

# Multi-fold gravity and double copy of gauge theory

Stephane H. Maes<sup>1</sup> 

May 4, 2021

## 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 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 resulting into what we define as the  $SM_G$ , the Standard Model (SM) with gravity non-negligible at its scales. This can contribute to resolving several open issues with the SM, and the Standard Cosmological Model, without new Physics other than gravity.*

*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 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 location. They can condensate into Dirac Kerr-Newman soliton Qballs to produce massive and charged particles, 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.*

*Over the last 20 years, a set of papers have introduced studies that indicate that gravity appears to be the dual of a suitable squared gauge theory: the double copy duality. This property appears through multiple order of perturbations, and multiple loop, and it is conjectured to extend through any order.*

*In this short note, we explain how such a results is actually directly, and globally, i.e. not only perturbatively, or, in other words, to any order, explained by the multi-fold mechanisms behind gravity and entanglement along with the underlying spin-2 symmetry. It physically, and microscopically explains both the double copy duality, and its validity to any order. The results holds for massless gravity and for massive multi-fold gravity.*

---

## 1. Introduction

---

<sup>1</sup> [shmaes.physics@gmail.com](mailto:shmaes.physics@gmail.com)

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 [1,30]. Entanglement of massive virtual particles leads to massive gravity contributions at very small scales without the usual problems of massive gravity (See references in [1,30]). Multi-folds mechanisms also result in a spacetime that is discrete, with a random walk fractal structure, and non-commutative geometry, which 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 [1,64]. Gravity can therefore be added to the Standard Model resulting into what we define as  $SM_G$ , i.e., 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, i.e. no new particles or forces, and Standard cosmological model [1,4,5,12-98]. These considerations hints at a even stronger relationship between gravity and the Standard Model. *Note added on March 15, 2003: In this paper, references in italic were added on March 15, 2003.*

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 [1,38,44]. It is supposedly always around right-handed neutrinos, due to chirality flips by gravity of the massless Weyl fermions [1,70], induced by 7D space time matter and scattering models [1,5,31,32,43,45,71,75,87] 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 location. They can condensate into Dirac Kerr-Newman soliton Qballs to produce massive and charged particles, 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 [31]. At energies above the electroweak symmetry breaking, massless particles are similar solitons induced by massless Higgs random walks [75-77].

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 Reisner 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 [1,64], but also with massive gravity components at very small scale that make gravity non-negligible at these scales[1,30,32,70]. Semi-classical models also turn out to work well till way smaller scales that usually expected. [5] may also justify different coupling values at very small scales, in the 2D massless random walk regime [1,14,26,75,76].

The multi-fold theory is best described with follow-up work tracked at [1,20,66,67,79].

[6] introduced the concepts that gravity is a double copy of other forces and its impact. (*Note added on March 15, 2023: [78] provides the non-perturbative version of it [99].*) The present paper compiles some of the most relevant papers, as entry points to the subjects, and results, then it shows how these results are to be expected in a multi-fold universe.

## 2. Copy double theory of gauge theory and gravity

An overview of the potential of this approach is discussed in [6,7].

The actual detailed papers are:

- The original paper where it is shown that (classical) tree-level gauge theory amplitudes can be rearranged to display a duality between color and kinematics: [8].
- The paper that understands this as a duality with gravity: Gravity diagrammatic numerators are the product of two corresponding gauge theory numerators (Feynman diagrams): [9].
- The Conjecture that such duality, and the notion of double copy, are perturbatively valid to all order (loops): [10].
- A general class of gauge theory solutions that double copy to gravity, namely those involving stationary Kerr-child metrics: [11]. These include the Schwarzschild and the Kerr-Newman black hole solutions. This paper explicitly details the double copy  $k_u k_v$  contributions.
- A non-perturbative formulation of the duality [99], that ensure that the relationship also exists non-perturbatively, as long that the non-perturbative theory can be understood as the / a well-defined limit of the perturbative approach, i.e., the limit of one of the series exist (then, the duality and [99] then ensuring existence of a well defined version of the other). This is indeed achieved because Yang Mills is renormalizable, in 2 to 4D spacetime. *Note added March 15, 2023: See references in [76,78,84], for a discussion that Yang Mills is well behaved from 2D till (5+ $\epsilon$ )D.*

### 3. The copy double duality in Multi-fold theory

The multi-fold theory can explain this! Indeed, in multi-fold theory, a graviton, and we know that graviton is non-perturbatively unphysical in multi-fold theory, but it can be associated a perturbative quasi particle on one hand [1,12,24,27,29,100], and to multi-folds (creating a 7D embedding space and living in AdS(5), or to closed superstrings living in AdS(5) ++ (where ++ denotes additional dimensions where superstrings live)[1,24,27,29,71], is attached to an entangled pair [1].

Now, if we want to model all possible interactions of these gravitons with other particles, including other gravitons, in a multi-fold, it amounts to including interactions with one, or the other entangled particles involved in providing the effective potential [1]. This is justifiable for a infinitesimally small  $\epsilon$  neighborhood, as envisaged by perturbative QFT and Feynman diagrams.

To match such a behavior, à la Feynman diagram, one needs therefore two (gauge) particles corresponding to the degrees of freedom to interact with each entangled particles in the pair. Therefore, indeed, we predict that diagrams (perturbatively) associated to graviton (even if quasi particle only valid to a (low) perturbative order) result from the product of all the diagrams, associated to two, not one, gauge particles. As a result indeed, we also see that gravity / entanglement multi-fold interactions are the square of gauge interactions [9]. *Note added on March 15, 2023: more details are provided in [84].*

A key consequence is also that, in general, entanglement is, a double copy dual (or square) of the suitable gauge theory. This is not just true for gravity. *Note added on March 15, 2023: New dualities result from it as discussed in [97], while [64] exploits the reasoning of the last bullet of section 2, and models of [97], to confirm that GR based gravity is asymptotically safe. This result has long lasting impact on the physicality of superstrings, M-theory, and most popular GUTs and TOEs [1,23-27,29,60,76].*

Interestingly, the particular solutions for suitable gauge theories are Schwarzschild and Kerr-Newman solutions [11]. This is in direct alignment with our results in [1,4]: we recovered microscopic black holes as implementation of massless and massive bosons and fermions in the multi-fold theory, they themselves are implemented as

patterns (massless at energies above the multi-fold gravity electroweak symmetry breaking, and condensates of massless Higgs bosons at energies below the multi-fold gravity electroweak symmetry breaking) [31,75-77].

