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HU - THE BIG POP COSMOGENESIS EQUATION OF STATE

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Abstract:
HU is the Hypergeometrical Universe Theory (HU)**[1-8]**, proposed in 2006, where the Universe is a Lightspeed Expanding Hyperspherical Hypersurface and Gravitation is an absolute-velocity-dependent, epoch-dependent force. Here we introduce the Big Pop Cosmogenesis and show our calculations associated with the Equation of State of the Universe. This article is the first in a series of articles[9-22] supporting the paradigm shift.

keywords: Cosmology, Cosmogenesis, Relativity, Spacetime, Hypergeometrical Universe Theory, Dark Matter, Dark Energy, L-CDM, Big Bang, Big Pop

1. INTRODUCTION

The Universe's expansion is oftentimes explained in terms of a balloon, where galaxies are mapped to dots. As the balloon expands, the dots move farther apart.

For almost a hundred years, this analogy has been used and that begets the question: Why isn't the Universe, an expanding balloon? The expanding balloon analogy clearly explains short-distance redshifting.

The reason lies in larger distances. Currently, scientists claim to have measured distances up to 46 billion light-years. Prior to my work, the hyperspherical hypersuperficial Universe was proposed by Richard Feynman and others and failed because of these large distance data. Solutions with light traveling in a log-spiral or with a variable velocity**[23,24]** were proposed and also failed. The reason for their failure is General Relativity. None of the solutions complied with General Relativity**[25,26]** and when they complied, they were just contrived versions of L-CDM. Of course, "failure" just means: They were not adopted by mainstream academia, where the bulk of the papers are produced.

The reason is simple. Lightspeed means constant speed, irrespective of the inner contents of the hyperspherical hypersurface (the Stress Tensor). Einstein's equations describe a Universe that is analogous to a stone thrown upward under a gravitational field. LEHU is akin to a circular pond wave expanding at a constant speed. HU introduces the Silver Surfer Paradigm for Motion**[14]** and places all particles in the Universe surfing the Inner Dilation Layer**[10]**.

The goal of this series of articles is to replace Special and General Relativity with HU laws of Nature shown below**[15]** and the current model for matter with HU's Fundamental Dilator Paradigm**[12]**.

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$$F_{Gravitational} = \left[\left(\frac{N}{\chi}\right)\frac{\lambda_1 c^2}{(2\pi)^3}\frac{\lambda_1}{R_0}\xi\right] M_1 M_2 \frac{1-\tanh^2(\alpha_\tau)}{\left(1+\frac{V_1\cdot\hat{R}}{c}+\frac{V_2\cdot\hat{R}}{c}+\frac{V_1 V_2}{c^2}\right)\left(1+\frac{V_2\cdot\hat{R}}{c}\right)}\frac{\hat{R}}{\Delta\Phi^2} \quad (1)$$

$$F_{Electromagnetism} = \frac{C_1 C_2}{4\pi\varepsilon_0}\frac{1-\tanh^2(\alpha_\tau)}{\left(1+\frac{V_1\cdot\hat{R}}{c}+\frac{V_2\cdot\hat{R}}{c}+\frac{V_1 V_2}{c^2}\right)\left(1+\frac{V_2\cdot\hat{R}}{c}\right)}\frac{\hat{R}}{\Delta\Phi^2} \quad (2)$$

To do so, HU will have to show that it can actually replicate GR and SR accomplishments**[20]** and succeed where General Relativity fails**[16,17]**.

Since big claims require a large body of evidence, the list of supporting articles is extensive and the scope is wide. Since editors have a limited scope, the theory is distributed over many articles**[9-22]**.

Appendix A contains a review of HU topology. Appendix B contains the derivation of the total mass of the lightspeed expanding hyperspherical universe. Appendix C contains the modeling of the speed of sound in the Neutronium as a function of density, showcasing the freezing of the hyperspherical harmonic acoustic oscillations. These oscillations are responsible for the low frequency (long wavelength) components of the Cosmic Microwave Background (CMB). Appendix C also contains the modeling of the Neutronium decay and the heating of the Universe which resulted in the short-wavelength plasma acoustic oscillations or baryonic acoustic oscillations. Notice that both processes have a beginning and are windowed by the continued slowing down of the sound velocity. Appendix D contains extra pictures and figures. **Table D.1 summarizes all results.**

THE BIG BANG MODEL

The current view of creation is that the Universe was born out of Singularity. This is supported by Hubble's observation of receding galaxies (redshift light from galaxies not connected gravitationally to our local cluster) and from the observation of the Cosmic Microwave Background.

The Horizon Problem is how to explain the Cosmic Microwave Background**[27]** homogeneity where opposing areas in the sky have the same temperature. Dr. Guth's**[28]** Inflation theory and Dr. Higgs' Model**[29-31]** for Inertial are the basis of the current Big Bang's eight-step Universe creation:

1. A False Vacuum decayed and released infinite amounts of energy which created matter and antimatter massless particles AND spacetime. Everything was inside a Singularity.
2. Matter and antimatter particles annihilate each other leaving just a sliver of matter particles.
3. Thermal Equilibrium is achieved.
4. Inflation takes place and expands the Universe into infinity. Inflation is driven by a postulated Inflaton Field. Notice that I chose to describe the Big Bang as creating an infinite universe because the explanation of a finite Universe inside a 3D non-embedded

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spatial manifold makes no sense. They would introduce edges where the Universe wouldn't exist. Hence, the Big Bang has to propose infinite energy, infinite mass, and infinite Universe size.

5. At some point, the Higgs' Mechanism for Mass creation kicks in and massless particles become massive.
6. Dark Matter and Dark Energy are created at some point and supposedly Universe accelerated expansion is driven by Dark Energy, once the Inflaton Field is turned off.
7. Undefined "Quantum Fluctuations" modulate space and seed galaxies.
8. The gas cools down after 380,000 years of adiabatic expansion to over 3000 Kelvin when recombination makes the Universe transparent and allows the CMB to escape. The temperature of the microwave radiation is 2.725 Kelvin and fluctuations are 1 in 100,000 in amplitude.

That is an utterly convoluted process and this complexity is part of the argument against the Big Bang Model.

Before we can talk quantitatively about the Universe we need to find out its mass and number of particles. We will do that but first, we have to review the Big Pop Cosmogenesis since one cannot derive the total mass of the Universe from General Relativity or from the Big Bang Theory.

HU Cosmogenesis distinguishes it from the prior 5D**[32-39]** Big Bang model and from the one proposed by Vilenking**[40]** because the initial fluctuation is dictated by the Heisenberg Principle and the creation of the Universe is both reversible and dynamic. Vilenkin proposed that "It is possible in principle that the big bang was a **quantum tunneling** event from nothing into 4D de Sitter space**"**. Quantum Tunneling requires the existence of a prior potential and the predecessor to our Universe to be already in an excited state (e.g. False Vacuum). A spontaneous metric fluctuation requires nothing like that. It is dynamic and continuous in time.

Vilenkin's model of a phase transition or quantum transition is a precursor to the current False Vacuum Decay model, where one assigns a state for a vacuum that has higher energy than the actual lowest vacuum state. Because of the higher energy, it is called a False Vacuum. That is a requirement because scientists see the Universe as having positive energy and that energy has to come from something, thus the False Vacuum.

HU initial Metric Fluctuation happens in space, which, in HU, is not distinguished from physical vacuum. The metric has to have dilation in the inner layers and contraction on the outer layers for obvious reasons **[10]**. It is clear that both the creation and the recombination of the contraction and dilation layers require no energy, and that the combined energy of both types of layers has to be zero. Notice that one can change the paradigm from Energy into metric deformation. It is easier to see that the metric deformation in two regions balances each other if the distance between points outside the deformation is not affected (radially opposing points).

So, HU sees both layers and because of that, there is no need to invoke a phase transition or a quantum transition from states. Of course, introducing those states requires further explanation, which the current view does not provide.

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All cosmological models are compliant with General Relativity and Einstein's equations, even when the model does not obey Einstein's equations.

Dr. Suntola**[23,24]** proposes a model where the Universe is the hyperspherical hypersurface of an expanding hypersphere. The speed of expansion is 3/2 of the speed of light. The age of the Universe is 9.3 billion light-years. That is not compliant with Special Relativity (having the whole Universe traveling faster than c).

A constant speed expansion is not consistent with Einstein's equations. In addition, the age of the Universe doesn't match our estimates. The photometrically determined SN1a distances (including larger than 14 billion light-years distances) are accommodated by the introduction of a 4D aperture argument where somehow the visibility of the SN1a diminishes as a function of distance. The issue is that at any given distance light is traveling within the 3D hypersurface and within the 3D hypersurface the illumination process is akin to the illumination of a 2D sphere without any 4D aperture. Hence the 4D aperture argument is contrived. Also, a log-spiral path for the optical path was given. Any time light is freely traveling through a 4D spatial manifold, its intensity has to decay with cubic distance. That discrepancy is not explained in his work.

Comparatively, I derived HU Laws of Nature where Newton's Gravitational Constant is epoch-dependent (inversely proportional to the 4D radius of the Universe) and derived the Supernova Absolute Luminosity G-dependence to be $G^{-3.33}$. Since SN1a detonates at the Chandrasekhar Mass Limit and that has a $G^{-3/2}$ dependence., SN1a distances have to be corrected by the epoch-dependent Absolute Luminosity (not a Stellar Candle). So, HU is compliant with modified SN1a distances and has an epoch-dependent Law of Gravitation and 4D Laws of Nature.

Dr. Suntola is a prolific scientist and I use his derivation of the mass of the hyperspherical Universe in Appendix B. If you don't start the right paradigm, the best a scientist can do is to wing the derivation with faulty logic. Until we achieve the Fundamental Theory of Everything, this is a general comment on all models.

Banerjee **[32]** replaced Dark Matter and Dark Energy with a hyperspherical hypersuperficial m-brane dotted with negative surface tension. Needless to say, that is the replacement of unsupported (never detected) Dark Matter and Dark Energy by another never detected construct. It brings nothing new and it just changes names. Since HU explains particles without the complexity of a m-brane (with just elasticity), Occam's Razor does not support Bannerjee's model.

The introduction of an extra spatial dimension always brings about these two questions:

a) Dimensional Leakage - Why doesn't Gravitation and Electromagnetism decay with cubic distance?
b) Dimensional Containment - Why doesn't matter wander off from the hypersurface?

Dr. Suntola did not explain a) which is a problem since light in Suntola's model actually travels through the 4D spatial manifold in a log-spiral trajectory. A universe expanding at 3/2 of the speed of light might require some explanation for b). Why doesn't matter wanders off from the hypersurface? Why is the Universe expanding at 3/2 of the speed of light as opposed to

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expanding at the speed of light as HU proposes? HU provides a mechanism for the motion (The Big Pop and the Prince Rupert Drop analogy).

Banerjee just postulated that Gravitation and Electromagnetism are 'superficial modes" without providing a physical model or deriving the corresponding natural laws. HU derives natural laws without an equivalent postulate. In fact, the observed light redshifts wouldn't be possible without considering the 4D nature of space in the propagation of ancient photons through them. The same would go for gravitation if one could create oscillating gravitational dipoles or monopoles. The Dimensional Confinement question is addressed by the fact that the m-brane carries matter as excitations of its inner structure and that is distinct from plain space outside the m-brane, hence matter cannot wander around.

Paul Wesson, from the 5D Consortium, proposed that the Big Bang could be an explosion in a higher dimensionality spatial manifold**[35]**, while the universe would be a standing 4D hypersurface. Wesson developed his model using Einstein's equations, hence it could never produce LEHU topology.

HU proposed that the Universe **surfs** the inner dilation layer which is the actual 4D Entropic Explosion. The entropic explosion is analogous to Prince Rupert Drop**[41-43]**, in many ways.

