The Geometry of Space and Time

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Abstract:

Time and space are clearly interconnected, but modern physics still struggles to unify their relationship to each other and quantum behavior. Here we demonstrate a plausible dimensional connection of time and space in our universe and the cosmos using a mathematically semi-classical and phenomenological approach. We show how quantum behavior applied to relativistic concepts could play a role in the overall geometry of both spacetime and the multiverse. By applying Newton's laws with time as a spatial dimension and employing quantum degrees of freedom to the entire universe, a description of the geometric relationship of time, space and gravity is established. This information is leveraged to show how quantum behaviors at the largest scales outside our universe can be employed to gain a deeper understanding of the size of our universe over time, dark energy and the cosmological constant.

Key Words: What is Mass, Multiverse Theory, Torus Field, What is Dark Energy, Cosmological Constant, Time as a Spatial Dimension, Time Acceleration

Introduction:

We investigate some of the issues in our understanding of gravity, space and time such as the fundamental basis for spacetime curvature around objects of mass and the cause of dark energy. Two base assumptions directly from Einstein and Feynman are built upon for this exploration: 1) Time is considered as a spatial dimension (understood from the behavior of objects at relativistic velocities experiencing time dilation),[1] and 2) Quantum behavior is understood as a potential in all possible degrees of freedom in 3D space forming a 3D set of possibility paths (synonymous with a multiverse and understood from the mathematics of Feynman diagrams in Quantum Field Theory).[2] We utilize a phenomenological and semi-classical mathematical approach to understanding our universe, similar to that of D. Sciama and N. Haramien.[3,4] A new interpretation of Hubble's Constant is proposed by utilized the understanding of time as a spatial dimension and Classical Newtonian and quantum mechanics are applied to measured and calculated values from the Cosmic Microwave Background (CMB) data to construct the geometry of our multiverse and spacetime universe. From the derived equations and geometry, a relationship between space, time and gravity is established and a new hypothesis for the progression and size of our universe is proposed. Energies for our universe (baryon, dark matter, dark energy), omega (dark energy) and cosmological constant are calculated using this method and are in good agreement with measured values. Finally, a simple mechanism is proposed for dark energy as well as a new understanding for the cosmological constant.

Physical Assumptions, Explanations and Mathematics:

In general relativity, an object with mass is proportionally associated with a curvature of spacetime radially around that object, centered on its center of mass.[5] Let's assume the curvature of spacetime around an object of mass is caused by a curvature force, F_c. This radially inward facing force would be perpendicular to our familiar force of gravity, F_g, between objects of mass which attract to minimize total spacetime curvature. To find an appropriate force equation to describe the curvature force, F_c, for a system of mass, M_{sys}, we require an acceleration of the inward curvature to satisfy the force equation:

$$F_c = M_{sys}a_c \quad (1)$$

If we assume the source of this acceleration to be constant, we should be able to find this acceleration by means of some acceleration of the universe itself. Indeed, we find such a value in the acceleration on large scales in our universe between galaxies: Hubble's constant. If we consider the entirety of our causally connected universe as our system, with center of mass at the observer (Milky Way Galaxy from our prospective), then we can determine the curvature acceleration, a_c, to be related to Hubble's constant, H_o, by:

$$a_c = 2H_o \quad (2)$$

The factor of 2 being due to Hubble's constant taking into consideration the distance changes from the central observer to the horizon in one direction rather than an equally radially outward facing acceleration of both +/- in any arbitrary x, y or z direction from the observer. Note that, in agreement with the cosmological principle and infinite Minkowski space, that the central observer is any arbitrary system in the universe since all points observe a homogenous (at large scales) universe from its center.[6] Note for our calculations herein, we will be using the approximate H_o derived from the Cosmic Microwave Background (CMB) of 66 km/s/Mparsec which converted to standard units is 6.41×10^{-10} m/s^2.[7]