As, in multi-fold universes, gravitons do not exactly exist in spacetime [1,12,24,27,29,100], one could argue if multi-folds are one (like a closed string), or a pair of entangled gravitons (one at each extremity/entangled particle and exit points of the multi-folds). It makes no difference: the diagrams involves two particles instead of one in both points of views. Indeed, when evaluating gravity at one spacetime location, i.e., the effective potential effects as in [1], at a distance  $r$  from the source (mass or energy), we are perturbatively involving just one (perturbative) graviton, determined by the sets of two entangled (virtual) (e.g. Gauge) particles beyond  $r$ . The fact that many (pairs of entangled particles beyond  $r$ ) are to be considered is another reason why the graviton is not physical in the 4D (multi-fold) spacetime [1]. *Note added on March 15, 2023: [101] then discusses how to deal with dynamic cases, where the history of entangled virtual pairs is dynamic, and leads to effects like frame-dragging and Lens-Thirring effects.*

It seems that the multi-fold theory provides a global approach to (massless) gravity that explains this double copy result at all orders. There also are symmetries and physical interpretations behind: the multi-fold mechanisms and mappings, that are also behind AdS/CFT correspondence, and the spin-2 (a set of  $180^\circ$  symmetries from one entangled particle to the other) properties of the multi-folds [1]. *Note added on March 15, 2023: It is among the key symmetry involved in justifying the symmetry of the SM, or rather  $SM_G$ , as shown in [80,102].*

Of course, one could also argue that, from a degrees of freedom point of view, the spin-2 of the graviton could be seen as a sum of two spin-1 bosons, and that this would be the reason for the double copy duality, e.g. as 2 sets of independently polarized massless bosons, instead of what we just explained. In a multi-fold universe, we can invalidate such an argument. Indeed, this explanation does not hold for multi-fold massive gravity [1,30]. Massive gravity, as encountered in multi-fold universes, would require massive spin-1 gauge bosons. These can't match all the massive gravity ranges due to the different massive SM particles, and multi-folds then would have to be matched: the explanation just does not work, while the reasoning above based on multi-fold mechanisms holds.

Therefore, through our reasoning, we predict that a double copy also holds for the massive gravity components, that only matters at the very small scales of the SM.

Based on [1,63-65] and the already mentioned ability to offer qualitative answers to many open issues of the SM and the Standard Cosmological Model ( $\Lambda$ CDM) [96], it is quite plausible that our real universe be multi-folds [1,4,5,12-98].

## 4. Conclusions

The copy double duality of gravity and suitable gauge theory is explained by the multi-fold mechanisms. In multi-fold universes, the duality is also extended to entanglement, not just gravity; as expected considering the E/G conjecture [13], a factual duality in multi-fold universe.

The analysis presented in this paper offers a good physical and microscopic explanation to the double copy duality between massless gravity and gauge theory. It seems an additional argument that the multi-fold theory is relevant to the real universe. We also argue that it holds for massive multi-fold gravity.

---

## References

[1]: Stephane H. Maes, (2020-2022) "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe", HIJ, Vol 2, No 4, pp 136-219, Dec 2022, <https://doi.org/10.55672/hij2022pp136-219>, <https://shmaesphysics.wordpress.com/2020/06/09/paper-published-as-preprint-quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe/>, <https://shmaesphysics.wordpress.com/2022/11/09/quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe-2/>, and [arXiv:2006.0088](https://arxiv.org/abs/2006.0088), (June 9, 2020).

[2]: Wikipedia, "Reissner–Nordström metric", [https://en.wikipedia.org/wiki/Reissner-Nordstr%C3%B6m\\_metric](https://en.wikipedia.org/wiki/Reissner-Nordstr%C3%B6m_metric). Retrieved on March 21, 2020.

[3]: Wikipedia, "Kerr–Newman metric", [https://en.wikipedia.org/wiki/Kerr-Newman\\_metric](https://en.wikipedia.org/wiki/Kerr-Newman_metric). Retrieved on March 21, 2020.

[4]: Stephane H Maes, (2021), "More on Multi-fold Particles as Microscopic Black Holes with Higgs Regularizing Extremality and Singularities", [arXiv:2210.0004v1](https://arxiv.org/abs/2210.0004v1), <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.

[5]: Stephane H Maes, (2021), "Right-handed Neutrinos and Traversable Wormholes: the key to entanglement, gravity and multi-folds extensions to ER=EPR?", [arXiv:2211.0173v1](https://arxiv.org/abs/2211.0173v1), <https://shmaesphysics.wordpress.com/2021/04/03/right-handed-neutrinos-and-traversable-wormholes-the-key-to-entanglement-gravity-and-multi-folds-extensions-to-errepr/>, April 3, 2021.

[6]: Charlie Wood, (2021), "An enigmatic connection between the forces of nature is allowing physicists to explore gravity's quantum side", <https://www.quantamagazine.org/how-gravity-is-a-double-copy-of-other-forces-20210504/>. Retrieved on May 4, 2021.

[7]: Natalie Wolchover, (2014), "Betting on the Future of Quantum Gravity. New calculations suggest physicists may someday discover a fundamental theory of gravity, but it could require a radical new perspective on the universe", <https://www.quantamagazine.org/betting-on-the-future-of-quantum-gravity-20140314/>. Retrieved on May 4, 2021.

[8]: Z. Bern, J. J. M. Carrasco, H. Johansson, (2008), "New Relations for Gauge-Theory Amplitudes", [arXiv:0805.3993v2](https://arxiv.org/abs/0805.3993v2).

