A Multi-fold Universe Genesis Inspired By Explosive Total Collision: The Source Of The Big Bang?

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Abstract:

In a multi-fold universe, gravity emerges from Entanglement through the multi-fold mechanisms. As a result, gravity-like effects appear in between entangled particles that they be real or virtual. Long range, massless gravity results from entanglement of massless virtual particles. Entanglement of massive virtual particles leads to massive gravity contributions at very smalls scales. Multi-folds mechanisms also result into a spacetime that is discrete, with a random walk fractal structure and non-commutative geometry that is Lorentz invariant and where spacetime nodes and particles can be modeled with microscopic black holes. All these recover General relativity at large scales, and semi-classical model remain valid till smaller scale than usually expected. Gravity can therefore be added to the Standard Model. This can contribute to resolving several open issues with the Standard Model, without new Physics other than gravity. These considerations hints at an even stronger relationship between gravity and the Standard Model.

Julian Barbour and his team, with their Janus point theory, have proposed unconventional views on topics like the arrow of time, entropy and the big bang. This paper analyses some of these ideas in the context of multi-fold universes, where the key idea of reversibility of all the law of physics does not seem to hold, and where we have a random fractal discrete spacetime instead of conformance and scale independence.

In this paper, we show that we can borrow some key concepts and repurpose them to justify the arrow of time, the growth of entropy along with growth in complexity. By borrowing the idea of N-body explosive total collision, we provide plausible scenarios for a genesis of the big bang and its inflation: the N-body collision of enough particles, governed by Ultimate Unification (UU) concepts, generated by quantum fluctuations, cyclic universes, or big crunch, can be the onset of a N-body explosion accompanied with a boost of spacetime energy: the inflaton field. We have previously proposed that, for multi-fold universes, the inflaton could be the Higgs field (minimally) coupled to gravity.

The proposed scenarios could also apply to big crunches, and some cyclic universes, if that were how the universe were to evolve. It also allows some interesting modeling of the inside of a blackhole with a new and compelling suggestion for the quantum extrema surface that may appear near it center.

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1. Introduction

The paper [1] proposes contributions to several open problems in physics like the reconciliation of General Relativity (GR) with Quantum Physics, explaining the origin of gravity proposed as emerging from quantum (EPR-Einstein Podolsky Rosen) entanglement between particles, detailing contributions to dark matter and dark energy, and explaining other Standard Model mysteries without requiring New Physics beyond the Standard Model, other

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than the addition of gravity to the Standard Model Lagrangian. All this is achieved in a multi-fold universe that may well model our real universe, which remains to be validated.

With the proposed model of [1], spacetime and Physics are modeled from Planck scales to quantum and macroscopic scales and semi classical approaches appear valid till very small scales. In [1], it is argued that spacetime is discrete, with a random walk-based fractal structure, fractional and noncommutative at, and above, Planck scales (with a 2-D behavior and Lorentz invariance preserved by random walks till the early moments of the universe). Spacetime results from past random walks of particles. Spacetime locations and particles can be modeled as microscopic black holes (Schwarzschild for photons and spacetime coordinates, and metrics between Reisner Nordstrom [2], and Kerr Newman [3] for massive and possibly charged particles – the latter being possibly extremal). Although surprising, [1] recovers results consistent with other like [4], while also being able to justify the initial assumptions of black holes from the gravity or entanglement model in a multi-fold universe. The resulting gravity model recovers General Relativity at larger scale, as a 4-D process, with massless gravity, but also with massive gravity components at very small scale that make gravity significant at these scales. Semi-classical models also turn out to work well till way smaller scales that usually expected.

The present paper builds, analyses and discusses the arguments presented in Julian Barbour's book on "The Janus Point" [5], and the more technical references provided in the book. In particular, we discuss entropy, complexity and time arrow for an open expanding, or contracting, universe, and big bang / inflation in a multi-fold universe.

2. Barbour's Janus Point

The purpose of this paper is not to explain nor review the Janus point proposal [5]. But rather to enumerate, and rephrased in our own words, some of the key ideas that we want to discuss, or possibly borrow.

Barbour argues that Thermodynamics and Statistical Physics have been developed and formulated in the context of closed systems, isolated from the rest, and close to equilibrium (i.e. typically adiabatic); something that is not a good representation of most of the systems in the universe that are not isolated / closed systems, but rather interacting with a universe in expansion. The expansion aspect is considered essential.