2. NEW MODEL FOR MATTER

HU proposed in its three hypotheses that the Universe was a Lightspeed Expanding Hyperspherical Hypersurface (**LEHU topology**) and that Matter is composed of coherences between stationary states of deformation. The **Fundamental Dilator** (FD) is the monomeric unit. Isotopes and subatomic particles are polymers of that monomeric unit. FDs obey the Quantum Lagrangian Principle (QLP). Later we will learn that particles SURF the Inner Dilation Layer.

The paradigm change for the definition of Matter is what allows for HU to propose the Universe creation in terms of metric deformations. There is no underlying complexity (confinement potentials, compact spaces, Inflation Fields, Dark energy, quantum fields, etc). Matter is created just using space elasticity.

All other models have Mass as being the main actor in their plays since that is a requirement by Einstein's Relativity where one has to have Mass to deform Spacetime.

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FOUR PHASES OF THE FUNDAMENTAL DILATOR

Here are the four phases of the Fundamental Dilator:

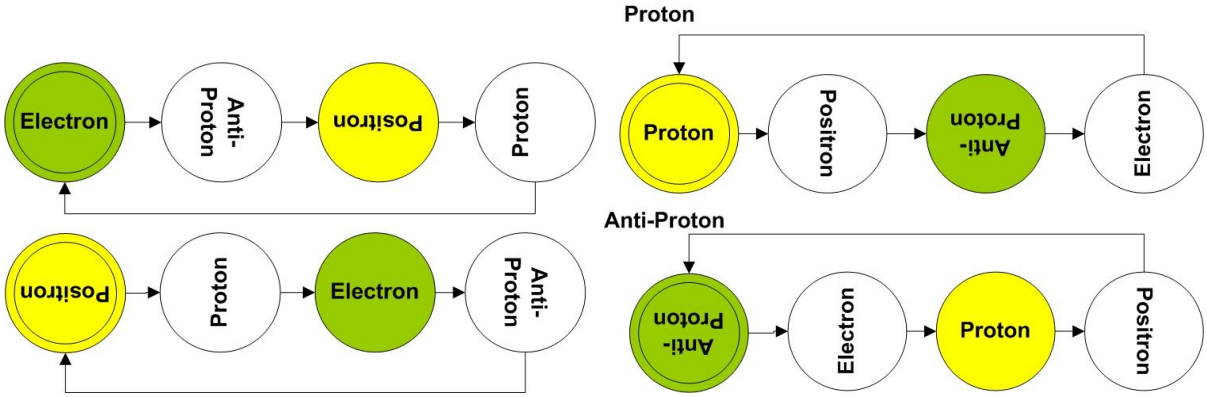

Figure 1. This figure depicts the Fundamental Dilator coherence. Each ball represents a localized deformation of space. The phases are relative to each other after the initial phase following the recombination of the Initial Metric Fluctuation. In other words, after the Universe executed its first step in the hyperspherical expansion, being positively charged or negatively charged became a relative matter. In the figure, I depicted yellow as positive and green as negative. The orientation of the letters indicates the orientation of the phase with respect to the 3D hypersurface (our 3D Universe). Electron and Proton states are expected to be narrow along the radial direction. This means that when they rotate 90 degrees, their overlap (footprint or 3D volume) with the 3D hypersurface goes to zero. Zero 3D volume implies that those phases do not interact. This allows for this shapeshifting, spinning in 4D construct to keep particles' nature (charge, inertial mass, dipole, multipole moments, and 3D volume).

If one assumes that mass is some density multiplied by a volume, it should be obvious that the 4D mass of the Fundamental Dilator is equal to the mass of a Hydrogen Atom.

THE QUANTUM LAGRANGIAN PRINCIPLE

QLP is a replacement for Newton's Laws of Dynamics. **It states simply that FDs will move into positions where they dilate space in phase with the local dilaton field.** Dilaton field is the interference pattern resulting from the traveling metric waves generated by the shapeshifting metric deformations (a.k.a. particles).

In other words, HU materializes metric waves in a 4D spatial manifold. The intersection of those waves within our 3D hypersurface is what we call de Broglie waves. In other words, the same waves that carry gravitation and electromagnetism are also responsible for de Broglie's "matter" waves.

HU GRAVITATION

HU Gravitation will be explained properly later. It should be said here that Gravitation is just a van der Waals force not distinct from electromagnetism. In other words, the same dilaton field generated by charged particles (e.g. electron and proton), also generates gravitation when the neutral moiety (hydrogen) is created. The reason we couldn't see this is because we didn't know about the Fundamental Dilator, Quantum Lagrangian Principle, and the extremely fast relaxation process (1E24 Hertz). In other words, extremely fast relaxation of charge distribution is what makes gravitation so weak. The extremely fast relaxation is what is shown in wavefunctions (the loci of FDs as they touch our Universe).

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PARTICLE-WAVE DUALISM IS REPLACED BY WAVE-GENERATOR AND QLP

The HU model for matter replaces the particle-wave description of matter with the recognition that particles create metric waves and they interact with these metric waves through the QLP. The final result is the same.

3. THE BIG POP COSMOGENESIS MODELS

Now let's delve into the model

Fig. 1 depicts the Big Pop Cosmogenesis proposed by the Hypergeometrical Universe Theory (HU).

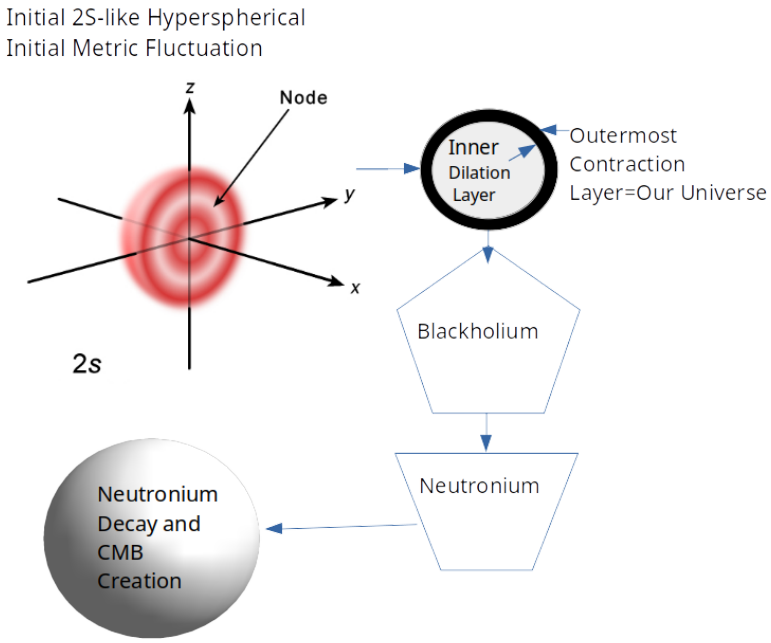

Figure 2. The Big Pop Cosmogenesis. HU proposes that the Universe started with a simple Heisenberg Principle Driven Hyperspherical Metric Fluctuation of 421 light-second 4D radius. The Universe starts from a Heisenberg-Principle dictated metric fluctuation having contraction in the outer layers and dilation in the inner layers, which partially recombines. That is called the Big Pop. After the partial recombination, the remaining layers are the Inner Dilation Layer and the Outermost Contraction Layer (our Universe).

Blackholium is a hyperspherical hypersuperficial Black Hole. Neutronium is a similarly shaped Neutron Star. Notice that as the Universe expands, density decreases in a predictable manner.

HU BIG POP

Immediately after the Initial Metric Fluctuation appeared, partial recombination followed. Dilation layers annihilated contraction layers until there was only one inner dilation layer and one outermost contraction layer. This process is the Big Pop.

The assignment of contraction for the outermost layer and dilation for the inner layer are essential since the opposite assignment wouldn't result in a Universe.

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HU EXPLAINS THE LACK OF ANTIMATTER USING SIMPLE SYMMETRY

Since the outermost layer is contraction and since the proton 3D volume is larger than the electron 3D volume, the initial phase associated with a positive charge was also contraction. HU assigns the Universe as starting with just electrons and protons (all electrons and protons it will ever have) since the very beginning.

This explains why there were never anti-particles in the Universe, in other words, HU eliminates any initial anti-matter using the spatial symmetry of the hyperspherical initial metric fluctuation. Without this, the current view fails to account for the ratio between photons and protons. The photon density is not consistent with having billions of universe masses of matter and antimatter mutually annihilating and converting the energy into photons.

HU EXPLAINS THE HORIZON PROBLEM USING SIMPLE SYMMETRY

While Dr. Guth has to invent a convoluted process to explain why the Universe is homogeneous, HU explains the same just using homogeneous initial conditions in all directions. In other words, since the Universe was hyperspherical Blackholium at Zero Kelvin when expanded homogeneously and isotropically, it resulted in a homogeneous density and temperature distribution.

Due to symmetry, all 3D forces (gravitation and electromagnetism) play no role in the Universe's expansion. The Universe was driven to expand by the remaining inner dilation layer. The Inner Dilation Layer (IDL) lags behind our 3D Universe and all particles SURF that wave. This is called the Silver Surfer Paradigm for Motion**[14]** and will be covered in another article of the series.

According to HU, the Universe goes through seven **milestones**:

- Big Pop - The end of the Initial Hyperspherical Metric Fluctuation. This is also the instant when the Universe started moving at the speed of light and the smooth outermost contraction layer became the Blackholium (hyperspherical hypersuperficial Black Hole containing Flat Hydrogen).
- Blackholium-Neutronium Phase-Transition which triggered the hyperspherical harmonic acoustic oscillations, a.k.a. Neutronium Acoustic Oscillations or N.A.O.
- Pre-Freezing. The moment before the velocity of sound decays suddenly within the superfluid neutron matter of the Neutronium phase. This happens around 300 MeV/fm^3 density.
- Pos-Freezing. The moment when the velocity of the sound becomes insignificant when compared with the speed of light.
- Pre-Big Bang. The moment before the Neutronium starts to decay (the proton fraction is still zero but will start moving up soon).
- Post-Big Bang. The moment after the proton fraction reaches 1, that is, all the energy from the Neutronium is released and we have a hot hydrogen plasma.

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THE BIRTH OF BLACKHOLIUM AND PRINCE RUPERT DROP ANALOGY

At that moment the Outermost Contraction Layer initiated its expansion at the speed of light propelled by the inner dilation layer, the conversion from a smooth (no internal degrees of freedom and thus zero entropy) contraction layer into a fragmented layer containing Flat Hydrogen occurred. This process has a physical analogy in Prince Rupert Drop.

Flat Hydrogen is the electron and proton state with a spin degree of freedom but without the orbital degree of freedom. That is the HU model for the composition of a Black Hole. HU shows that 3D Forces go to zero at a maximum acceleration (maximum density) and at maximum velocity (lightspeed). The maximum density happens when particles are sitting at a Compton Wavelength of a Hydrogen atom distance from each other. That replaces the Planck Length in the current literature. Needless to say, there is no physics that would constraint interaction at the Planck Length since the current view relies on Newton's Empirical Law of Gravitation.

At that instance, the Universe was born with Zero Entropy (no internal degrees of freedom). Subsequent expansion broke the smooth contraction layer into Flat Hydrogen. So, HU has the Universe starting as a Zero Kelvin Blackholium.

That is the first instant when the Fundamental Dilator representation for Matter becomes valid since there was no Matter before that.

The expanding contraction layer is now a Blackholium or a hyperspherical hypersuperficial Black Hole. So, it is a Black Hole spanning the whole Universe and it has a hyperspherical hypersuperficial shape. Symmetry alone will tell you that Gravitation doesn't matter. Gravitation will only become locally relevant when density decays much further.