[9]: Zvi Bern, Tristan Dennen, Yu-tin Huang, Michael Kiermaier, (2010), "Gravity as the Square of Gauge Theory", [arXiv:1004.0693v1](https://arxiv.org/abs/1004.0693v1).

[10]: Zvi Bern, John Joseph M. Carrasco, Henrik Johansson, (2010), "Perturbative Quantum Gravity as a Double Copy of Gauge Theory", [arXiv:1004.0476v2](https://arxiv.org/abs/1004.0476v2).

[11]: Ricardo Monteiro, Donal O'Connell, Chris D. White, (2010), "Black holes and the double copy", [arXiv:1410.0239v2](https://arxiv.org/abs/1410.0239v2).

[12]: Stephane H Maes, (2020), "Multi-fold Gravitons In-N-Out Spacetime", [arXiv:2010.0155v1](https://arxiv.org/abs/2010.0155v1), <https://shmaesphysics.wordpress.com/2020/07/27/multi-fold-gravitons-in-n-out-spacetime/>, July 27, 2020, (posted September 6, 2020).

[13]: Stephane H Maes, (2020), "The E/G conjecture: entanglement is gravity and gravity is entanglement", [arXiv:2010.0139v1](https://arxiv.org/abs/2010.0139v1), <https://shmaesphysics.wordpress.com/2020/10/15/the-e-g-conjecture-entanglement-is-gravity-and-gravity-is-entanglement/>, October 15, 2020.

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

[15]: Stephane H Maes, (2020), "Explaining Dark Matter Without New Physics?", [viXra:2007.0006v1](https://arxiv.org/abs/2007.0006v1), <https://shmaesphysics.wordpress.com/2020/06/21/explaining-dark-matter-without-new-physics/>, June 21, 2020.

[16]: Stephane H Maes, (2020), "Multi-Fold Universe Dark Matter Successful Explanation and the "Too Thin Universe" but "Too Strong Gravity Lensing by Galaxy Clusters""", [viXra:2102.0079v1](https://arxiv.org/abs/2102.0079v1), <https://shmaesphysics.wordpress.com/2020/09/15/multi-fold-universe-dark-matter-successful-explanation-and-the-too-thin-universe-but-too-strong-gravity-lensing-by-galaxy-clusters/>, September 14, 2020.

[17]: Stephane H Maes, (2020), "Multi-Fold Universe Dark Matter Effects Survive Low-Mass Galaxies with Dark Matter Deficits and Excesses", [viXra:2105.0042v1](https://arxiv.org/abs/2105.0042v1), <https://shmaesphysics.wordpress.com/2020/10/14/multi-fold-universe-dark-matter-effects-survive-low-mass-galaxies-with-dark-matter-deficits-and-excesses/>, October 14, 2020.

[18]: Stephane H Maes, (2020), "Multi-Fold Dark Matter Effects and Early Supermassive Black Holes", [viXra:2105.0041v1](https://arxiv.org/abs/2105.0041v1), <https://shmaesphysics.wordpress.com/2020/10/15/multi-fold-dark-matter-effects-and-early-supermassive-black-holes/>, October 15, 2020.

[19]: Stephane H Maes, (2020), "Gravity-like Attractions and Fluctuations between Entangled Systems?", [viXra:2010.0010v1](https://arxiv.org/abs/2010.0010v1), <https://shmaesphysics.wordpress.com/2020/06/25/gravity-like-attractions-and-fluctuations-between-entangled-systems/>, June 24, 2020.

[20]: Stephane Maes, (2020-23), "Web Site Tracking all Publications around the Multi-fold universe", Navigation page listing all papers. <https://shmaesphysics.wordpress.com/shmaes-physics-site-navigation/>.

[21]: Stephane H Maes, (2020), "Multi-fold Higgs Fields and Bosons", [viXra:2204.0146v1](https://arxiv.org/abs/2204.0146v1), <https://shmaesphysics.wordpress.com/2020/11/10/multi-fold-higgs-fields-and-bosons/>, November 6, 2020.

[22]: Stephane H. Maes, (2020), "Comment on why no supersymmetry", <https://shmaesphysics.wordpress.com/2020/10/11/circular-arguments-in-string-and-superstring-theory-from-a-multi-fold-universe-perspective/#comment-934>. Published on October 12, 2020.

[23]: 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://arxiv.org/abs/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.

[24]: Stephane H Maes, (2020), "Circular Arguments in String and Superstring Theory from a Multi-fold Universe Perspective", [viXra:2103.0195v1](https://arxiv.org/abs/2103.0195v1), <https://shmaesphysics.wordpress.com/2020/10/11/circular-arguments-in-string-and-superstring-theory-from-a-multi-fold-universe-perspective/>, October 5, 2020.

[25]: Stephane H Maes, (2021), "The String Swampland and de Sitter Vacua: A Consistent Perspective for Superstrings and Multi-fold Universes", [viXra:2208.0078v1](https://arxiv.org/abs/2208.0078v1), <https://shmaesphysics.wordpress.com/2021/01/12/the-string-swampland-and-de-sitter-vacua-a-consistent-perspective-for-superstrings-and-multi-fold-universes/>, January 9, 2021.

[26]: Stephane H Maes, (2021), "Quantum Gravity Asymptotic Safety from 2D Universal Regime and Smooth Transition to Dual Superstrings", [viXra:2208.0151v1](https://arxiv.org/abs/2208.0151v1), <https://shmaesphysics.wordpress.com/2021/02/07/quantum-gravity-asymptotic-safety-from-2d-universal-regime-and-smooth-transition-to-dual-superstrings/>, January 29, 2021.

[27]: Stephane H Maes, (2020), "Dualities or Analogies between Superstrings and Multi-fold Universe", [viXra:2006.0178v1](https://arxiv.org/abs/2006.0178v1), <https://shmaesphysics.wordpress.com/2020/06/14/dualities-or-analogies-between-superstrings-and-multi-fold-universes/>, June 14, 2020.