Barbour does not focus much on irreversibility, as he explains that the fundamental laws of physics are time reversible or time symmetric, and irreversibility typically comes from effective theories that hide some effects in say irreversible dissipations. Therefore, the notion of arrow of time, which should not exists if Physics is time symmetric, is conventionally explained as the result of the thermodynamics of closed system that predicts that for such a system, there is always an increase of entropy, which is observed or modeled as an increase of disorder.

Yet, the universe and systems that we observe are characterized by significant increases of complexity and order (think of gravitational structures or life), something that is, a priori, contradictory with the explanation presented above. For example, to support what we observe in the universe today, it would be required that the initial conditions of the universe at the big bang were very special, and with very low entropy.

[5] also proposes that the universe is fundamentally relational and distances (or durations) are purely defined as ratios and shapes as angles, with Physics originally scale-independent and shape / angle-dependent (i.e. conformant): Physics at the early stages would not care about absolute distances or scales. What is relevant occurs in a shape space. This is aligned with string conformance, but also a fractal structure, and asymptotically safe Physics.

Hence:

- The suggestion and analysis that actually in an universe in expansion, shape complexity increases (first) in a relational world where distances are measured by ratios (not absolute dimensions), and shapes, by angles (not by scales). It does not really discuss though when scale invariance would weaken, or what happens differently in a contracting universe.
- The suggestion that in such a universe, there is an attractor (towards a set of (discrete) points or a curve (for the GR version of it)) in shape space, with respect to which the content of the universe can be seen as a N-body system on an explosive total collision path. See [5] for references to different studies of 3- and N-body systems and their chaotic and attractor properties.
- The universe is also proposed to be in the constrained mode where the total energy, momentum and angular momentum are all zero; something justified for energy for example by the claim that no absolute notion of scale exists initially: this can only make sense if the total energy budget is null.

With this, the Janus point theory argues that the notion of time, and of an arrow of time, do not originally exist (no ratio to relate to). The Janus point is the spacetime point of explosive total collision from which Barbour argue the system can move forward (e.g. explosion of single body and pairs of orbiting bodies) or backward (idem but as reversing the colliding evolution). In both cases, the chaos of the explosion creates periodic orbital motions for escaping subsystems, which allows internal systems (like humans) to perceive an evolution of time; for example by associating the passage of time to the regular orbital motion of surrounding bodies.

These orbital moves are considered examples of increased complexity from the original explosive chaos, therefore physically explaining why an expanding universe would have an increasing complexity as time increases; thereby at least in their view a better proposal than the challenge in explaining initial conditions that would provide for initial low entropy allowing existing structure despite entropy increases.

3. Multi-fold Universes and Janus Point Models

We are interested to see what can be borrowed from such a proposal for multi-fold universe. The main motivation for doing so are:

- Does an expanding open (not in an isolated box) system really have different Thermodynamics?
- Does N-Body total collision provide a way to explain the origin of either the big bang or the inflaton?
- Can anything be extracted from the scale invariance / shape complexity concepts?

Needless to say that this is to balance with tensions and problems a priori between multi-fold universes, as well as conventional Physics, and the proposals from [5].

There are some fundamental differences between the two models. Let us enumerate what we will not consider, or what we will modify, when inspiring us from the analysis:

- In a multi-fold universe, we determine that Physics (gravity, entanglement and even wavefunction collapse) are fundamentally irreversible or not T-symmetric [1,7]. As a result, it seems possible to identify an arrow of time. There is no need for a two-future proposal at the Janus point. A 3-body or N-body explosive total collision does not require two future. Following up on the explosion is sufficient: no need to involve the god Janus, and its symmetric (double) head.
- [1] proposes a model where the spacetime is discrete, fractal (due to random walk), Lorentz invariant and non-commutative. There is a minimum length: the universe is not exactly purely relational, scale and conformant invariant.
    - The fractal aspect gives some notion of scale invariance but probably not as envisaged in [5]. At larger scale, multi-fold Physics are not exactly following the basis of the Janus point model of

scale and shape independence. We need to work in configuration space, not in the shape space, if we want to reuse N-body collisions.

- A priori, it should not be an issue as N-body is typically a configuration space problem [17,18]. In fact a recent study showed that it may be questionable if the proposal in shape space is indeed leading to total collisions and reset as argued in [5]: in shape space, only specific solutions are undergoing total collisions, others never encounter it [11]. On the other hand, total collision is always encountered in configuration space for shape and scale dependent Physics, and for Newtonian physics, and an equivalent GR attractor also correctly exists for GR.

