HYPERGEOMETRICAL UNIVERSE THEORY SUPERNOVAE HIGH Z PREDICTIONS

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Abstract: This article shows that the proposed Hypergeometrical Universe (HU) topology and the epoch-dependent G ($\propto$inverse of 4D Radius) consistently predicts the correct distances(z) for the type 1A Supernova Union2.1 data. This might indicate a potential bias on the interpretation of this dataset. This is very important since theories based upon Inflation, Dark Matter, Dark Energy Models rely on the Supernova Survey to extract their parameters. Conversely, the matching of HU predictions to the unbiased data lends credence to this alternative view of the Universe expansion, topology and composition.

INTRODUCTION

The aim of this article is to study how the consideration of a particular framework (HU)[1] would modify the conclusions derived from the Supernova Survey (Union2.1) [2]. Current analysis indicates that many of the Supernovae explosions take place at distances larger than the maximum distance traveled during the Universe lifetime (circa 14 Billion Years). This paradoxical result is the motivation for Inflation Theory, the proposition of Dark Energy (to support the expansion) and Dark Matter to counterbalance it.

This Supernova Survey is composed of observations of Type 1A Supernova explosions. Type 1A Supernova explosions are thought to have as precursors a binary system of White Dwarfs or White Dwarf –Star. The justification for the consistency in Luminosity is that the White Dwarf steals material from the companion until it reaches the Chandrasekhar mass[3]. At that point, the electron Fermionic repulsion cannot keep the Dwarf from collapsing any longer. The collapsing process ignites Carbon-Oxygen fusion and the whole White Dwarfs burns starting from the core as a shockwave until the top layer is ejected by a neutrino pulse. ^{56}Ni is formed in the process. Subsequent nuclear reactions are responsible for all the observed luminosity. The luminosity profile shapes are supposed to be modulated by the eject volume. Light emitted has to diffuse through this eject. It is thought that the larger the explosion, the larger the ejecta and larger the luminosity time width.

To achieve the required precision, WLR (width luminosity relation) [4-8] is used. This is an observational relationship that requires time-scaling to standardize the luminosity curves. Since the normalization process makes use of the assumption that all Supernovae explosions are the result of the same process with small variations due to different ejecta volumes or composition, its correction to a scenario where G is epoch dependent would entail only the understanding how the Peak Luminosity depends upon G. All thing equal, one would just have to scale down the apparent distance by the square root of the scaling factor modifying the Luminosity.

Arnett [4] showed that the peak luminosity is equal to the rate of energy deposition (^{57}Ni creation). Since this is a nuclear chemistry reaction, that rate depends upon the product of [C] and [O] concentrations, which are dependent on the volume the G-Dependent Chandrasekhar mass is distributed.

The normalization process by WLR is akin to rescaling the White Dwarf(G) such that it has the same volume as a White Dwarf of the current epoch. Rescaling the volume while keeping the mass constant yields concentrations that have $G^{-3/2}$ dependences. Thus Luminosity dependence is G^{-3}.

We proceeded with the introduction of the HU scenario, derived its predictions and recovered a Luminosity dependence of G^{-3} and thus the apparent distances were corrected by $G^{-3/2}$. The resulting distances are a perfect match to the HU predictions and the distances are within the expected distances for our aged Universe.

The predictions compared favorably with Friedmann- Lemaître Model with fittings found in the literature. We found many distinct fittings indicating that this model is not consistent across all the dataset.

METHODS

The Hypergeometrical Universe Theory (HU)

In HU, the 3D Universe spatial coordinates are mapped into a light-speed expanding hyperspherical hypersurface. This expanding hypersurface is considered to be embedded into a 4D non-compact spatial manifold. **This hypersurface is expanding at the speed of light (c) radially. It shouldn't be necessary to state that this is not in conflict with Relativity. Relativity's domain is xyzt and placing the whole Universe on an inertial referential traveling perpendicularly to xyz frame does not affect any observable.**

Because of its moving framework nature, the experimental measurements of the speed of light are compatible with the actual speed of light being equal to $\sqrt{2}c$. The derivation of the Laws of Gravitation and Electromagnetism[1] resulted in having G to be epoch dependent, that is, G is inversely proportional to the 4D radius of the Universe.