[28]: Stephane H Maes, (2020), "Alignments and Gaps Between Multi-fold Universes And Loop Quantum Gravity", [viXra:2006.0229v1](https://shmaesphysics.wordpress.com/2020/06/19/multi-fold-universes-analysis-of-loop-quantum-gravity/), <https://shmaesphysics.wordpress.com/2020/06/19/multi-fold-universes-analysis-of-loop-quantum-gravity/>, June 18, 2020.

[29]: Stephane H Maes, (2020), "Superstrings Encounter of the Second, Third or Fourth Types?", [viXra:2010.0140v1](https://shmaesphysics.wordpress.com/2020/07/19/superstrings-encounter-of-the-second-third-or-fourth-types/), <https://shmaesphysics.wordpress.com/2020/07/19/superstrings-encounter-of-the-second-third-or-fourth-types/>, July 5, 2020.

[30]: Stephane H Maes, (2020), "Massless and Massive Multi-Gravity in a Multi-fold Universe", [viXra:2010.0095v1](https://shmaesphysics.wordpress.com/2020/06/30/massless-and-massive-multi-gravity-in-a-multi-fold-universe/), <https://shmaesphysics.wordpress.com/2020/06/30/massless-and-massive-multi-gravity-in-a-multi-fold-universe/>, June 19, 2020.

[31]: Stephane H Maes, (2021), "Multi-fold Gravity-Electroweak Theory and Symmetry Breaking", [viXra:2211.0100](https://shmaesphysics.wordpress.com/2021/03/28/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.

[32]: Stephane H Maes, (2021), "Multi-fold Non-Commutative Spacetime, Higgs and The Standard Model with Gravity", [viXra:2212.0037v1](https://shmaesphysics.wordpress.com/2021/04/18/multi-fold-non-commutative-spacetime-higgs-and-the-standard-model-with-gravity/), <https://shmaesphysics.wordpress.com/2021/04/18/multi-fold-non-commutative-spacetime-higgs-and-the-standard-model-with-gravity/>, April 11, 2021.

[33]: Stephane H Maes, (2020), "Derivation of the Equivalence Principle in a Multi-fold Universe", [viXra:2010.0090v1](https://shmaesphysics.wordpress.com/2020/06/29/derivation-of-the-equivalence-principle-in-a-multi-fold-universe/), <https://shmaesphysics.wordpress.com/2020/06/29/derivation-of-the-equivalence-principle-in-a-multi-fold-universe/>, June 19, 2020.

[34]: Stephane H Maes, (2020), "Progress on Proving the Mass gap for Yang Mills and Gravity (maybe it's already proved...)", [viXra:2006.0155v1](https://shmaesphysics.wordpress.com/2020/06/12/progresses-on-proving-the-mass-gap-for-yang-mills-and-gravity-maybe-its-already-proven/), <https://shmaesphysics.wordpress.com/2020/06/12/progresses-on-proving-the-mass-gap-for-yang-mills-and-gravity-maybe-its-already-proven/>, June 12, 2020.

[35]: Stephane H Maes, (2020), "Gravity Induced Anomalies Smearing in Standard Model so that Protons May Never Decay, Except in Black holes", [viXra:2006.0128v1](https://shmaesphysics.wordpress.com/2020/06/13/gravity-induced-anomalies-smearing-in-standard-model-so-that-protons-may-never-decay-except-in-black-holes/), <https://shmaesphysics.wordpress.com/2020/06/13/gravity-induced-anomalies-smearing-in-standard-model-so-that-protons-may-never-decay-except-in-black-holes/>, June 13, 2020.

[36]: Stephane H Maes, (2022), "Gravity or Magnetic Monopoles? You Cannot Have Both! II", [viXra:2006.0190v2](https://shmaesphysics.wordpress.com/2022/08/20/gravity-or-magnetic-monopoles-you-cannot-have-both-2/), <https://shmaesphysics.wordpress.com/2022/08/20/gravity-or-magnetic-monopoles-you-cannot-have-both-2/>, August 20, 2022; Stephane H Maes, (2020), "Gravity or Magnetic Monopoles? You Cannot Have Both!", [viXra:2006.0190](https://shmaesphysics.wordpress.com/2020/06/15/gravity-or-magnetic-monopoles-you-cannot-have-both/), <https://shmaesphysics.wordpress.com/2020/06/15/gravity-or-magnetic-monopoles-you-cannot-have-both/>, June 15, 2020.

[37]: 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/), <https://shmaesphysics.wordpress.com/2020/06/16/ultimate-unification-gravity-led-democracy-vs-uber-symmetries/>, June 16, 2020.

[38]: Stephane H Maes, (2020), "Right-handed neutrinos? Mass? Ask Gravity", [viXra:2007.0018v1](https://shmaesphysics.wordpress.com/2020/06/21/right-handed-neutrinos-ask-gravity/), <https://shmaesphysics.wordpress.com/2020/06/21/right-handed-neutrinos-ask-gravity/>, June 23, 2020.

[39]: Stephane H Maes, (2020), "Strong CP Violation Tamed in The Presence of Gravity", [viXra:2007.0025v1](https://shmaesphysics.wordpress.com/2020/06/23/strong-cp-violation-tamed-in-the-presence-of-gravity/), <https://shmaesphysics.wordpress.com/2020/06/23/strong-cp-violation-tamed-in-the-presence-of-gravity/>, June 21, 2020.

[40]: Stephane H Maes, (2020), "Gravity Dictates the Number of Fermion Generations: 3", [viXra:2007.0068v1](https://shmaesphysics.wordpress.com/2020/06/24/gravity-dictates-the-number-of-fermion-generations-3/), <https://shmaesphysics.wordpress.com/2020/06/24/gravity-dictates-the-number-of-fermion-generations-3/>, June 24, 2020.

[41]: Stephane H Maes, (2020), “Gravity Stabilizes Electroweak Vacuum – No Bubble of Nothing to Worry About!”, [viXra:2007.0173v1](https://shmaesphysics.wordpress.com/2020/06/24/gravity-stabilizes-electroweak-vacuum-no-bubble-of-nothing-to-worry-about/), <https://shmaesphysics.wordpress.com/2020/06/24/gravity-stabilizes-electroweak-vacuum-no-bubble-of-nothing-to-worry-about/>, June 24, 2020.

