Multi-fold Dark Matter and Energy Effects Fit The Ratios to Normal Matter in the Universe

Stephane H. Maes.[1]

August 14, 2022

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, whether 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 (GR) at large scales and semi-classical models remain valid till smaller scale than usually expected. Gravity can therefore be added to the Standard Model resulting into what we define as SM_G. This can contribute to resolving several open issues with the Standard Model without New Physics other than gravity, i.e. no new particles or forces, or with the standard cosmological model (ΛCDM) in terms of dark matter and dark energy.

The present paper provides estimates for the ratios of normal matter to multi-fold dark matter effects (~ 1 to 5) and to dark energy (~ 1 to 14). These ratios match the estimates for our real universe, in particular the Λ-CDM model.

Such results increase the relevance of multi-fold theory. To our knowledge, being able to predict such ratios, ab initio, i.e., solely based on the underlying microscopic mechanisms is not a small feat, and the reasonings presented in this paper, would not be applicable to ratio estimates from the other mainstream theories. It is a strong validation of the multi-fold theory, and its potential applicability to our real universe and its cosmology. It also validates the E/G conjecture with its proposal that entanglement creates gravity like effects.

1. Introduction

The original multi-fold theory 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 (virtual) particles, detailing contributions to dark matter and dark energy effects, and explaining other Standard Model mysteries without requiring New Physics beyond the Standard Model with gravity effect non negligible at its scales, other than the addition of gravity to the Standard Model Lagrangian, and the consequences of being in a multi-fold universe. All this is achieved in a multi-fold universe that may well model our real universe, which remains to be validated. This paper may be another step in that direction.

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 (2D) random walks of particles. Spacetime locations and particles can be

[1] shmaes.physics@gmail.com

Cite as: Stephane H Maes, (2022), "Multi-fold Dark Matter and Energy Effects Fit The Ratios to Normal Matter in the Universe", https://zenodo.org/doi/10.5281/zenodo.10071554, https://shmaesphysics.wordpress.com/2022/08/14/multi-fold-dark-matter-and-energy-effects-fit-the-ratios-to-normal-matter-in-the-universe/, August 14, 2022.

modeled as microscopic black holes (Schwarzschild for photons and concretized spacetime coordinates, and metrics between Reisner Nordstrom [2] and Kerr Newman [3] for massive, and possibly charged, particles – the latter being possibly extremal), minimum black holes [1,4], or random walk patterns for massless particles above the energy scales of the gravity electroweak symmetry breaking [2,61]. Although possibly surprising, [1] recovers results consistent with others (see [4] and its references), 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 [1,6], as a 4D process, with massless gravity, but also with massive gravity components at very small scale that make gravity non-negligible at these scales [1,35]. Semi-classical models also turn out to work well till way smaller scales that usually expected.

Multi-folds are encountered in GR at Planck scales [5,6] and in Quantum Mechanics[2] (QM) if different suitable quantum reference frames (QRFs) are to be equivalent relatively to entangled, coherent or correlated systems [7]. This shows that GR and QM are different facets of something that each cannot well model: multi-folds. QFT, and the SM also encounters then as in [59,*115*]. *Note added on November 3, 2023: References in italic were added on November 3, 2023.*

The paper starts with an overview of the multifold dark matter and dark energy mechanisms [1,21,22,40] and past papers discussing qualitative alignment with observations and simulations [9-11]. Then, we discuss how back of the envelope combinatorics of the two mechanisms provide estimates of the ratios of normal matter to respectively dark matter and dark energy, and match observations in our real universe.

Such results, for the first time obtained from ab initio microscopic models or associated first principles , are a strong indication of the relevance of the multi-fold theory to characterize our real universe: to our knowledge, nobody has ever been able to motivate such ratios so far: at best simulation have estimated the values to match observation that is quite different [18]. The ratios are both a reflection of the degrees of freedom, and hence contributions, of gravity effect coming from entanglement (dark matter) and those coming from local embedding in a 7D space created by the multi-fold mechanisms responsible for gravity as an attractive effective potential [1,19,34,50,52,62}.

