TEMPORAL NO-LINEARITY: AN ALTERNATIVE TO DARK ENERGY

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ABSTRACT

Mathematical compatibilities and constrains of a hypothetical 5D space-time with time referenced by two coordinates (3-2), has been recently described in detail into several papers (again). It has been prescribed from the GR, the compatibility constrains of the FLRW metric in each temporal brane, to be restricted only to Closed Universes, Smooth Initial Singularities and "Open CTC". In a first view, this leads to leave these works in the consideration of mathematical games discarded by the Standard Candles data. However, if time would be referred by two coordinates, they would not be linearly related, and it will be mathematically stated that space-time may not be flat in any case, because time-like branes geometry will never be. If so, time scale "lived" over a two-time dimension geodesic necessarily is not constant over its linear projection on one of both coordinates and consequently the correlations between Redshift and Distance Modulus, -Distance Ladder-, may be corrected by a synchronization function (if a no-linear two-time geodesic trajectory over a "warped temporal geometry" is linearly divided in constant segments, then their projections are not linear in any case). We apply an example of time-trajectory over the time slices, matching the Standard Candle data for a Closed Universe dominated by matter (>90%) in a bulk 3-2, with open temporal branes and smooth Singularity.

Key words: closed universe; multidimensionality; time-like dimensions; no-linear time; accelerated expansion; smooth big bang

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1. INTRODUCTION

Every Truth is certain only inside its Paradigm. Data can certify consistency with in, even they do not certify the exclusivity of an interpretation, but in reference to its assumptions. The interpretation of the observational data on SNeIa&GRB, as an acceleration of Expansion is true within its relativistic Paradigm 3-1.

The Horizon's Problem, the Dark Energy, the Dark Matter, the baryonic decay [6], the relativistic determinism, the entropy of the black holes, the galactic macro-singularities, multiverses,... can be considered within this Paradigm, as issues pending to solve by insisting with additional hypotheses, or also as symptoms of the need for a Paradigm Change, in any case, to which Unification target also points.

A single temporal dimension -linear time-, kidnap GR into determinism: if Relativistic Mechanics were considered from two or more time dimensions, the temporal branes would be nothing more than a frame of a statistical population of potential time trajectories, defined by temporal geometries (equivalent to microstates). If this temporal geometry would be flat, then time trajectory would be linear, recovering 4D.

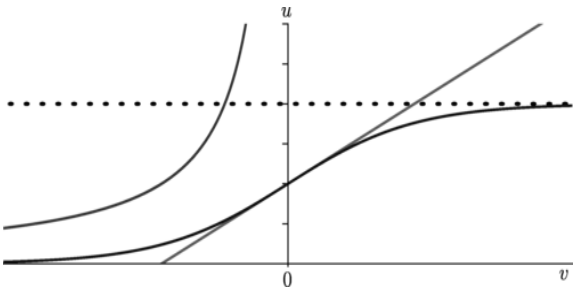
FLRW Metric, Cosmological Deceleration, Causality (CTC), Well-posedness, more symmetries for more equations, tachyons and phantom particles, dimensional compactification,... they have been often considered as "pathologies", reason for disinvestment in multitemporal theories. But alternatively, they may also can be considered as limiting conditions that alternative interpretations of the astrophysical data available, must meet. They can also be clues to find that time-geodesic function.

There had been alternative interpretations of SNeIa&GRB data: Effects that may influence the extrapolation of the maximum brightness (subclasses of SNeIa and influence of metallicity [7]&[8]); Incoherent Light, [9]; Tired Light, Variable speed of Light (VSL) [10] and/or variable G at cosmological scale (MOG by Moffat [11], MOND by Milgrom [12], Bekenstein [13],…). In this paper we will analyze another approach: if time can be referred by two no-

linear related coordinates. A Universe with no-flat temporal geometry.