[42]: Stephane H Maes, (2020), “More Matter Than Antimatter, All Falling Down”, [viXra:2010.0121v2](https://shmaesphysics.wordpress.com/2020/07/05/more-matter-than-antimatter-all-falling-down/), <https://shmaesphysics.wordpress.com/2020/07/05/more-matter-than-antimatter-all-falling-down/>, July 5, 2020. (V2: April 8, 2021)

[43]: 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/), <https://shmaesphysics.wordpress.com/2020/08/30/tracking-down-the-standard-model-with-gravity-in-multi-fold-universes/>, August 20, 2020.

[44]: Stephane H Maes, (2020), “No Conventional Sterile Neutrinos In a Multi-fold Universe: just SMG business as usual”, [viXra:2103.0202v1](https://shmaesphysics.wordpress.com/2020/10/02/no-conventional-sterile-neutrinos-in-a-multi-fold-universe-just-smg-business-as-usual/), <https://shmaesphysics.wordpress.com/2020/10/02/no-conventional-sterile-neutrinos-in-a-multi-fold-universe-just-smg-business-as-usual/>, October 1, 2020.

[45]: Stephane H. Maes, (2020), “Particles of The Standard Model In Multi-Fold Universes”, [viXra:2111.0071v1](https://shmaesphysics.wordpress.com/2020/11/05/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.

[46]: Stephane H Maes, (2020), “Viable Lattice Spacetime and Absence of Quantum Gravitational Anomalies in a Multi-fold Universe”, [viXra:2205.0143v1](https://shmaesphysics.wordpress.com/2020/12/13/viable-lattice-spacetime-and-absence-of-quantum-gravitational-anomalies-in-a-multi-fold-universe/), <https://shmaesphysics.wordpress.com/2020/12/13/viable-lattice-spacetime-and-absence-of-quantum-gravitational-anomalies-in-a-multi-fold-universe/>, December 4, 2020.

[47]: Stephane H Maes, (2021), “New Physics with LHCb to explain loss of lepton universality, or just gravity?”, [viXra:2103.0191v1](https://shmaesphysics.wordpress.com/2021/03/29/new-physics-with-lhcb-to-explain-loss-of-lepton-universality-or-just-gravity/), <https://shmaesphysics.wordpress.com/2021/03/29/new-physics-with-lhcb-to-explain-loss-of-lepton-universality-or-just-gravity/>, March 29, 2021.

[48]: Stephane H. Maes, “A bold prediction on the muon anomalous magnetic moment, and expected results to be published on April 7, 2021 by the Fermilab Muon g-2, and its explanation”, [viXra:2104.0030v1](https://shmaesphysics.wordpress.com/2021/04/01/a-bold-prediction-on-the-muon-anomalous-magnetic-moment-and-expected-resulted-to-be-published-on-april-7-2021-by-the-fermilab-muon-g-2-and-its-explanation/), <https://shmaesphysics.wordpress.com/2021/04/01/a-bold-prediction-on-the-muon-anomalous-magnetic-moment-and-expected-resulted-to-be-published-on-april-7-2021-by-the-fermilab-muon-g-2-and-its-explanation/>, April 1, 2021.

[49]: Stephane H Maes, (2021), “New Physics is often not so new”, <https://shmaesphysics.wordpress.com/2021/04/27/new-physics-is-often-not-so-new/>, April 27, 2021.

[50]: Stephane H Maes, (2020), “Multi-Fold Black Holes: Entropy, Evolution and Quantum Extrema”, [viXra:2105.0136v1](https://shmaesphysics.wordpress.com/2020/11/01/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.

[51]: 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/), <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.

[52]: Stephane H Maes, (2020), “Implicit Multi-Fold Mechanisms in a Neural Network Model of the Universe”, [viXra:2012.0191v1](https://shmaesphysics.wordpress.com/2020/09/12/implicit-multi-fold-mechanisms-in-a-neural-network-model-of-the-universe/), <https://shmaesphysics.wordpress.com/2020/09/12/implicit-multi-fold-mechanisms-in-a-neural-network-model-of-the-universe/>, September 12, 2020.

[53]: Stephane H Maes, (2020), “Interpretation of “Neural Network as the World””, [viXra:2012.0197v1](https://shmaesphysics.wordpress.com/2020/09/14/interpretation-of-neural-network-as-the-world/), <https://shmaesphysics.wordpress.com/2020/09/14/interpretation-of-neural-network-as-the-world/>, September 14, 2020.

[54]: Stephane H Maes, (2020), “Entangled Neural Networks from Multi-fold Universes to Biology”, [viXra:2207.0174v1](https://shmaesphysics.wordpress.com/2020/12/31/entangled-neural-networks-from-multi-fold-universes-to-biology/), <https://shmaesphysics.wordpress.com/2020/12/31/entangled-neural-networks-from-multi-fold-universes-to-biology/>, December 25, 2020.

[55]: Stephane H Maes, (2020), “Area Laws Between Multi-Fold Universes and AdS”, [viXra:2010.0207v1](https://shmaesphysics.wordpress.com/2020/08/10/area-laws-between-multi-fold-universes-and-ads/), <https://shmaesphysics.wordpress.com/2020/08/10/area-laws-between-multi-fold-universes-and-ads/>, August 10, 2020.

[56]: Stephane H Maes, (2020), “Different approaches to compute Hawking Black Holes Decay”, [viXra:2208.0009v1](https://shmaesphysics.wordpress.com/different-approaches-to-compute-hawking-black-holes-decay/), <https://shmaesphysics.wordpress.com/different-approaches-to-compute-hawking-black-holes-decay/>, August 1, 2022. (Originally published July 11, 2020).