CURRENT VIEW OF THE UNIVERSE

When observing type 1A Supernova explosions (stellar candles) on a telescope, Edwin Hubble [8] noticed a frequency shift that when modeled by a velocity-dependent Doppler shift indicated that the Universe was expanding and that the receding velocity increased linearly with the observation distance. So, if you measure the frequency shift, one can calculate the astronomical distance.

The Doppler-shift is related to implied recessing velocity by:

$$\frac{v}{c}=\sqrt{\frac{(1+z)^2-1}{(1+z)^2+1}}=\frac{H_0}{c}d_{Hubble}(z) \tag{1}$$

These supernova explosions are called stellar candles because of the mechanism that creates them yields a consistent and repeatable <u>**absolute**</u> luminosity intensity profile.

The spectral shift is represented by a factor z:

$$z = \frac{\Delta\lambda_{obs}}{\lambda_0} \tag{2}$$

$$1 + z = \frac{\lambda_{obs}}{\lambda_0} \tag{3}$$

For sake of comparison we will use the both the original Hubble Law when plotting the Supernova dataset, fittings and predictions.

$$v = H_0 d \tag{4}$$

and the improved Hubble Law [7]:

$$\begin{gathered} d_L(z; \mathbf{\Omega}_M, \mathbf{\Omega}_\Lambda, H_0) = \frac{c(1+z)}{H_0 \sqrt{|\kappa|}} \left(\sqrt{|\kappa|} \int_0^z \left[(1+z')^2 (1 + \mathbf{\Omega}_M z') - z'(2+z') \mathbf{\Omega}_\Lambda \right]^{-\frac{1}{2}} dz' \right) \\ \textit{where} \\ \kappa = 1 \\ \mathbf{\Omega}_M = 0.27 \\ \mathbf{\Omega}_\Lambda = 0.73 \\ H_0 = 70 \end{gathered} \tag{5}$$

The question we want to address is if there is a model that can reproduce the data under a different paradigm that would indicate a bias in the current interpretation. The data used comes from the Supernova Broad Survey Union 2.1 dataset [2].

If this model requires no parameters, that is even better.

We will start with a proposal for the Universe topology and model how past epochs observation are understood within that framework.

Hypergeometrical Universe - Viewing the Past

The proposed topology is of a light-speed expanding hyperspherical hypersurface to represent the spatial coordinates of our Universe. This means that the 3D Universe is a moving inertial frame with very specific topology, curvature (there are three curvatures one spatial and others spacetime related).

The absolute speed of light becomes $\sqrt{2}c$. This doesn't affect any experimental measurements since they are done within the confines of the hypersurface and within very small Cosmological Angles. A Cosmological Angle is represented in Figure 1 as alpha.

Having the whole Universe traveling at the speed of light in any direction doesn't conflict with Relativity. Relativity statements pertain to spacetime and there is no reason why they are automatically extended to a reality where there is an extra non-compact radial coordinate R. The dynamics leading to this state of motion has been presented elsewhere and is not a relevant part of this work.

Figure 1 shows a cross section XYZR. Since R maps into a Cosmological time Φ ($R=c\Phi$), there should be an identical cross-section with R replaced by Φ.

All Science has been dealing with what is inside the hypersurface, so $xyz\tau$ and $x'y'z'\tau'$ inertial frames are represented by locally distorted regions on the hypersurface described by Lorentzian metrics. This means that the introduction of an extra non-compact spatial coordinate is compatible with Strict Relativity.

This is a digression since the point we are trying to make is if this model is consistent with the Supernova Data in a different manner than current interpretations thus indicating a potential systematic error.

