Measuring the Universe Part I – Dark Matter, Dark Energy, and The Big Flip.

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Abstract

In Part I, of a two-part discussion, we establish minimum measurement frames of reference for any complex and/or real measurements in a purely statistical model for the universe. The goal of this paper is to provide a model that adheres to Planck measurement standards and explains both the nature of dark matter and dark energy-without the use of zero-point vacua. We introduce a model for the expansion of the universe based on the limits of geometric completeness and the principles of phase space bifurcation. Measuring the Universe, Part II, will focus on establishing the relation between galaxy formation, the galactic web and the statistical phase space potential defined by the limits of Lorentz invariance and the relationship between the fundamental constants.

1.0 Introduction

Often our universe is described as having a beginning, and no ending, because this is how we experience time. To our, human, frame of reference time has a direction. The question of what constitutes the complete nature of the universe will always be related to how time is measured and the boundaries of measurement theory. But what is a universe? We will begin with a short discussion of the definitions and boundaries we supplied in our previous papers[6-14]. In all of those papers we have stated that both zero and infinity are outside the boundaries of measurement. Here, we will attempt to demonstrate that the elimination of smooth approaches to zero results in a measureable universe. Terms like “energy”, “force”, “field” and “mass” are translated into terms based in set theory, probability and finite geometry. By positioning all forces as *probabilities*, we are able to measure them in relative and quantum time. This allows us to combine quantum theory and general relativity into a single frame of reference, without the use of zero point vacua. We begin where we left off; a proven theorem of completeness [14] and the connection of geometric boundaries to measurement in real space. The following definitions for geometric completeness and minimum measurement were established in our last two papers:

Complete system of geometry- Any complete system of geometry must be able to satisfy all the requirements of Riemannian geometry as well as clearly defining the boundary between the real and complex planes.

Minimum measurement- Any minimum measurement is able to be oriented on a coordinate plane and contains the same minimum real lengths required of any modular form, elliptic curve or non-trivial zero.

We also live in a universe that appears to have a measureable redshift, indicating that the expansion of the universe is accelerating. Planck measurements of baryonic acoustic oscillations (BAO) in the early universe currently set one of the tightest measurement standards for any model [4]. To create a model that can match the Planck accuracy requires that we generate an equivalency to BAO measurements through all epochs. In addition there are a number of model requirements that are tied to Lorentz invariance and the relationships between the fundamental constants. Recently a number of prominent researchers published a list of conventions for any theorist attempting to match the current ΛCDM model parameters [5]. We include their table of conventions as a valid picture of Lorentz invariance:

CONVENTIONS

Definition	Meaning
$\hbar = c = k_B = 1$	Natural units
$\kappa^2 \equiv 8\pi G_N = M_{\rm Pl}^{-2}$	Gravitational constant
$(- + + +)$	Metric signature
$g_{\mu\nu}$	Metric tensor
$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R$	Einstein tensor
Λ	Cosmological constant
$\mathrm{d}s^2 = -\mathrm{d}t^2 + a^2(t)\left[\frac{\mathrm{d}r^2}{1-kr^2} + r^2\left(\mathrm{d}\theta^2 + \sin^2\theta \mathrm{d}\phi^2\right)\right]$	Friedmann-Lemaître-Robertson-Walker (FLRW) spacetime metric
$a(t)$	Scale factor
$a_0 = 1$	Scale factor today (set to unity)
t	Cosmic (proper) time
$\tau(t) = \int_0^t \frac{\mathrm{d}t'}{a(t')}$	Conformal time
$\dot{} \equiv \frac{\mathrm{d}}{\mathrm{d}t}$	Cosmic time derivative
$' \equiv \frac{\mathrm{d}}{\mathrm{d}\tau}$	Conformal time derivative
$T^{\mu\nu} = \frac{2}{\sqrt{-g}} \frac{\delta \mathcal{L}_m}{\delta g_{\mu\nu}}$	Energy-momentum tensor of the Lagrangian density $\mathcal{L}$
$z = -1 + \frac{1}{a}$	Cosmological redshift
$H(z) = \frac{\dot{a}}{a}$	Hubble parameter
H_0	Hubble constant
$h \equiv H_0/100\,\mathrm{km\,s^{-1}Mpc^{-1}}$	Dimensionless reduced Hubble constant
$\rho_m,\ \rho_b,\ \rho_r$	Energy density of total matter, baryonic matter, and radiation
$\rho_{\rm DM},\ \rho_{\rm DE}$	Energy density of dark matter and dark energy
Ω_m	Present-day matter density parameter
$\Omega_r = 2.469 \times 10^{-5} h^{-2}(1 + 0.2271 N_{\rm eff})$	Present-day radiation density parameter
$\Omega_{\rm DM},\ \Omega_{\rm DE}$	Present-day density parameters of dark matter and dark energy
$\Omega_{\rm CDM}$	Present-day density parameters of cold dark matter
$\Omega_m(z) = \frac{\kappa^2 \rho_m}{3H^2}$	Matter density parameter
$\Omega_r(z) = \frac{\kappa^2 \rho_r}{3H^2}$	Relativistic content density parameter
$\Omega_{\rm DE}(z) = \frac{\kappa^2 \rho_{\rm DE}}{3H^2}$	Dark energy density parameter
$w \equiv \frac{p}{\rho}$	Equation of state (EoS) parameter
c_s	Sound speed
$r_s \equiv \int_0^\tau c_s(\tau')\mathrm{d}\tau'$	Sound horizon
$r_d \equiv r_s(\tau_d)$	Sound horizon at drag epoch
σ_8	Amplitude of mass fluctuations on scales of $8\,h^{-1}$ Mpc
$S_8 = \sigma_8\sqrt{\Omega_m/0.3}$	Weighted amplitude of matter fluctuations

