Corrected 2nd Draft

Toward a Retro-Causal Hologram Universe Simultaneous Solution to the Cosmological Constant & Arrow of Time Enigmas

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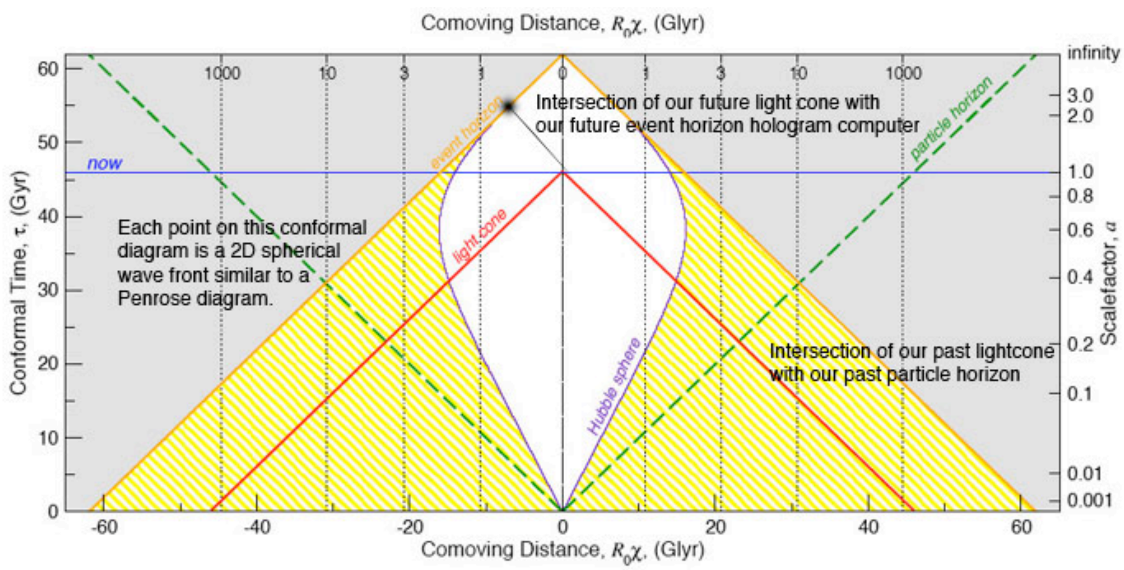
Abstract

The bias against Wheeler-Feynman retro-causal advanced waves from a future absorber, a general lack of understanding when the asymptotically constant de Sitter horizon is in our subjective observable causal diamond piece of the multiverse, Hawking's chronology protection conjecture, and the lack of comprehension of the strange implications of the t'Hooft-Susskind hologram principle have not allowed us to see what is in front of our eyes since the discovery of dark energy energy accelerating the expansion rate of 3D space ten years or so ago. Bernard Carr has already published a brief account of my idea that retrocausality is the key to understanding the biggest problem in physics today – why the dark energy density is so small. My paper with Creon Levit (NASA AMES) based on my brief talk at DICE 2008 further developed that idea. This paper, is still a simpler explanation of why the virtual boson dark energy density is so small and how it is intimately connected to the Arrow of Time of the Second Law of Thermodynamics. The basic idea is so simple that any bright curious schoolboy or girl can grasp it without too much difficulty. Our universe grows from one qubit at the moment of inflation to an asymptotically constant de Sitter horizon hologram screen $\sim 10^{123}$ qubits that is also the upper limit to the total thermodynamic entropy of our observable universe in the precise sense of Tamara Davis's 2004 Ph.D. dissertation at the University of New South Wales. The early universe is obviously not de Sitter, therefore, we have already there an obvious temporal asymmetry explaining the Arrow of Time. The dark energy density we see in our past light cone is proportional to the inverse area of our future de Sitter horizon at its intersection with our future light cone in accord with the Wheeler-Feynman principle. Our future de Sitter null horizon is the Wheeler-Feynman "total future absorber" of last resort giving us "retrocausality without retrocausality" similar to the "nonlocality without nonlocality" of the "no cloning a quantum" or "passion at a distance" of orthodox quantum theory's "signal locality." The link between our future and our past is a globally self-consistent time loop in the sense of Igor Novikov. Indeed, this is a bootstrap of self-creation from future to past. The past dark energy density is indeed the Planck density at the moment of inflation, but Tamara Davis's Fig 5.1 shows that this density quickly drops to the small constant value that has been dominant in the past few billion years – bearing in mind that what matters, is not the spacelike intersection at a constant conformal time, but, rather, the intersection of the observer's future light cone with his future dark energy horizon. However, I have not yet proved that the dark energy seen in our past light cone is really advanced Hawking radiation from our future observer-dependent de Sitter

cosmic horizon that is, in addition, likely to be a holographic (post) quantum computer not in sub-quantal equilibrium.