- Yet, asymptotic safety of gravity in multi-fold theory [22], and renormalizability of the Standard Model (SM) ([23] and reference therein especially reference 37 in [23]), however indicate a conformant behavior beyond (a) fixed point(s). So, some form of scale and shape invariance will indeed occurs at very small scales and high energy. But not at larger scales.
- [1, 10] introduces the notion of Ultimate Unification (UU) at very smalls scales where the gravitation effects match the interaction strengths of all other interactions. Above UU energies (i.e. high temperatures, early in the big bang that it be localized or over a larger region, or at very small scales), All particles behave as same carriers of gravity (and any other interactions if their charges exist non-neutralized) with a same intensity. Amazingly it justifies suitability of just a Newtown gravity analysis, used by [5], at these extremely small scales!
- [1,6] derives time and minimum time length for observers within the universe; albeit inexistent from the outside, assuming that an external universe would exist, something that could be argued to be an oxymoron. However an external mathematical model could fit the bill, even if not attached to a physical observer.
- [1] relies on time (energy) and space fluctuations to justify matter and spacetime generation.
- The N-Body total explosion collision is an attractive proposal to explain a total zero energy along with an explosive behavior, but the equation needs to consider more forms of energy than just kinetic and potential energy. The result of energy conservation is:

$$E_{kinetic} + E_{Grav} + E_{Other} = 0 \quad (1)$$

- In (1), E_{Other} represents the energy internal to the universe spacetime.
- Null total momentum and total angular momentum make a lot of sense, if the collision is total, even if the extent of the minimum length could argue against a null angular momentum. Yet we would argue that this is a byproduct of the discrete nature of multi-fold universe who would otherwise be at zero angular momentum. Also. we accept the generally accepted view that the real universe does not seem to rotate anyway [24], despite some results arguing to the contrary like [25].

We do agree with the analysis of Barbour's team that the Thermodynamics of open systems is different from Thermodynamics or isolated closed (and/or adiabatic) systems. Yet we are not convinced that this results into any resulting major differences in a conventional universe, or in a multi-fold universe: by definition, the whole universe is a closed Thermodynamics system and so the whole universe entropy must always grow no matter what the differences are between an open and a closed system.

For example, if matter falls into a multi-fold black hole, the black hole entropy increases, due to black hole horizon increase, while the entropy external to the black hole decreases to compensate the lost spacetime and particles due to the blackhole horizon increase. Meanwhile, yes, the expansion of the universe creates new spacetime that have been added to the universe: the total entropy increases, but expansion was not needed to respect the second law of Thermodynamics. See also [20].

In fact that same reasoning can be for a contracting multi-fold universes up to the expansion analysis. Contraction in a conventional universe will reduce entropy, but in a multi-fold universe it contracts the universe content, not

the concretized space-time: entropy can continue to grow as these continue to support microstates, fluctuations and some multi-fold dark energy effects [12]. As long that black hole evaporation can take place the model remains. At smaller scales, the analysis in [1,10], and UU, allows break up of black holes into smaller and smaller black holes till all are individual particle with democratic same intensity effect for all interactions. These processes continue to increase, or flatten, the entropy evolution.

What about gravitation attraction. In stars, and everywhere, matter agglomeration and clumping is taking place, the entropy associated to the event is always positive. A good analysis is provided in [13] about the gravothermal catastrophe. It explains how gas or dust clumping can be associated to increase of entropy (along with increases of temperature homogeneity). So larger solar systems and orbital systems are covered. The same paper describes how star formation, and their lifecycle, involving nuclear reactions, also result into increases in entropy [14]. All these effects, involving bound systems, are not affected that the universe expands or contracts.

The last complex system that we will consider is life, and its apparition on earth. It is well known that life in a life supporting environment that provides sources of energy, or "interactions", and thermal baths, where to dump heat (e.g. the earth) [15,16].

Going back to [1,10] and UU, at very smalls scales in a total N-body collision, and prior to the (big bang) explosion, the entropy continues to increase (≥ 0).

So, even in an open system like regions of the universe, or for the whole universe, and for gravitational effects, entropy increases without needing to revert to a different model à la entaxy ([5]) or shape space. The universe can organize itself with gravitational structure, or life, without violating the second law of Thermodynamics in an expanding universe. The N-body explosive total collision proposal of [5] is therefore useful to explain the explosion, but not that much needed to explain complexity, or the universe's initial conditions, other than its explosive or inflationary nature. It is also not needed to explain the arrow of time as we know that, in a multi-fold universe, Physics is not time symmetric.