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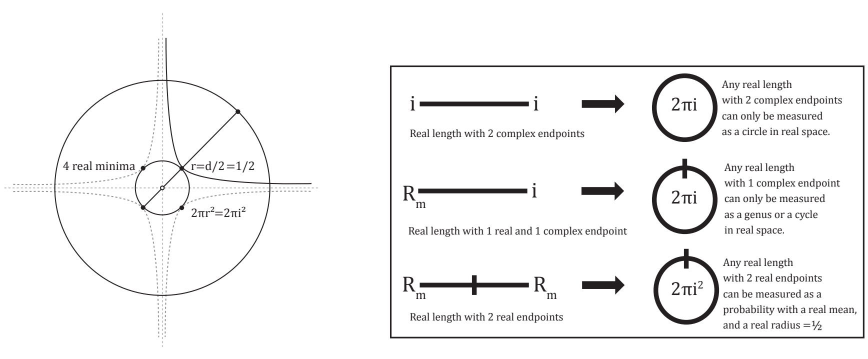
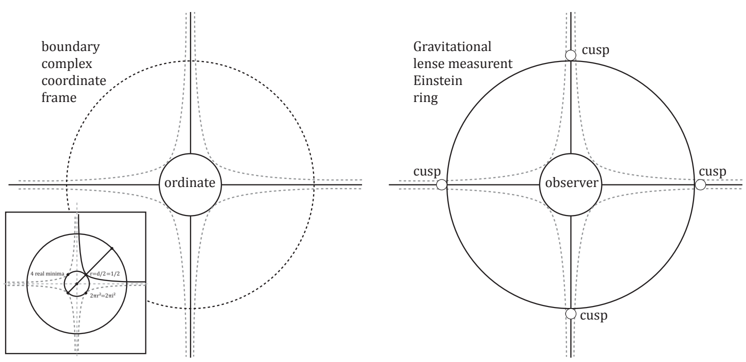
Because we will be working primarily with the fundamental constants, we won't encounter any problems meeting these standards. However, all boundaries and complex potentials will be expressed as statistical probabilities. This differs from Gaussian dynamics which, though quantified in physics, are not complete mathematically. In Gaussian, (and Hilbert), spaces, all zeroes are smooth and incomplete. As we will discuss, *completeness in physical theory comes from a complete theory of mathematics.* The result is that all "forces " and smooth zeros are held to the boundaries of the complex plane, as statistical potential. This includes gravity, dark matter and dark energy. As we proved, rigorously, *the minimum real or complex measure in any complete system of geometry is a simple, closed, curve* [14] *(Figure 1).*



(Figure 1) *Any complete system of geometry must be able to represent both the vertex of a cone in real space, and a genus one modular form (torus) in the upper half of the coordinate plane. All modular forms and homolographic groups, in any complete system of geometry, have a minimum real length* $= 2\pi i$. *Any real length or radius, with real and complex endpoints, can be held to the minimum measure of a simple closed curve.*