NEUTRONIUM PHASE

Further expansion leads to the Blackholium-Neutronium phase transition where an orbital degree of freedom is gained with the emission of electron neutrinos. At that instant, Flat Electrons combined to form neutrons, and the Blackholium became a Neutronium.

The Blackholium-Neutronium Phase Transition also triggers Hyperspherical Harmonic Acoustic Oscillations (a.k.a. Neutronium Acoustic Oscillations or N.A.O.). They are distinct from the sound waves triggered when the Neutronium decayed and released the 0.782343 MeV per neutron. Those correspond to the Baryonic Acoustic Oscillations and have a much shorter wavelength. The reason for the shorter wavelength is the much slower sound velocity. Incidentally, a shorter wavelength in the CMB spherical harmonic decomposition corresponds to a higher frequency or higher l.

THE FREEZING OF HYPERSPHERICAL ACOUSTIC OSCILLATIONS AND NEUTRONIUM DECAY DYNAMICS

The neutronium acoustic oscillations are sensitive to the speed of sound in the neutron matter.

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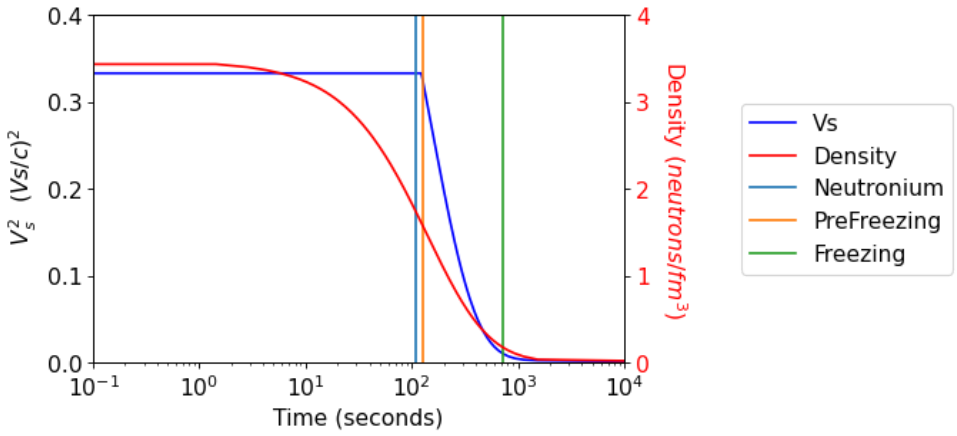

Figure 3. This figure shows the slow down of the velocity of sound inside the Neutronium as a function of time t. Since density is known at any given time, it is possible to calculate when the hyperspherical harmonic acoustic oscillations, triggered by the Blackholium-Neutronium phase transition, freeze.

Hebeler **[44]**, Bedaque, and Steiner**[45]** use the calculated nuclear saturation density as a reference density. HU predicts the density at the Blackholium to be 8 hydrogen atoms per cubic cell, with cell length equal to the Compton Wavelength of a hydrogen atom, or 1.32 femtometers. The density is $8/(1.32^3)$ per femtometer or 3.48/fm^3. For neutrons, we consider that 4 neutrons occupy the cell or 1.74/fm^3. HU assigns n_0 to 0.43/fm^3 or 1 neutron per cell.

In principle, Bedaque states that the properties of matter at densities comparable to the nuclear saturation density ($n_0 \approx 0.16$/fm^3) are determined by QCD. In practice, it has been very difficult to extract the QCD predictions for dense matter except at extremely high densities where asymptotic freedom allows for perturbative calculations. In other words, the actual value of n_0 is approximate and HU's assignment is within reason.

Hence we will be using n_0 that is around three times more diluted. This has no influence on the conclusions. In fact, even the assignment of the maximum density as having 8 neutrons per cell, has no influence. It would just affect HU's prediction of the Initial Radius and nothing else. So, 8, or 4 or 2 neutrons per cell for the Neutronium wouldn't affect the conclusions. The exact density will only be known when we precisely measure the actual radius of a Black Hole.

Below are the results of modeling the freezing of hyperspherical acoustic oscillations and the modeling of the Neutronium decay (both shown in Appendix C).

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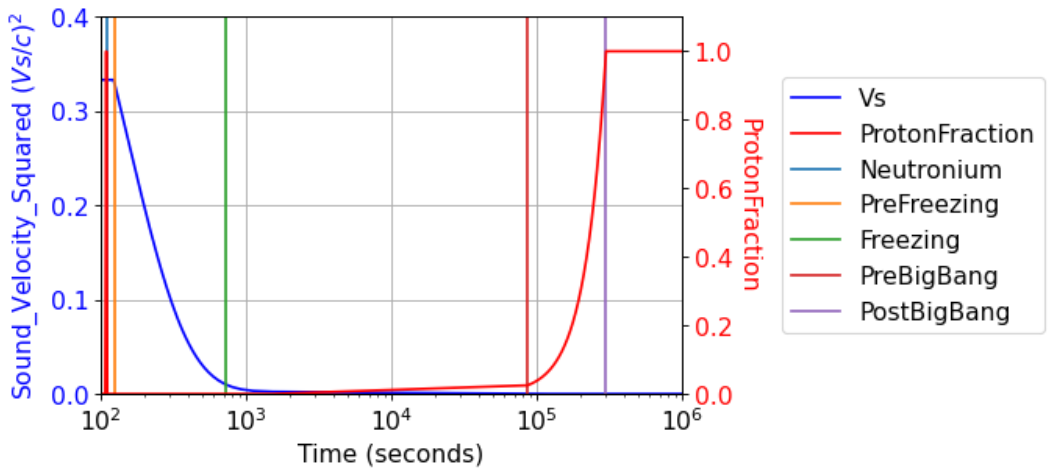

Figure 4. This figure depicts the $C_s^2 = \left(\frac{Speed\ of\ Sound}{c}\right)^2$ for the Neutronium phase and the evolution of the proton fraction during the HU Big Bang. This speed of sound transition is responsible for freezing the hyperspherical harmonic Neutronium Acoustic Oscillations. The evolution of the proton fraction maps the release of energy during the Neutronium decay.

The Big Pop Cosmogenesis was used to replicate the Cosmic Microwave Background observation by the Planck Satellite. Details will be discussed in another article of this series**[10].**

Here are the Cosmic Microwave Background observation by the Planck Satellite and HU simulation using Hyperspherical Harmonics:

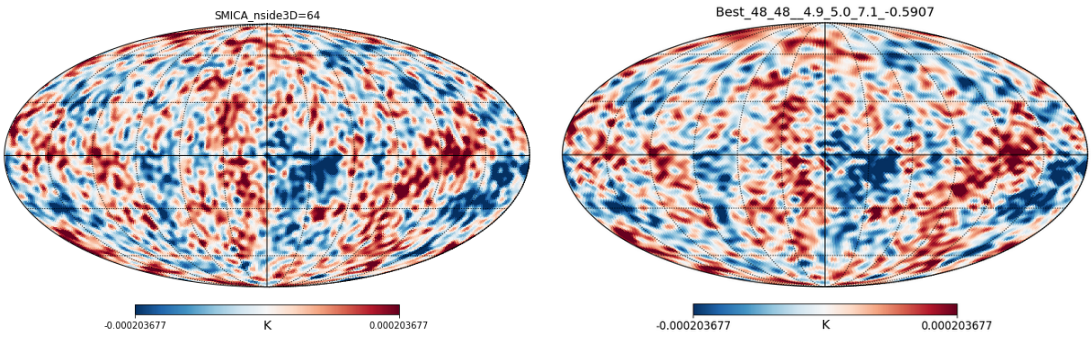

Figure 5. This figure shows Planck Satellite CMB observation filtered to show the low-frequency components and the simulation using hyperspherical harmonics (up to k=49).

This was used to pinpoint the location of Earth as

χ= 339.46 degrees

θ = 341.1 degrees

ϕ= 104.08 degrees

The Neutronium decay results in the Baryonic Acoustic Oscillations and corresponds to the difference between these two images:

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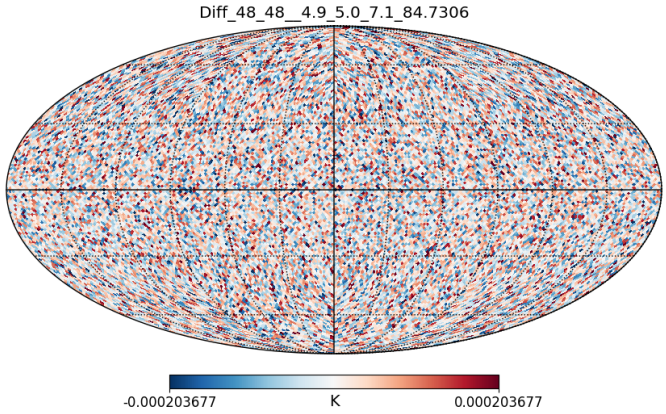

Figure 6. Simulated and Observed CMB difference. Baryonic Acoustic Oscillations related to Neutronium decay.

THE HEATING UP OF THE UNIVERSE - NEUTRONIUM DECAY

Table 1 shows some figures associated with the Neutronium Decay (a.k.a. HU Big Bang).

HU Big Bang Observable Universe Properties		
PreBigBang Volume of the Observable Universe	7.55e+40	m3
BigBangEnergy	3.66E+66	J
BigBangEnergyDensity	4.87E+25	J/m3
Supernova Density (supernova per cubic lyr)	4.13E+29	1/lyr3
BigBangEnergyDensity	4.13E+73	J/lyr3
Big Bang Maximum Temperature	3.05E9	K

Table 1. Neutronium decay provides the energy for heating up the Universe. Densities are calculated using the PreBigBang volume since the volume changes a lot during the heating process.

The energy density is colossal because the Neutronium decay occurred very early in the life of the Universe.

All the energy was released between 8.7E4 seconds (24.16 hours) and 3E5 seconds (83.3 hours) after the Big Pop. Hence the HU Big Bang happened for 59 hours and started at the end of the first day in the life of this Universe.

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	Pressure N/m²	Time (s)	Radius (lyr)	Density (kg/m³)	Temp K	Time (year)	Radius (l-s)	Obs. Volume (lyr³)	HU Volume (lyr³)	Neutron Density (1/m³)
Pre BB	2.43E+23	8.69E+04	2.77E-03	6.51E+11	1.000E-04	2.8E-03	8.7E+04	8.9E-08	4.2E-07	3.9E+38
Post BB	5.35E+20	3.01E+05	9.54E-03	1.59E+10	2.746E+09	9.5E-03	3.0E+05	3.6E-06	1.7E-05	9.5E+36

Table 2 . This table shows the conditions during the HU Big Bang.

During and after the Neutronium decay, one considers that an adiabatic process is taking place. Since the density is still high, the gamma is fitted. y is the normalized density n/n_0

Gamma Fitting		
Plasma Gamma	1.22	
Hydrogen Gamma	1.33	
Adiabatic Boundary	2.60E+10	kg / m3
Adiabatic Boundary_y	3.57E-08	
Adiabatic Boundary_t	2.55E+05	seconds

Table 3. The Universe goes from a superfluid neutron matter Neutronium phase to a plasma phase during the process of Neutronium decay. Plasma Gamma is the average gamma coefficient until the recombination event. The recombination event happened when the Universe was 11.1 million years old, the plasma temperature was 3443 Kelvin and the gas density was 8.30E-17 kg/m³. The redshift for the CMB is z=1263.

During the Neutroniun decay, energy is injected into the plasma due to neutron decaying into proton, electron, antineutrino with a release of 0.782343 MeV per neutron, while adiabatic cooling was taking place according to an average **gamma of 1.22**.