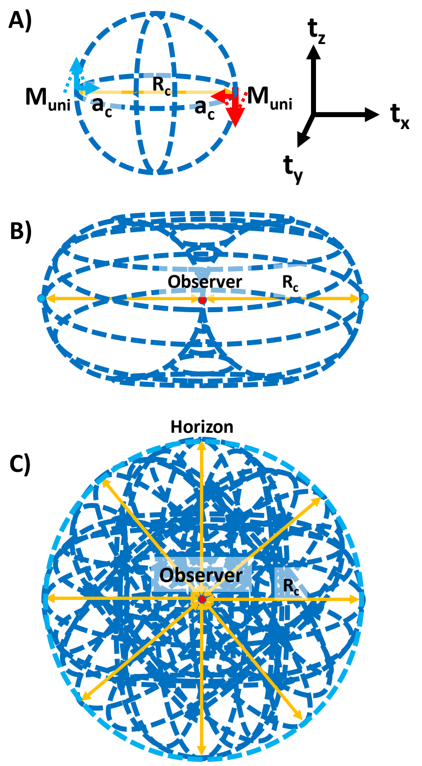
Taking our entire universe as the system, we get the force equation:

$$F_c\,(uni) = M_{uni}a_c \quad (3)$$

If we model the gravitational spacetime curvature in our universe as being in an orbit around another object at the edge of our 46.5 billion light year away cosmic horizon, R_c, we can use Newton's Law of Gravitation to create another force equation:

$$F_c\,(uni) = M_{uni}M_cG/R_c^2 \quad (4)$$

Combining (3) and (4) can yield us an equality where we can solve for the mass of the object at the edge of our cosmic horizon, M_c:



Scheme 1: A) Time orbital surface B) Cosmic torus and C) Cosmic orbital of timespace.

$$a_c = M_cG/R_c^2 \quad (5)$$

Solving for M_c yields 3.72 x 10^{54} kg. If we plug this value into the mass-energy conversion equation ($E = mc^2$) we get 3.34 x 10^{71} J. Interestingly, this value is often given as the total energy of the universe, E_{uni}, and thus M_c can be thought of as the energy-mass of the universe, M_{uni}, such that:

$$E_{uni} = M_cc^2 = M_{uni}c^2 \quad (6)$$

This suggests that any mass system within the universe, including the universe as a whole, is being gravitational attracted to an equal relativistic energy universe with center of mass at our cosmic horizon, R_c.

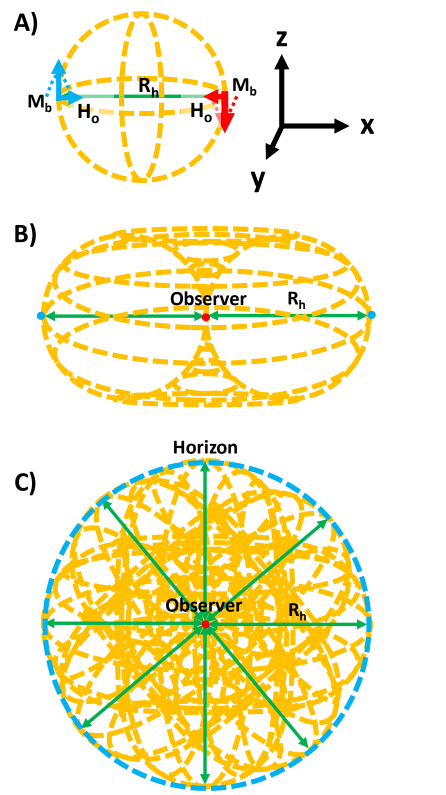
Consider for a moment that our universe on large scales can be thought of as a clock which tracks the progression of time via the increasing distance between galaxies. In this way, our cosmic horizon is a sort of time horizon, since this distance is calculated by the outward progression of galaxies in our universe, and is thus its location is defined by the change in position of galaxies at our universes event horizon, $R_{h,}$ over the time the light took to reach us. Thus, cutting across the orbit could itself be considered moving through the time dimension.