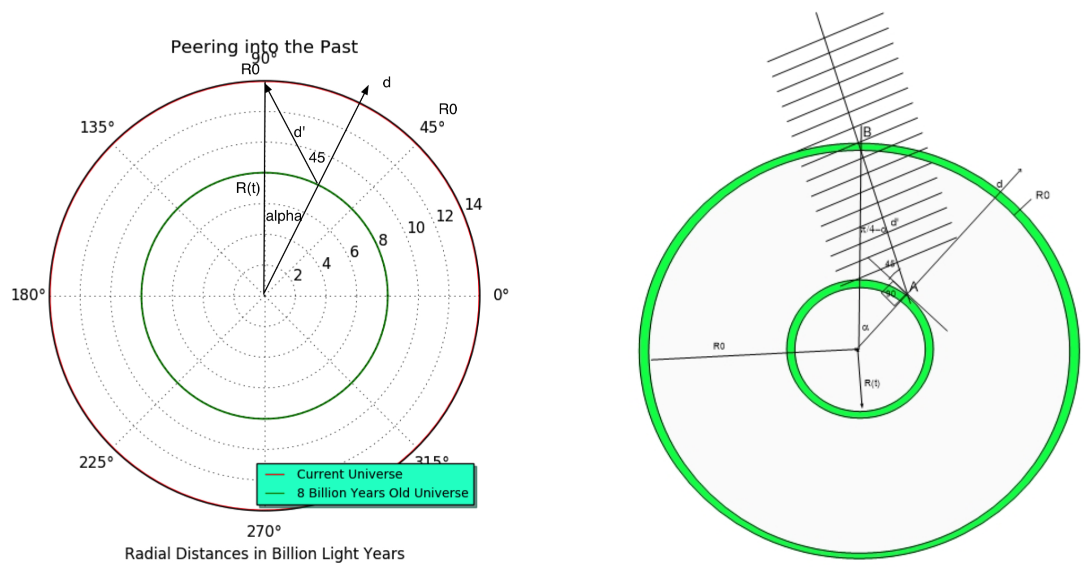

Figure 1. The figure on the left shows how one interprets peering into the past within the Hypergeometrical Universe Theory. We indicated two epochs - the current and the one for the 8 billion years old Universe. On the right panel, one can see how plane waves project themselves into the current hypersurface R_0. The mapping of the Cosmological Angle Alpha to $[R_0,0]\text{->}[0, \pi/4]$ is the result of 45 degrees light propagation and a direct result of the proposed topology.

It should be clear that d' indicates an observation angle, being its projection onto the hypersurface what we usually recognize. The requirement that light travels along 45 degrees to reach us at our epoch, creates a one-to-one mapping between the region on R(t) and its projection on R_0.

Even though light will always travel through the 4D spatial manifold, the requirement of always observing light that travels at 45 degrees imply that we are considering just the focus plane in our measurements. Within a given angular volume, observations can come from slight different epochs (like color aberration). This is exactly what would happen when you look at very small cosmological angles and observe a larger error on the determination of the Redshift parameter z.

For a given cosmological angle α, simple trigonometry yields:

$$\frac{sin(\alpha)}{d'} = \frac{sin(\frac{3}{4}\pi)}{R_0} = \frac{sin(\frac{\pi}{4}-\alpha)}{R(t)} \tag{6}$$

where $\alpha = \frac{d}{R_0}$

From equation (6):

$$\frac{d_{HU\_corrected}}{R_0} = \frac{R_0 - R(t)}{R_0} = 1-\sqrt{2} * sin(\frac{\pi}{4}-\alpha) = 1-\sqrt{2} * sin\left(\frac{\pi}{4}-\frac{d}{R_0}\right) \tag{7}$$

This is the distance that maps to the expected distance of the current view, that is, if the speed of light were c (instead of $\sqrt{2}c$ while traveling along the 4D spatial manifold), this would be the distance traversed at the speed of light during the time between the Supernova explosion and its observation.

Considering plane wavefronts (see Fig 1), the relationship between an observed wavelength and the 4D wavelength is such that for α=0:

$$\lambda_{obs} = \lambda_0 = \sqrt{2}\lambda_{4D} \tag{8}$$

where λ_{4D} is the wavelength traveling within the 4D spatial manifold. At very close cosmological distances, we observe $\lambda_0 = \sqrt{2}\lambda_{4D}$.

since the speed of light is $\sqrt{2}c$ while traversing the 4D spatial manifold at 45 degrees.

For any other cosmological angle α the relationship is given by:

$$\frac{\lambda_{4D}}{\lambda_{Obs}} = sin\left(\frac{\pi}{4}-\frac{d}{R_0}\right) \tag{9}$$

where d is the projection of the observation point on R(t) back onto R_0.