As Δx neutrons are converted into protons, electrons, and antineutrinos, energy is released corresponding to an electron temperature jump of ΔT. That happens concomitantly with adiabatic cooling from the continuous expansion.

$$\Delta T = \frac{2}{3k_B}\left(M_N - M_P - M_E \right) \Delta x \tag{3}$$

Where x is the proton fraction, M_N, M_P, and M_E are the masses of the neutron, proton, and electron respectively and k_B is the Boltzmann Constant.

The adiabatic cooling is expressed by the equation below:

$$TV^{(\gamma-1)} = C_1 \tag{4}$$

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Fig. 7 below shows the temperature profile resulting from this process. The maximum temperature was 3.05E9 Kelvin. Notice that the cooling of the CMB radiation and of the hot hydrogen have the same density dependency. In other words, gas and photons cool down at the same rate although through different processes.

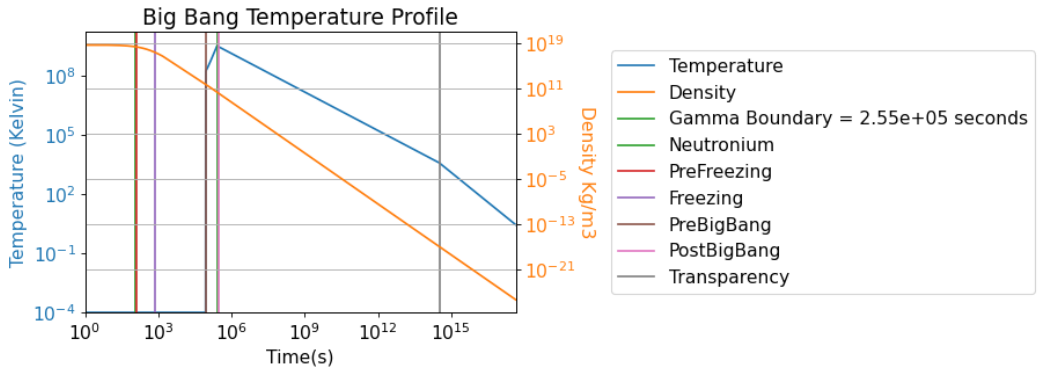

Figure 7. This figure depicts Neutronium decay even and the adiabatic cooling up to our current 2.725 Kelvin temperature. HU assigns that both the gas and the photon bath have the same temperature. Density is also shown as a function of time.

BARYOGENESIS

For the first year, the Universe was denser and hotter than the Sun, but unlike the Sun, the antineutrinos produced cannot escape. The antineutrino density is the same as the proton or electron density. These are HU's predicted conditions for baryogenesis.

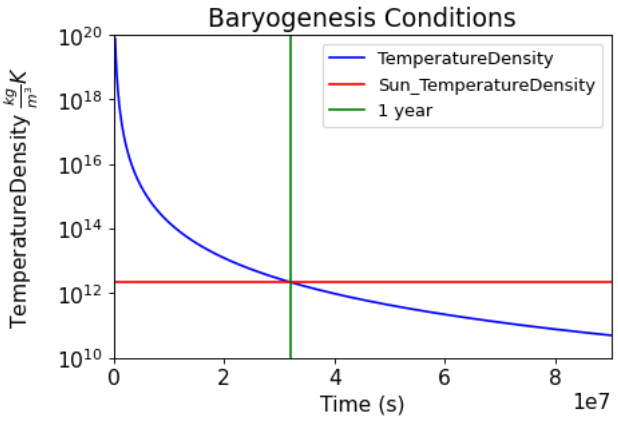

Figure 8. This figure depicts the product of temperature times density. The red line is the temperature density product at the core of the Sun. At the peak, the product for the Neutronium Decay was 100 million times higher than the Sun's core. Maximum temperature 3.05E9 Kelvin. These conditions are consistent with the observed Baryogenesis. The quantitative nature of this modeling will allow for a better understanding of Baryogenesis.

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THE ADIABATIC EXPANSION AND THE TRANSPARENCY EPOCH

The recombination epoch is defined by the Saha equation**[46]**:

$$\frac{n_{i+1}n_e}{n_i} = \frac{2}{\lambda^3}\frac{g_{i+1}}{g_i}\exp\left[-\frac{(\epsilon_{i+1}-\epsilon_i)}{k_BT}\right] \tag{5}$$

$$\lambda \stackrel{\text{def}}{=} \sqrt{\frac{h^2}{2\pi m_e k_B T}} \tag{6}$$

- η_i is the density of atoms in the *i*-th state of ionization, that is with *i* electrons removed.
- g_i is the degeneracy of states for the *i*-ions
- ϵ_i is the energy required to remove *i* electrons from a neutral atom, creating an *i*-level ion.
- n_e is the electron density
- λ is the thermal de Broglie wavelength of an electron
- m_e is the mass of an electron
- T is the temperature of the gas
- h is Planck's constant

From the Saha equation for a single ionization:

$$\frac{n_e^2}{n-n_e} = \frac{2}{\lambda^3}\frac{g_1}{g_0}\exp\left[\frac{-\varepsilon}{k_BT}\right] \tag{7}$$

$$\frac{1}{\lambda} = \sqrt{\frac{2\pi m_e k_B T}{h^2}} \tag{8}$$

$$n_e = nx \tag{9}$$

Where x is the ionized fraction. So, one solves this equation for z and the boundary where gamma switches using the current temperature T=2.725 K, x=½ and gamma=4/3

$$\frac{x^2}{1-x} = \frac{2}{n\lambda^3}\exp\left[\frac{-\varepsilon}{k_BT}\right] \tag{10}$$

We allow the gamma to be piecewise constant with a moving adiabatic boundary. The fitting results are presented in Table 3.

LOCATION OF THE TRANSPARENCY ZONE

Starting from our current CMB temperature and the knowledge that the cooling process since the transparency epoch was adiabatic($\gamma = \frac{4}{3}$), HU calculated what is the density and corresponding z that produces ionization fraction= 0.5.

Recombination Data	
z	1262
TransparencyRadius	11,105,550 light-year

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TransparencyTime	11.1 million years after the Big Pop
Density At Recombination	1.0E−17 kg/m^3 or 9.51e-18 atm
T at Recombination	3443 K

Table 4. HU tells us that recombination occurred at 11.1 million years after the Big Pop and that the temperature of the plasma was 3443 Kelvin.

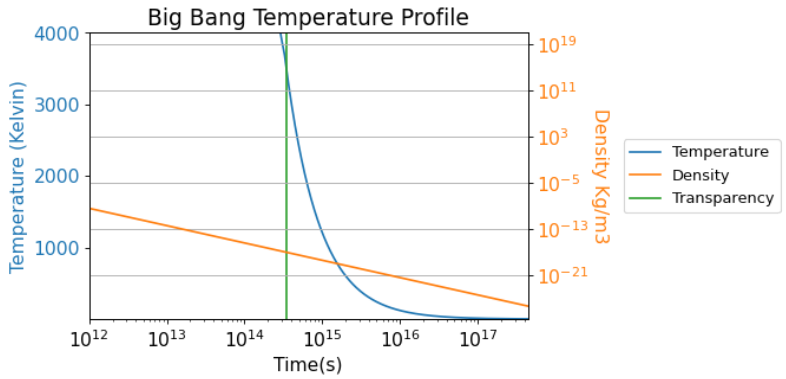

Figure 9. This figure depicts the temperature and density from the Transparency epoch (11.1 million years old Universe) to the current epoch.

THE CURRENT UNIVERSE

Current Observable Universe		
Observable Universe Volume	1.16E+31	lyr3
Observable Universe Mass	4.89E+52	kg
Number of Neutrons	2.92E+79	
BigBangEnergy	3.66E+66	J
BB Number of Supernovae	3.66E+22	
Current Hyperspherical Universe		
HU Volume	5.45E+31	lyr3
HU Mass	2.31E+53	kg
Number of Neutrons HU	1.38E+80	
BigBangEnergy HU	1.73E+67	J
BB Number of Supernovae HU	1.73E+23	

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Table 5. Properties associated with the current Universe, both observable and hyperspherical. The number of Supernovae or the number of neutrons is the value for the corresponding partitions. They correspond to the number of Supernovae (standard SN=1E51 ergs) to the energy released in the Neutronium Decay Event.

4. DISCUSSION

Against the Big Bang Theory, is the fact that there has been no actual observation of Dark Matter, Dark Energy, Inflaton Field. Even the Higgs Boson hasn't been shown to give mass to anything.

I mentioned that because there was a precedent in Particle Physics when pion zero was assigned certain abilities (carry the Strong Force) and later the theory was recanted.

In other words, just because a theory tells you something that doesn't mean it is true. The multiple steps (creating massless particles, and then adding mass to them) are unnecessarily complex if you consider HU's alternative. HU just creates all the mass in the Universe as a zero Kelvin Blackholium. A single step for the Universe's creation is better, according to Occam's Razor than multiple steps without a single observation to support them.

LEHU is not a solution to Einstein's equations and HU's Laws of Nature are a full replacement to General and Special Relativity. HU explains something as fantastic as the receding motion of all galaxies in the Universe as a simple case of inertial motion in 4D.This is only possible because of both the LEHU topology and the epoch-dependent G in HU's Law of Gravitation.

HU uses the equation of state for the neutron star**[45,46]** for the period during and after the Neutronium decay. This is just an acceptable approximation, in the same way, adiabatic expansion of monoatomic hydrogen is an approximation to the dynamics the Universe went through, which includes star and galaxy formation, star deaths, etc.

This means that the perfect adiabatic cooling of the intergalactic gas might deviate from the theoretical predictions. That said, the equilibrium between the 21-cm hydrogen line and the CMB radiation bath might help the gas to follow our predictions. Data on the evolution of the intergalactic gas**[47]** is not precise enough at this moment for us to draw any conclusion.

5. CONCLUSIONS

HU provides a simple picture of the Universe's creation and a trivial energy source to heat up the Universe: Neutron Decay. It creates the Universe as a Zero Kelvin Blackholium as the final product of the Big Pop. Blackholium, a perfectly homogeneous, isotropic initial condition that is also consistent with the Second Law of Thermodynamics and does so using simply the Heisenberg Principle. In a single scoop, it solves the inexistence of Anti-Matter in the Universe and the homogeneity and isotropy of the Cosmic Microwaves Background.

The driving "force" for the expansion of the Universe is Inertial Motion or Natural Propagation of Information within the 4D spatial Manifold**[10]**.

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HU explains Hubble's Observations using simply Inertial Motion in 4D**[48]**. No forces are required. This is only possible because of the Silver Surfer Paradigm for Motion**[14].**

HU creates the Universe without breaking a single law of physics and using the simplest possible model. HU's Universe contains only space, deformed space, and time. Those are the Fundamental Concepts and because of that HU is a Fundamental Theory.

The proton-fraction is shown in Figure 4. Its value is used to calculate the heating of the Universe during the Neutronium decay.

This is the HU Big Bang, which started at the end of the first day and lasted 59 hours.

The Universe goes through seven milestones:

- Big Pop - The end of the Initial Hyperspherical Metric Fluctuation. This is also the instant when the Universe started moving at the speed of light and the smooth outermost contraction layer became the Blackholium (hyperspherical hypersuperficial Black Hole).
- Blackholium-Neutronium Phase-Transition which triggered the hyperspherical harmonic acoustic oscillations, a.k.a. Neutronium Acoustic Oscillations or N.A.O.
- Pre-Freezing. The moment before the velocity of sound decays suddenly within the superfluid neutron matter of the Neutronium phase. This happens around 300 MeV/fm^3 density.
- Pos-Freezing. The moment when the velocity of the sound becomes insignificant when compared with the speed of light.
- Pre-Big Bang. The moment before the Neutronium starts to decay (the proton fraction is still zero but will start moving soon.
- Post-Big Bang. The moment after the proton fraction reaches 1, that is, all the energy from the Neutronium is released and we have a hot hydrogen plasma.