2. FLRW METRIC

The application of the Campbell Theorem in its weak statement to a multitemporal configuration, allows a unique solution in which any FLRW metric can be embedded in a 3-2 Ricci Flat Space, maintaining the symmetry group. Within the multidimensional paradigm, assuming Friedmann's Model, the detailed analysis in [1]&[2] of the metrics, states the compatibility of relativistic equations with temporal branes in Universes of 3 spatial and 2 temporal dimensions (3-2), with certain restrictions. From [1]:



" *FIG. 1: Timelines in the time plane of the bulk M-metric, each one leading to different FLRW projected metrics. The big-bang singularity is here the u = 0 line. The straight line corresponds to the standard pure radiation model (recovering 4D by rotation & translation). The other two lines correspond to FLRW models without big bang, with an initial accelerating (inflationary) phase and a final decelerating phase. In the hyperbola case, the deceleration is not apparent (see the text for the detailed calculation in [1]). In the hyperbolic tangent case, the inflexion point corresponds to a pure radiation phase. A stationary state is reached asymptotically in this case.*" (Bona et al., 2018)

From a 5D = 3-2 Paradigm, FLRW metric as a constrain, states:

- The Universe has to be closed: decelerated Scale Factor. For a generic equilibrium combination of matter, radiation and cosmological constant, with an adiabatic index

  $\omega_{max} \leq 1/3$, if $\epsilon = -1 \Rightarrow k = +1$
- The necessary and sufficient condition for the absence of particle horizons is a "Smooth Big Bang" (asymptotic): the proper time derivative of the expansion factor R(t) must be finite and not diverge faster than R^{-2}, [3]. Horizon Problem would be an answer to a wrong question.
- Inside a 5D Universe, a temporal trajectory function $\tau = \Psi(t)$, as hyperbolic examples in fig 1, cannot be constant or linear in any case. Any linear relationship between temporal coordinates, -a straight line in the temporal plane u/v in fig 1-, by rotation and/or translation, would reset the 4D configuration.
- Then 5D space-time, can never be always flat, thought there is a no-linear time geodesic trajectory. It can seem to be approximately flat on the asymptotic phases over v-axis (in fig 1, at the smooth BB process, or even in its tired old phase; in fig 3, only in its stabilization process). From this assumption, if Universe seems to be 4D at low redshift, is because we are in an asymptotic stabilization evolution, very similar to an horizontal straight line (dots in fig 1). $\Psi'(t) \approx$ constant.
- Any function that relates temporal coordinates, $\Psi(t)$, will represent a trajectory in the temporal geometry always longest than its projection on any axis, or any straight line $\Psi = a + bt$, (see Fig 1, with hyperbolic examples). A billion-year living over the trajectory τ for a 5D observer, will be projected to less than a billion-year at the v-axis set as t; and the other way around, a year from a 4D assumption measure, t, will be translated to more than a year over τ if the observer do not synchronize clocks.

$$t_2 - t_1 < \int_{t_1}^{t_2} \sqrt{1 + (\Psi'(t))^2}\, dt \qquad (1)$$

From a Bulk of 3 space – 2 time dimensions, if we experience a single time trajectory at a constant rate taken over $\tau = \Psi(t)$, when we measure time with a constant clock, we state a constant "length" of a time lapsed segment of $\Psi(t)$. This time-length cannot be projected linearly on a constant scale over the single time v-axis; which will mean that the moment in history in which an event occurs, will be apparently further on time for the one who takes brightness and redshift as measures of certain event, from the 4D assumption (constant projected v-time-scale), than for the 5D assumption (constant time-scale over the

time trajectory). In this case we will have to apply a synchronization function:

$$z(t) = \frac{1-R(t,\Psi(t))}{R(t,\Psi(t))} \qquad (2)$$

The single time coordinate assumption, drives to a constant Scale Factor, eventually modified by an extra accelerating rate to fit observational data. Though graphically the measures will stand over the flat expectative, or also can be represented with a variable look back time scale shrinking z (Fig 4).

If the Universe has a configuration of at least two temporal dimensions, the Distance Ladder assuming 4D, would be affected by a correction due to a no linear decelerating Scale Factor, depending on the shape of Ψ(t) and always maintaining the inequality for any function representing the association between both time coordinates. A second 10 Bly ago, were "quicker" for our today's clock (length over v-axis), but not for same clock if used by then (length over Ψ(t)). As analogy, a clock held by a near-c traveler, would seem "slower than a second per second" from our clock point of view, being both clocks identical. In this case, they have a well-known synchronization function by SR.

In the opposite direction in v axis, the more far from BB smooth process, the more linear-like approximation in both hyperbolic examples of fig 1. In a naive analogy 2-1D, from our clock point of view (t over v-axis), it could be imagined as a time-bubble seeming to grow very fast at the beginning and slowing with time, or in look-back-time, accelerating growth of the Universe at high z (enlarging the apparent distance between z, because the shortest projected time by then). But for a clock measuring at each moment, evolving with the age of the Universe, it would seem to be a constant Expansion rate.