Any real length or radius, with either real and complex endpoints, can be held to the minimum measure of a simple closed curve, $(2\pi i)$, in any complete system of geometry *(Figure 1)*. This eliminates points as physical objects and places all Hilbert potential in the complex plane. All "forces" are quantified and held to the same theory of geometric completeness. In our earlier paper, regarding completeness and relative sets as they are related to paradox [9], we proved that the limit of completeness is the measurement of paradox related to the set of all sets. As we demonstrated, geometric completeness allows us to address quantum uncertainty and relativity using set theory and geometric completeness. By adhering to the principles of relative set theory and establishing a minimum measurement of a closed curve for *all* observational frames of reference we will demonstrate that *both DM and DE are the inevitable result of the interaction of Bayesian statistical probability and Markovian complex potential in any complete universe.* Throughout our discussions, we have stressed the need to think outside of our human frame of reference. Our frame of reference requires that we view all probabilities as relative and continuous. Our view of time is like an endless, flowing river. We exist in a cause and effect universe that can see "fields" and "forces", but not the probabilities behind them. For any observer in a statistical frame of reference, probability is only force. Because gravity and DM share a common observer frame of reference, they can both be measured using gravitational lensing.

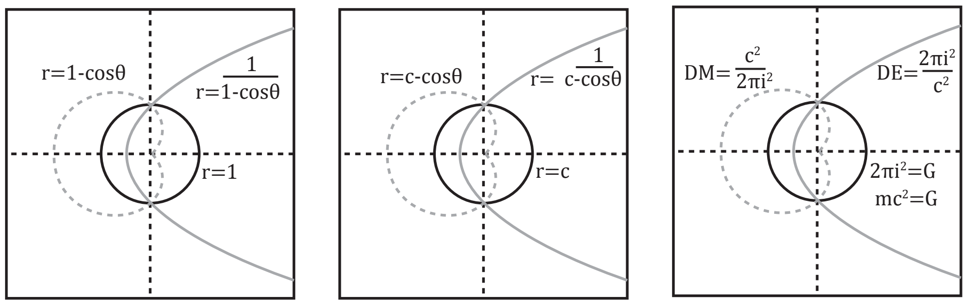
We can create an equivalency between the geometric completeness and the boundaries for all relative, Lorentz invariant, observer frames of reference by equating to measurements using gravitational lensing. Lensing measurement frames of reference (MFR) will allow us to equate our mathematical boundaries to those of a strong an Einstein ring. In this context, a common observer frame of reference provides the origin for the measurement of gravity and DM in the same coordinate plane and in real space. *(Figure 2)* shows the comparison between simultaneous geometric potentials and measurements using gravitational lensing.



(Figure 2) *Geometric completeness can be equated to strong gravitational measurements of an Einstein ring*

Just as in our theorem of completeness [14], all observer MFR have a minimum measurement of a circle ($2\pi i$). On the left of (*Fig. 3*), we show the limits to measurement in real space. On the right we use the same boundaries to describe real space using the observer as the origin of the coordinate space. Our geometric boundaries equate to any 4-point (Einstein ring), three-point and 2-point measurement of strong, and weak, gravitational lensing. In this model, *all MFR are held to the limits of the theorem of geometric completeness*. *Complete geometric potential provides the basis for measured probability in the real and complex planes*.

Relative set theory requires that any set contain both real and complex potentials in a single relative measurement. To be able to combine quantum and classical probabilities into a single measurement requires that all potentials exist simultaneously. For our model, a*n inverse curve can provide the ideal* *platform for the simultaneous relative measurements that define the boundaries associated with gravity, DM and DE (Figure-3).*



(Figure 3) *To be able to combine quantum and classical probabilities into a single measurement requires that all potentials exist simultaneously.*

To be able to combine quantum and classical probabilities into a single measurement requires that all potentials exist simultaneously. In our illustration, the parabola is the inverse curve of the complete circle. Equivalent elliptic curves contain a complex point at the origin of the coordinate plane. All three boundaries intersect at the poles and can be equated to boundaries associated with polarity and charge. Curve and inverse curve can provide the MFR for gravity, dark matter and dark energy independent of "mass". Let us review how these potentials can model the actions of force and mass in the standard model:

Gravity and Quantum Gravity - General relativity and Lorentz invariance define the limits of gravity. Gravity is measured using mass, gravitational waves, and gravitational lensing. Polarity also conforms to gravimetric distortions of space-time and can be measured using gravitational waves. Quantum gravity must also adhere to a number of additional boundaries that can only be measured using statistics. This is equivalent to the principle applied by Richard Feynman to describe the statistics of the EM field, using Quantum Statistical Dynamics (QSD). In order to operate in quantum time any model for quantum gravity must also include uncertainty. Our model achieves this by classifying gravity, and all other "forces", as probabilities. It is also how we are able to describe quantum mechanics without violating the rules of Lorentz invariance.