Transparency Epoch or Event is the moment when **density** and **temperature** allow for light to propagate. HU has both density and temperature. Temperature is dependent both on density and redshift. HU does not postulate either.

Since the Universe density is prescribed by the lightspeed expansion, HU can calculate the density and temperature at any time. This precise modeling is required to calculate the precise moment of transparency (recombination).

During the first year of this Universe's existence, the Baryogenesis conditions were better than the core of the Sun. This is shown in Fig. 8, where the initial Temperature-Density product was 100 million times higher than at the core of the Sun.

HU places recombination at 11.1 million years after the Big Pop (the creation of the Universe). The CMB plasma temperature was 3443 Kelvin and the redshift was 1262. The pressure was 9.5E-18 atm with a density of 1E-17 kg/m^3.

Where n_0 is given by 1 particle per unit cell. The unit cell has a side with a length equal to the Compton wavelength of a hydrogen atom. The maximum concentration has 8 Flat Hydrogen units (one in each vertice)and represents the Blackholium phase. The Neutronium phase is assigned to half of that density or 4 Neutrons per cell.

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Antimatter is eliminated by symmetry. The Horizon Problem is solved by symmetric and isotropic homogeneous initial conditions.

Epoch-dependent G and LEHU topology eliminate the need for Dark Matter and Dark Energy**[48]** and Appendix A.

HU offers a new model for the creation of the Universe which requires less speculation and that is consistent with the Laws of Nature. HU's model for Matter allows for Matter to be spontaneously created from a metric fluctuation. The current paradigm focuses on Energy, a non-fundamental construct. The fundamental constructs of HU's Universe are time, space, and deformed space. In other words, HU's goal is to explain all physics in terms of time and space, whereby space one should include metric and dimensionality as variables.

HU allows for a new level of detail in the understanding of the Universe, which includes the recalibration of our Cosmic Distance Ladder (because of G being epoch-dependent) and the materialization of the Expanding Balloon Analogy.

Notice that the realization of an otherwise theoretical construct was what Einstein did when he realized Minkowski's spacetime.

LEHU is not compatible with Einstein's equations. HU doesn't shy away from that part of the controversy. During the current series of articles, HU will make the case to replace GR and SR and the current Standard Model of Particle Physics and Cosmology.

APPENDIX A
THE HYPERGEOMETRICAL UNIVERSE MODEL

HU contains three hypotheses:

- The 3D Universe is a lightspeed expanding hyperspherical hypersurface embedded into a 4D spatial manifold.
- Matter is composed of polymers of the Fundamental Dilator (FD).
- FD obeys the Quantum Lagrangian Principle (QLP). QLP just states that FD will move into positions where they don't do any work. This is supported by particles not dissipating just because they exist.

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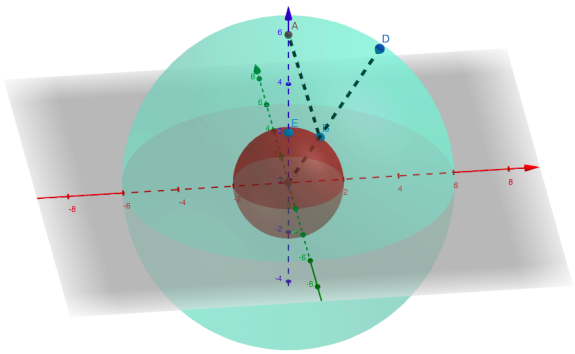

Figure A.1. This figure shows the Lightspeed Expanding Hyperspherical Universe (LEHU) topology. HU Silver Surfer Paradigm implies that most galaxies are at rest with respect to the Fabric of Space (the locus of the Universe represented by the spherical surfaces here). The outermost hypersurface is the CURRENT UNIVERSE. The emphasis in Current is because HU has Absolute Time and a preferred reference frame, the Fabric of Space. HU Laws are written on this 4D Absolute Reference Frame.

Just from looking at the topology, it becomes self-evident that gravitation becomes irrelevant at the very early days of the Universe because of symmetric initial conditions.

In addition, it becomes self-evident that none of the 3D forces (Electromagnetism and Gravitation) have any influence on the expansion of the Universe since they are perpendicular to the direction of expansion.

HU shows that to be the case by analyzing the Supernova Cosmology Project**[48]** data under the hypothesis of G being epoch-dependent and consistent with HU Laws of Nature, shown below:

$$F_{Gravitational} = \left[\left(\frac{N}{\chi}\right)\frac{\lambda_1 c^2}{(2\pi)^3}\frac{\lambda_1}{R_0}\xi\right] M_1 M_2 \frac{1-\tanh^2(\alpha_\tau)}{\left(1+\frac{V_1.\hat{R}}{c}+\frac{V_2.\hat{R}}{c}+\frac{V_1 V_2}{c^2}\right)\left(1+\frac{V_2.\hat{R}}{c}\right)}\frac{\hat{R}}{\Delta\Phi^2} \quad (1)$$

$$F_{Electromagnetism} = \frac{C_1 C_2}{4\pi\varepsilon_0}\frac{1-\tanh^2(\alpha_\tau)}{\left(1+\frac{V_1.\hat{R}}{c}+\frac{V_2.\hat{R}}{c}+\frac{V_1 V_2}{c^2}\right)\left(1+\frac{V_2.\hat{R}}{c}\right)}\frac{\hat{R}}{\Delta\Phi^2} \quad (2)$$

The value of G is inversely proportional to the 4D radius of the hyperspherical Universe. This dependence is propagated to supernova physics. The Absolute Luminosity of Supernovae is shown to have a $G^{-3.33}$ dependence. This means that the SN1a distances were overestimated by $G^{1.66}$.

The redshift z is related to the Cosmological Angle Alpha shown below **[11]**:

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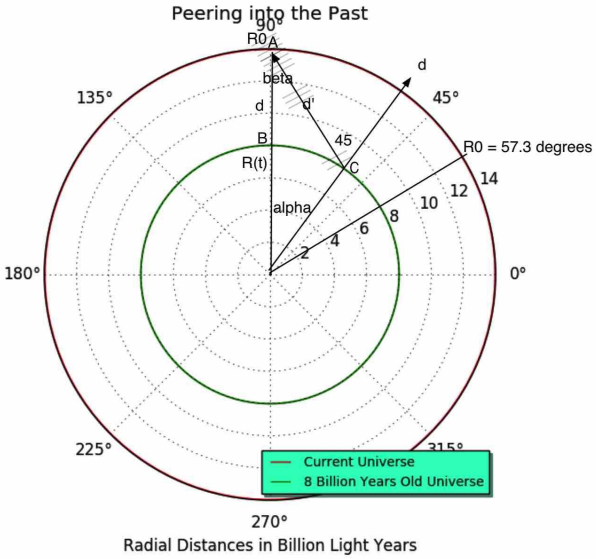

Figure A.2. This figure shows the cross-section of LEHU. This is a momentum diagram showing how the light emitted in a given epoch (4D radius R(t)) relates to the redshift z.

The Cosmological Angle Alpha is given by:

$$\alpha = \frac{\pi}{4} - arc\sin\left(\frac{1}{\sqrt{2}(1+z)}\right) \tag{A.1}$$

The distance d(z) is actually the distance between epochs, that is, all light emitted by a given epoch (4D radius Universe) has the same distance to any point in the Current Universe, **where it is detected**, irrespective of the actual distance in 4D or direction. I mentioned "where it is detected" because the detection mechanism defines the optical path and because HU obeys retarded potentials.

$$d(z) = R_0(1 - \cos(\alpha) + \sin(\alpha)) = R_0 - R(t) = R_0\frac{z}{(1+z)} \tag{A.2}$$

$$R(t) = \frac{R_0}{(1+z)} \tag{A.3}$$

This is because HU proposes that Light travels in self-similar paths, where the traversed distance radially is equal to the traversed distance by the projection of the photon position on the outermost hypersurface (our current epoch)[11].

$$\alpha(t) = \frac{R_0 - R_{00}}{R_0} - \frac{R(t) - R_{00}}{R_0} = \frac{R_0 - R(t)}{R_0} \tag{A.4}$$

R_{00} is the 4D radius of where the emitter is located and R_0 is the current 4D radius. R(t) is the 4D radius of the traveling photon.

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$$\frac{d\alpha(t)}{dt} = -\frac{c}{R_0} \tag{A.5}$$

$$R_0 \frac{d\alpha(t)}{dt} = \frac{dR_0\alpha(t)}{dt} = -c = -\frac{dR(t)}{dt} \tag{A.6}$$

This path results in a constant rate of Energy or momentum decay as a function of radius.

$$E = \frac{E_0}{(1+z)} = \frac{hc}{\lambda_0(1+z)} \tag{A.7}$$

$$\frac{dE}{dz} = -\frac{E_0}{(1+z)^2} \tag{A.8}$$

$$R(t) = R_{00} + ct = R_0 \frac{R(t)}{R_0} = \frac{R_0}{1+z} \tag{A.9}$$

Where R_{00} is the 4D radius at the light emission and R_0 is the current 4D radius.

$$\frac{dR}{dz} = -\frac{R_0}{(1+z)^2} \tag{A.10}$$

$$\frac{dE}{dR} = \frac{\frac{dE}{dz}}{\frac{dR}{dz}} = \frac{E_0}{R_0} \tag{A.11}$$

Since $E_0 = p_0 c$

$$\frac{dp}{dR} = \frac{\frac{dp}{dz}}{\frac{dR}{dz}} = \frac{p_0}{R_0} \tag{A.12}$$

This is the physical meaning of the proposed optical path. Having the photon momentum rate of decay constant w.r.t traversed radial path makes the arc of the trajectory self-similar.

This is a physics argument based upon the fact that only within the LEHU (moving Universe) there is anything that can dephase the metric waves associated with the electromagnetic field. In other words, HU abides by Maxwell's Law, where Field created Polarization and then Polarization created Field. Since the polarizable medium is always localized at the locus of the current hyperspherical hypersurface, the optical path is self-adjusting and only defined at the moment of the absorption.

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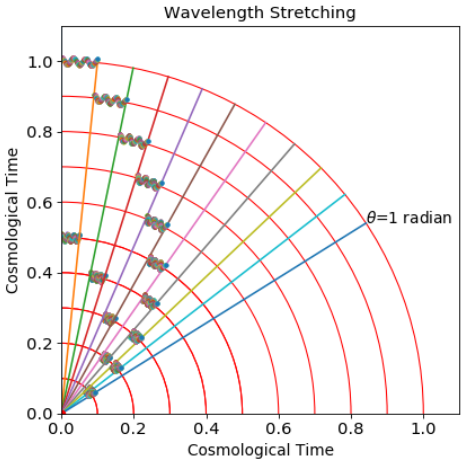

Figure A.3. This figure shows the self-similar optical paths for ancient photons. Notice that both observations might be looking at the same spot in the CMB. The optical path is defined at the moment of detection.

SN1a DATA ANALYSIS

After correcting SN1a normalized distances to account for the epoch-dependent G and the Supernova Absolute Luminosity G-dependence of $G^{-3.33}$, they are parameterless predicted using d(z)=z/(1+z) with a Hubble Constant $H_0=c/R_0$ = 69.69 km/(s.Mpc) and R_0=14.03 Billion Light Years.