Multiplying both sides by $\sqrt{2}$

$$\frac{\sqrt{2}\lambda_{4D}}{\lambda_{Obs}} = \frac{\lambda_0}{\lambda_{Obs}} = \frac{1}{(1+z)} = \sqrt{2}sin\left(\frac{\pi}{4}-\frac{d}{R_0}\right)$$

Hence:

$$d = R_0 * \left(\frac{\pi}{4} - arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right)\right) \tag{10}$$

$$\alpha = \frac{\pi}{4} - arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right) \tag{11}$$

This is the **Hypergeometrical Universe relationship between d and z**, were d is projected on the current epoch. For prior epochs, one should use the sine relationship to derive:

$$d' = \sqrt{2}R_0 sin(\alpha) = \sqrt{2}R_0 sin\left(\frac{\pi}{4} - arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right)\right) \tag{12}$$

Notice that this is a different relationship between d and z than the one described on equation (1).

A 1St Quadrant supernova presenting a redshift z, travels at

$$\alpha = \frac{v}{c} = \frac{4}{\pi}\frac{d}{R_0} = 1 - \frac{4}{\pi} arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right)$$

and is located at distance

$$d = R_0 * \left(\frac{\pi}{4} - arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right)\right)$$

where

$$R^{1stQuad}{}_0 = \frac{c}{H_0} = 13.96bly$$

The numerical value of R_0 is only used to scale Supernova Distances from the Survey. A normalized R_0 is used for the trigonometric relationships. For the first quadrant one would use

$$R_0 = 1$$

$$R(t) = R_0\left(\cos(\alpha) - sin(\alpha)\right)$$

The second quadrant data is just a reflection of the $\pi/4-(1-R(z))$ at distance $\pi/4$. The farthest light possible (from One Radian) would have a redshift z.

$$\frac{\lambda_0}{\lambda_{Obs}(OneRadian)} = \frac{1}{(1+z_{OneRadian})} = -\sqrt{2}sin(\frac{\pi}{4} - 1)$$
$$z_{OneRadian} = 3.696$$

Counterintuitive since we are not considering Doppler shift as being a cause for redshift. By all measures we are running away from the Big Bang at the highest speed possible (c). This seriously question the use of Doppler effect as a way to model redshifting. Is Doppler Redshifting really allowed under Relativity?

Filtering light with that redshift might allow to see the farthest possible.

How Big is Our Universe?

The First Quadrant is 13.96 Bly long. The Second Quadrant [pi/4,1] maps to a "zero" 4D Radius hypersphere.

Can We See The Second Quadrant?

Yes. You can see but it will appear in the opposite direction where it really is. This means that as you peer into the distance with your telescope pointing in one direction, anything beyond the first quadrant will actually be located on the opposite direction in the Universe. We can only see up to a radian. Beyond that it is the rest of the four quadrants that comprises our Universe. While limited to the speed of light c, we can only explore the first quadrant.

Where does the Microwave Background Comes From?

The microwave background is generated at $\alpha = \pi/4$, or at 13.96 Bly away. The fact that $\pi/4 - \Delta\alpha$ and $\pi/4 + \Delta\alpha$ appear in opposing directions in our Universe means that there will be correlation between points on opposing positions in the Universe. They are actually close to each other and not correlated through some inflationary process.

How far are we seeing right now?

The farthest type 1A Supernova in the Survey Union 2.1 is just above half of our Universe real 4D Radius ($0.70R_0$).

Hypergeometrical Universe Covariance – Epoch Dependent G

In looking back into prior epochs, Gravitational Constant G scales [1] up as:

$$G_f(d') = \frac{R_0}{R(t)} = \frac{1}{\cos(\alpha) - sin(\alpha)} \tag{13}$$

despite of the pole at 45 degrees, one doesn't need to worry since saturation1 occurs before R(t)=0.

The distance between Universe epochs is what is traversed at the speed of light c and that is given by:

$$d_{epoch}(t) = 1 - \frac{1}{G_f} = \frac{R_0 - R(t)}{R_0} = 1 - \cos(\alpha) + sin(\alpha) =$$

$$d_{epoch}(t) = 1 - \cos\left(\frac{\pi}{4} - arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right)\right) + sin\left(\frac{\pi}{4} - arcsin\left(\frac{1}{\sqrt{2}(1+z)}\right)\right) \tag{14}$$

This value is the one used on the predictions of the Hypergeometrical Universe. This is the distance travelled by a light entity traveling at the speed of light c, during the time the Universe took to reach our epoch. This is equivalent to the distance d on our epoch. This is the appropriate mapping since in the HU model, light travels at $\sqrt{2}c$ within a 4D spatial manifold.