[57]: Stephane H Maes, (2020), “Comments to “Yes, Stephen Hawking Lied To Us All About How Black Holes Decay””, <https://osf.io/v7thb/>, <https://shmaesphysics.wordpress.com/2020/07/11/comments-to-yes-stephen-hawking-lied-to-us-all-about-how-black-holes-decay/>, July 11, 2020.

[58]: Stephane H Maes, (2021), “Multi-fold gravity and double copy of gauge theory”, <https://shmaesphysics.wordpress.com/2021/05/04/multi-fold-gravity-and-double-copy-of-gauge-theory/>, May 4, 2021.

[59]: Stephane H Maes, (2020), “A Multi-fold Universe Genesis Inspired By Explosive Total Collision: The Source Of The Big Bang?”, [viXra:2208.0082v1](https://shmaesphysics.wordpress.com/2021/01/17/a-multi-fold-universe-genesis-inspired-by-total-explosion-collision-the-source-of-the-big-bang/), <https://shmaesphysics.wordpress.com/2021/01/17/a-multi-fold-universe-genesis-inspired-by-total-explosion-collision-the-source-of-the-big-bang/>, January 12, 2021.

[60]: Stephane H. Maes, (2021-2022), “Our universe is 4D”, Comments and following comments at <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/#comment-1416>. January 16, 2021 and after.

[61]: 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/), <https://shmaesphysics.wordpress.com/2020/06/28/entanglement-concretizes-time-in-a-multi-fold-universe/>, June 28, 2020. Also published as: Stephane H Maes, (2020), “Entanglement and Random Walks Concretize Time in a Multi-fold Universe”, [viXra:2010.0083v1](https://shmaesphysics.wordpress.com/2020/06/28/entanglement-concretizes-time-in-a-multi-fold-universe/), <https://shmaesphysics.wordpress.com/2020/06/28/entanglement-concretizes-time-in-a-multi-fold-universe/>, June 28, 2020.

[62]: Stephane H Maes, (2020), “No Gravity Shield in Multi-folds Universes”, [viXra:2010.0032v1](https://shmaesphysics.wordpress.com/2020/06/26/no-gravity-shields-in-multi-folds-universes/), <https://shmaesphysics.wordpress.com/2020/06/26/no-gravity-shields-in-multi-folds-universes/>, June 26, 2020.

## References added on March 15, 2023

[63]: Stephane H Maes, (2020), “Multi-folds, The Fruit From The Loops? Fixing “Oops for The Loops” May Encounter Multi-folds in General Relativity And The E/G Conjecture”, [viXra:2212.0206v1](https://shmaesphysics.wordpress.com/2021/12/31/multi-folds-the-fruit-from-the-loops-fixing-oops-for-loops-encounters-multi-folds-and-the-e-g-conjecture-in-general-relativity/), <https://shmaesphysics.wordpress.com/2021/12/31/multi-folds-the-fruit-from-the-loops-fixing-oops-for-loops-encounters-multi-folds-and-the-e-g-conjecture-in-general-relativity/>, January 1, 2022.

[64]: Stephane H Maes, (2022), “Deriving the Multi-fold Theory from General Relativity at Planck scale”, [viXra:2302.0129v1](https://shmaesphysics.wordpress.com/2022/02/22/deriving-the-multi-fold-theory-from-general-relativity-at-planck-scale/), <https://shmaesphysics.wordpress.com/2022/02/22/deriving-the-multi-fold-theory-from-general-relativity-at-planck-scale/>, February 22, 2022.

[65]: Stephane H Maes, (2022), “From Quantum Relational Equivalence to Multi-folds Encounter in the Real Universe and Confirmation of the E/G conjecture”, [viXra:2302.0108v1](https://shmaesphysics.wordpress.com/2022/02/12/from-quantum-relational-equivalence-to-multi-folds-encounter-in-the-real-universe-and-confirmation-of-the-e-g-conjecture/), <https://shmaesphysics.wordpress.com/2022/02/12/from-quantum-relational-equivalence-to-multi-folds-encounter-in-the-real-universe-and-confirmation-of-the-e-g-conjecture/>, February 7, 2022.

[66]: Stephane H Maes, (2021), “The Multi-fold Theory: A synopsis”, [viXra:2112.0144v1](https://shmaesphysics.wordpress.com/2021/12/24/the-multi-fold-theory-a-synopsis-so-far-v2-end-of-2021/), <https://shmaesphysics.wordpress.com/2021/12/24/the-multi-fold-theory-a-synopsis-so-far-v2-end-of-2021/>, December 24, 2021. Note that additional links will always be available

at <https://shmaesphysics.wordpress.com/2021/05/03/the-multi-fold-theory-a-synopsis-so-far/> to track the latest and interim versions of the synopsis, as they may be published under different title or URL/publication numbers.

[67]: Stephane H Maes, (2022), “Understanding the Multi-fold theory principles and the SM\_G”, [osf.io/xc74t](https://osf.io/xc74t/), [https://shmaesphysics.wordpress.com/2022/03/11/understanding-the-multi-fold-theory-principles-and-the-sm\\_g/](https://shmaesphysics.wordpress.com/2022/03/11/understanding-the-multi-fold-theory-principles-and-the-sm_g/), March 11, 2022.

[68]: Stephane H. Maes, (2022), “Comment on LQG, Superstrings, Supersymmetry and most GUTs/TOEs, all have big problems exposed by the Multi-fold Theory”, <https://shmaesphysics.wordpress.com/2021/12/27/the-multi-fold-theory-a-synopsis/#comment-3293>. Published on January 9, 2022.

[69]: Stephane H Maes, (2022), “Oops For The Loops II: Real Oops; LQG Does Not Optimize the Hilbert Einstein Action”, [arXiv:2301.0036v1](https://arxiv.org/abs/2301.0036v1), <https://shmaesphysics.wordpress.com/2022/01/05/oops-for-the-loops-ii-real-oops-lqg-does-not-optimize-the-hilbert-einstein-action/>, January 5, 2022.