Tamara Davis has plotted the large-scale history of our observable universe based on the best data from precision cosmology circa 2004. Her basic results relevant to this paper are show below adapted from her Ph.D. dissertation.



The above picture is adapted from Fig 1.1 of Tamara Davis's Ph.D.[1] Our past particle horizon is the future light cone of our past moment of the creation (aka Alpha Point) of our observable finite piece of the total material multiverse of parallel "Level 1" worlds on the same inflation bubble.[2] Retarded light waves coming from our past particle horizon along our past light cone are infinitely redshifted – we will not see them or anything beyond it. Our future event horizon is the past light cone of our future Omega Point "End Time" that is finite on the Penrose conformal scale but infinite on our proper time clock scale. For the subtle details read Tamara Davis's Ph.D. Even eminent cosmologists have gotten these details wrong. The time evolution of the area/entropy of our future horizon is shown in the thin solid middle line of Davis's (adapted) Fig 5.1 below. According to my retrocausal version of the hologram principle, the dark energy density ρ we measure along our past light cone now is proportional to the reciprocal area Λ of the intersection of our future light cone with our future event horizon forming a Novikov loop in time.[3]

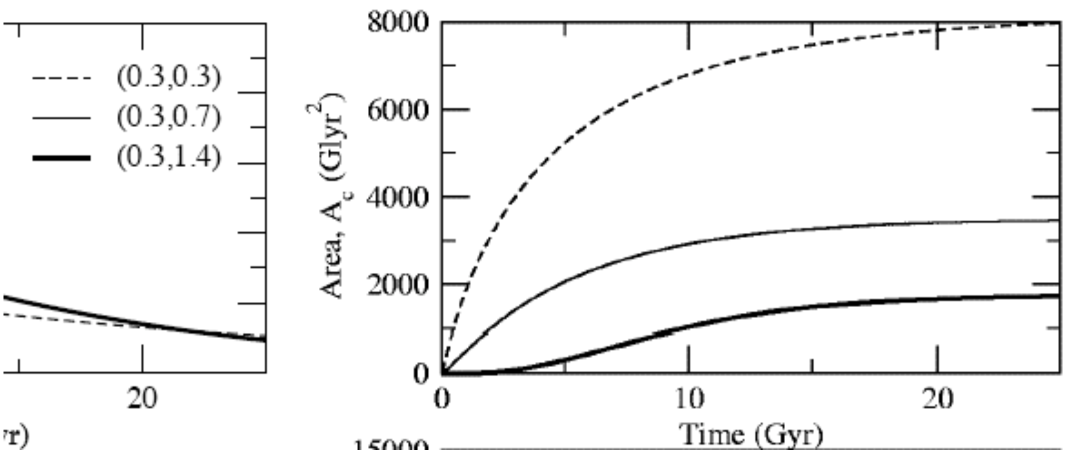
[1] http://www.physics.uq.edu.au/download/tamarad/papers/thesis_complete.pdf
[2] http://space.mit.edu/home/tegmark/crazy.html
[3] http://en.wikipedia.org/wiki/Novikov_self-consistency_principle

$$\rho \equiv \rho_{Dark\_Energy} = \frac{8\pi G}{c^4}\Lambda_{virtual\_boson}$$
$$\Lambda_{virtual\_boson} = \frac{1}{Area_{future\_horizon}} \equiv \Lambda \tag{1.1}$$

The maximal upper bound to the total entropy of our observable universe sandwiched between our past and future thermal horizons in the causal diamond is

$$\begin{aligned} S(t) &= \frac{k_B}{4L_P^2\Lambda(t)} \\ &= \frac{k_B c^3}{4\hbar G\Lambda(t)} \underset{t\to\infty}{\rightarrow} \frac{k_B c^3 R_{Hubble}^2}{4\hbar G} \end{aligned} \tag{1.2}$$

The maximal upper bound of the thermodynamic entropy S of our universe, therefore, has the Planck value at the Alpha Point prior to the hot thermal Big Bang but relatively quickly approaches the small constant de Sitter value we actually observe today.