The Janus point model (with the update total energy) is interesting but as a source of an explosive future not as a source of two futures for the universe.

4. Some Multi-fold N-body Explosive Genesis Scenarios

In the multi-fold spacetime reconstruction [1], the initial moments are dominated by the Ultimate Unification (UU), where all interactions are at the same level of intensity [1,10].

Neutrality of the universe for all its charges, except (relativistic) masses, seems an additional requirement to recover a N-body mechanisms: on average, if N is large any charge effect is neutralized and only gravity matters.

In a multi-fold universe, when modeling particles (even for fields), which is what [1] recommends, the source and gravity is an effective potential strongly reminiscent the Newtown gravity potential. Albeit GR models the universe, close to collision, a Lagrange N-body model applies [5,15,16], and is sufficient to characterize what happens. In fact this reasoning shows that in a multi-fold universes, the GR attractor model of Barbour would be correct and, we believe that this is therefore also true in non-multi-fold situations, as indicated in [17].

It is now time to discuss what could be a multi-fold universe genesis.

Let us consider the following scenario. As described in the spacetime reconstruction part of [1], and considering the embedding of a multi-fold universe in a 7D vacuum space ruled by GR(7D) [8], created by multi-folds around any 4D fluctuations, i.e. the 7D spacetime does not precedes the fluctuations, it is not physical:

- Quantum fluctuations (geometrical objects) can create everywhere particle pairs that come and go. Some are massless, a subset could even be sometimes temporarily massive. Some create, or concretize, patches of a spacetime that could be connected as part of a same 4D manifold. We should consider a fluctuation creating a large set (and certainly more than 3) of particles, which could correspond to a regular 4D pseudo-Riemannian manifold. It may take a very long time, i.e. many iterations as time is so far meaningless, before this happens suitably.
- After many attempt, such a set, improbable but the object of N-body attractor for any such set of particles per [5,11,17,18], will enter in total explosion collision. Never mind if some other particles don't participate in other sets, located further away.
- Because of the small scale, we are under the UU regime, and Newton potential models are good approximations, disregarding any charge that would be ultimately neutralized by others (per the neutrality condition mentioned earlier). All particles are massless moving at the speed of light (Any massive fluctuation is left behind).
- When total collision occurs, equation (1) is considered and it is the equation that drives the collision then the explosion. If enough particles are involved, at collision, E_{Grav} goes a very large negative value (bound only by the uncertainties and minimum length). It is quasi-infinity. As the kinetic energy $E_{kinetic}$ is bound by the supra luminosity principle, E_{Other} will need to also grow very large to respect (1). The only way to do this is to model it as an influx of new very high inflaton field, plausible per the proposals of [8,9,19], with a high potential that capture the potential energy needed to satisfy (1). E_{Other} can be the source of the high energy particles available to start growing spacetime by exponential random walks, where spacetime is concretized, and new particles created by existing particles at each clock tick: i.e. inflation [1]. During explosions, particles can be dominated by massless Higgs fields per [9]. The Big Bang scenario a la multi-fold described in [1] has its initial energy content motivated.
- Extrapolating on what happen with infinite potential energies, quasi total overlap in an uncertainty region and total reset of the gravity solutions in a N-body system, we can postulate that all history of the past (e.g. incoming particles) are lost at this point (the Janus point of [5]) and the explosion starts anew with pairs of particles that it creates, initially under the UU regime.

Note that the scenario, and especially the last bullets, teach us much and warrants extra discussions, addressing some questions.

Could such an event locally repeats itself today? Yes it could but the presence of the massive inflaton/Higgs with uncounted numbers of Higgs renders the situation much harder to model and ascertain. Furthermore as we would be outside the UU scales, the other interactions, including especially electromagnetism action of a whole zoology of particles render the gravity driven explosive total collision hard: even if possible, it is way less probable that in our UU initial regime. So while not forbidden, at this stage of our model, such a situation is not expected to take place, at least not as simply as we describe.

In the case of cyclic universes with big crunches models, this would mean that a re-expansion due to explosive total collision would require that the whole universe returns to a UU phase, as it reaches its final stages of contraction. Yes it is possible. It is to be noted that the potential torsion supported by multi-fold mechanisms [1] and dark energy effects may also contribute to preventing singularities, and replacing, or rather enhancing, the effects.