An observer conditioned by 4D assumption (projected time trajectory over a constant scale over v-axis), would include a synchronization bias on respect a 5D observer, considering a constant scale over the time-like geodesic, in the correspondence between time and redshift. Thus, adjusting the observational data of the SNeIa&GRB, is only to choose a correct hypothesis of Ψ(t), representing in its relation to the Distance Modulus, μ, an axis with Redshift according to time scale on the trajectory, τ. Setting the lifetime of the Universe to 1:

$$\frac{1}{z_\tau+1} = \int_{\frac{1}{z_t+1}}^{1} \sqrt{1+(\Psi'(t))^2}\, dt \qquad (3)$$

With z_τ and z_t, we do not mean to say there are two redshifts, but a different time scale transformation between z and look-back-time, depending on the 3-1 & 3-2 paradigms: how old is z at the relative scale of the other dimensional assumption.

$$\frac{1}{z_\tau+1} \;\&\; \frac{1}{z_t+1} \qquad (4)$$

being z_τ, the redshift where the μ has to be considered from a 3-2 bulk perspective at the scale of z_t, (as a translation of z on the time axis, but from each perspective they size same z in different time scales).

So, if time has two coordinates, maybe space is no-always flat, but for sure time is not flat and follow a no-linear trajectory in a warped temporal surface, but we use the projected time to site an event. By ergodicity, the 4D clock may overestimate the look-back-time-distance and has to be corrected, because c is distance over time events and may seem to happen further than they really do, if we assume constancy of the denominator. This will always happens for any Ψ(t), but the bias quantification will depend on the time-geodesic shape. From this assumption, SNeIa & GRB data may not be interpreted as an Acceleration of Expansion, but as an asymptotic stabilization of the second temporal coordinate in a matter dominated Universe.

No-flat Universe in Expansion of the time-like coordinates, are consistent with the equations of the RG in a decelerating Universe and the FLRW metric, guaranties Causality if τ = Ψ(t) is open and asymptotic. Although, before proposing a time geodesic trajectory shape -as those in fig 1-, that will make consistent the hypothesis with astrophysical data, a "pathology" remains unsolved…

3. WELL-POSEDNESS

Adding a dimension increases the mathematical cost, which is already very expensive in term of symmetry assumptions, even for 4D which implies 10 equations, but 5D raises the number to 15 and though needs more symmetries to determine the system. With no

extra conditions PDE's may become ultra-hyperbolic. Our proposal is to add a temporal geodesic trajectory hypothesis, open-asymptotic-Ψ(t), that must deductively postulate symmetries for including them into GR equations, maybe due to an extra conserved quantity, which will determine the system of differential equations.

That means the requirement for NLT to add an hypothesis, but by the way the same happens to be in the Acceleration Interpretation, which needs also an addendum in 4D Paradigm: Dark Energy. In both cases, graphically acceleration or deceleration can alternatively be represented as a no-linear scale from constant z to t, to an apparent variable z to constant t, (fig.4), shrinking v scale if there is some kind of Energy in such a shape that drives to an inflexion point from concave to convex at $z \approx 0.64$ (i.e. due to the radiation+matter dynamic as t^n -$n < 1$-, while Dark Energy is supposed to be growing as e^t), or expanding the v-axis scale if there is some kind of gravitational brake.

Another way (fictitious but didactic) to formulate and visualize the time-v-axis variable scale in terms of corrected apparent look back time to redshift, stretching the double-time geodesic over v-axis by an apparent no constant time rate, which means an apparent VSL (not real in 5D, but this could be the interpretation from a 4D assumption). That means, if we set as constant $8\pi G/c^4$, which relates the second derivative of the metric tensor $G_{\mu\upsilon}$, with the relativistic energy-momentum tensor, $T_{\mu\upsilon}$, has to remain constant, G would apparently be variable to the 4th power of the apparent change of c, just if so, from 4D assumption.

That apparent G(t) would be time dependent only if we use our day clock and would also drive to consider the no-baryonic Dark Matter interpretation, that would be interpreted from 3-2 bulk, as a consequence of clocks desynchronization. In fact, observational data indicate that if extrapolated to the Transparency Event, the CMB peaks should be attributed, at least to a much greater extent than now a days, to baryonic dark matter. But *"Dark matter had less influence in the early universe. Observations of distant galaxies carried out with the VLT suggest that they were dominated by ordinary matter*". R.Genzel, [6].