For the multi-fold theory, this is key, especially, as multifold dark matter effects are one of the strongest avenue to a first experimental validation by confirming the E/G conjecture [14], based on the multi-fold mechanisms [1], and the discovery that entanglement is responsible for gravity fluctuations [1,12], between real particles as in the multi-fold dark matter effects, and gravity in general when adding entanglement between pairs of virtual particles and anti-particles emitted by sources of energy/masses. Dark matter effects are the easiest way to observe multi-fold effects beyond gravity [1,40]. Obtaining the correct ratios is a key step in that direction.

We acknowledge that the approach based on degrees of freedom may appear deceptively simple. Yet it directly relates to the multi-multi-fold dark matter and dark energy effects.

2. Multi-Fold Explanation to Dark Matter

[1,8,21,22,40] recovers automatically (cold) dark matter effects with its model of attractive effective potential appearing between physical (real) entangled systems [12], at the difference of virtual ones that already account for gravity.

Accordingly, emitted massless (or quasi massless, i.e. neutrinos) particles are entangled in pairs or with their source or intermediate systems. This account for extra gravity-like attraction towards the center and / or halos

[2] Standing in for Quantum Physics in general.

around galaxies. It is illustrated in figure 1 (from [40]). Whatever escapes further probably accounts for the wider distribution of dark matter and the associated cosmic web [*128*].

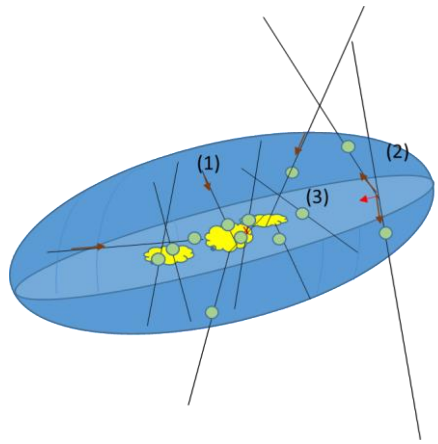

Figure 1: It illustrates how the different entanglements cases, discussed in the text, appear as dark matter with attraction towards the galaxy center and mass in the center or in halos. Green circles represent center of masses. (Reused from [1,40]).

[10] (see its figure 2 in [10]) explains that it can also account for globular galaxies where no significant dark matter is detected.

[9-11] provide additional analyses of astronomical observations that challenged conventional dark matter theories. It shows that we can account for all the reported behaviors.

[10,13,*129*] provide other examples where multi-fold dark matter effects match simulation results and/or observations: simulated loss of dark matter in galaxy close encounters, excess of disk galaxies vs. what is conventionally predicted thanks to less galaxy-to-galaxy attraction due to multi-fold dark matter effects and dark matter halo expansion with time. With multi-fold dark matter effects, MOND [17] are no more “the only alternative explanation” to such conventional dark matter challenges. MOND also encounters many challenges anyway [MOND] [17,*119*,*129*].

[60] further argues that there are no dark matter particle to be discovered.

3. Predicting the Ratio of Normal Matter to Multi-fold Dark Matter Effect Equivalents

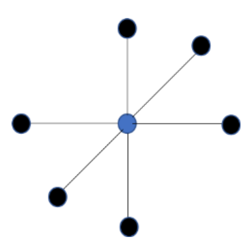

Figure 2: Degrees of freedom and the basic cell to consider for multi-fold dark matter effects due to entangled black dots producing an attractive effective potential towards the blue dot. We see 6 degrees of freedom.

Figure 2 illustrates the degrees of freedom encountered with the multi-fold dark matter mechanisms.

Figure 3 shows it in the context of many cells, remembering per [1,6,15,16,*96*] that cells are 2D spacetime processes at microscopic dimensions.