Exploring the energy relationship further, the energy of the universe can be described in terms of two orbiting bodies as:

$$E_{uni} = M_{uni}^2G/2\pi R_c \quad (7)$$

Interestingly, the denominator is two times the circumference of the orbit. To understand why this might be, we must understand the statistical and quantum nature of time. Quantum field theory (QFT) operates via the assumption of all possibilities occurring on the quantum level simultaneously in time to give rise to fields.[2] Here we will apply this principle to time on the cosmic scale by suggesting that many timelines are possible for the universe. The time orbit derived from (5) is depicted in Scheme 1A with the understanding that the relative position of orbiting bodies has full directional degrees of freedom (left/right/up/down) at the fixed distance R_c in adjacent directions; creating a time orbit surface of possible timeline paths. We can now consider additional degrees of freedom for each position in time (AKA, any point on the time orbit surface) as being potentially in another orbit in any arbitrary direction normal to the surface, extending into this degree of freedom yields a dynamic torus depicted in Scheme 1B with its center being a single point which is at any place in time centered on the observer. Note that the dynamics of this cosmic torus are such that in order for all points to be potentially at its center, it must have inward and lateral rotational degrees of freedom, which shift as the observer moves through energetic microstates in time and space. Finally, if we consider central axis rotations which when considered as possibilities allows for the formation of a 3D cosmic orbital made of dynamic torus' which exist in all orientations depicted in Scheme 1C with the internal volumetric dimensions of microstate possibilities of time denoted t_x, t_y and t_z. To our universe, these would appear as a potential of all possible movement vectors in x, y and z which can be taken by every system therein, and could thereby be considered a 3D multiverse, or timespace. The term timespace is denoted here because of the dependence which multiple probable timelines (3D time) have on any single microstate configuration of space. Inversely, spacetime is the single timeline realized from microstate configurational change in 3D space. If we take a cross sectional slice of the cosmic orbital of timespace, we find that its circumference is in fact $2\pi R_c$, as is any 2D slice through the center of any torus making up the structure. Thus, the energy of the universe as described in (7) seems to require taking into consideration any full timeline path in an arbitrary orbit at distance R_c which can be thought of as a closed timeline loop. Note that each closed timeline loop of $2\pi R_c$ represents a finite 3D space (such as our causally connected universe) which is assumed to undergo a course of microstate changes (driven by entropy) through time, until by some mechanism it returns back to the same configuration, closing the loop. In our universe, this loop closure, which perhaps represents a return of the universe to the singularity takes about 289 billion years. Thus, this theory supports cyclical time, possibly convergent with the concepts in loop quantum gravity.[8]

Above, we derive the notion of time from a finite changing space using physically measured cosmic values. Below, we will derive the notion of 3D space from the above. If the path around timespace represents the full distance of any given timeline cycle in our universe, we can see that a shorter path exists through the center of the volume at a distance of $2R_c$ with distance from any central observer of R_c. Much like in an electrons charge field, where the electron is causally connected to all future positions in x, y and z creating a volume of probability, here we will causally connect the central observer to the cosmic horizon. By connecting these causally connected points through probability and time into a circle



Scheme 2: A) Horizon orbit B) Horizon Torus and C) Horizon orbital of spacetime.

with circumference R_c, we arrive at a new orbital in Scheme 2A. The diameter of our new 3D sphere is denoted R_h, which is related to R_c by:

$$R_h = R_c/\pi \qquad (8)$$

R_h incidentally, gives a value 1.40 x 10^{26} m, which if we convert to a time, t_h, via the speed of light:

$$t_h = R_h/c \qquad (9)$$

Yields the value 4.68 x 10^{17} s. Interestingly, this value, is the same as the time distance to the particle horizon given the H_o derived from the Cosmic Microwave Background (CMB) mentioned above:

$$t_h = c/H_o \qquad (10)$$

Note that although the age of the universe is largely in question, the distance we observe to the particle horizon of the universe is calculated by the redshift of light from the CMB.[9] Therefore, R_h is the distance in meters to the event horizon at the time of the CMB, and we will thus denote the surface the horizon orbit.