Another "possible clue" to constrain the translation between a symmetry hypothesis and a temporal geodesic trajectory function proposition $\tau = \Psi(t)$, for well-posedness purposes, may be the Entropy. Entropy increases if matter is allowed to clump together, releasing potential energy and creating clusters, that further unbalance the contents. As the mass is finite, CMB entropy would be finite -to the square-, proportional to an hypersurface (Holographic Principle [14]). Wheeler & DeWitt already postulated an analogy with the Universe Wave Function, [15].

Despite to the fact that a gas has a dynamic configuration in the position of all its molecules, although its entropy is calculated according to the number of possible configurations, (besides they are used to measure, thermodynamics does not pretend that they all exist in Parallel Universes). Each macrostate would be constituted by equivalent configurations of temporal evolutions on two dimensions, gravitationally consistent of all the masses and the Destiny would not be written -Recurrence Theorem-, although its patterns would be predictable with some probability, ... multitemporality would allow a GR with time-arrow.

By the way, another clue to propose a Ψ(t), is the question of how a linear Bang, transform into a generical orbital and spinning movements? (maybe Kolmogorov turbulences?). We know at present time, everything inside rotate, but the Universe itself seems not to have an Angular Momentum. Now. Was it so at the Big Bang smooth process? Is it possible to consider an Angular Momentum Conservation to income a symmetry at the very BB moment, but not now?

Observations about Universal Angular Momentum or Expansion, recommend to use a function that becomes flat after the BB smooth process: $t \approx \tau$ reaching stationary state in our days (shape-like hyperbolic tangent case in fig 1).

Those and more 5D well-posedness requirements could be an open frame to additional hypothesis taken as restrictions to be fulfilled for any temporal geodesic trajectory. Here are some possibilities to speculate about the determination of equations through an additional synchronization function.

With those “clues”, we will propose an extra hypothesis to determine the system as an example… but even SNeIa&GRB data themselves provides an observational shape that can be inversely fitted just approximating a statistical regression, to be understood lately through a conservation law or not. Even hyperbolical tangent example, with appropriate parameters, will fit astronomical data, but why that shape? Ψ(t) to determine PDE’s remains open, and many propositions may fit data.

4. FIRST SHOT

The range of possibilities is wide and we have tried several “temporal geometry speculations” [4]. Between such many options, our “first shot” is to be consistent with the initial Novikov conjecture for a single event (Big Bang as a White Hole born from a “Higher Dimension Mother Black Hole”, inheriting its entropy, mass, charge, and angular momentum, but losing a dimension), [5]. There had been several models which even proposed a switching between space and time nature of coordinates inside a Black Hole.

By analogy with the family of geometric solutions for the movement of a particle according to a central force, inversely proportional to the cube -3 coordinates- to its distance to the origin, (Cotes spiral), the First Shot additional function has been to test if a synchronization due to Hyperbolic Time Spiral with h proportional to constant Λ/Ω. It fits with data.

This “first shot” is not a Rotational Universe proposal, because it would need to be space over time, (if we could approximate a simplification where time is warped and space near-flat, is it not possible to consider also the evolution of time over space?). Just for the sake of the analogy in losing a dimension, we must refer Silk [16], who formally demonstrated that the 4-1D rotational models presented density instability on space-like dimension when perturbing along the axial axis, but stabilized in the perpendicular plane of rotation. An additional space-like dimension, would be unstable and would concentrate mass in the vicinity of a disk, folding into a small and constant value (thickness). Analogously to galaxies or planetary systems, it would concentrate time-space in a temporal brane orthogonal to the temporal axis: it would collapse and lose that dimension (orthogonal disc in the Fig 3).

Assuming the analogy into this very particular “temporal geometry” synchronization, taken as a first shot example of the τ = Ψ(t) hypothesis, the assumption could be easily extended to 3-3, losing a third time-like dimension at the Big Bang asymptotic smooth process. (All those justifications of the first shot origin, are no more than the explanation of the why we have chosen this example, including some conservation law, and not other with no fundamental motivation -like hyperbolic examples-, but the proceeding is appliable to any other justification of a different hypothesis, that match requirements).

