\frac{e^2 c^2}{4\alpha^2}\right) = \hbar c \tag{10}$$

where the frame signatures of the three composite terms are respectively (cf. Appendix I)

$$\frac{1}{\frac{1}{\sim\sim\sim}\frac{--}{\sim\sim}} =\sim= \frac{-}{\sim}; \qquad \frac{\sim\sim\ --}{\sim\sim} = --; \qquad \frac{-\ -\ -}{\sim} \tag{11}$$

The first composite term in Eq. 10 wherein the permittivity of vacuum and the permeability of vacuum are respectively

$$\epsilon_0 = \frac{1}{\mu_0 c^2}, \quad and \quad \mu_0 = 4\pi \times 10^{-7} H/m \tag{12}$$

has dimension rate, which is quantified using

$$\alpha\Big(c^2\ 4\pi \times 10^{-7} H/m\Big)\frac{1}{\pi}\frac{1}{c^2} = 4\alpha \times 10^{-7} H/m = 4\alpha \times 10^{-7} (Joule/m)\frac{1}{Ampere^2} \tag{13}$$

yielding

$$4\alpha \times 10^{-7} (Joule/m)\left(\frac{1}{Ampere^2}\frac{e^2 c^2}{4\alpha^2}\right) = \hbar c \tag{14}$$

whereupon the $Joule$ is geometrized,

$$4\alpha \times 10^{-7} (J \to m) = 4\alpha \times 10^{-7} \times 8.261 \times 10^{-45} = 2.4113 \times 10^{-53} \tag{15}$$

This numerical value is interpreted as

$$\frac{4\overline{\Delta q}^2}{\widetilde{s}^2 \pi^2} \tag{16}$$

and the rate is solved as

$$\overline{\Delta q}/s = 0.7714 \times 10^{-26}\ m s^{-1}. \tag{17}$$

Hence, after multiplication of Eq. 10 once again with $c = m/s$, $[m/s] = \ ^{-}/\ \sim)$ its square root is written

$$\left(\frac{2\overline{\Delta q}}{\widetilde{s}}\right)\left[\left(\frac{1}{\pi}\right)\left(\frac{ec}{2\alpha}\right)\right]\frac{1}{Ampere} = \sqrt{\hbar c} \tag{18}$$

Eq. 18 conforms to Eq. 4 since the 3:rd term in parenthesis, the magnetic charge (cf. [7], has the signature of the momentum frame and, also historically, was first identified as a one-dimensional string [8]. Table I may provide a hint at the origin of the factor π in Eq. 18. Of the units that are measurable to the quantum observer only the magnetic charge has a divergence (required classically for symmetry with electrical charge). Therefore the factor π may be regarded as adapting the divergence to one dimension. The quotient $\sqrt{\hbar c}/\overline{\Delta q}$ is not equal to the rest of the terms on the left side since the $Joule$ has been geometrized. The quotient is $2.095 \times 10^{-9} m$, which probably pertains to the range of the magnetic charge. It corresponds to 40 Bohr radii or 20 atom diameters but a full magnetic charge would correspond to twice that, or $4.19 \times 10^{-9} m$, a range characteristic of nanotechnology applications and energy-converting biomolecules including enzyme subunits.

The rate $\overline{\Delta q}/s$ is identified as the Hubble expansion rate on a unit length basis [4] [5]. This numerical value is in agreement with contemporary standard cosmology and, incidentally, provides exactly the same age of the universe[3] as does current standard cosmology [5], cf. [9], 13.7 billion years [4] The inverse of the line increment, $\overline{q}$ is interpreted as the radius of the universe [5].