Combining (9) and (10) gives an interesting relationship between the CMB Hubble's Constant and the universal event horizon:

$$R_h = c^2/H_o \qquad (11)$$

Essentially equating the size of the observable universe to the acceleration between objects in space.

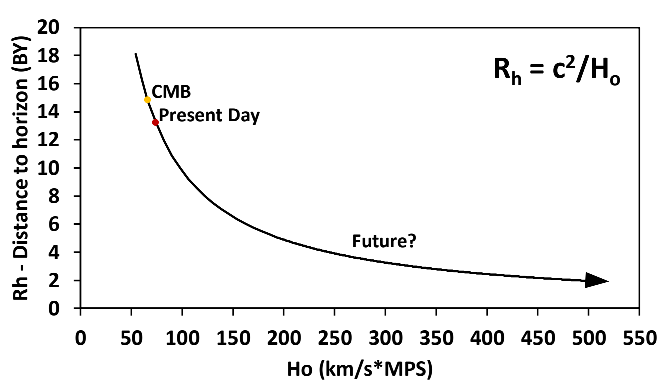


Figure 1: Hubble's constant effect on the distance to the event horizon.

Figure 1 shows graphically how these values are related inversely, and how growing in Hubble's constant (as our universe appears to be doing) leads to a shrinkage in the distance to the horizon. Because this value is commonly used as the age of the universe, perhaps the current assertions of the universe being 13.8 BYO is premature. Additionally, while it is true that galaxies are accelerating apart, the observable universe is apparently shrinking with time. Perhaps this shrinking of the causally connected universe with increased Hubble's constant is related to the cyclic mechanism of our universe, where upon large enough H_o the universe reverts to a singularity. Note that the measurement of present-day Hubble's constant is from galaxy regression in spacetime, which might indicate how far along the path in time we are (with more data) while the CMB value used to determine the orbit may remain constant in timespace, only linking to spacetime at the time of the CMB.

If we consider the force of the horizon orbit, we can obtain the Newton's law equations for an arbitrary system of mass, M_{sys}:

$$F_h = M_{sys}H_o \tag{12}$$

$$F_h = M_hM_{sys}G/R_h^2 \tag{13}$$

Combining (12) and (13) gives us an equality:

$$H_o = M_hG/R_h^2 \tag{14}$$

Solving for M_h yields 1.88 x 10^{53} kg, a value that reflects ~5% of M_{uni}, which appears to reflect the mass of all baryon matter in the universe, M_b (presumably at the time of the CMB). If we convert the cosmic equality in (5) using (1) and (8) into terms of H_o and R_h, we can achieve:

$$2H_o = M_{uni}G/(\pi R_h)^2 \tag{15}$$

Combining (15) and (14) to get M_b in terms of M_{uni} yields:

$$M_b = M_{uni}/2\pi^2 = 0.0507{*}M_{uni} \tag{16}$$

If we take into account the baryon matter of our entire universe, we get the force equation:

$$F_b = M_bM_bG/R_h^2 \tag{17}$$

These relationships suggest that baryon matter is the result of the horizon orbit of our universe, and that an equal mass of baryon matter to our universe exists at the event horizon of our universe, possibly reflective of a Dirac-Milne-type of universe where an antimatter universe, whose mass is the result of motion is the opposite direction in the horizon orbit to our own.[10] This could be considered as relative time flow direction (antimatter is matter moving backwards in time relative to us), characterized by the receding of large-scale objects from each other in our universe by Hubble's Constant.

