

Latest Highlights and Results From Multi-Fold Models

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September 20, 2020

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 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 model remain valid till smaller scale than usually expected. Gravity can therefore be added to the Standard Model (SM). This can contribute to resolving several open issues with the Standard Model without new Physics other than gravity. These considerations hints at a even stronger relationship between gravity and the Standard Model.

This short paper highlights some key conclusions of the Journey so far (September 2020), especially in terms of New Physics.

1. As of September 20, 2020:

In a Multi-fold universe:

- 1) Gravity is non-negligible at the Standard Model scales. The resulting SM_G explains much of the Standard model behaviors, quantum properties (including amounts and masses of particles and fields) as well the standard cosmological model. See [2].
- 2) Spacetime is 4-D. *Note added on 3/13/21: See also [7,8].*
- 3) New Physics, GUTs and TOEs that require:
 - a) Significantly more particles or fields with respect to SM
 - b) More than 4D where gravity and particles exist

are unphysical and conflict with the SM (and SM_G) and therefore are invalidated by asymptotic safety of gravity and observations of SM.

- 4) (3) affect all GUTs, TOE, Supersymmetry, Superstrings, Modern supergravity and M-theory (and 12D evolutions), already called in question earlier [2], as well as most GUTs that escaped the analysis from [3,4].
- 5) Induction with unconstrained KK models may escape the issue as the embedded spacetime is empty (vacuum solutions)
- 6) AdS(5) aspects (e.g. ER=EPR, Holography, AdS/CFT correspondence, gravitons in AdS(5)) may survive, as only gravitons live in AdS(5). It is fortunate, as these results were also derived from multi-fold mechanisms. They are valid because they are recovered in multi-fold universe, and possibly with other holographic motivations. Consistency expectations had to keep these aspects valid. Yet, their formulations now depend on the underlying theory. We have covered, in [1,2] the variations of these frameworks with respect to multi-fold universes.
- 7) On the other hand, across [1,2], we used to say AdS(5) (+ additional dimensions) when trying to reconcile with say superstrings. we used to say AdS(5) (+ additional dimensions) when trying to reconcile with say superstrings. At this stage, we have determined that what happens in these additional dimensions are probably only mathematical curiosities.

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- 8) A 2D regime remain the only domain where these New Physics theories, if they also include a 2D regime, may still be physical as an approximation of random walk during spacetime reconstruction à la [1].
- 9) Many more Physics implications especially in terms of entanglement and quantum gravity (reconciliation of GR and Quantum Physics) exist [1], and the latest set of discoveries can be found at [2].

In our real universe, (assuming here that it may differ from multi-fold universes. If it is correctly modeled by multi-fold universe then obviously (1) thru (9) hold).

- (1) may or may not hold, although we believe we can make a case for it independently of multi-fold universes.
- (2) thru (8) hold even in the absence of multi-fold behavior. (3) is obviously the highlight!
- So let us state it explicitly: In the real universe, New Physics like supersymmetry and superstrings, GUTs and TOEs that require:
 - Significantly more particles or fields with respect to SM
 - More than 4-D where gravity and particles exist

seem unphysical and conflict with the SM (and SM_G), and therefore are invalidated by asymptotic safety of gravity, along with observations of the SM.

Oh, and yes, quantum gravity is asymptotically safe in multi-fold universe and in the real universe (which is a 4D spacetime). *Note on March 13, 2021: See [7-9].*

Derivation of most of the above statements come from [5].

2. Caveats and Conclusions

These conclusions do not invalidate the mathematical framework of strings and superstrings and the dualities that it established nor, of course, the suitability of strings as dual resonant model for the string interaction [6].

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