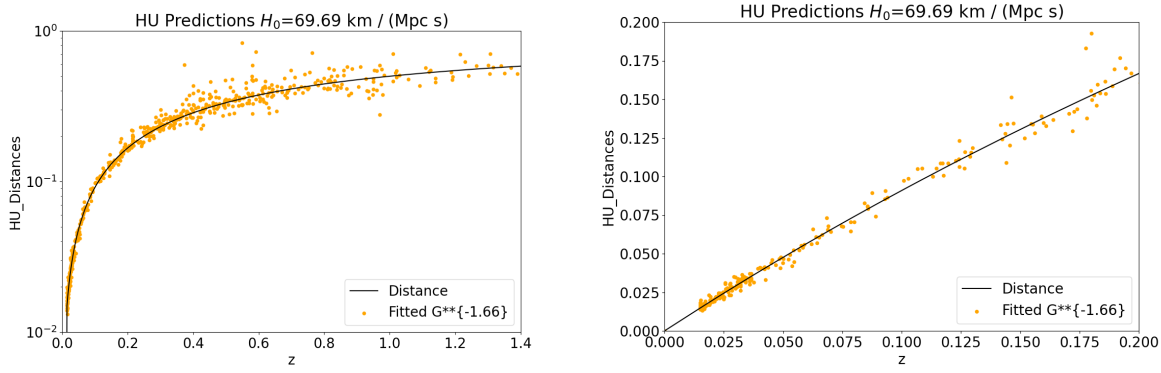

Figure A.4. SN1a distances HU parameterless predictions. These plots support both the Lightspeed Expanding Hyperspherical Hypersurface (LEHU topology) and HU epoch-dependent Law of Gravitation.

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APPENDIX B

ENERGY CONSERVATION AND THE TOTAL MASS OF THE UNIVERSE

Energy is conserved throughout the Life of the Universe. The total energy is only zero if you consider also the Dilation Layer that travels behind the Contraction Universe. Contraction and Dilation were the initial phases of these two layers, prior to the Big Pop.

So, let's start with the Zero Energy equation.

The total energy just prior to the Big Pop was the sum of the energies of the Inner Dilation Layer (IDL) and the Outermost Contraction Layer (OCL):

$$\text{DilationEnergy(IDL)}+\text{ContractionEnergy(OCL)}=0 \qquad \text{(B.1)}$$

The Inner Dilation Layer energy is equal to the energy required to push all the matter in the universe at the speed of light. This is what allows for the accounting to close at the end of this Universe's life. When the Universe is sufficiently diluted, the only energy left will be m_0c^2. The sum of all m_0c^2 will add to the inner dilation layer energy and results in zero.

Our concept of inertia/relativistic mass is a 3D concept based upon the interaction of the variable dilaton field moving things around the hypersurface. The Inner Dilation Layer is a constant hypervolumetric metric deformation. Relativistic Mass has no bearing upon it.

In fact, the energy accounting has to be done before the fragmentation of the Blackholium and before any 3D forces arise. In other words, the energy equation has to be done in terms of dilation and contraction of Space. The energy used to contract space in the outermost contraction layer is the same energy that would be gained from contracting the space of the inner dilation layer. That is how eq. (1) should be interpreted since there is really no gravitation between the dilation layer and the bodies in the contraction layer (our universe).

This is a purely metric interaction between the two Universe layers that could be modeled following reasoning in line with Ricci's flow equations. Since the total mass/energy of the Contraction Layer (our Universe) never changes, then inter-Universe interaction should remain the same for the life of the Universe. **One should consider that the Inner Dilation Layer contains the negative energy required for the total energy to create the Universe to be zero.**

The 4D radius of the Dilation Layer is just a de Broglie step (Compton Wavelength of a Hydrogen atom) smaller than the 4D radius of the Contraction Layer.

The derivation of the mass of the Universe follows the work of Dr. Suntola. Dr. Suntola also proposed that the Universe was a hyperspherical hypersurface. To accommodate the Supernova Cosmology Project results, Dr. Suntola had the Universe expanding at 3/2 of the speed of light ($t = 2/3\ R_4/c$) or having the speed of light being epoch-dependent and light traveling in a log-spiral trajectory. That said, we agree with how to derive the total mass of the Universe despite not agreeing upon the reasoning behind the derivation.

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MASS OF THE UNIVERSE

The total volume of the hyperspherical shell is given by[24]:

$$V = 2\pi^2 R_4^3 \tag{B.2}$$

Below is the equation of a section of an n-dimensional hyperspherical shell covering angle ϕ:

$$volume(n,\phi) = \frac{2 * \pi^{(\frac{n-1}{2})} * \int_0^{\phi} sin(x)^{(n-2)} dx}{\Gamma(\frac{n-1}{2})} R^3 \tag{B.3}$$

The element of volume of the n-dimensional hyperspherical shell is given by:

$$\frac{dvolume(n,\phi)}{d\phi} = \frac{2 * \pi^{(\frac{n-1}{2})} * sin(\phi)^{(n-2)}}{\Gamma(\frac{n-1}{2})} R_4^3 \tag{B.4}$$

Let's consider our case where the hyperspherical shell is 4D:

$$\frac{dV_4}{d\phi} = \frac{\Delta volume(4,\phi)}{\Delta\phi} = \frac{2 * \pi^{(\frac{3}{2})} * sin^2(\phi))}{(\frac{1}{2}\sqrt{\pi})} R^3 = 4\pi sin^2(\phi) R_4^3 \tag{B.5}$$

The Gravitational energy for a probe m (inside the shell) interacting with the rest of the 4D shell is given by:

$$E_g = -\int_0^{\pi} \frac{Gm\rho}{d} dV_4 = -\int_0^{\pi} \frac{Gm\rho 4\pi sin^2(\phi) R_4^3}{R_4\phi} d\phi = -4\pi Gm\rho R_4^2 \int_0^{\pi} \frac{sin^2(\phi)}{\phi} d\phi = -\frac{2}{\pi}\frac{GmM}{R_4}\int_0^{\pi} \frac{sin^2(\phi)}{\phi} d\phi \tag{B.6}$$

This simplifies into:

$$E_g = -0.776\frac{GmM}{R_4} \tag{B.7}$$

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since:

$$\frac{2}{\pi}\int_0^{\pi}\frac{sin^2(\phi)}{\phi}d\phi = 0.7759291742 \tag{B.8}$$

with

$$M = \rho V_4 = \rho 2\pi^2 R_4^3 \tag{B.9}$$

We will use our CURRENT 4D radius as an approximation of infinite gravitational dilution and that each layer is going through an adiabatic expansion. Matter would have zero ABSOLUTE VELOCITY with respect to the Fabric of Space (see the Silver Surfer Paradigm For Motion).

Applying that to our "fragmented" contraction layer:

$$0 = -\frac{0.776GMm}{R_4^2} + mc^2 \tag{B.10}$$

Where we are also using the corollary of the Silver Surfer Paradigm of Motion that in infinite time, the absolute tangential (velocity within the 3D universe) velocity of all particles will be zero, leaving the 4-momentum only dependent upon the rest masses. **In other words, the Silver Surfer Paradigm of Motion and the Absolute Spatial Frame of Reference (the Fabric of Space) are essential for this argument.**

Thus

$$\frac{0.776G\left(\rho 2\pi^2 R_4^3\right)m}{R_4^2} = 0.776G\left(\rho 2\pi^2 R_4\right)m = mc^2 \tag{B.11}$$

Where we will use R_4=R_0=14.03 GLY, and G = 6.67408 E-11 $m^3\ kg^{-1}\ s^{-2}$

$$\rho = \frac{c^2}{0.776G2\pi^2 R_0^2} = 4.99\times 10^{-27}\frac{kg}{m^3} = 2.98 \text{ hydrogen atoms per cubic meter} \tag{B.12}$$

This allows us to calculate the total mass of the hyperspherical Universe as:

$$M = \rho 2\pi^2 R_0^3 = 2.3E53 \text{ kg} \tag{B.13}$$

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MASS OF THE EMBEDDED SPHERE (OBSERVABLE UNIVERSE)

$$M_{3DUniverse} = \rho \frac{4\pi}{3} R_0^3 = 4.89E52 \text{ kg} \tag{B.14}$$

Since the maximum density (Black Hole density) is given by having 8 flat hydrogen atoms in a lattice with a side 1.32 femtometer. That density corresponds to having 8*0.43 flat hydrogen atoms per cubic femtometer or 5.82E18 kg/m^3 (Black Hole Density or BHD).

BHD= 5.82E18 kg/m^3 (B.15)

Using the Black Hole density above, one can calculate the initial 4D radius of the Universe as:

$$R_4^0 = \sqrt{\frac{c^2}{0.776G2\pi^2\rho_{BH}}} = 421 \text{ light-seconds} \tag{B.16}$$

Notice that there is uncertainty on how many Flat Hydrogens one would have per cell. This has no bearing on the dynamics of the Universe proposed in this article. It only affects one prediction: The Initial 4D radius of the Universe.

APPENDIX C

DERIVATION OF SOUND SPEED AND NEUTRON DECAY

Here we follow Hebeler et all work on modeling neutron matter **[44,45]**

To calculate the proton fraction within the Neutronium as a function of time or density we used the following equations for pressure and Energy for the neutronium matter.

$$\frac{P(y,x)}{n_0 T_0} = \frac{2}{5}\left[x^{\frac{5}{3}} + (1-x)^{\frac{5}{3}}\right](2y)^{\frac{5}{3}} - \left[(2\alpha - 4\alpha L)\, x(1-x) + \alpha L\right] y^2 + \gamma\left[(2\eta - 4\eta L)\, x(1-x) + \eta L\right] y^{\gamma+1} \tag{C.1}$$

$$EK = \frac{3}{5}\cdot 2^{\frac{2}{3}}\left(x^{\frac{5}{3}} + (-x+1)^{\frac{5}{3}}\right)\left(\frac{n}{n_0}\right)^{\frac{2}{3}} \left(2\left(\eta - 2\eta_L\right)(x-1)x - \eta_L\right)\left(\frac{n}{n_0}\right)^{\gamma} + \frac{\left(2\left(\alpha - 2\alpha_L\right)(x-1)x - \alpha_L\right)n}{n_0} \tag{C.2}$$

Where n_0 is the Nuclear Density of o.434/fm^3 and:

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$$T_0 = \left(\frac{3\pi^2 n_0}{2}\right)^{\frac{2}{3}} \frac{\hbar^2}{2m} = 71.6 \text{ MeV} \tag{C.3}$$

The proton-neutron equilibrium equation is given by:

$$\frac{1}{T_0}\frac{d\left(\frac{EK}{n}\right)}{dx} = \mu \tag{C.4}$$

Where x is the proton fraction and:

$$y = \frac{n}{n_0} \tag{C.5}$$

During the Neutronium decay the equilibrium equation becomes:

$$\frac{1}{T_0}\frac{d\left(\frac{EK}{n}\right)}{dx} = (2y)^{\frac{2}{3}}\left(x^{\frac{2}{3}} - (-x+1)^{\frac{2}{3}}\right) + 2\left(\left(\alpha - 2\alpha_L\right)(x-1) + \left(\alpha - 2\alpha_L\right)x\right)y - 2\left(\left(\eta - 2\eta_L\right)(x-1) + \left(\eta - 2\eta_L\right)x\right)y^{\gamma} - \frac{MN - MP}{T_0} \tag{C.6}$$

$$\mu = \frac{hc}{2\pi}\sqrt[3]{(3\ \pi^2 x\ y\ n_0)} \tag{C.7}$$

Where n is determined just by the Mass of the Universe and the 4D radius of the Universe at any given time.