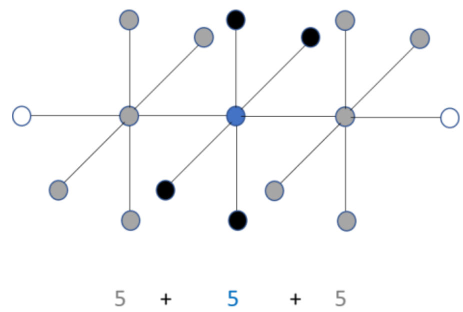

Figure 3: When considering the spacetime as a 1D spatial (2D process) at small scales, per [1,6,15,16], we discover that the contributions (between two dots on a line) per cell is 5 degrees of freedom.

The entanglement contributions aimed at the blue dot in figure 3 result from the end points connected to it, but when considered in a 1D chain, one is shared with its neighbors and the contributing degrees of freedom are 5.

It is assuming that every (concretized) spacetime location contributes proportionally to the mass it hosts at its location, which could be 0. It is not a constraining assumption, which is why we know that the ration observed in the universe has to lead to a 1/5 ratio. Propagation further and further away remain in that same ratio.

As a result, on average, for every entanglement issued from the blue dot (e.g. entangled massless concretized locations or particles that interacted through it) we have 5 times more degrees of freedom which are aiming the resulting attractive effective potential V_{eff} at it: For 1 node of matter we have 5 nodes worth of dark matter effects. Just as in the real universe [20], and as illustrated for example in the Λ-CDM [18] also known as the standard cosmology model

To our knowledge, so far , no other model / theory has been able to explain ab initio this ratio. A theory assuming cold (or other) particles can't reuse this argument. MOND [17], or tensor vector gravity [*130*] are unrelated to the considerations that we used to predict 1/5.

4. Multi-fold Dark Energy Effects

Besides effect of random walks at very high energy (soon after the big bang) [1,16], the multi-fold dark energy effects, shown in figure 4, come from quantum fluctuations [1,19].

As described in [1,19], multi-fold dark energy effects/contributions to dark energy result from the effect of quantum fluctuations, for all particles, real and virtual, which create an effective potential, attractive towards the (7D) embedding space created by the multi-folds.

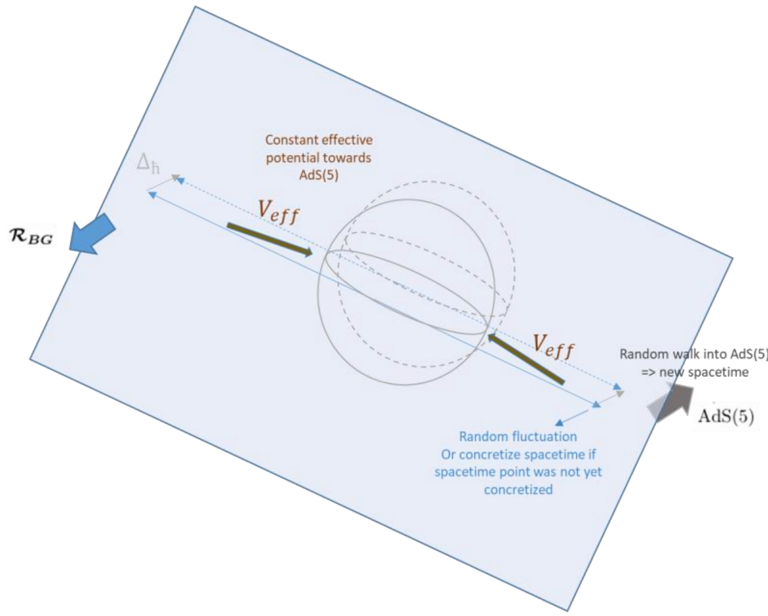

Figure 4: Multi-fold dark energy effects as proposed in [1,19].

5. Predicting the Ratio of Normal Matter to Multi-fold Dark Energy effects

Figure 5 shows the possible contribution to a ε fluctuation of entangled end points that have a nonzero contribution to the middle (geometrical center of the pair).