[70]: Stephane H Maes, (2022), “Can Chirality Flips Occur in a Multi-Fold Universe? What About Conservation Laws? II”, [arXiv:2204.0152v2](https://arxiv.org/abs/2204.0152v2), <https://shmaesphysics.wordpress.com/2022/08/20/can-chirality-flips-occur-in-a-multi-fold-universe-what-about-conservation-laws-ii/>, August 20, 2022 & Stephane H Maes, (2020), “Can Chirality Flips Occur in a Multi-Fold Universe? What About Conservation Laws?”, [arXiv:2204.0152](https://arxiv.org/abs/2204.0152), <https://shmaesphysics.wordpress.com/2020/12/07/can-chirality-flips-occur-in-a-multi-fold-universe-what-about-conservation-laws/>, December 6, 2020.

[71]: Stephane H Maes, (2021), “Multi-fold Embeddings, Space Time Matter Induction or Gravity Asymptotically Safe and The AdS/CFT Correspondence Conjecture, they all can recover the Standard Model”, [arXiv:2212.0120v1](https://arxiv.org/abs/2212.0120v1), <https://shmaesphysics.wordpress.com/2021/12/20/multi-fold-embeddings-space-time-matter-induction-or-gravity-asymptotically-safe-and-the-ads-cft-correspondence-conjecture-they-all-can-recover-the-standard-model-or-smg/>, December 20, 2021.

[72]: Stephane H Maes, (2022), “Trans-Planckian Censorship Conjecture: Factual in Multi-fold Universes as well as GR Universes”, [arXiv:2303.0025v1](https://arxiv.org/abs/2303.0025v1), <https://shmaesphysics.wordpress.com/2022/03/13/trans-planckian-censorship-conjecture-factual-in-multi-fold-universes-as-well-as-gr-universes/>, March 12, 2022.

[73]: Stephane H. Maes, (2022), “Experimental confirmation, as expected that antimatters also falls down, as would be in a multi-fold universe”, <https://shmaesphysics.wordpress.com/2020/07/05/more-matter-than-antimatter-all-falling-down/#comment-3276>. January 6, 2022.

[74]: Stephane H Maes, (2022), “Multi-fold Dark Matter and Energy Effects Fit The Ratios to Normal Matter in the Universe”, <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.

[75]: Stephane H Maes, (2022), “Multi-fold Discrete Fractal Spacetime, and the Viability of Local vs. Non-Local Hidden Variable Viability”, <https://shmaesphysics.wordpress.com/2022/10/30/multi-fold-discrete-fractal-spacetime-and-the-viability-of-local-vs-non-local-hidden-variable-viability/>, October 30, 2022.

[76]: Stephane H Maes, (2022), “2D Random Walks of Massless Higgs Bosons as Microscopic Interpretation of the Asymptotic Safety of Gravity, and of the Standard Model”, <https://shmaesphysics.wordpress.com/2022/12/28/2d-random-walks-of-massless-higgs-bosons-as-microscopic-interpretation-of-the-asymptotic-safety-of-gravity-and-of-the-standard-model/>, December 28, 2022.

[77]: Stephane H. Maes, (2022), “Invalidation and Proof of the Mass Gap, and Viability of The Standard Model on a Discrete Spacetime”, <https://shmaesphysics.wordpress.com/2022/07/15/invalidation-and-proof-of-the-mass-gap-and-viability-of-the-standard-model-on-a-discrete-spacetime/>, July 15, 2022.

[78]: Stephane H Maes, (2020), “A Non-perturbative Proof of the Asymptotic Safety of 4D Einstein Gravity, With or Without Matter”, <https://shmaesphysics.wordpress.com/2022/05/04/a-non-perturbative-proof-of-the-asymptotic-safety-of-4d-einstein-gravity-with-or-without-matter/>, May 4, 2022.

[79]: Stephane H. Maes, (2022), “What is the Multi-fold Theory? Its Main Characteristics in a Few Words”, [vixra:2207.0172v1, https://shmaesphysics.wordpress.com/2022/07/28/what-is-the-multi-fold-theory-its-main-characteristics-in-a-few-words/](https://shmaesphysics.wordpress.com/2022/07/28/what-is-the-multi-fold-theory-its-main-characteristics-in-a-few-words/), July 28, 2022.

[80]: Stephane H. Maes, (2022), “Justifying the Standard Model  $U(1) \times SU(2) \times SU(3)$  Symmetry in a Multi-fold Universe”, <https://shmaesphysics.wordpress.com/2022/08/08/justifying-the-standard-model-u1-x-su2-x-su3-symmetry-in-a-multi-fold-universe/>, August 8, 2022.

[81]: Stephane H Maes, (2022), “Unruh effects, Hawking Black Hole Evaporation, Quantum Corrected Larmor Formula, Numbers of Particles in Curved Spacetime: “Same-Same, but Just A Bit Different””, <https://shmaesphysics.wordpress.com/2022/07/25/unruh-effects-hawking-black-hole-evaporation-quantum-corrected-larmor-formula-numbers-of-particles-in-curved-spacetime-same-same-but-just-a-bit-different/>, July 25, 2022.

[82] Stephane H. Maes, (2022), “Time-Varying Multi-fold Dark Energy Effects and Implications for the Hubble Tension”, <https://shmaesphysics.wordpress.com/2022/11/13/time-varying-multi-fold-dark-energy-effects-and-implications-for-the-hubble-tension/>, November 13, 2022.

[83]: Stephane H Maes, (2022), “Direction of Possible Multi-folds Corrections to the W Boson Mass”, <https://shmaesphysics.wordpress.com/2022/04/08/direction-of-possible-multi-folds-corrections-to-the-w-boson-mass/>, April 8, 2022.

[84]: Stephane H Maes, (2022), “Multi-folds in Yang Mills Feynman Diagrams”, <https://shmaesphysics.wordpress.com/2022/04/05/multi-folds-in-yang-mills-feynman-diagrams/>, April 5, 2022.

[85]: Stephane H. Maes, (2022), “A Conjecture: No Dark Matter will be discovered at LHC, or elsewhere”, <https://shmaesphysics.wordpress.com/2022/07/08/a-prediction-no-dark-matter-will-be-discovered-at-lhc-or-elsewhere/>, July 8, 2022.