WHITE DWARF(G) CHANDRASEKHAR MASS AND RADIUS

The Chandrasekhar mass has a dependence of $G_f^{-3/2}$. This nuclear reaction is a second-order nuclear chemistry reaction, being the rate of ^{56}Ni creation proportional to the square of the mass, thus proportional to G^{-3}, so the Absolute Luminosity of the solar candles will scale down according to the same factor. The apparent distance will be systematically overestimated by a factor of $G^{3/2}$ (Appendix A). That is the reason why in a 14 Billion Years Old Universe, we are currently "seeing" Supernova explosions as far as 25 Billion Light-Years away. This might be a mirage due to not taking into consideration the scenario offered by HU.

$$AbsLuminosity(d') \propto G_f(d')^{-3} \tag{15}$$

$$RealDistance(d') = \frac{AparentDistance}{G_f(d')^{\frac{3}{2}}} \tag{16}$$

RESULTS

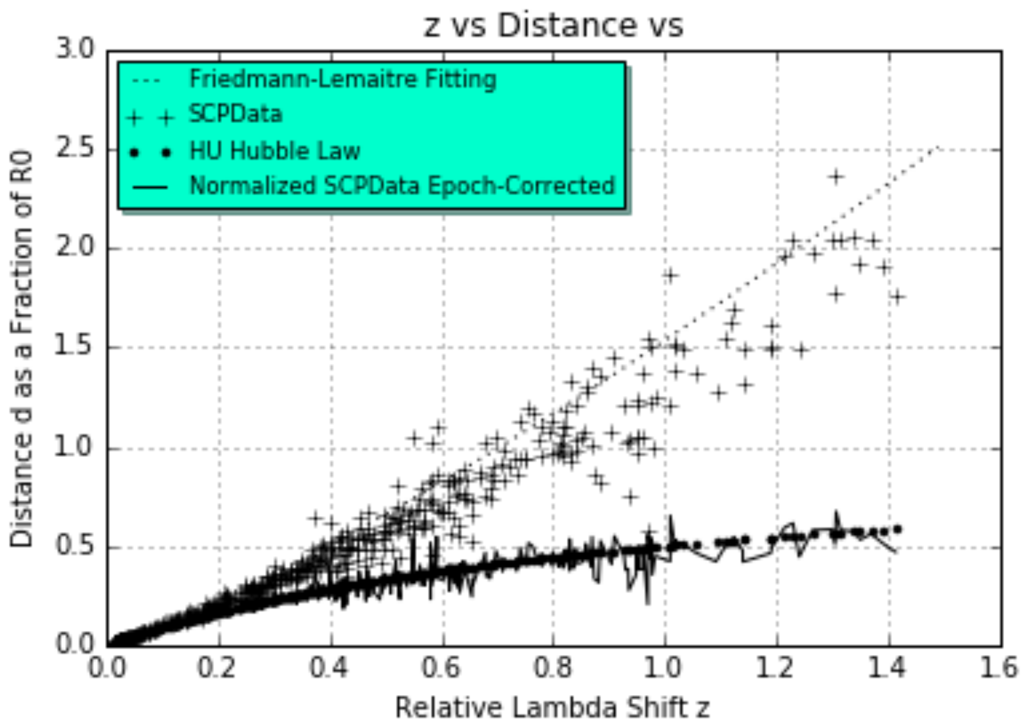

Figure 2. Here are depicted the Friedmann-Lemaitre Hubble Law, the raw astronomic data (SCPUnion2.1) normalized using the full 4D radius of the Universe (13.96 Bly). Also represented are the raw data scaled-down by the $G_f(d')^{-3/2}$ scaling factor and the HU predictions for the first quadrant.