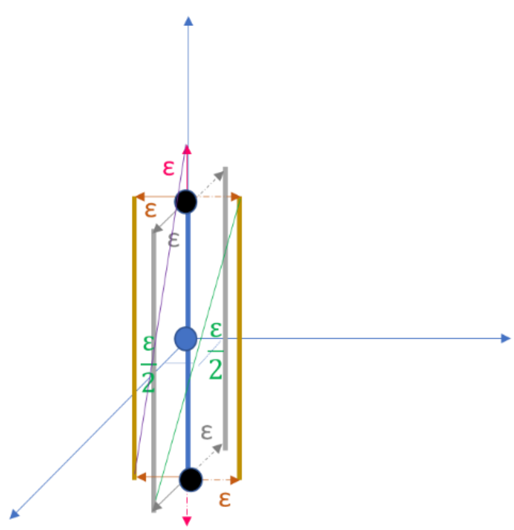

Figure 5: Contributions of different end point combinations that have a non-zero impact on the middle point for a give entanglement between the extreme points. Color coding reflect the contributions in (1).

Accordingly, we have:

$$4\,\varepsilon + \left(8\,\frac{\varepsilon}{2}\right) + \left(8\,\frac{\varepsilon}{2}\right) + \left(8\,\frac{\varepsilon}{4}\right) = 14\,\varepsilon \qquad (1)$$

, for any available ε fluctuation that we can assume proportional to the only energy present that is relevant: the normal matter energy.

Therefore the ratio for regular matter to dark energy is 1 to 14. Again as observed in our real universe [20].

Note that this ratio is independent of what are the fluctuation amplitudes/energies, but that we may expect the resulting effect to be proportional to the amount of energy/mass at a given location, i.e., the origin in figure 5. It matters to relate to the ratio for dark matter.

To our knowledge, no other theory can ab initio predict this ratio. For example, a typical approach based on QFT vacuum fluctuations, and leading to the cosmological constant problem, would a priori rather produce a ~ 6 ε contribution (3 x 2 degrees of freedom in embedding space).

6. Matching the real universe

As is currently known, the composition of the universe seems to be roughly [18,20]:

- 5% Normal matter
- 25% Dark matter
- 70% Dark energy

This gives us ratio of 1 to 5 and 1 to 14 for normal matter respectively to dark matter and dark energy. Just as we obtained.

It closely matches the standard cosmology model [18], and many other models and experimental data evaluating these dark components.

Following [6], we argue that the real universe is most probably multi-fold. Hence these result apply to our universe. Fortunately, they match observation results so far.

7. Multi-fold implications

As far as we know, so far, no other model has actually been able to explain ab initio the proportions of dark matter, dark energy and normal matter. So it matters, even if the derivation may seem too simple and crude.

Furthermore, the model explains why no dark matter as ever been discovered (it is not matter/particles to discover) [1,40,60], and solves the cosmological constant problem [1,19], while essentially being compatible with all current aspects of the Λ-CDM [18], as well as being able to address the observation challenges with dark matter discussed in section 2. *Note added in November 3, 2023: [117] shows how the multi-fold theory address better many cosmological challenges.*

In particular the results of section 3, which stands on their own, in the sense that does not depend on the dark energy results, are strong indication of validations of key proposals of the multi-fold theory:

- The multi-fold mechanisms, associated to entanglement, and resulting into gravity attractive effective potentials V_{eff} [1,12,*126,127*]
- The E/G conjecture [14].
- Entanglement generating gravity effects [1,12,14].

We always saw this as a way to experimentally support the relevancy of the multi-fold proposal, with entanglement resulting into gravity.

Also, it is very important to us, as it is also the first time that we have managed to obtain convincing quantitative results, which we are slowly preparing to address based on the evolution of our work so far [1,21-23].

It really seems like our strongest sign of validation so far of the multi-fold theory as relevant to our real universe.

7. Conclusions

This paper provides quantitative prediction for the ratios of normal matter to dark matter and normal matter to dark energy. These ratios match Today's observations, and the Cosmological Standard model. They embody the multi-fold dark matter and dark energy effects and they do not similarly support most other theories, despite the almost childish concepts behind the degrees of freedom.