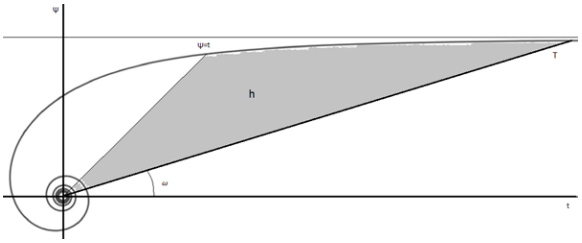


FIG. 3. v/t; u/Ψ. Additional hypothesis for Ψ(t), -no linear time geodesic in a no flat temporal geometry-, in polar coordinates T = B/ω, being T, linear time as a 4D assumption. Obviously, “temporal rotation” is only a semantic analogy to describe a simplification for warped time geometry, not a physical description.

If we assume ergodicity between space and time expansion, conserved quantity h may be interpreted as proportional to Λ/Ω, and the slope Ψ', as the Hubble “Constant”, H_o. (Then, choosing an appropriate synchronization between t & τ, we will be able to approach the CMB event in 5D time-scale in terms of the gap between measurements based on the Distance Ladder and based on CMB: around 8%, [18]).

Just inside the prospected margin of slope at the projected curves of fig. 4. It would be great but quite strange, to fix Ψ(t) in a First Shot synchronization, but either this shape will be discarded in the future, in our simulations it fits surprisingly fine with scare data in high z. In any case, equation (3) translated to polar coordinates, has been solved and the relation between survival time dimensions would be:

$$\left(\sqrt{B^2+1}+B\,\ln(1+Z)\frac{B+\sqrt{B^2+\frac{1}{(1+Z)^2}}}{\left(B+\sqrt{B^2+1}\right)}-\sqrt{B^2+\frac{1}{(1+Z)^2}}\ ,\ \frac{c}{Z+1}\right) \qquad (5)$$

Being B = 2Λ/Ω, the shape parameter of the time-spiral, because ergodicity, proportional to radiation/matter.

From this perspective, the cycling phase of the spiral trajectory, while time changes from positive to negative values and back again (smooth and asymptotic Big Bang), began before 5% from our age, but as the 13.72 billion light-year is sized from 4D perspective, this does not mean after CMB of a 5D perspective (in this example around 8% higher scope, fitting with observations). By then a second measured by a clock, may seem -apparently, if we synchronize with now a days clock- a very much shorter projection of the same second at the same clock, (Fig. 3, negative t & Ψ).

When we set this "first shot time-geodesic example", there is a statistical coincidence between both approaches (4D+ΛCDM & NLT+inverse time trajectory spiral) up to z ≈ 2, and we have used a sample of higher z-GRB, to fit data with hypothesis on a model for regression as 44 + b ln(z), [17]. Without being conclusive, given the wide standard deviation of the scarce data at z > 1, in this example it is confirmed that by moving the apparently higher z_τ in terms of the 4D time-scale, in the Distance Modulus/Look-Back-Time graph, with B = 0.07 (best-fitted tuning with a 4D Flat Universe model), the SNeIa&GRB Distance Modulus data are compatible either with accelerated or decelerated Universe, Matter Dominated > 90% (as we have assumed in the additional first shot hypothesis, proportionality between h & Λ/Ω to determine Ψ with inverse spiral shape).

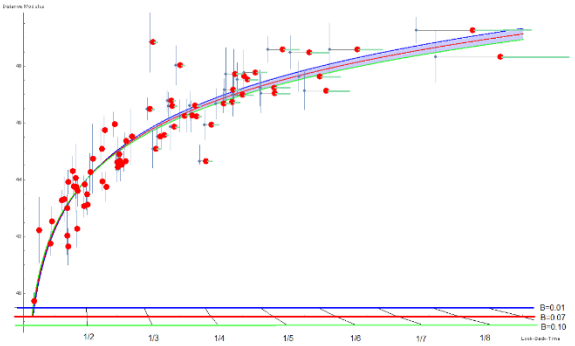


FIG. 4. Small-Blue dots with blue error bars are the GRB events over 4D time-scale, same as 5D with B=0.01, (referred to red axis), and though blue line is its regression. Big-Red dots are GRB events over 5D time-scale with First Shot Ψ(t) additional hypothesis -B=0.07 fitted with Flat Universe at constant-scale-, and red line is its regression. Green regression is fitted with B=0.1 (Λ≈95%), over red constant-scale v-axis. Filled in grey are the range of regressions from B=0.01 to 0.1. Blue regression at blue scale is red-dashed, as so it is green regression at green scale. Dashed red line, as a reference to fit, for a 4D Flat Universe Model radiation/matter: 0.5/0.5 with Ψ'= H_o = 69.6. So we can set the Legacy No Flat Time Energy hold in its warpness, between 0.5 to 9.5%, from Open to Closed Universe, Matter Dominated >90%.