Where the Modified Hubble (Friedmann- Lemaître) Law is given by [7]:

$$d_L(z; \mathbf{\Omega}_M, \mathbf{\Omega}_\Lambda, H_0) = \frac{c(1+z)}{H_0 \sqrt{|\kappa|}} \left(\sqrt{|\kappa|} \int_0^z \left[(1+z')^2 (1+\mathbf{\Omega}_M z') - z'(2+z')\mathbf{\Omega}_\Lambda \right]^{-\frac{1}{2}} dz' \right)$$

where

$\kappa = 1$

$\mathbf{\Omega}_M = 0.27$

$\mathbf{\Omega}_\Lambda = 0.73$

$H_0 = 70$

HU Predictions - Goodness of fitting

From the plot in Figure 3, it is clear that Friedmann- Lemaître cosmologies provides a worse fitting than the non-parametrized predictions of the Hypergeometrical Universe Theory. In addition, fitting to different epoch provide different parameters and thus different physics.

HU predictions goodness of fitting is presented below:

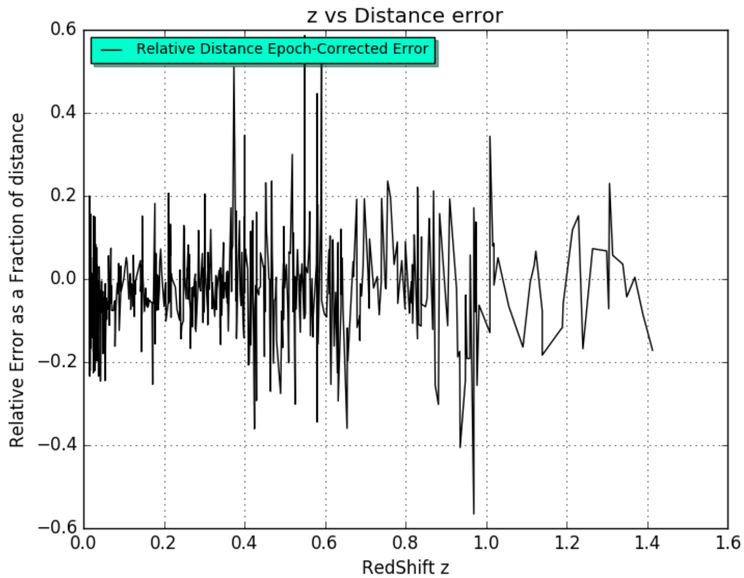

Figure 3. Relative Distance Error for epoch corrected survey distances. Power_divergenceResult(statistic=2.1587887660434681, pvalue=1.0)

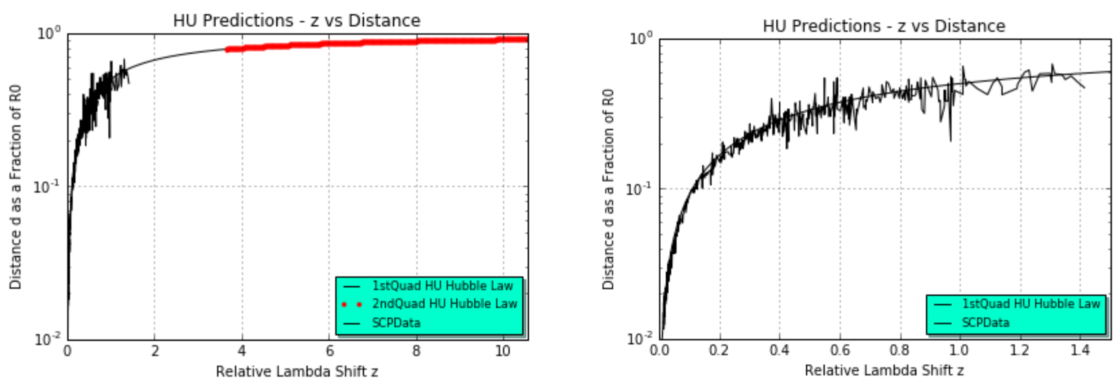

Figure 4. HU predictions versus Supernova Survey corrected data. Notice that these are predictions and not parametrized fittings from which one would extract a model dependent physics. Left panel shows both quadrants while right panel shows details of the first quadrant.

DISCUSSION:

The Hypergeometrical Universe theory [1] <u>non-parametrized</u> predictions were shown to consistently reproduce the observational astronomic data better than the best current Friedmann- Lemaître Cosmological Fitting. Failure of this model might be because different region fittings yielded a different set of parameters (Dark Energy/Dark Matter related parameters). That indicates that this General Relativity variant using Dark Energy as Cosmological Constant and Dark Matter as added Gravitational pull fails at large in describing the Universe.