Equilibrium Conditions within the Neutronium:

$-B = \varepsilon\left(n_0, \frac{1}{2}\right) + \frac{MN + MP}{2}$	$p = n^2 \left.\frac{\partial(\varepsilon/n)}{\partial n}\right\|_{n=n_0, x=1/2} = 0$
$K = 9n^2{}_0 \left.\frac{\partial^2\varepsilon}{\partial n^2}\right\|_{n=n_0, x=1/2}$	$S = \frac{n_0}{8}\left.\frac{\partial^2\varepsilon}{\partial x^2}\right\|_{n=n_0, x=1/2}$
$L = 3\frac{n_0}{8}\left.\frac{\partial^3\varepsilon}{\partial n \partial x^2}\right\|_{n=n_0, x=1/2}$	

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$\alpha = -\frac{2\left(5BK - 3(4B-K)T_0\right)}{5(9B-K)T_0 + 3T_0^2}$	$\eta = -\frac{18\left(25B^2 + 10BT_0 + T_0^2\right)}{5\left(5(9B-K)T_0 + 3T_0^2\right)}$
$\gamma = \frac{5K + 6T_0}{9\left(5B + T_0\right)}$	$\alpha_L = \frac{1}{18}\frac{(9T_0\alpha(\gamma-1) + 2T_0(3\gamma-2) - 18S\gamma + 6L)}{T_0(\gamma-1)}$
$\eta_L = \frac{1}{18}\frac{(9T_0\eta(\gamma-1) + 6L - 18S + 2T_0)}{T_0(\gamma-1)}$	
K=236.0 MeV, B=16.0 MeV, L=50.0 MeV, S=32.0 MeV	

Table C.1. This table contains the conditions for the nuclear parameters and the explicit solutions to the parameters.

APPENDIX D

EXTRA FIGURES

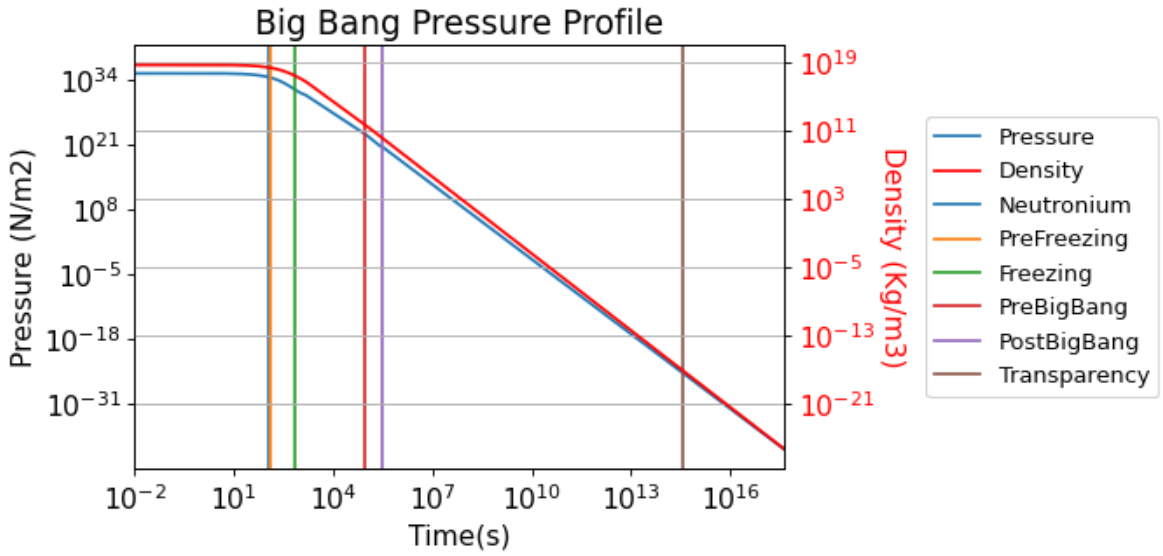

Figure D.1. This figure depicts the pressure and density of the Universe since the Big Pop.

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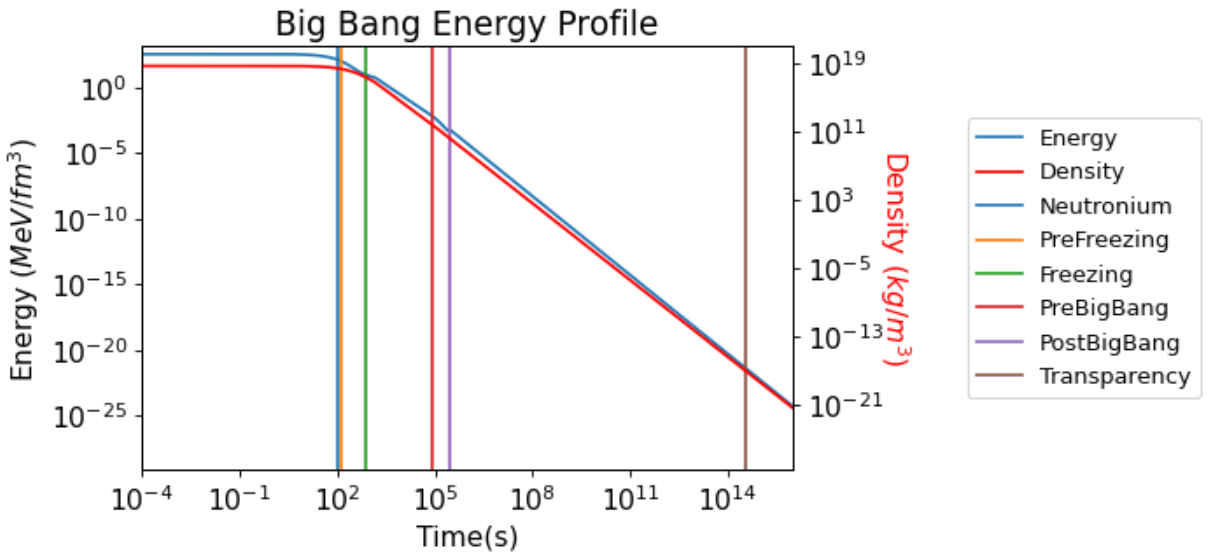

Figure D.2. This figure depicts the energy and density of the Universe since the Big Pop. Energy excludes the rest energy of the particles.

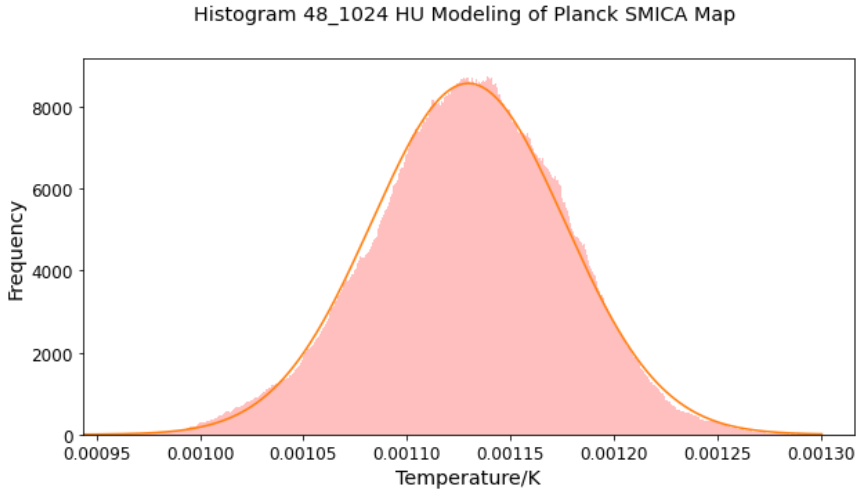

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Figure D.3. This figure depicts the temperature distribution of the simulated Cosmic Microwave Background.

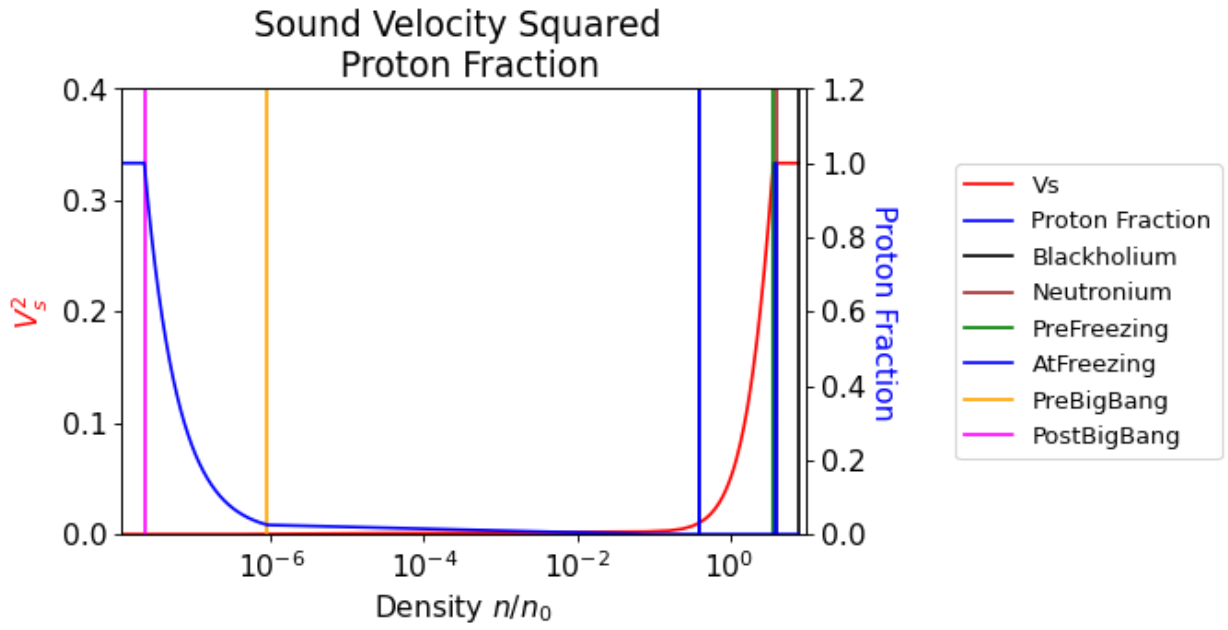

Figure D.4. This figure depicts the $C_s^2 = \left(\frac{Speed\ of\ Sound}{c}\right)^2$ for the Neutronium phase. It shows the abrupt speed of sound change around 300 MeV/fm^3. This transition is responsible for freezing the hyperspherical harmonic Neutronium Acoustic Oscillations.

EXTRA TABLES

	Density n/n_0	Density MeV/fm^3	Density (Kg/m3)	Neutron Density (1/m3)	Pressure N/m^2	Time (s)
Blackholium	8.00E+00	3.29E+02	5.82E+18	3.5E+45	2.81E+35	0.00E+00
Neutronium	4.00E+00	1.13E+02	2.91E+18	1.7E+45	4.83E+34	1.09E+02
PreFreezing	3.64E+00	9.77E+01	2.64E+18	1.6E+45	3.77E+34	1.26E+02
Freezing	4.04E-01	8.98E+00	2.94E+17	1.8E+44	1.25E+32	7.18E+02
PreBB	8.95E-07	5.93E-03	6.51E+11	3.9E+38	2.43E+23	8.69E+04
PostBB	2.19E-08	5.30E-04	1.59E+10	9.5E+36	5.35E+20	3.01E+05
Transparency	1.38E-35	3.93E-22	1.01E-17	6.0E+09	2.52E-25	3.51E+14
Today	6.87E-45	2.46E-28	4.99E-27	3.0E+00	7.85E-41	4.43E+17

Table D.1.A.