What about the inside of blackholes? We know that particles crossing the horizon will rapidly fall to its center. While that is not a total collision (everything does not reach the center at the same time), it could be seen as an endless sequence of total collisions, between what reaches it and everything in the center's uncertainty region. With such a reasoning, the information content is wiped out at the center in the endless explosive total collisions and particles would stirred up in that inside region, generating information white noise. This is just an hypothesis worth exploring but consistent with [20]. In fact the stir up near the center may be actual physical events occurring

near the center that are only sketched in [21] (and the references that it provides), and that were not encountered in [20]: a quantum extrema surface occurring also near the center (not the one appearing close to the horizon). It is for further study, including considering the additional effects of torsion [1] and multi-fold dark energy effects [12].

Could the process repeat in many places (instead of a single point)? The answer is yes. But probably only the first explosive total collision would take place, and it would overtake whatever other similar fluctuations are doing (but not yet reached) elsewhere. Yes, if two explosive total collision occurred exactly at the same time, This would possibly be observable, e.g. with some region expanding towards us. As this is not the case, while a valid option, this scenario is probably not something that maps to our real universe history. What is more plausible is the first case where many fizzling regions are overtaken before total explosive collision takes place.

In all the envisaged Big bang cases, [1] holds and the universe total momentum and angular momentum are expected to be null. Conformant cyclic cosmology (CCC) universes [26] may also support scenarios as proposed above in this section, with fluctuations starting in the BEC (Bose Einstein Condensate).

5. Conclusions

The paper reuses some of the concepts form the Janus point to provide a justification for an origin of the high energy and inflaton (or minimally coupled Higgs filed) proposed in [1 (other than related to 7D induced space time matter in [8]). It also relies strongly on the effective potential associated to entanglement and gravity encountered in [1] and the concept of UU [10] to justify the validity of a Newtonian explosive total collision as the source of the big bang and inflation energy level.

The analysis and genesis scenarios are by no means presented with the view that these are the final or correct explanation of what happened. They are rather examples that explains how the Multi-fold reconstruction can be bootstrapped with the necessary initial energy, and entropy, leading to the big bang and inflation.

Aspects of the analysis can be repeated in any universe, not necessarily multi-fold. However the consistency of the reasoning is based on the multi-fold universe reconstruction scenario of [1], the further analysis of inflation discussed in [1,12] and the UU regime [1,10]. More details on the multi-fold models, and its latest implications so far can be found tracked at [8]. However, in non-multi-fold universes, we do not know if we can similarly argue for a gravity dominated total collision as other effects of charges or Grand Unifications may behave differently (e.g. considering the WGC implications).

Interestingly the analysis also showed plausibility, and challenges, of the proposed scenario in cases of big crunch and cyclic universes. It also opened the door to an interesting view of what happens inside a blackhole and in particular physical phenomena that may explain the physics behind the quantum extrema surface appearing near the center of a blackholes as mentioned for example in [21].

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References:

[1]: Stephane H. Maes, (2020), "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe", viXra:2006.0088v1, https://vixra.org/pdf/2006.0088v1.pdf (June 9, 2020).

[2]: Wikipedia, “Reissner–Nordström metric”, https://en.wikipedia.org/wiki/Reissner%E2%80%93Nordstr%C3%B6m_metric. Retrieved on March 21, 2020.

[3]: Wikipedia, “Kerr–Newman metric”, https://en.wikipedia.org/wiki/Kerr-Newman_metric. Retrieved on March 21, 2020.

[4]: Burinskii, Alexander, (2008), "The Dirac-Kerr-Newman electron", arXiv:0507109v4

[5]: Julian Barbour, (2020), “The Janus Point: A New Theory of Time”, Basic Books

[6]: Stephane H Maes, (2020), “Entanglement Concretizes Time in a Multi-fold Universe”, viXra:2010.0083v1, https://shmaesphysics.wordpress.com/2020/06/28/entanglement-concretizes-time-in-a-multi-fold-universe/, June 28, 2020.

[7]: Stephane H Maes, (2020), “The W-type Multi-Fold Hypothesis and Quantum Physics Interpretation of wave Functions and QFT”, viXra:2207.0118v1, https://shmaesphysics.wordpress.com/2020/12/24/the-w-type-multi-fold-hypothesis-and-quantum-physics-interpretation-of-wave-functions-and-qft/, December 20, 2020.