[86]: Stephane H. Maes, (2022), “Multi-fold Gravity can Violate P-Symmetry. It is Aligned With Observations of Asymmetry of the Orientation of Tetrahedra of Galaxies”, <https://shmaesphysics.wordpress.com/2022/12/10/multi-fold-gravity-can-violate-p-symmetry-it-is-aligned-with-observations-of-asymmetry-of-the-orientation-of-tetrahedra-of-galaxies/>, December 10, 2022.

[87]: Stephane H. Maes, (2022), “Multi-folds, Non-Commutative Spacetime, Spin, and All That”, <https://shmaesphysics.wordpress.com/2022/12/31/the-principles-of-quantum-mechanics/>, December 31, 2022.

[88]: Stephane H Maes, (2022), “Comments on Multi-fold mechanisms as Hermitian vs. Unitary processes”, <https://shmaesphysics.wordpress.com/2020/06/25/gravity-like-attractions-and-fluctuations-between-entangled-systems/#comment-4359>, July 27, 2022.

[89]: Stephane H Maes, (2022), “The Replica Trick, Wormholes, Island formula, and Quantum Extremal Surfaces, and How the AdS/CFT Correspondence Conjecture, and Hence the M-theory, Encounters Multi-folds”, <https://shmaesphysics.wordpress.com/2022/09/20/the-replica-trick-its-wormholes-islands-and-quantum-extremal-surfaces-and-how-the-ads-cft-correspondence-conjecture-and-hence-the-m-theory-encounters-multi-folds/>, September 26, 2022.

[90]: Stephane H. Maes, (2022), “A Better Quantum Extremal Surface and Island Interpretation that explains the Associated Massive Gravity”, <https://shmaesphysics.wordpress.com/2022/12/03/a-better-quantum-extremal-surface-and-island-interpretation-that-explains-the-associated-massive-gravity/>, December 3, 2022.

[91]: Stephane H Maes, (2023), “A qualitative hint that the multi-fold dark energy effect could fit the cosmological constant estimate”, <https://shmaesphysics.wordpress.com/2020/06/19/explaining-dark-energy-small-cosmological-constant-and-inflation-without-new-physics/#comment-6021>, January 30, 2023.

[92]: Stephane H. Maes, (2023), “The Multi-fold Least Action Principle, a Quasi Theory Of Everything”, <https://shmaesphysics.wordpress.com/2023/02/19/the-multi-fold-least-action-principle-a-quasi-theory-of-everything/>, February 19, 2023.

[93]: Stephane H. Maes, (2022), “Article questioning the Big Bang based on early galaxies encountered by JWST”, <https://shmaesphysics.wordpress.com/2021/01/17/a-multi-fold-universe-genesis-inspired-by-total-explosion-collision-the-source-of-the-big-bang/#comment-4577>, August 21, 2022.

[94]: Stephane H. Maes, (2022), “Comments and answer to questioning the Big Bang based on early galaxies encountered by JWST”, <https://shmaesphysics.wordpress.com/2021/01/17/a-multi-fold-universe-genesis-inspired-by-total-explosion-collision-the-source-of-the-big-bang/#comment-4604>, August 26, 2022.

[95]: Stephane H. Maes, (2023), “Yeah or Nay on Black Holes as Explanation for Dark Energy?”, <https://shmaesphysics.wordpress.com/2023/03/01/yeah-or-nay-on-black-holes-as-explanation-for-dark-energy/>, March 1, 2023.

[96]: Wikipedia, “Lambda-CDM model”, [https://en.wikipedia.org/wiki/Lambda-CDM\\_model](https://en.wikipedia.org/wiki/Lambda-CDM_model). Retrieved on August 14, 2022.

[97]: Stephane H Maes, (2022), “The Yang Mills Double Copy leads to New AdS/CFT + Gravity Correspondences, or How the M-theory encounters Multi-fold Universes”, <https://shmaesphysics.wordpress.com/2022/04/22/the-yang-mills-double-copy-leads-to-new-ads-cft-gravity-correspondences-or-how-the-m-theory-encounters-multi-fold-universes/>, April 22, 2022.

[98]: Stephane H. Maes, (2023), “Multi-Fold dark Matter effects & Rotation Curve Differences in Galaxies in Clusters, Yet Respect of the Strong Equivalence Principle”, <https://shmaesphysics.wordpress.com/2023/01/29/multi-fold-dark-matter-effects-rotation-curve-differences-in-galaxies-in-clusters-yet-respect-of-the-strong-equivalence-principle/>, January 29, 2023.

[99]: nLab, “classical double copy”, <https://ncatlab.org/nlab/show/classical+double+copy>. Retrieved on April 22, 2022.

[100]: Stephane H Maes, (2022), “Gravitational Bootstrap, S-matrix, Superstrings, and The Plausible Unphysicality of Gravitons”, [arXiv:2301.0155v1](https://arxiv.org/abs/2301.0155v1), <https://shmaesphysics.wordpress.com/2022/02/06/gravitational-bootstrap-s-matrix-superstrings-and-the-plausible-unphysicality-of-gravitons/>, February 6, 2022.

[101]: Stephane H. Maes, (2023), “Dynamic sources, Dynamic Multi-folds, and General Relativity Lens-Thirring and Frame Dragging Effects”, <https://shmaesphysics.wordpress.com/2023/03/12/dynamic-sources-dynamic-multi-folds-and-general-relativity-lens-thirring-and-frame-dragging-effects/>, March 12, 2023.

[102]: Stephane H Maes, (2021), “Pointers to Nowhere with Geometric Unity Theory, or Some Ways Forward in Multi-fold Universes?”, [arXiv:2210.0081v1](https://arxiv.org/abs/2210.0081v1), <https://shmaesphysics.wordpress.com/2021/03/07/pointers-to-nowhere-with-geometric-unity-theory-or-some-ways-forward-in-multi-fold-universes/>, March 7, 2021.