The standard theory of hot Big Bang Nucleosynthesis provides estimates of the elemental composition of primordial matter, which in the case of the $^4He/H$ quotient agree with data from hot stars extrapolated back to zero metallicity [9] assumed to represent primordial conditions [5]. This primordial mass fraction of $^4He/H$ is 0.25, corresponding to a proton to neutron ratio of 7 [9]. By comparison, the Λ_0 particle, which is generated by 'associated production' in particle accelerators decays into 64% protons and 36% neutrons whereupon the latter further decay into protons and electrons to the extent that the primordial mass fraction is reached and surpassed in a matter of minutes. Several unstable elementary particles decay partly into Λ_0 whereupon stable matter is formed in this manner. Therefore, from an energy point of view, the Λ_0 may be regarded as an excited state of primordial matter by analogy with the electron shell picture of the hydrogen atom. Suppose that the energy it represents, $E_{\Lambda o} = 1.1157 \times 10^9 eV = 1.477 \times 10^{-54} m$ is contributed equally by each surface element at the cosmological horizon (as seen by the un-barred observer) to yield one unit of energy. This theoretical construct is similar to the CBR in Standard Cosmology. Then

$$\left(\frac{E_{\Lambda o}}{c\tau}\right)\pi(r_{universe})^2 = 1 \qquad \left(= \frac{1.477 \times 10^{-54}}{3 \times 10^8 \times 2.631 \times 10^{-10}}\,\pi \right) \tag{19}$$

and

$$\overline{\Delta q} = 1/r_{universe} = 0.767 \times 10^{-26} \tag{20}$$

as seen by the barred observer. The denominator in the first composite term in Eq. 19 is the length the equivalent energy travels at the speed of light until it decays by half (τ = mean life of the Λ_0)[6]. This is similar to the Bohr geometry where the electron at infinite distance looses half its potential energy into radiation and maintains the other half as kinetic energy when settling in the ground state (cf. [10]). It is interesting that the two numerical values in Eq. 17 and 20 are so close but the one derived previously from the Bohr atom requires fewer assumptions and will be used for the subsequent calculations in this series of papers.

In order to examine if the instability of space inherent in the geometry can be interpreted as a vacuum fluctuation one approach is to redefine uncertainty relations ([1] [2]). Then

$$\overline{h} = \overline{\Delta q} m \tag{21}$$

[3]At the time of editing this paper, in 2024, this age of the universe is still within errors of standard cosmology. However, the latter is model-dependent: The local apparent Hubble rate obtained by astronomical observations give a better reference since it narrows in more and more towards the theoretical value calculated in this series of papers.

[4]Standard cosmology now indicates an age of 13.69 ± 0.13 years. The current official value of the Hubble rate is 72 ± 3 km/sec/Mpc which equals here $0.778 \times 10^{-26} s^{-1}$ (s = m). In the present geometry, the age of the universe is obtained by adding line increments to each unit length on the $\overline{q}$ axis until the velocity of c is reached at the cosmological horizon yielding the age as $\overline{\Delta q}^{-1} s$.

[5]The CBR is usually regarded as the strongest direct evidence of a primordial hot big bang. However, direct observation of astrophysical objects demonstrate that gravitationally aggregated hot matter has a tendency to cool down below the expected temperature because of magnetic effects. For example, the surface of the sun is cooler than its surrounding gas. Many astrophysical objects do not seem to be formed by random statistical motion but instead have an axial geometry. If the extent and nature of the magnetism in aggregated matter were known and taken into account it would probably alter Big Bang cosmology.

[6]see 'Comments' section for a perspective

corresponds to Planck's constant applied to this geometry and since, in that case,

$$\Delta E \Delta t = \overline{h} \tag{22}$$

the magnitude of these vacuum fluctuations would be such as to allow the energy of 41 Λ_0 particles to be stabilized by the current age of the universe (the latter being numerically equal to $\overline{q}$ using geometrized units), corresponding to 45 GeV. To see if there is any substance in this numerical value, focus is set on the resonance particles, the W and the Z -bosons, and on the quark-antiquark mesons, which are candidates for such large vacuum fluctuations [11] [12] [13]. In agreement with the original interpretation of the electro-weak force as a sum of a vector current and an axial current (cf. [14]) the W and the Z boson are expressed respectively as [11]