[8]: Stephane H Maes, (2020), “Tracking Down The Standard Model With Gravity In Multi-Fold Universes”, viXra:2011.0208v1, https://shmaesphysics.wordpress.com/2020/08/30/tracking-down-the-standard-model-with-gravity-in-multi-fold-universes/, August 20, 2020.

[9]: Stephane H Maes, (2020), “Multi-fold Higgs Fields and Bosons”, viXra:2006.0088v1, https://shmaesphysics.wordpress.com/2020/11/10/multi-fold-higgs-fields-and-bosons/, November 6, 2020.

[10]: Stephane H Maes, (2020), ”Ultimate Unification: Gravity-led Democracy vs. Uber-Symmetries”, viXra:2006.0211v1, https://shmaesphysics.wordpress.com/2020/06/16/ultimate-unification-gravity-led-democracy-vs-uber-symmetries/, June 16, 2020.

[11]: Paula Reichert, (2020), "Investigating total collisions of the Newtonian N-body problem on shape space", arXiv:2012.06776v1

[12]: Stephane H Maes, (2020), ”Explaining Dark Energy, Small Cosmological Constant and Inflation Without New Physics?”, viXra:2006.0261v1, https://shmaesphysics.wordpress.com/2020/06/19/explaining-dark-energy-small-cosmological-constant-and-inflation-without-new-physics/, June 19, 2020.

[13]: David Wallace, (2009), “Gravity, entropy, and cosmology: in search of clarity”, arXiv:0907.0659v1.

[14]: Gordon Mccabe, (2009), "Star formation and entropy", http://mccabism.blogspot.com/2009/09/star-formation-and-entropy.html. Retrieved on January 14, 2021

[15]: Wikipedia, “Entropy and life”, https://en.wikipedia.org/wiki/Entropy_and_life. Retrieved on January 16, 2021

[16]: Natalie Wolchover, (2014), "A New Physics Theory of Life", https://www.quantamagazine.org/a-new-thermodynamics-theory-of-the-origin-of-life-20140122/. Retrieved on January 16, 2021

[17]: Govind S Krishnaswami and Himalaya Senapati, (2019), "An Introduction to the Classical Three-Body Problem From Periodic Solutions to Instabilities and Chaos", Resonance, volume 24, pages 87–114.

[18]: Christian Marchal, Donald G Saari, (1976), "On the final evolution of the n-body problem", Journal of Differential Equations Volume 20, Issue 1, Pages 150-186.

[19]: Stephane H. Maes, (2020) “Particles of The Standard Model In Multi-Fold Universes”, https://shmaesphysics.wordpress.com/2020/11/05/particles-of-the-standard-model-in-multi-fold-universes/, (November 4, 2020).

[20]: Stephane H Maes, (2020), “Multi-Fold Black Holes: Entropy, Evolution and Quantum Extrema”, https://shmaesphysics.wordpress.com/2020/11/01/multi-fold-black-holes-entropy-evolution-and-quantum-extrema/, October 31, 2020.

[21]: Quanta Magazine, (2020), "The Most Famous Paradox in Physics Nears Its End", https://www.quantamagazine.org/the-black-hole-information-paradox-comes-to-an-end-20201029/. Retrieved on October 29, 2020.

[22]: Stephane H Maes, (2020), “Renormalization and Asymptotic Safety of Gravity in a Multi-Fold Universe: More Tracking of the Standard Model at the Cost of Supersymmetries, GUTs and Superstrings”, viXra:2102.0137v1, https://shmaesphysics.wordpress.com/2020/09/19/renormalization-and-asymptotic-safety-of-gravity-in-a-multi-fold-universe-more-tracking-of-the-standard-model-at-the-cost-of-supersymmetries-guts-and-superstrings/, September 18, 2020.

[23]: Emilian. Dudas, (2014), “Field Theory and the Standard Model”, https://cds.cern.ch/record/2114788/files/1-46%20Dudas.pdf, CERN.

[24]: Daniela Saadeh, Stephen M. Feeney, Andrew Pontzen, Hiranya V. Peiris, Jason D. McEwen, (2016), “How isotropic is the Universe?”, arXiv:1605.07178v2

[25]: Lior Shamir, (2020), “Multipole alignment in the large-scale distribution of spin direction of spiral galaxies”, arXiv:2004.02963v5.

[26]: Wikipedia, “Conformal cyclic cosmology”, https://en.wikipedia.org/wiki/Conformal_cyclic_cosmology. Retrieved on January 7, 2021.