Conversely, the reproduction of observational astronomic data provides some level of support for the hypothesis that G is epoch-dependent and proportional to the inverse 4D radius and that there might be a systematic error in converting the Luminosities into distances.

The scaling up of the gravitational constant G is an integral part of the Hypergeometrical Universe rationale since it is how one derives the HU Gyrogravitational Law.

This scaling up also provides support for the hypothesis of **Epoch Covariance**.

> As space contracts and G increases, stars and galaxies also contracts and so does their energy output ($G_f(d')^{-3}$ scaling factor). This is important otherwise astronomical observations would indicate a distorted picture of weaker Supernovas contained in unusually luminous Galaxies.

Stronger gravity also means that star/galaxy formation will occur ahead of constant-G models predictions. Since HU provides a clear description of how space expands, cosmological simulations could be simplified. Gyro-gravitation and Gyro-electromagnetism will add some complexity [11].

Universe New Size

The Universe is 13.96 bly. The region between [0,π /4] is a direct view. The region[π/4,1] is viewed in the opposite direction in the sky.

Reflective Universe

The second quadrant appears in the opposite direction as the first quadrant, that is, looking into the Universe is almost like looking through a converging lens, depending upon the position of the object with respect to the focus, the image will appear upside-up or upside-down. In the Universe, the situation is slightly more complex and if we look an object beyond the first quadrant, that object will appear exactly in the opposite direction in the Universe!

Correlation on the Microwave Cosmic Background

Positions close to the first quadrant (13.96 Bly away) on each side will appear in opposing directions in our Universe. That region is the source of the CMB radiation and actual proximity is what explains correlation.

Acceleration Predictions

On the HU Theory, the Universe is not accelerating radially. The rest of the 3D Universe is accelerating away from each other with at:

$$acceleration(L) = \frac{c^2 L}{R_0^{\ 2}} \tag{17}$$

$$acceleration(R_0) = \frac{c^2}{R_0} \tag{18}$$

This is what one would expect from simple analysis based on purely geometrical arguments. If observations are consistent with these predictions, Dark Energy will again not be needed to expand the 3D Universe. This is an approximation since it is based on derivatives on $R(t)=R_0$. If acceleration observations cover a range of distant epochs, a more detailed but still simple analysis along the lines we presented here should be used instead.

In summary, for not taking into consideration the HU scenario (or other variants of it) the current interpretation of this Supernova Dataset and the current use of WLR to infer Absolute Luminosities might be systematically overestimating distances. There might be a great benefit from considering epoch dependent G theories, since they challenge the current view of an Inflationary Universe full of Dark Matter and expanded through Dark Energy. The Hypergeometrical Universe theory, offering predictions that fit the data on all z ranges, might be a good candidate.

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Appendix A.

The goal of this appendix is to properly support the argument that the peak luminosity is proportional to the product of the concentrations of [C] and [O] under standardized conditions. Under standardized conditions [C] concentration is proportional to $G^{-3/2}$ leading to luminosity proportional to G^{-3}.

Arnett (1982) first demonstrated that at maximum light the instantaneous bolometric luminosity is approximately equal to the instantaneous rate of energy deposition by radiative decay*[6]*

First, let's understand what drives the Supernova explosion:

$$^{12}C_6 + {}^{12}C_6 \ -> {}^{24}Mg_{12}$$

$$^{24}Mg_{12} + {}^{16}O_8 -> {}^{40}Ca_{20}$$

$^{40}Ca_{20}+^{16}O_8$-> ^{56}Ni

The process is driven by the burning of Carbon. The Luminous output is powered entirely by the decay chain[6]:

^{56}Ni –>^{56}Co –> ^{56}Fe

Derivation of Chandrasekhar mass and Radius:

Below is the equilibrium equation for the pressure and potential energy.

$$\frac{1}{r^2}\frac{d}{dr}\left(\frac{r^2}{\rho}\frac{kT}{\mu m_H}\frac{d\rho}{dr}\right)=-4\pi G\rho$$

One modifies the equation such as to recover Lane-Emden equation. The first zero of solution provides the Radius of the White-Dwarf at the Chandrasekhar limit:

$$R = a\xi 1 = \left[\frac{(n+1)K}{4\pi G}\right]^{1/2} \rho_c^{(1-n)/2n}\xi 1$$

The integral of the density up to that Radius provides the Chandrasekhar Mass:

$$M = \int_o^R 4\pi r^2\rho\, dr = 4\pi \left[\frac{(n+1)K}{4\pi G}\right]^{3/2} \rho_c^{(3-n)/2n}\ \xi_1^2 \left| \frac{d\theta}{d\xi}\ \xi 1\right|$$