$$M_W = A\overline{\Delta q}^2 + B_1\overline{\Delta q}^2\pi C \tag{23}$$

and

$$M_Z = A\overline{\Delta q}^2 + B_2\overline{\Delta q}^2\pi C. \tag{24}$$

The difference,

$$\Delta M_{(W-Z)} = \Delta B\pi\overline{\Delta q}^2 C \tag{25}$$

is solved in the framework of the Standard Model with $\overline{\Delta q}^2 = 45\ GeV$ and $C = 0.229$ interpreted as $C = sin^2\theta$ where θ is the electro-weak mixing angle [9] [7], yielding $\Delta B = 1/3$, $B_1 = 1/9$ and $B_2 = 4/9$. Since rational fractions of π are obtained, resonance between the electroweak current and the apparent cosmological expansion rate can be claimed already at this point but the evaluation can be taken further. The radial component of the W boson (the last composite term in Eq. 23) is solved to be $P = 3.6\ GeV$, which equals the mass of two π(1800 mesons oraverage energy of the known $c\bar{c}$ -mesons. The latter are candidates for mass generation schemes in the Standard Model, cf. [15], by analogy with Cooper pairs The $c\bar{c}$ mesons entering as an average around $3.6GeV$ above is consistent with calculations indicating that their quarks contribute with the up and down quarks to mass generation schemes. Therefore it is particularly interesting that they can be regarded here as a manifestation of a vacuum fluctuation linked to the apparent Hubble expansion. A software was developed solely for the purpose of examining the relation of the rest masses of more than 200 known elementary particles to this (or any other) value of P. By probing the quotient $\sqrt{M/P}$ the $c\bar{c}$ family of mesons were found to be off resonance by only 0.024 [12][8]. Several other interesting relations between the square roots of the masses and that of P were also found using the software[9].

3 Discussion

The results presented provide strong evidence that the apparent cosmological expansion can be regarded as a vacuum instability. In 2001, when the results based on the Bohr atom were first submitted for publication, there was an official uncertainty of the Hubble expansion rate of about 10% (71 ± 7) and the age of the universe was estimated at between 12 and 18 Gyr. These ranges have now narrowed considerably and the calculations based on the Bohr atom have been supplemented with data on the W boson, the Z boson and the $c\bar{c}$ meson family to support the original theory. However, since the Big

[7] In 2004, when these results were first published the value 0.229 was a little high whereas now in 2010 the official calculations converge towards 0.231 the recent paper, # 31 in this series, maintains the value 0.229

[8] as of 2006, the average mass of 13 $c\bar{c}$ particles is 3.697 GeV, http://pdg.lbl.gov

[9] this software and a tutorial are available for download on this webpage. It is said to be compatible up to 36bit Win 7.0, probably also on later Win-versions if a suitable DOS environment is downloaded from the Internet. Some examples of screenshots can be found in the author's papers [12] and [13] in the reference list. As of the time of writing the software has not been checked for errors but editing is planned for the not so immediate future.

Bang model is perhaps as rooted in established physics as was the ether concept in the 20:th century it is likely that a cosmological model based on the present geometry will still be met with considerable resistance. Nevertheless, the results provide a self-consistent viable model which may provide a perspective to the established cosmological models. Besides the numbers derived from the Bohr atom this cosmological model benefits conceptually from Dirac strings that hide divergence into one dimension leading to quantization, something which is expected to be of importance for interpreting the apparent divergence of the universe. Therefore, 'Bohr-Dirac universe' or 'quantum universe' might be good working names for future reference to the present theory and its applications.

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4 Comments

The idea here that the particle's mass is distributed at velocity c along the momentum axis is related to the notion of particle creation at the boundary of a black hole. Recently, in paper # 35 in this series, the (Hubble) line increment squared was interpreted as an instance of 'action', ΔEt, and shown to harbor quantitatively both the W and the Z boson (even the 'Higgs' particle) in a scenario where the universe's relativistic horizon is interpreted as an inverted Schwarzchild black hole. In this construct, a penta-meson, rather than a Λ_0 particle was evaluated for the role of an excited threshold state beyond which the matter becomes stable.