Following [6], we suggest that the real universe is most probably multi-fold. Hence these result apply indeed to our universe.

It is a resounding indication of the value behind the multi-fold theory, and its proposal like the multi-fold mechanisms [1,21,22], the E/G conjecture [1,12,14], the multi-fold dark matter effects [1,40], and multi-fold dark energy effects [1,19], as well as the broader SM_G: the standard model (SM) with gravity effects non-negligible at its scale [1,8,21,22,33,*119*].

We can only hope that these results will bring more attention of the Physics community to the Multi-fold theory.

Appendix A: Review of the Multi-fold theory

The multi-fold theory was introduced in [1]. Tutorials and overviews can be found at [8,22,23,33] while the latest developments, updates and discussions can always be found at [8].

In a multi-fold universe [1,22,23,33], gravity emerges from entanglement through the multi-fold mechanisms. As a result, gravity-like effects appear in between entangled particles [1,12,14], whether they be real or virtual. Long range, massless gravity results from entanglement of massless virtual particles [1,12]. Entanglement of massive virtual particles leads to massive gravity contributions at very smalls scales [1,35]. It is at the base of the E/G Conjecture [26], and the main characteristics of the multi-fold theory [33]. Multi-folds mechanisms also result in 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 [1,4,15,19,36-39]. All these recover General Relativity (GR) at large scales, and semi-classical model remain valid till smaller scale than usually expected. Gravity can therefore be added to the Standard Model (SM) resulting into what we define as SM_G: the SM with gravity effects non-negligible at its scales. This can contribute to resolving several open issues with the Standard Model without new Physics other than gravity. These considerations hint at an even stronger relationship between gravity and the Standard Model, as finally shown in [34].