The ordinate area in the above piece of Tamara Davis's Fig 5.1 is $\Lambda(t)^{-1}$ where t is a convenient measure of time from the Alpha Point. See the original Ph.D. for those details. The important qualitative idea here is to imagine a plot of the reciprocal of the middle thin solid line plot showing how the dark energy density accelerating the rate of expansion of 3D space quickly drops from the large Planck value of $\hbar c/L_P^4$ approaches the asymptotic constant de Sitter value of $\hbar c/NL_P^4 \sim 10^{-23}\,\hbar c/NL_P^4$ on the cosmic landscape[4] of chaotic eternal inflation of Max Tegmark's Levels 1 and 2 material parallel universes.

Imagine both intersections of our future and past light cones with our future and past event and particle horizons respectively. Both are 2D spherical shell walls of light a Planck length thick in which we are always at the center. We can also imagine these two

[4] http://en.wikipedia.org/wiki/String_theory_landscape

spherical walls of light on the co-moving now line of the above Fig 1.1 spacelike separated from us. We are always closer to our future sphere horizon than our past sphere horizon, though it takes us an infinite amount of proper clock metric time to reach our final Omega Point that is finite in Roger Penrose's "conformal time" measure.

Each sphere is pixelated with one Planck area per Bekenstein BIT, but only our future sphere is the hologram quantum computer retrocausally projecting advanced Wheeler-Feynman metric gravity 3D hologram images volume quanta of size

$$\Delta L(t) = \left(\frac{L_P^2}{\sqrt{\Lambda(t)}} \right)^{1/3} \tag{1.3}$$

In other words, the number of volume quanta $N(t)$ in our observable universe now equals the number of pixels on our future horizon's intersection with our future light cone. I am only using the Penrose-Hawking classical causal signal rules here neglecting effects of post-quantum signal nonlocality from Bohmian sub-quantal non-equilibrium developed by Antony Valentini.[5]

Our future horizon radiates advanced thermal Hawking radiation back from our future along our future light cone that we detect as the dark energy zero point vacuum fluctuations primarily of virtual photons. This is the Unruh effect[6] of unitarily non-equivalent quantum vacua seen by locally coincident inertial and accelerating detectors. Virtual off-shell zero point boson quanta for the inertial observer are real on-shell thermal black body quanta for the accelerating static non-inertial observer. The two are connected by the Bogoliubov transformation.[7] Thus, for static LNIF detectors clamped to constant r *with no orbital angular momentum relative to us at* $r = 0$, our future universe is approximated by the representation of the de Sitter geometrodynamic field

$$ds^2 = \left(1 - \frac{\Lambda r^2}{2}\right)(ct)^2 - \frac{dr^2}{\left(1 - \frac{\Lambda r^2}{2}\right)} - r^2 d\Omega^2 \tag{1.4}$$

Each hovering static LNIF detector has covariant proper radial acceleration pointed away from us equal to[i]

[5] http://eprintweb.org/S/authors/All/va/Valentini
[6] http://en.wikipedia.org/wiki/Unruh_effect
[7] http://en.wikipedia.org/wiki/Bogoliubov_transformation

$$
\begin{aligned}
g(r) &= \frac{c^2 \Lambda r}{\sqrt{1-\frac{\Lambda r^2}{2}}} + c^2\sqrt{\Lambda} \\
&\underset{r\to 0}{\to} c^2\sqrt{\Lambda} \\
&\underset{r\to\sqrt{\frac{2}{\Lambda}}}{\to} \infty
\end{aligned} \tag{1.5}
$$

Note that we are not quite inertial, but are covariantly accelerating in this idealized large-scale de Sitter future to past retrocausal metric field. The advanced Wheeler-Feynman radiation we see has an absolute Kelvin temperature of

$$
T_{DE} \sim \frac{\hbar c}{k_B}\sqrt{\Lambda} \tag{1.6}
$$

Note that the black body irradiance[8] goes as T_{DE}^4, but Einstein's gravity field equation tells us to convert it to the vacuum curvature using the inverse G-string tension $L_P^2/\hbar c$. What I have not yet done is to prove that this model gives us precisely the N^{-1} fitting observation

$$
\Lambda \sim \frac{1}{NL_P^2} \sim \frac{1}{R_{Hubble}^2} \tag{1.7}
$$

That is the crucial test of the model.

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[i] This is analogous to hovering static LNIF observers outside the event horizon of a black hole. However, we are always at the dead center of our spherical cosmic future event horizon inside it not outside it. The residual acceleration $c^2\sqrt{\Lambda}$ is a future hologram surface effect.

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[8] http://en.wikipedia.org/wiki/Stefan–Boltzmann_law