APPENDIX I not edited herein, available separately on this webpage

Table I, (copied in its entirety from ref. [6]). Related physical units and entities grouped according to their 'frame signature' as seen in a one-dimensional universe by a local (barred) observer capable of direct observations along the axis of observation (= momentum axis) and indirect measurements perpendicular to this axis (indicated by a tilde). The names of the physical units and notations in parenthesis in the 'Systeme International' appear in the third column ('sec' is used for 's') with two alternative (and equivalent) frame signatures immediately to the left and right. Densities based on local and non-local volumes (Vol) are indicated by bars and tildes respectively. The signature to the far left (first column, 'comp' for 'comparison') is derived by multiplying the basic one by that inherent in the geometry, $^{-}/\sim$. The signature in the column marked '3D' is obtained by factorizing out the squared frame signature of energy and taking the cubic root of the residue unless this is not possible. The signature of the squared energy is thrice a local dimension (3D) denoted by the letter 'Y'. In incompatible cases the signature of the residue appears and the first physical unit in the group is marked 'N.A.'. In the sixth column the basic frame signatures are divided by that of time in order to get the dimension of an entity undergoing quantitative changes with time and in the seventh column those time derivatives are compensated for the dimensionality inherent in the geometry as indicated above. Most of the special names of the physical units and their SI base units may be found in [7].

Table I

(Comp)	Basic	Unit	Alternative	3D	t^{-1}	t^{-1} (Comp)
¯	~	Group A:	¯/ ~	~/ ¯ ¯ ¯	1	~
		Time (sec)		N.A.		
		Mass (kg, sec)				
		Electric Charge (C)				
		Electric Flux				
		Force (N)				
		c				
		Vector Potential, A				
~~	¯	Group B:	~~~/ ~	1/ ¯ ¯	¯/ ~	¯
		Length (m)		N.A.		
		Momentum				
		Power (W)				
		Resistance (Ω)				
		Magnetic Charge $\overline{C}$				
		Electric Potential (V)				
¯ ¯	~~~	Group C:	¯ ¯/ ~	Y/ ~	¯	~~~
		Energy (J)				
		Magnetic Flux (Wb)				
		$G = c^3$				
1/_	1/ ~~~	Group D:	~/_ _	Y ~~~	1/_ _	1/ ~~~
		Energy Density (Vol ¯)				
		Electric Flux Density (C/m^2)				
		Pressure (Pa)				
		Electric Displacement				
1	1/ ~	Group E:	~/ _	~/ _ _ _ _	1/ _	1/ ~
		Frequency (Hz)		N.A.		
		Magnetic Flux Density (T)				
		Magnetic Charge Density (Vol ~)				
		Magnetic Field Strength, B (T)				
1/ ~	1/ _	Group F:	~/ ~ ~ ~	1/ _ _ _ _	~/ _ _	1/ _
		Magnetic Field, H (A/m)		N.A.		
		Intensity (VA/m^2)				
		Electric Charge Density (Vol ~)				
		Poynting Vector (W/m^2)				
_/ ~	1	Group G:	¯/ ~~	Y/ _	1/ ~	1
		Acceleration				
		Current (A)				
		Energy Density (Vol ~)				
		Electric Field Strength (V/m)				
		Material Constants:				
¯	~	Permeability H/m	¯/ ~	~/ _ _ _	1	~
1/_	1/ ~~~	Permittivity, F/m	~/_ _	Y ~~~	1/_ _	1/ ~~~
1	1/ ~	Capacitance (F)	~/ _	~/ _ _ _ _	1/ _	1/ ~
1/ ~	1/ _	Conductance	~/ ~ ~ ~	1/ _ _ _ _	~/_ _	1/ _
¯ ¯	~~~	Inductance (H)	¯ ¯/ ~	Y/ ~	¯	~~~