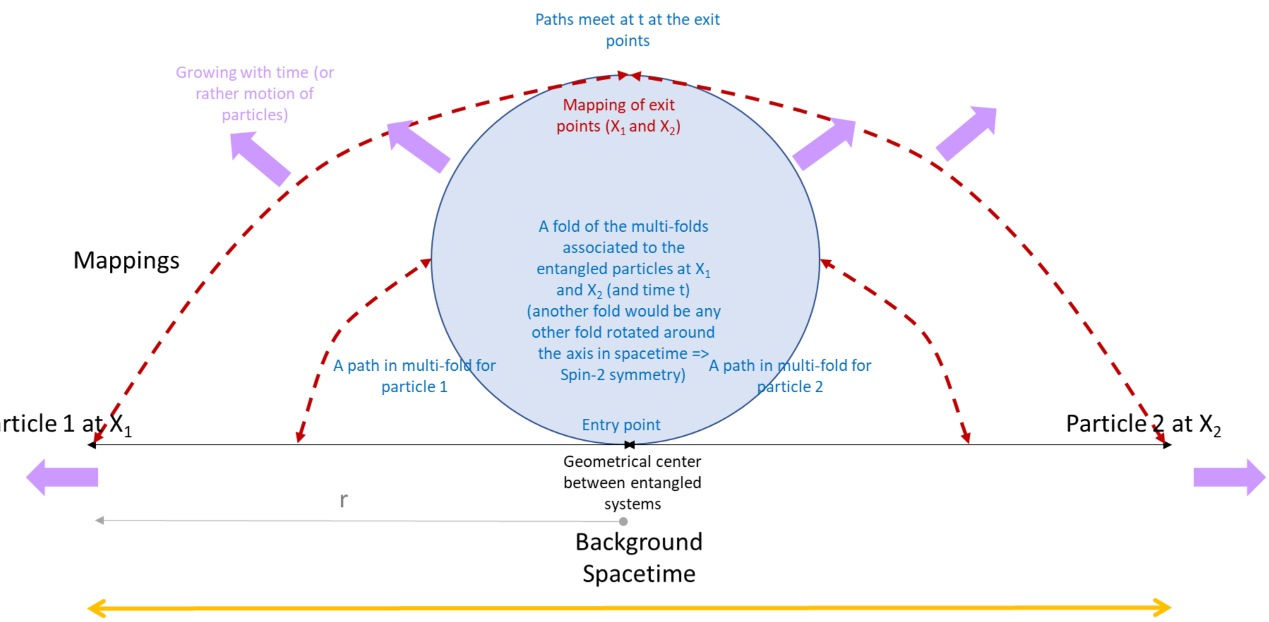

Figure 6 illustrates, in a simplified manner, the multi-folds, multi-fold mechanisms, their kinematics/dynamics and mappings for two entangled particles moving in opposite directions. From ([23])

Note added on November 3, 2023: Note that based on [125], the support domain defined in [1,126], is actually the historical path of the entangled particles, when the evolution is not in a line. [1,101] also describe the dynamic effects of multi-folds.

Justification of the multi-fold mechanisms and mappings as well as properties like tenancy, hierarchic entanglement and mappings have been presented in [1, 22,23,33,34,37,75,*96,106,109,119*].

Among the multi-fold SM_G discoveries, the apparition of an always-in-flight, and hence non-interacting, right-handed neutrinos, coupled to the Higgs boson is quite notable. It is supposedly always around right-handed neutrinos, due to chirality flips by gravity of the massless Weyl fermions, induced by 7D space time matter induction and scattering models, and hidden behind the Higgs boson or field at the entry points and exit points of the multi-folds. Massless Higgs bosons modeled as minimal microscopic black holes mark concretized spacetime locations. They can condensate into Dirac Kerr-Newman soliton Qballs to produce massive and charged particles [1,4], thereby providing a microscopic explanation for a Higgs driven inflation, the electroweak symmetry breaking, the Higgs mechanism, the mass acquisition and the chirality of fermions and spacetime; all resulting from the multi-fold gravity electroweak symmetry breaking. Massless particle on the other hand result from patterns of the random walks. The multi-fold theory has also concrete implications on New Physics like supersymmetry, superstrings, M-theory and Loop Quantum Gravity (LQG) [1,8,15,22,23-27,28-32].

The multi-fold 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 than the addition of gravity to the Standard Model Lagrangian [1,4-16,19,21-92,*93-127,129*]. 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 concretized spacetime coordinates, and metrics between Reissner Nordström [2], and Kerr Newman [3] for massive, and possibly charged, particles – the latter being possibly extremal). Although possibly surprising, this recovers results consistent with others (see [4], and its references), while also being able to justify the initial assumptions of black holes from the models of gravity or entanglement in a multi-fold universe. The resulting gravity model recovers General Relativity at larger scale, as a 4D process, with massless gravity, but also with massive gravity components at very small scales, which make gravity non-negligible at these scales. Semi-classical models also turn out to work well till way smaller scales than usually expected.

Multi-folds are encountered in GR at Planck scales [5,6] and in Quantum Mechanics (QM) if different suitable quantum reference frames (QRFs) are to be equivalent relatively to entangled, coherent or correlated systems [7]. This shows that GR and QM are different facets of something that they cannot well model: multi-folds.

We have also shown the power of 2D random walks as key to understanding much of physics including QFT [1,15,16,28,60,61,73,*93,96,109,117,118,125*].

Considering results as in [5-7,28,34,59,74,81,*102,106,109*], and our answers to so many open issues with the SM and the ΛCDM can be qualitatively explained with the SM_G and multi-fold mechanisms, as discussed for example in [1,4-16,19,21-92,*93-127,129*], we can then argue that these conclusions can probably apply to our real universe, especially considering how the multi-fold mechanisms recover GR [1,6], and can be encountered in GR at Planck scales, with the spacetime reconstruction [1,*93*], and with the top-down-up-and-upper derivation of the multi-fold theory [6]. At the risk of repeating ourselves, as a result spacetime is, at very scales sales, discrete, generated by random (Levy) walks, and therefore (multi-fractal), non-commutative and yet Lorentz symmetric [1,6,28,38,61,81,*93,96,106,109*].

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