New Physics with LHCb to explain loss of lepton universality, or just gravity?

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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 (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 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. These considerations hints at a even stronger relationship between gravity and the Standard Model.

Recently, there has been a flurry of enthusiasm following announcement of 3.1-sigma violation of lepton universality at LHCb. Many articles, papers and pundits see it as hints of New Physics.

In this paper we hypothesize that gravity could explain these observation, instead of New Physics understood as new particles or forces. The proposal can be strongly justified in a multi-fold universe with SM_G. It could also make sense, in general, whenever SM_G can be motivated.

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1. Introduction

The multi-fold paper [7] 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 [10], spacetime and Physics are modeled from Planck scales to quantum and macroscopic scales and semi classical approaches appear valid till very small scales. In [7], 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 [60] and Kerr Newman [17] for massive and possibly charged particles – the latter being possibly extremal). Although surprising, [10] recovers results consistent with others (see [32] 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

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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 reviews the hints of New Physics. It therefore provides a simple argument based on gravity in the context of SM_G, to explain the reported observations. Then based on the work on particles as microscopic black holes regularized by Higgs boson condensates, we provide a string argument that could extend to other past hints of violation of lepton universality.

2. Hints of New Physics at LHCb?

There have been a report of 3.1 standard deviations, i.e. still below the 5-sigma threshold for confirmation, of violations of lepton universality in B meson decays [1,2,3]. According to the Standard Model (SM) and lepton universality for the weak interaction (lepton coupling constant to gauge bosons does not depend on the flavor of the leptons) [6]. Yet, B mesons should decay to a kaon and two muons at the same rate at which they decay to a kaon and two electrons. Yet LHCb is seeing a difference in this rare beauty decay: B mesons seem to decay to muons 15 percent less often than they do to electrons.

It immediately resulted into a flurry of articles and papers announcing hints of new Physics, new particles and a fifth force (see [4] and for examples the papers it mentions); potentially a sign of the desperation of many in High energy particle Physics and Theoretical Physics; although supersymmetry may not immediately explain such results either; at least for other violations like in [5].

This result announcement come on top of other universality violation results like in [5,6] and its reference [15,16] (also not yet at the 5-sigma threshold) where for examples tau excesses would have similarly be observed. Note however that this paper will not discuss the tau excess and probably should wait the new LHCb and Belle experiments current in plan [1]. The experimentations were different as they studied interactions where lepton and anti-neutrino of the corresponding flavor were produced and neutrino related considerations may have to added. So we should not worry for now that these involved excess of the heaviest lepton (tau) versus the lightest (muons) instead of excess of electrons (lightest versus muons in [1].

3. SM_G to the rescue – An hypothesis

We suggest that SM_G, i.e. the SM with gravity non-negligible at the SM scales [7-9], something encountered in a multi-fold universe, could provide an explanation without requiring New Physics (understood in terms of adding new particles like leptoquark as in [1] and in the papers mentioned in [4] (or neutral vector bosons (Z') or even extra Higgs boson), or forces). If we wanted to solely limit ourselves to SM_G, within a multi-fold universe or not, more thoughts are required to justify the deficit of muons besides stating the following: because of the mutual attraction between the entangled lepton and anti-lepton (due to entanglement if in a multi-fold universe [7,10] but with universal effect between the flavors, and due to gravity, in all cases – multi-fold or not), the propensity to have the W^+ decay is reduced between the more massive pairs, even if only slightly. This could be enough to explain the muon deficit observed in [1].

4. Multi-fold and SMG to the rescue – a more detailed hypothesis

If we throw in multi-fold mechanisms, then the modeling of particles as microscopic black holes regularized as Qballs of condensed Higgs bosons [7,13,14], suggest that the same model (Qballs) applies to leptons as to quarks.

Therefore, just as for QCD, where a proton can be art of its time a superposition of a neutron and a pion (see [11,12] and references within), the same could happen between the Qballs (of the different leptons and anti-leptons, i.e. all possible product of W^+ decays) forming, all the time time, within the see of Higgs in the Qball of the W^+, before the decay finally takes place: when there is a stronger attraction between them, there is less energy benefits for them to form (they recombine more often something that is also systematic as we are talking of lepton and its anti-lepton). Even if very small, this effect should result into less decays into muon and anti-muon pairs that electron and positron pairs.

By the way, and without the same analysis, with respect to the other experimental results mentioned above [15,16], the leptons in the decay products are not particles and anti-particles. It is reasonable to expect that it reduces the suppression effects towards the heaviest leptons while still ensuring non universality of leptons beyond the weak interaction. Favorable energy balance may now favor the heaviest decay outcome.

To that effect it is also important to understand that string interaction also have effects that render all the result hard to fully interpret. In [1], it is argue that they are well understood as equivalently playing a minimal role. We argue that the argument does not apply for gravity if we subscribed to SMG, even more in a multi-fold universe.

We also argue that such effects exist in all weak interactions. They just typically are hidden by string interaction and other effects. Experiments as in [1] and [5,6] are situation where, as argued in [1], the other interactions dominate and hides (for now, for the limit of what we can measure) these effects.

Let us conclude by also adding that following [14], we know the significant impact of the Higgs field and bosons, and of gravity on the weak interaction.