Dark Matter - DM can be measured using gravitational waves and gravitational lensing. DM exists in the complex 2-dimensional plane as Lorentz invariant potential. Like quantum gravity, DM is only measurable in real space as a relative statistical sum of complex frames of reference. *In our model DM is measured as simultaneous complex potential that is measured using gravitational lensing.*

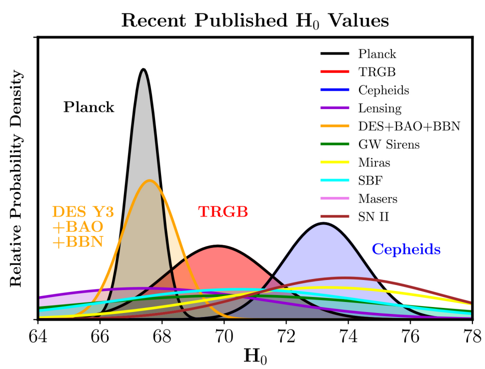
Dark Energy - DE represents the sum of all measured probabilities, and observer frames of reference limited by the speed of light. In our model, we will demonstrate how to equate DE potential to the finite curvature of the universe and to the boundaries established by a statistical black body. DE is currently measured using the Friedman equations, the expansion of the Cosmic Microwave Background (CMB), and the Hubble constant.

These simultaneous, and relative, measurement frames of reference (MFR) will allow us to combine quantum and relative equivalencies into a cohesive model that maintains Lorentz invariance for all measurements limited, or not limited, by the speed of light. Each MFR contains both real and imaginary potentials that are based in relative set theory. Mathematical and geometric requirements in real space then can be equated to statistical potential for the measurements of DM and DE using gravitational wave measurements. The advantage we have, in our statistically based model, is that we can also generate equivalencies between quantum (complex), and relative measurement frames of reference using the limits of set theory. In our paper, "Viewing paradox through the lens of general relativity", we demonstrated that relative set theory can satisfy geometric completeness and as well as fulfilling quantum requirements of simultaneous measurement and uncertainty. In our next section, we will demonstrate how relative frames of reference can resolve the current tension between local and Planck measurements of the Hubble constant.

1.1 Relative frames of reference for the Hubble constant.

In the last section we demonstrated how frames of reference and measurement minimums within that frame of reference, can establish a common basis between classical and quantum measurements. To create an equivalent model to the big bang (BB), we will treat statistical equivalencies as relative observer frames of reference and explore how statistical measurement frames of reference influence how we measure the Hubble constant.

The Planck measurements of the Hubble constant and the measurement of the Hubble constant using type 1A-SN are currently in tension. (Figure-4) shows us the current range of recent published values of the Hubble constant.



(Figure 4) *This illustration from Wendy Freedman's recent paper " Hubble tensions in perspective" shows the range of recent published values of the Hubble constant. Her team's measurements of the tip the red giant branch support a Hubble value matching the predictions of our theory. (Wendy L.Freedman ApJ 919 16- 2021)*

We can demonstrate how these seemingly different measurements are actually in agreement. The reason each experiment are getting different measurements for the acceleration of the universe is that they are using different fundamental constants as a basis for their MFR. If we consider each MFR as a prime measurement, using a different fundamental MFR, then any measurement in-between must use a combination of both fundamental constants to achieve a common *relative* measurement.

The Planck experiment uses an acoustic scale to measure micro-fluctuations in the Cosmic Microwave Background (CMB) temperature to establish measurement boundaries. Cepheid's are measured using the speed of light as a boundary. From our paper on the resolution of the Hubble tension, we use the following values for the fundamental constants.

K_B =1.38064852 $E - 23\ m^2$ kgs^{-2} K^{-1}

$c = 2.99792458 \text{ E8 } {}^{\mathrm{m}}/_{s}$

$h = 4.135667696\, E - 15\, eV\ \mathrm{Hz}^{-1}$

$$\frac{\text{Planck measurement minimum} = K_B}{\text{Hubble measurement minimum} = \text{ hc}} = \frac{1.380648}{1.239841} = 1.113568 \quad (1)$$

$$\frac{\text{Hubble measurement } \mathrm{H}_0}{\text{Planck measuremnt } \mathrm{H}_0} = \frac{74.73}{67.11} = 1.1135 \quad (2)$$

$$s = \frac{H_0}{2\pi} = \frac{6.99}{6.28} = 1.113 = \frac{K_B}{\text{hc}} \quad (3)$$

$$i^{\,2} = (c)^2 = (1.113\ x\ 2.99792458)^2 = (3.33686)^2 = 11.134 \quad (4)$$

We can now establish a minimum measurement for the equation of state parameter, using the speed of sound multiplied by the speed of light:

$$H_0 = \frac{i^{\,2}}{R_m} = \frac{2\pi i^{\,2} hc}{K_B} = \frac{2\pi i^{\,2}}{c^2} \quad (5)$$