If we consider the energy of baryon matter in our horizon orbit, we can construct the equalities:

$$E_b = M_bc^2 \tag{18}$$

$$E_b = M_bH_oR_h \tag{19}$$

$$E_b = M_b^2G/R_h \tag{20}$$

Where the energy of baryon matter in our universe is considered over the distance to our event horizon, R_h. If we utilize the same degrees of freedom applied to the cosmic orbital to the horizon orbital, we produce a horizon torus and horizon orbital of Scheme 2B and 2C, respectively. Note that for any two opposing points on the surface of the time orbital of timespace there exists a 1D linear thread through its 3D time-volume which represents a 2D closed surface around a 3D volume of space. The relationship between these volumes thus being that of a hypersphere where the entire surface of timespace contains the information of all possible microstates within the volume of the horizon orbital of spacetime. This relationship of time and space thus elucidating the Holographic Principle, where on any 2D surface can be encoded all the microstate quantum information of its enclosed 3D volume.[11] Furthermore, upon close determination of this relationship, we can see that movement through space requires movement through time, since microstate changes in space incur equal linear motion in time, hence space and time are deeply interconnected.

Now imagine two kinds of interactions can occur on material systems in spacetime within our observable universe: Those from within our observable spacetime ($E_{ST/TS}$) and those from the outer timespace ($E_{(TS\text{-}ST)/TS}$). Interactions can be represented as total energy of the universe where the relationships are:

$$E_{uni} = E_{ST/TS} + E_{(TS\text{-}ST)/TS} \qquad (21)$$

Because timespace includes within it the totality of possible configurations within spacetime, we can take the energy of a linear portion of time representing our causally connected spacetime (R_h) and find its ratio to timespace ($R_c = \pi R_h$). we can obtain the relative ratios of internal-internal, $E_{ST/TS}$, and internal-external, $E_{(TS\text{-}ST)/TS}$ interactions:

$$E_{ST/ST} = E_{uni}*R_h/R_c = E_{uni}/\pi \sim 0.318*E_{uni} \qquad (22)$$

$$E_{(TS\text{-}ST)/TS} = E_{uni}*(R_c\text{-}R_h)/R_c = E_{uni}*[(\pi\text{-}1)/\ \pi] \sim 0.682*E_{uni} \qquad (23)$$

Amazingly, we find that $E_{(TS\text{-}ST)/TS}$ is equivalent to the dark energy content of the universe, E_{de}, as measured in the CMB.[12] The omega term used to denote the percentage of dark energy is given by:

$$\Omega_{de} = (R_c - R_h)/R_c = (\pi - 1)/\pi = 0.682 \qquad (24)$$

This leaves the $E_{ST/TS}$ term to be equivalent to the total matter energy content of the universe (including baryon and dark matter), E_m, also as measured in the CMB.

Now consider the masses associated with E_m and E_{de}:

$$M_m = c^2/E_m \qquad (25)$$

$$M_{de} = c^2/E_{de} \qquad (26)$$

The mathematics described above assume M_m accounts for mass within spacetime (causally connected baryon and dark matter) and M_{de} accounts for mass outside our spacetime but within timespace (causally disconnected matter beyond the universes event horizon). If we model the effective energy between these systems in reference to their respective energies, we obtain the following relationships:

$$E_{de} = M_{de}M_mG/2\pi R_h \tag{27}$$

$$E_m = M_m^2G/2\pi R_h \tag{28}$$

These equations show that the energy between these masses is considered over a cross-sectional circumference of the visible universe ($2\pi R_h$).