The proposal here is just that: a proposal or hypothesis based on how we have seen SM_G and Multi-fold mechanism helping with SM challenges. More modeling and experiments are needed, first of all the determine if there was even an issue to start with. As discussed even just having SMG valid may suffice to motivate our proposal.

5. Conclusions

We have proposed how SM_G in general or, better yet, SM_G in a multi-fold universe could explain the observed apparent violations of lepton universality without requiring New Physics, understood as without requiring new particles or new forces.

The hypothesis is especially string when it can rely on the multi-fold model if particles as regularized black holes as Qballs or solitons made of Higgs condensates. The idea relies on copying the sea of quarks and gluons of QCD to explain why leptons pairs of different masses may behave differently despite having a universal interaction with gauge / weak bosons.

Because of the relatively limited access to data and limited quantitative model still in the multi-fold theory, this proposal is really to be understood as just a proposal to bring forward the possibility and encourage discussions.

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References:

[1]: LHCb collaboration, (2021), "Test of lepton universality in beauty-quark decays", arXiv:2103.11769v1 (https://arxiv.org/pdf/2103.11769.pdf).

[2]: CERN, (2021), "Intriguing new result from the LHCb experiment at CERN. The LHCb results strengthen hints of a violation of lepton flavour universality", https://home.cern/news/news/physics/intriguing-new-result-lhcb-experiment-cern. Retrieved on March 23, 2021.

[3]: Daniel Garisto, (2021), "Unexplained Results Intrigue Physicists at World's Largest Particle Collider Muons and electrons might not experience the same fundamental interactions, contrary to Standard Model predictions", March 25, 2021. https://www.scientificamerican.com/article/unexplained-results-intrigue-physicists-at-worlds-largest-particle-collider/. Retrieved on March 29, 2021.

[4]: Stephane H. Maes, (2021),), "Comments on hints of new Physics", https://shmaesphysics.wordpress.com/2020/06/14/dualities-or-analogies-between-superstrings-and-multi-fold-universes/#comment-1794 and following comments.

[5]: Clara Moskowitz (2015), "2 Accelerators Find Particles That May Break Known Laws of Physics. The LHC and the Belle experiment have found particle decay patterns that violate the Standard Model of particle physics, confirming earlier observations at the BaBar facility", September 9, 2015. https://www.scientificamerican.com/article/2-accelerators-find-particles-that-may-break-known-laws-of-physics1/. Retrieved on March 29, 2021.

[6]: Wikipedia, "Lepton", September 9, 2015. https://en.wikipedia.org/wiki/Lepton. Retrieved on March 29, 2021.

[7]: Stephane H. Maes, (2020) "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe", viXra:2006.0088v1, (June 9, 2020). (See also https://shmaesphysics.wordpress.com/2021/03/01/quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe/).

[8]: Stephane Maes, (2020), "Web Site Tracking all Publications around the Multi-fold universe", Navigation page listing all papers. https://shmaesphysics.wordpress.com/shmaes-physics-site-navigation/.

[9]: Stephane Maes, (2021), "Current Review – All Publications around the Multi-fold universe – February 2021", https://osf.io/8b69k, https://shmaesphysics.wordpress.com/shmaes-physics-site-navigation/, February 15, 2021. (More recent updates available at the URL).

[10]: Stephane H. Maes, (2020) "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe", viXra:2006.0088v1, (June 9, 2020). (See also https://shmaesphysics.wordpress.com/2021/03/01/quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe/).

[11]: Natalie Wolchover, (2021), "Decades-Long Quest Reveals Details of the Proton's Inner Antimatter", https://www.quantamagazine.org/protons-antimatter-revealed-by-decades-old-experiment-20210224/. Retrieved on February 24, 2021.

[12]: Ethan Siegle, (2021), "What Rules The Proton: Quarks Or Gluons?", https://www.forbes.com/sites/startswithabang/2021/03/18/what-rules-the-proton-quarks-or-gluons/?sh=5f0743ab6353. Retrieved on March 18, 2021.

[13]: Stephane H Maes, (2021), "More on Multi-fold Particles as Microscopic Black Holes with Higgs Regularizing Extremality and Singularities", https://shmaesphysics.wordpress.com/2021/02/28/more-on-multi-fold-particles-as-microscopic-black-holes-with-higgs-regularizing-extremality-and-singularities/, February 25, 2021.

[14]: Stephane H Maes, (2020), "Multi-fold Gravity-Electroweak Theory and Symmetry Breaking", https://shmaesphysics.wordpress.com/2021/03/28/multi-fold-gravity-electroweak-theory-and-symmetry-breaking/, March 16, 2021.

[15]: LHCb collaboration, (2015), "Measurement of the ratio of branching fractions $B(B^{-----}0\to D*+\tau-\nu^{---}\tau)/B(B^{-----}0\to D*+\mu-\nu^{---}\mu)$", arXiv:1506.08614v2.

[16]: Belle Collaboration, (2015), "Measurement of the branching ratio of $B^- \to D(*)\tau^- \nu^-\tau$ relative to $B^- \to D(*)\ell^- \nu^-\ell$ decays with hadronic tagging at Belle", arXiv:1507.03233v3.

[17]: Wikipedia, "Kerr–Newman metric", https://en.wikipedia.org/wiki/Kerr-Newman_metric. Retrieved for this paper on March 21, 2020.