The more closeness with less matter may be interpreted as a stronger effect of the Λ on the shape of the time spiral over the Ω gravitational "brake". 5D perspective allows open, flat and closed configurations, but to seem Spatially-Flat, Matter ≈ 96.5% & Legacy Time Brane Warp Energy ≈ 3.5%. This do not withdraw completely Dark Energy, but makes unnecessary the acceleration to explain data, only because time is set in two coordinates instead of one.

Flat-like & Warp-like coordinates simplification, diversifies space & time nature of dimensions; but warpness in a couple of coordinates, may produce effects even in space-like dimensions, while if they have lower strength. That may be observable maybe during early BB process, probably not from our time position.

5. CONCLUSION

The analyzed papers [1]&[2]&[3], confirm that a bulk 3-2 configuration is compatible with the relativistic equations, with the FLRW metric and with a smooth singularity for each temporal brane, without the need for compactification. The price for the change of the time-scale, the Universe must be closed, but precisely restrictions are fed back, because another price to pay makes up for warps time coordinates. When translating the Redshift Scale to Look-Back-Time, according to this criterion, the Closed Universe is compatible with the Standard Candles data and more than this: fits quite well. Data in Fig 4 sign by themselves.

We provide here a procedure to test the additional symmetries that are needed to determine the equations, through its time-like-geodesic, but we do not claim to have found the conservation laws that adjusts the definitive correlation of astrophysical data. With an example, we demonstrate that the procedure can give consistent results with a broad spectrum of hypotheses and that Dark Energy is not

the only answer. We succeed to fit the astrophysical data in a Space-Flat, Warped-Time and Causal and Closed Universe with Smooth BB, as much accurate as the Open Universe Dark Energy interpretation.

It may be said that this time brane warping evolution to produce an hyperbolic trajectory is highly speculative. Neither in the single constant time interpretation, nature and dynamics of Dark Energy are not known, though it would be unfair to demand to an alternative interpretation to fix the definitive Ψ(t). In the main while, if we consider there have to be Dark additional hypothesis for its dynamics, both interpretation would be at the same level.

We may choose between a not known energy or not know warped extra time-like dimensions, but this last one is not dark, do not have a Horizon Problem; can explain no-baryonic Dark Matter ($G^{1/4}$, and through it understand the giga black holes on the galaxies centrum and the why we are going to size much more massive gravitational merging events in the near future); fill the gap on H_o measurements on respect CMB; and opens GR to statistics of time trajectories or no-linearly warped branes.

As future surveys incorporate more events in $z > 2$ and better measurements of H_o, the regressions will be more accurate and it will be possible to improve determination of more universal symmetries with this tool. We will continue to test other Ψ(t) additional hypotheses that adjust the data and incorporate H_o to the tuning, but we already anticipate that the fact that space-time ergodicity and a conserved Λ/Ω may be proven consistent, it will not mean there are no other candidates for temporary functions, derived from it.

This is not a rotational and/or a variable constant theory. Time rotation is a graphical description by analogy of an example of a temporal geodesic shape. Speed of Light Gravitational Constant or Fine Structure Constant, remain "constant" for every time when clocks measures from its own time, but apparently they are not from 4D time-scale if observers presume the same clock along time, just because every clock measures the same length time, but our projected clock on a single linear time, do not measures the very far away time properly because assumes linear time-like-geodesics. Ψ(t) & Ψ'(t), set the bias.

In our understanding, there is something perfectly clear: even they are both highly speculative, No-Linear Time (Space Open, Flat or Closed Universe), fits data as well as Dark Energy (Open Universe) and offers a mathematical road to walk. Maybe there is not Dark Energy or no-baryonic Dark Matter (apparent variable c, G, H_o & α), or maybe there are no other time-like dimensions. Maybe this "first shot" is not the right one, but other time-geodesics can be.

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