If we now think about the curvature of the event horizon, k_h, it can be defined as 1/radius such that:

$$k_h = 1/R_h \tag{29}$$

If we take the gaussian curvature, K_c, which takes into account the curvature of a 2D surface:

$$K_c = k_h^2 = 1/R_h^2 \tag{30}$$

When considering the shape of the surface, if we assume a sphere or torus shape, a Ricci scaler factor of 2 gives:

$$S = 2*K_c = 2/R_h^2 = \Lambda \tag{31}$$

Interestingly, this value gives us $1.0x10^{-52}$ m^{-2} which in fact is the cosmological constant, Λ, that describes dark energy in our universe. Note that this value can also be reached through the more standard equations pulled from the Friedman equation:

$$\Lambda = 4\Omega_{de}\pi G\rho_b/c^2 \tag{32}$$

$$\Lambda = 3\Omega_{de}H_o^2/c^4 \tag{33}$$

Where ρ_b is the baryon density of the universe defined as:

$$\rho_b = M_b/V_{uni} \tag{34}$$

The volume within our causally connected horizon, $V_{uni} = 4/3*\pi*R_h^3$, gives: $1.15x10^{79}$ m^3. Solving for baryon density using our above value for M_b yields $\rho_{bm} = 1.6x10^{-26}$ kg/m^3. Solving for (32) using this value and the various constants used throughout this communication yields: $1.0x10^{-52}$ m^{-2}.

Therefore, the cosmological constant appears to be a function of the curvature of our universe's event horizon.

Conclusion and final thoughts:

A 3D statistical analog to our spacetime, timespace, was derived by utilizing a simple Newtonian gravitational equation and measured values from our universe as the result of an orbit of our universe through time and extrapolating to have degrees of freedom similar to that observed in quantum systems. Within this timespace, all possible microstates exist, whereas in spacetime only one microstate is experienced at a time. Any path through the dimensions (t_x, t_y, t_z) can be called a timeline and all relativistic energy in the universe was calculated as a result of this orbit. Spacetime was derived as being the encoded set of changing microstates in an observable timeline, the 3-spacial dimensions (x, y and z) derived utilizing the same quantum relationships of degrees of freedom as that of timespace. The spacetime portion of timespace can be modeled such that it gives rise to baryon mass in our universe from an orbit at our universe's event horizon. Within timespace is included the casually connected (spacetime-spacetime) and causally disconnected (timespace-spacetime) universe, within which can be deduced the effect of gravity from inside and outside observable space and leads to the calculation of matter energy (baryon + dark; 31.8%) and dark energy (68.2%), respectively, which agrees with measured quantities. Lastly, the cosmological constant was derived in agreement with those calculated using portions of the Friedman equation using this method and found to be a result of curvature in the universe from the mass energy contained within the causally connected spacetime.

Glossary of Terms:

Hubble's Constant:

H_o (CMB) = 66 km/s/Mparsec, 6.41 x 10^{-10} m/s^2

H_o (Current) = 74 km/s/Mparsec, 7.19 x 10^{-10} m/s^2

Curvature (Time) Acceleration:

a_c = 134 km/s/Mparsec, 1.28 x 10^{-9} m/s^2

Gravitation Constant:

6.67 x 10^{-11} m^3/kg*s^2

Speed of Light:

c = 2.998 x 10^8 m/s

Cosmological Distance:

R_c = 46.5 BLY, 4.40 x 10^{26} m

Horizon Distance:

R_h = 1.40 x 10^{26} m

Horizon Time:

t_h = 14.8 billion years, 4.68 x 10^{17} s

Cosmological Constant:

Λ = 1.0 x 10^{-52} m^{-2}

Omega-Lambda:

Ω_{de} = 0.682

Mass:

Universe: M_{uni} = 3.72 x 10^{54} kg

Baryon: M_b = 1.88 x 10^{53} kg

Dark Energy: M_{de} = 2.54 x 10^{54} kg

Matter: M_m = 1.18 x 10^{54} kg

Energy:

Universe: E_{uni} = 3.34 x 10^{71} J

Baryon: E_b = 1.69 x 10^{70} J

Dark Energy: E_{de} = 2.28 x 10^{71} J

Matter: E_m = 1.06 x 10^{71} J

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