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How the ER = EPR, GR = QM and AdS/CFT correspondence conjectures, can be explained in multi-fold theory, along with the E/G conjecture. A call to the Physics Community!

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Abstract:

This paper is a call to the Physics community, to all those interested in ER = EPR, GR = QM and the AdS/CFT correspondence conjecture, you should consider how the multi-fold theory and the E/G conjecture explain and realize them in a multi-fold universe.

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 small 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 defined 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. These considerations hints at an even stronger relationship between gravity and the Standard Model.

This paper provides references to how AdS(5), the AdS/CFT correspondences, ER=EPR and GR=QM conjectures are encountered in a multi-fold universe and explained microscopically. It leads to the E/G conjecture, that gravity and entanglement explain one another even in our real universe. Outside multi-fold theories, the main additions that we provide and lead to the new interpretation, e.g. the E/G conjecture, come from i) multi-fold mechanisms that allow path integrals to include traversing of the multi-fold, something typically not considered with the wormholes models prevalent with these other conjecture because of transferability challenges in the real universe ii) a SM_G model where in-flight right-handed neutrinos suddenly allow for wormhole to be traversed and look like multi-fold even in our real universe.

1. Introduction

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. 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

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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 Nordstrom [2] and Kerr Newman [3] for massive and possibly charged particles – the latter being possibly extremal). 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, 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. Semi-classical models also turn out to work well till way smaller scales than usually expected.

In this paper, we make a call to the Physics community to pay attention at how like the AdS/CFT correspondence, the ER = EPR and the GR = QM conjectures are encountered and modeled in the multi-fold theory [1,9]: it should, if nothing else, inspire some progress with these conjectures.

The paper is intentionally short to maintain the focus on the call to the Physics community, instead of the details that can be found in the references.

2. Core multi-fold message

The results of [1] lead to the E/G conjecture: in a multi-fold universe, entanglement is gravity and gravity is entanglement. In other words, entanglement creates gravity effects and gravity results from entanglement effects. The conjecture is that this statement applies also to our real universe [8].

This result is really essential and the holy grail in our view of work like the AdS/CFT correspondence conjecture, the ER = EPR conjecture and the GR = QM conjecture. From a multi-fold point of view, all these works have so far blocked on challenges with the traversability of wormholes, something that multi-fold mechanisms avoid, while the multi-fold theory also seems to resolve wormhole traversability with the right role played in SM_G ² by in-flight right-handed neutrinos³. We suggest focusing on [1,5,6,8,10] for more details. The proposed references answer much of these issues in surprising ways.

Outside multi-fold theories, the main additions that we provide and lead to the new interpretation, e.g. the E/G conjecture, come from i) multi-fold mechanisms [1] that allow path integrals to include traversing of the multi-fold, something typically not considered with the wormholes models prevalent with these other conjecture because of transferability challenges in the real universe ii) a SM_G model where in-flight right-handed neutrinos suddenly allow for wormhole to be traversed and look like multi-fold even in our real universe [8].

More details on the multifold theory and latest developments can be tracked at [7,9].

3. Conclusions

This short paper calls the community of Physics to realize that the multi-fold theory has led to interesting, (mostly qualitative) developments that may help progress and complement or provide a new setting for conjectures like

² See [1,7,9] for a discussion of SM_G , the standard model with non-negligible gravity effects at the scale of SM.

³ We hope that the growing communities interested and believing in these conjectures can read and understand how our work validate, with twists these conjecture. The twist being the machinery of the multi-fold theory, in a multi-fold universe.

the AdS/CFT correspondence conjecture, the ER = EPR conjecture and the GR = QM conjecture. We recommend that this be investigated and encourage discussions, reviews and collaborations.

Of course we want to also emphasize that the multi-fold theory is also of interest to High Energy Particle Physics, with the SM_G, the standard model with gravity not negligible at its scale [1,7,9]; to quantum gravity, especially in the context of superstrings, supersymmetry, LQG and asymptotic safety and to cosmology with its model for multi-fold dark matter, dark energy and inflation effects [1] and the related papers tracked in [7,9].

As announced, the paper was intentionally kept short to maintain the focus on the call to the Physics community, instead of the details that can be found in the references.

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