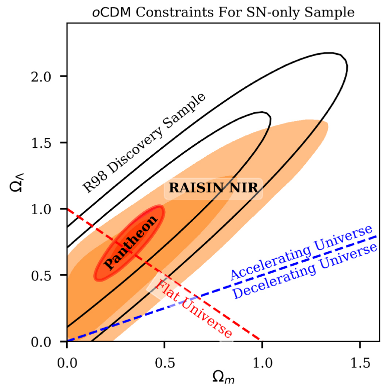
$$H_0 = \frac{2\pi i^{\,2}}{c^2} = .6990(i^2) \quad (6)$$

$$c_s{}^2 = \frac{69.9c^2}{2\pi} = 1 \quad (7)$$

if, $i^{\,2} = \left(\frac{1}{c_s}\right)^2$, then: (8)

$$H_0 = \frac{2\pi i^2}{c^2} = \frac{2\pi}{(c_s c)^2} \quad (9)$$

This will allow us to measure, the universe as a finite, and curved, statistical black body for all Lorentz invariant probabilities. In a recent paper [3], researchers used RAISIN data in combination with local measurements of SN-1A super nova and TRGB, tip of the red giant branch, measurements to create a reverse distance ladder using the relationship between the fundamental constants. *(Figure 5)* is an example of how these measurements result in a positive curvature and, therefore, closed universe.



(Figure 5) *Cosmological parameter measurements from* oCDM *(a CDM model allowing non-zero curvature) with SNe alone. Open contours show the Riess et al. (1998) discovery sample, red contours show the Pantheon constraints from Scolnic et al. (2018), and the results from RAISIN SNe are in orange. All contours show the 68% and 95% confidence intervals(Jones et al. eprint arXiv:2201.07801, Jan 2022)*

For this paper, the team built a reverse Hubble distance ladder tying luminosity to the *simultaneous, and relative, measurements* of "cosmic matter density(Ω_m), dark energy density(Ω_Λ) and spatial curvature(Ω_k),." using the following equations:

$$d_L(z, \omega, \Omega_m, \Omega_k, \Omega_\Lambda) = (1+z)\frac{c}{H_0}\int_0^z \frac{d_z}{E(z)} \quad (10)$$

$$E(z) = \left[\Omega_m(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\Lambda(1+z)^{3/(1+\omega)}\right]^{\frac{1}{2}} \quad (11)$$

$$E(z)^2 = \Omega_m(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\Lambda(1+z)^{3/(1+\omega)} \quad (12)$$

Inserting our value for the Hubble constant gives:

$$d_L(z, \omega, \Omega_m, \Omega_k, \Omega_\Lambda) = (1+z)\frac{c^3}{2\pi i^2}\int_0^z \frac{d_z}{E(z)} \quad (13)$$

And if,

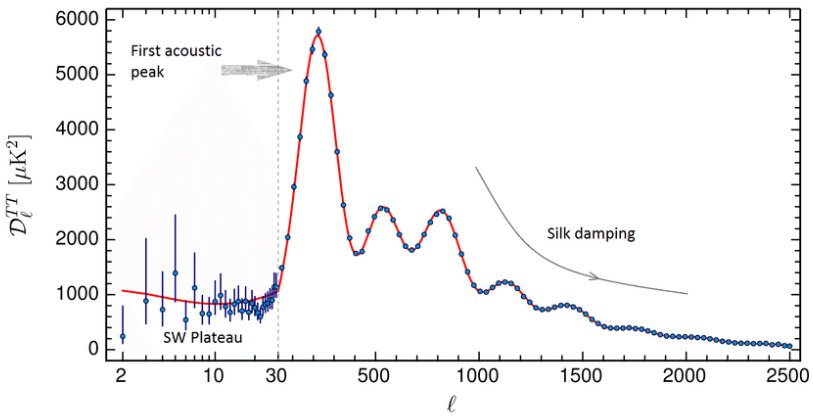
$$E(z)^2 = i^2 \quad (14)$$

Then a prime measurement for a reverse distance ladder is,

$$d_L(z, \omega, \Omega_m, \Omega_k, \Omega_\Lambda) = (1+z)\frac{c^3}{2\pi i^2} \quad (15)$$