The average density M/V is given by:

$$\bar{\rho}=\frac{M}{V}=\frac{4\pi\left[\frac{(n+1)K}{4\pi G}\right]^{3/2}\rho_c^{(3-n)/2n}\ \xi_1^2\left|\frac{d\theta}{d\xi}\ \xi 1\right|}{\frac{4\pi}{3}\left[\frac{(n+1)K}{4\pi G}\right]^{3/2}\rho_c^{3(1-n)/2n}\xi_1^3}=3\ \rho_c\xi_1^{-1}\left|\frac{d\theta}{d\xi}\ \xi 1\right|$$

and it is independent upon polytropic index n and G. This also implies that the central density is independent upon G.

For the highly relativistic case n=3, so M is independent of ρ_c .

$$M \propto G^{-3/2}$$

And R is proportional to:

$$R \propto G^{-1/2}$$

This means that under different G environments, the particle density remains the same (independent upon G), the core density is the same, the pressure profile is also the same. The only difference is that this White Dwarf is a scaled down version of the current epoch G_0 (make G_0=1).

WLR (Width-Luminosity Relationship)

> *The WLR is an observed relation between peak magnitude and a measure of width. To obtain an accurate result in the face of measurement error and the temporal sparsity of observed data, both the peak magnitude and the width are measured by fitting observed data to templates determined from well-observed supernovae (Hamuy et al. 1996b; Riess et al. 1995). It is important to employ the same methods to measure the peak magnitude and width in our models. We "observe" our synthetic lightcurves by employing the MCLS (Multi-Color Lightcurve Shape) method of Riess et al. (1995), employing the revised vectors used in Riess et al. (1998) (kindly provided by Dr. Riess). We have also determined the $\Delta m_{15}(B)$ decline-rate parameter for our models using the χ^2 template-fitting technique described by Hamuy et al. (1996c). [10]*

The issue with this statement is that no variable G environment was considered in this analysis by Pinto et all[10]. Since under different G the particle density, pressure profile and reaction rate remains the same for the duration of the initial reaction ($^{12}C_6 + {}^{12}C_6$ -> $^{24}Mg_{12}$), the only difference is the duration of the luminosity raising slope.

Time Scaling under constant coasting velocity

It was observed that a so-called Width-Luminosity-Ratio (WLR) rule to be a way to standardized observations. This requires the time scaling of luminosity curves such as to obtain equal width processes and thus equal absolute luminosity. The scaling of buildup time under conditions of constant coasting velocity is equivalent to scale the White Dwarf volume across different values of G.

Now, after the time scaling (volume scaling), the corresponding particle densities are actually different ($\propto G^{-3/2}$) than the ones for current epoch White Dwarfs and the absolute Luminosity scales with G^{-3}. Current measurements do not make that adjustment and would have a bias if HU hypothesis of variable G is correct.

> *While this width-luminosity relation (henceforward WLR) is very well substantiated observationally, it is an empirical relation which has remained largely unexplained. H¨oflich et al. (1996) showed that many current explosion models come close to this relation and suggested that the relation was determined primarily by the precise nature of the explosion itself. In this paper we provide the rudiments of a physical explanation for the WLR which is based upon the physics of radiation flow in SNe Ia, one in which the details of the explosion itself are largely masked. If true, this argues strongly against any significant bias arising in the WLR due to evolutionary effects in the supernova progenitors.[10]*

On Pinto and Eastman [10], one can clearly see that effect of the time scaling procedure on the leading edge of the Luminosity Profile.

The leading edge derivative depends upon the particle concentration of the Supernova. That density is not dependent upon G. The duration of the process depends upon G. By making all leading edges normalized, the time scaling is effectively rescaling the volumes of all White Dwarfs and extracting the Peak Luminosity from the WLR relationship. The rescaling of volumes has to be accompanies with a rescaling of the concentrations (C and O), responsible for that ^{56}Ni build-up. Luminosity is proportional to that rate and that is proportional to G^{-3}.