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	Density (Kg/m3)	Time (s)	Radius (lyr)	Temp K	Time (year)	Radius (light-seconds)	Observable Volume (lyr^3)	HU Volume (lyr^3)
Blackholium	5.82E+18	0.00E+00	1.33E-05	1.000E-04	0.0E+00	421	9.9E-15	4.7E-14
Neutronium	2.91E+18	1.09E+02	1.68E-05	1.000E-04	3.5E-06	5.3E+02	2.0E-14	9.4E-14
PreFreezing	2.64E+18	1.26E+02	1.73E-05	1.000E-04	4.0E-06	5.5E+02	2.2E-14	1.0E-13
Freezing	2.94E+17	7.18E+02	3.61E-05	1.000E-04	2.3E-05	1.1E+03	2.0E-13	9.3E-13
PreBB	6.51E+11	8.69E+04	2.77E-03	1.000E-04	2.8E-03	8.7E+04	8.9E-08	4.2E-07
PostBB	1.59E+10	3.01E+05	9.54E-03	2.746E+09	9.5E-03	3.0E+05	3.6E-06	1.7E-05
Transparency	1.01E-17	3.51E+14	1.11E+07	3.443E+03	1.1E+07	3.5E+14	5.7E+21	2.7E+22
Today	4.99E-27	4.43E+17	1.40E+10	2.725E+00	1.4E+10	4.4E+17	1.2E+31	5.5E+31

Table D.1.B. These tables contain the Universe's properties at the Universe's milestones: Blackholium, Neutronium, PreFreezing, Freezing, PreBigBang, PostBigBang, Transparency, Today. The initial radius of the Universe was 421 light-seconds. n_0 is the Nuclear Matter Density parameter. HU considers it to be the inverse of the volume of a minimum cell (cell side equal to the Compton Wavelength of a Hydrogen Atom). Universe peak temperature was 3 billion degrees Kelvin.

Initial Properties		
Initial 4D Radius of the Universe	421	ls
Initial Volume of the Observable Universe	2.65E+56	m3
Current Properties		
rho	4.99E-27	kg / m3
rho_atoms	2.98	Hydrogen Atoms per m3
Cell Length (m)	1.32E-15	m
EnergyPerSupernova	1.00E+51	ergs

Table D.2. This table summarizes the general conditions of the Universe. The initial 4D radius of the Blackholium was 421 light-seconds 4D radius. This radius is connected with what is considered to be the Black Hole density. The Fundamental Cell has a size length equal to the Compton Wavelength of a Hydrogen Atom or 1.32 femtometers. If that cell contains a single neutron, the density is called the Nuclear Matter Density $(1/1.32^3)=0.435\ fm^{-3}$. I assigned Blackholium density to having 8 neutrons per cell. The choice of Black Hole density just changes the initial 4D radius, but it doesn't change the dynamics of the Universe. The current average density is 2.98 atoms per cubic meter.

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Initial Properties		
Initial 4D Radius of the Universe	421	ls
Blackholium Density	5.82E+18	kg/m3
Neutronium Density	2.91E+18	kg/m3
EnergyPerSupernova	1.00E+51	ergs
Initial Observable Universe		
Initial Volume of the Observable Universe	9.9E-15 8.38E33	Lyr3 m3
Mass of the Observable Universe	4.89E52	kg
Initial Hyperspherical Universe		
Initial Volume of the Hyperspherical Universe	4.7E-14 3.98E34	Lyr3 m3
Mass of the Hyperspherical Universe	2.3E53	kg
Current Properties		
rho	4.99E-27	kg / m3
rho_atoms	2.98	Hydrogen Atoms per m3
EnergyPerSupernova	1.00E+51	ergs

Table D.3. This table summarizes the general conditions of the Universe.

REFERENCES

1. Smarandache, F. (2007). *Hadron Models and related New Energy issues*. https://digitalrepository.unm.edu/math_fsp/283/
2. Smarandache, F., & Christianto, V. (2007). *Quantization in Astrophysics, Brownian Motion, and Quantization in Astrophysics, Brownian Motion, and Supersymmetry Supersymmetry*. https://digitalrepository.unm.edu/math_fsp/76/
3. Pereira, M. (2017). The Hypergeometrical Universe: Cosmogenesis, Cosmology and Standard Model. *World Scientific News*, *82*, 1–96. www.worldscientificnews.com
4. Pereira, M. (2018). The Case for a Fourth Spatial Dimension and the Hyperspherical Force. *World Scientific News*, *98*, 127–139. www.worldscientificnews.com
5. Pereira, M. (2018). The Hypergeometrical Force: The Coma Cluster without Dark Matter. *World Scientific News*, *101*, 222–228. www.worldscientificnews.com
6. Pereira, M. (2019). The Optical Path of Ancient Photons and the Supernova Project. *World Scientific News*, *130*, 195–215. www.worldscientificnews.com
7. Pereira, M. (2017). The Hypergeometrical Universe: Cosmogenesis, Cosmology and Standard Model. *Global Journal of Science Frontier Research*, *17*(5). https://globaljournals.org/GJSFR_Volume17/3-The-Hypergeometrical-Universe.pdf
8. Pereira, M. A. (2010). The Hypergeometrical Universe: Cosmology and Standard Model. *AIP Conference Proceedings*, *1316*(1). https://doi.org/10.1063/1.3536448
9. Marco Pereira. THE BIG POP COSMOGENESIS EQUATION OF STATE. 2022. ffhal-03510701f
10. Pereira, M. A. (2022). *HU - The Big Pop Cosmogenesis*
11. Pereira, M. A. (2022). *HU - The Optical Path of Ancient Photons and the Supernova Project*.
12. Pereira, M. A. (2022). *HU - The Fundamental Dilator and the Quantum Lagrangian Principle*
13. Pereira, M. A. (2022). *HU - Quantum Lagrangian Principle and Newtonian Dynamics*
14. Marco Pereira. HU -THE SILVER SURFER PARADIGM FOR MOTION. 2022. ffhal-03510758f
15. Pereira, M. A. (2022). *HU - Derivation of Relativistic Natural Laws*
16. Pereira, M. A. (2022). *HU - The Hypergeometrical Acceleration and the Spiral Galaxy Rotation Curve Conundrum*
17. Pereira, M. A. (2022). *HU - The Coma Cluster Conundrum and the Bullet Cluster Observation*
18. Pereira, M. A. (2022). *HU - Tully-Fisher Test and the Tolman Relationship*
19. Pereira, M. A. (2022). *HU - Hypergeometrical Standard Model of Particle Physics*
20. Pereira, M. A. (2022). *HU - Challenging Relativity with Absolutivity*
21. Pereira, M. A. (2022). *HU - What are Gravitation and Nuclear Forces*
22. Pereira, M. A. (2022). *HU - Quantum Gravity*
23. Suntola, T. (2005). Observations support spherically closed dynamic space without dark energy. In C. Roychoudhuri & K. Creath (Eds.), *The Nature of Light: What Is a Photon?* (Vol. 5866, p. 160). https://doi.org/10.1117/12.621065
24. Suntola, T., & Day, R. (2004). *Supernova observations fit Einstein-deSitter expansion in 4-sphere*. https://arxiv.org/abs/astro-ph/0412701v2
25. Einstein, A. (1905). {Zur Elektrodynamik bewegter K{ö}rper}. ({German}) [{On} the electrodynamics of moving bodies]. Annalen Der Physik, 322(10), 891–921.

26. https://einsteinpapers.press.princeton.edu/
27. *Planck Collaboration, Aghanim, N., Akrami, Y., Ashdown, M., Aumont, J., Baccigalupi, C., Ballardini, M., Banday, A. J., Barreiro, R. B., Bartolo, N., Basak, S., Battye, R., Benabed, K., Bernard, J.-P., Bersanelli, M., Bielewicz, P., Bock, J. J., Bond, J. R., Borrill, J., … Zonca, A. (2018). Planck 2018 results. VI. Cosmological parameters.* http://arxiv.org/abs/1807.06209
28. Guth, A. H. (1981). Inflationary universe: A possible solution to the horizon and flatness problems. *Physical Review D*, *23*(2), 347–356. https://doi.org/10.1103/PhysRevD.23.347
29. Higgs, P. W. (1964). Broken Symmetries, Massless Particles, and Gauge Fields. *Physics Letters*, *12*(2), 132–133. https://doi.org/10.1016/0031-9163(64)91136-9
30. Higgs, P. W. (1964). Broken Symmetries and the Masses of Gauge Bosons. *Physical Review Letters*, *13*(16), 508–509. https://doi.org/10.1103/PhysRevLett.13.508
31. Higgs, P. W. (1966). Spontaneous Symmetry Breakdown without Massless Bosons. *Physical Review*, *145*(4), 1156–1163. https://doi.org/10.1103/PhysRev.145.1156
32. Banerjee, S., Danielsson, U., Dibitetto, G., Giri, S., & Schillo, M. (2018). Emergent de Sitter Cosmology from Decaying Anti–deSitter Space. *Physical Review Letters*, *121*(26), 261301.
33. Kaluza, Theodor (1921). "Zum Unitätsproblem in der Physik". Sitzungsber. Preuss. Akad. Wiss. Berlin. (Math. Phys.): 966–972.
34. Klein, Oskar (1926). "Quantentheorie und fünfdimensionale Relativitätstheorie". Zeitschrift für Physik A. 37 (12): 895–906.
35. Wesson, P. S., Liu, H., & Seahra, S. S. (2000). *The big bang as a higher-dimensional shock wave*.
36. *Wesson, P. S. (2014). The Status of Modern Five-Dimensional Gravity. International Journal of Modern Physics D, 24(1), 1530001.* https://doi.org/10.1142/S0218271815300013
37. *Liko, T., & Wesson, P. S. (2005). The big bang as a phase transition. International Journal of Modern Physics A, 20(10), 2037–2045.* https://doi.org/10.1142/S0217751X05022299
38. *Wesson, P. S., & Liu, H. (2001). The cosmological constant problem and Kaluza-Klein theory. International Journal of Modern Physics D, 10(6), 905–912. https://doi.org/10.1142/S0218271801001396*
39. *Seahra, S. S., & Wesson, P. S. (2003). Universes encircling five-dimensional black holes. Journal of Mathematical Physics, 44(12), 5664–5680. https://doi.org/10.1063/1.1623617*
40. Vilenkin A., 1982, Phys. Lett. B 117, 25
41. Prince Rupert's Drops. (1876). *Popular Science Monthly*, *8*.
42. Bochkov, M., Gusenkova, D., Glushkov, E., Zotova, J., & Zhabin, S. N. (2016). Resistive method for measuring the disintegration speed of Prince Rupert's drops. *European Journal of Physics*, *37*(5). https://doi.org/10.1088/0143-0807/37/5/055707
43. Prince Rupert Drop video - https://www.youtube.com/watch?v=xe-f4gokRBs
44. Hebeler, K., Lattimer, J. M., Pethick, C. J., & Schwenk, A. (2013). Equation of state and neutron star properties constrained by nuclear physics and observation. *Astrophysical Journal*, *773*(1). https://doi.org/10.1088/0004-637X/773/1/11
45. Bedaque, P. F., & Steiner, A. W. (2015). Sound velocity bound and neutron stars. *Physical Review Letters*, *114*(3), 031103. https://doi.org/10.1103/PhysRevLett.114.031103

46. Saha, M. N. (1921). On a Physical Theory of Stellar Spectra. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *99*(697), 135–153. https://doi.org/10.1098/rspa.1921.0029
47. *Melia, F. (2021). The anomalous 21-cm absorption at high redshifts. European Physical Journal C, 81(3). https://doi.org/10.1140/EPJC/S10052-021-09029-4*
48. *Riess, A. G., Filippenko, A. v, Challis, P., Clocchiatti, A., Diercks, A., Garnavich, P. M., Gilliland, R. L., Hogan, C. J., Jha, S., Kirshner, R. P., Leibundgut, B., Phillips, M. M., Reiss, D., Schmidt, B. P., Schommer, R. A., Smith, R. C., Spyromilio, J., Stubbs, C., Suntzeff, N. B., & Tonry, J. (1998). Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant To Appear in the Astronomical Journal.*