1.2 The universe as a perfect blackbody

The measurement of Baryonic Acoustic Oscillations (BAO) frozen into the CMB can be considered the gold standard of measurement for any modeling of the evolution of the universe. (Figure 6) shows the extreme accuracy obtained from the Planck measurements [4]. The standard set by the Planck measurements can be considered a prime measurement because it depends on the establishment of a linier scale with the fundamental constants. In the case of the Planck results, this constant is the speed of sound as established by the measurement of BAO at small angular scales. Any model, hoping to explain the nature of the expansion of the universe, must be able to match the Planck acoustic scale.



(Figure 6) *Any model, hoping to explain the nature of the expansion of the universe, must be able to match the Planck acoustic scale. (The Planck Collaboration A&A 641, A7 2020)*

There is a growing consensus among astrophysicists [5] that the Planck data points to a closed universe resonating as a perfect blackbody [4]. As we discussed, in our paper regarding the nature of the Planck constant and the limits to a perfect blackbody, a*ny perfect blackbody has a finite geometric limit.* Because our model is based in geometric completeness, we can tie the geometric potentials of a perfect black body to Lorentz invariance.

$$\frac{i^2}{R_m} = \frac{unmeasured\ geometric\ complex\ potential}{measured\ statistical\ probability} = 1 \quad (16)$$

$$\frac{i^2}{R_m} = \frac{2\pi\, i^2}{Lorentz\ invariant\ probability} \quad (17)$$

The principles that we established earlier in both set theory and probability theory, can be tied directly to the to the curvature of the universe as defined by the Friedman equations:

$$quantum\ measurement\ scalar\ (flat\ universe) = \frac{2\pi i^2}{3^2} = \frac{1}{9} = .111111 \quad (18)$$

$$relative\ measurement\ scalar\ (closed\ universe) = \frac{2\pi i^2}{c^2} = \frac{1}{c^2} = .1112 = \left(\frac{\dot{a}}{a}\right)^2 \quad (19)$$

Defining the closed nature of the universe allows us to define Dark Energy as the geometric complex potential for all Lorentz-invariant probabilities limited by the speed of light and thermodynamic probability:

$$H_0 = \frac{i^2}{R_m} = \frac{2\pi i^2 hc}{K_B} = \frac{2\pi i^2}{c^2} = \left(\frac{\dot{a}}{a}\right)^2 \quad (20)$$

The statistical equivalencies we established using the RAISIN luminosity distance ladder will allow us to match the accuracy the Planck measurements based on the relationship between the fundamental constants. To do this we include the speed of sound as established by Planck measurements of BAO using the speed of sound:

$$d_L(z, \omega, \Omega_m, \Omega_k, \Omega_\Lambda) = (1+z)\frac{2\pi i^2}{R_m} = (1+z)\frac{2\pi i^2}{h^3} = (1+z)\frac{2\pi i^2}{c^3} = (1+z)\frac{2\pi i^2\, K_B}{hc} \quad (21)$$

$$d_{PL}(z, \omega, \Omega_m, \Omega_k, \Omega_\Lambda) = (1+z)\frac{2\pi i^2}{R_m(c_s c)^2} = (1+z)\frac{2\pi i^2}{h^3(c_s c)^2} = (1+z)\frac{2\pi i^2}{c(c_s c)^2} = (1+z)\frac{2\pi i^2\ K_B}{h(c_s c)^2} \qquad (22)$$

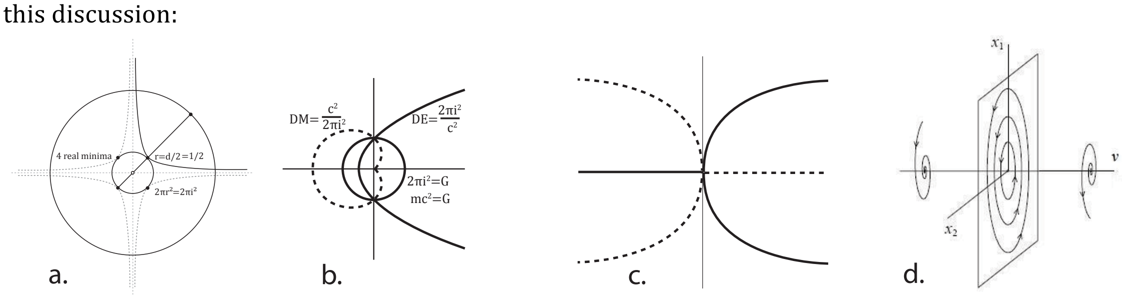
Based on the recent released papers by the Event Horizon Collaboration (Paper VI May, 2022). We can also use the Kerr metric as a measurement of ideal General Relativistic Magnetic Hydrodynamic (GRMHD} potential as well as Lorentz invariance the Kerr metric into an inverse distance ladder gives:

$$d_{KL}\left(z, \omega, \Omega_m, \Omega_k, \Omega_\Lambda, \mathrm{t_g}\right) = (1+z)\frac{2\pi i^2}{R_m(c_s c)^2} = \ (1+z)\frac{2\pi i^2}{GMc^3} \qquad (23)$$

These equivalencies will allow us to satisfy the measurement requirements of a statistically evolving black body that fits both early and local measurements of the fundamental constants, without the need for zero-point vacuum. A closed universe is a closed simple curve. We have also discussed how the simultaneous measurement of curve, inverse curve and elliptical curve, can be equated to the gravitational lensing measurements associated Gravity, Dark Matter and Dark Energy.

1.3 The Big Flip

In this section, we shall demonstrate how the relative measurements of gravity, DM and DE evolve within the boundaries a statistical black body. We will, essentially, replace the Big Bang(BB) with the big flip(BF). We discuss how local bifurcation boundaries generate global bifurcation phase spaces and then apply the principles of phase space bifurcation to an evolving set of relative frames of reference. The mathematical requirements of phase space transitions can be used to explain the relative homogeneity of the universe as well as providing an explanation for the probabilities we associate with both DM and DE. Evidence for this equivalency can be found in the Sloan Digital Sky Survey of over 12,000,000,000 galaxies using gravitational lensing. As we have stressed in each section, any measurements using gravitational lensing can be equated to our limits on geometric completeness. We will extend the equivalencies we established in previous sections to statistical bifurcation nodes. Because we work with the fundamental constants, we can apply quantum principles to any global phase space transition. This allows us to establish the global phase changes while preserving Lorentz invariance. *(Figure 7)* summarizes the mathematical and statistical boundaries that lead to different phase space requirements. On the left are the relative measurement boundaries we established in previous sections. On the right are the two types of bifurcation used in this discussion:



(Figure 7) *The measurement boundaries we equated to gravitational lensing can be used as bifurcation nodes in phase space transitions. (a.) Mathematical potential and the rules of geometric completeness establish minimum measurement boundaries in real space. (b.) Simultaneous measurement of relative geometric potentials can be used to model DM and DE (c.) Pitchfork bifurcation allows the translation of a single complex potential into two probabilities. (d.) Hopf bifurcation provides acceleration potential on the surface of a cone that can be equated to the boundaries associated with DE.*

The measurement boundaries we equated to gravitational lensing can be used as bifurcation nodes in phase space transitions. In our illustration, (a.) Mathematical potential and the rules of geometric completeness establish minimum measurement boundaries in real space. (b.) Simultaneous measurement of relative geometric potentials can be used to model DM and DE. (c.) Pitchfork bifurcation allows the translation of a single complex potential into two probabilities. (d.) Hopf bifurcation provides acceleration potential on the surface of a cone that can be equated to the boundaries associated with DE. We can use the equivalencies, that we established earlier, between the fundamental constants and the Hubble constant to develop local bifurcation nodes for our global model:

$$\frac{H_0}{2\pi i^2} = \frac{6.99}{6.28} = \frac{K_B}{\text{hc}} = 1.113 \qquad (24)$$

$$\frac{2\pi i^2 K_B}{hc} = H_0 \qquad (25)$$

We will use these equivalencies to set relative scalars for our measurements, of the curvature of the universe, that can be attached to any power law measurements. Because all Lorentz invariant measurements of the universe are relative, we can also establish local bifurcation nodes for relative and quantum global Markovian and/or Bayesian statistical phase spaces:

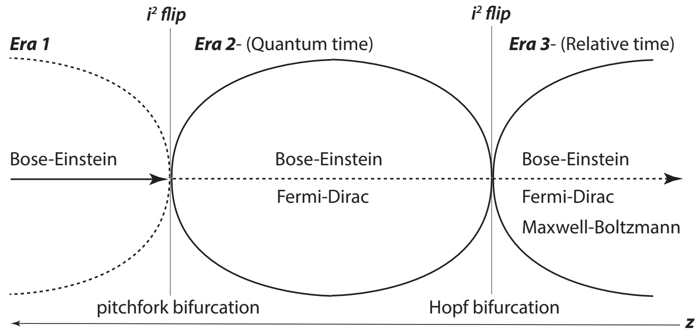
$$quantum\ measurement\ scalar\ (flat\ universe) = \frac{2\pi i^2}{3^2} = \frac{1}{9} = .111111 \qquad (26)$$

$$relative\ measurement\ scalar\ (closed\ universe) = \frac{2\pi i^2}{c^2} = \frac{1}{c^2} = .1112 \qquad (27)$$

$$Markovian\ measurement\ frame\ \{local\ bifurcation)\ = \frac{2\pi i^2}{hc} \qquad (28)$$

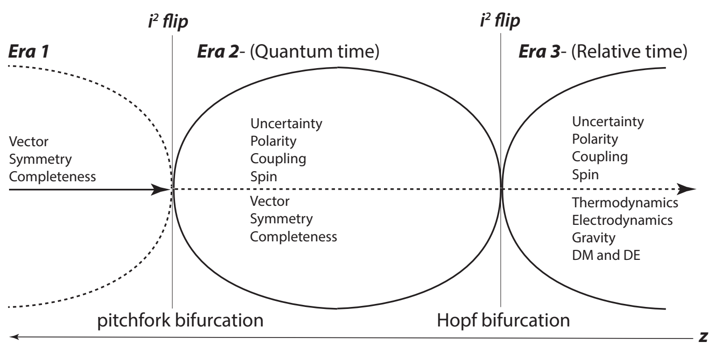
$$Bayesian\ measurement\ frame\{global\ bifurcation) = \frac{2\pi i^2 K_B}{hc} = H_0 \qquad (29)$$

We can use the same geometric boundaries to represent the simultaneous measurement of Bose-Einstein, Fermi Dirac, and Maxwell- Boltzmann statistical measurements as a function time in both the real and complex planes. Bose-Einstein and Fermi-Dirac statistical measurement frames operate using Markovian time and *they preserve the principle of uncertainty.* Above a measureable energy level, Maxwell- Boltzmann statics override all other statistical variations and the laws of Bayesian thermodynamics take over. The measurement, of these statistical variations, defines most aspects of the standard model of high energy particle physics (HEP). In HEP, as in this model, all measurements are probabilities. Each phase space is Lorentz invariant and follows the limits of geometric completeness at the local scale. This results in the globalization of local bifurcation nodes *(Figure 8).*



(Figure 8) *In the evolution of statistical phases of a perfect blackbody, each phase space is Lorentz invariant and follows the limits of geometric completeness. This results in the globalization of local bifurcation nodes. Era 1- follows the rules of geometric completeness and symmetry. Bose-Einstein potentials are converted to polarity and coupling potential in Fermi Dirac space. Era 2 is currently referred to as "the Dark Ages". Fermi-Dirac statistics hold all potentials to the Lyman line. Era 3- is our local universe driven by Bayesian cause and effect statistics and limited by the speed of light.*

(Figure 9) demonstrates how the forces we associate with the Standard Model of Physics are the result of statistical boundaries in phase space. (Era 1) - follows the rules of geometric completeness and symmetry. Bose-Einstein potentials are converted to polarity and coupling potential in Fermi Dirac space. (Era 2) -is currently referred to as "the Dark Ages". Fermi-Dirac statistics hold all potentials to the Lyman line. (Era 3) - is our local universe driven by Bayesian cause and effect statistics and limited by the speed of light. As the universe evolves statistically so do the requirements of each phase-space.



(Figure 9) *As the universe expands it is required to follow phase space limitations. Forces in this model are equated to global phase space boundaries required by geometric completeness and the rules of relative measurement.*

As we mentioned earlier, phase spaces are a natural explanation for the relative homogeneity that we observe in all eras. In the first image released from the James Webb Space Telescope, (just hours before I published this paper on July 11, 2022) we get a glimpse further back in than ever before in human history. It is much too early to draw any conclusions, but, at first glimpse, this image demonstrates the same relative homogeneity that we find in our local universe. This supports our model of global phase space bifurcation boundaries required by geometric completeness, the rules of relative measurement and the boundaries of Lorentz invariance. In Part II of *Measuring the Universe*, we will examine how these phase space requirements, and relative measurements, result in the all the potentials we associate with galaxy formation and the development of the galactic web and further evidence from the JWST.

References

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