Microscopic Interpretation of The Gravity Electroweak Symmetry Breaking

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March 27, 2025

Abstract:

In previous papers, we proposed detailing the concepts of gravity electroweak symmetry breaking, in the context of the multi-fold universe. Accordingly, massive particles are modeled as microscopic black holes as Higgs boson condensate Qballs, and massless particles are modeled as 2D random walk patterns of massless Higgs bosons.

In this paper, we present a microscopic interpretation of what happens above, at and below the gravity electroweak symmetry breaking. This includes how we have condensation into a BEC Qball of Higgs condensate, while massless particles remain patterns of random walks, which disappear at higher temperatures, leading to eth Ultimate Unification (UU}, where only 2D random walks of massless bosons take place.

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1. Introduction

This paper is derived from [162], for the purpose of making sure that the topic of microscopic interpretation of the (multi-fold) gravity electroweak symmetry breaking is noticed, and not obscured by the black hole regularity discussions that dominate [162].

In [1,8-10,16,22,23,28,29,30,35,36,64,66,72,89,130,131,137,151,152,157,162,170,176] and references therein, we discuss the proposal of modeling SM (Standard Model) particles as microscopic black holes, and associated new life cycle for multi-fold black holes, the Ultimate Unifications, and a non-strict version of the Weak Gravity Conjecture (WGC) [1,28,64,131,137,151,152,221,222].

With the multi-fold mechanisms [1,8-10,22,131,137,140,152], SM particles and their quantum numbers and properties result from multi-fold space time matter induction and scattering [1,4,29,33-35,36,63,139,140,144,150,161,198-206], that is essentially a stable unconstrained (not compactified) Kaluza Klein approach. Massive particles are soliton induced Qballs of Higgs condensate with a superconducting Higgs skin, and massless particles are induced patterns of 2D random walks of massless Higgs bosons. Mass, spin, chirality, internal symmetries, and SM symmetries result from it [1,8-10,22,23,116,131,137,144,150,152,161,170]. All look like microscopic black holes.

In [162], we show that such solitons induced by multi-fold space time matter induction and scattering, Qballs and patterns of random walks are stable, i.e., without singularities, In-and-Out equilibrium of evaporation, and no extremality problems, just as for regular black holes, considering that all multi-fold black holes are regular [1,31,64,66,89,137,151,152,157,162].

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Cite as: Stephane H. Maes, (2025), “Microscopic Interpretation of The Gravity Electroweak Symmetry Breaking", https://doi.org/10.5281/zenodo.15099220, https://shmaesphysics.wordpress.com/2025/03/27/microscopic-interpretation-of-the-gravity-electroweak-symmetry-breaking/, March 27, 2025. (https://osf.io/q5erz)

In the present paper, we discuss the detailed microscopic interpretation of what happens at high temperature (UU, split up into massless bosons in 2D random walks [1,8-10,22,62,72,131,137,152,170]), and before, at and after the multi-fold gravity electroweak symmetry breaking [1,4,23,29,35,36,72,124,130,137,162,170].

As always because of how often the multi-fold theory allows the recover, explain, or resolve aspects and open issues of the SM, and the Standard Cosmology Model [100] (even if it may have to evolve some models, but probably not its principles [128] – including comments on the web page) [1-157,161-176].

Also, the paper includes a model for radiation, interactions, absorption, acceleration and deceleration [31,162].

This work is extracted from [162], and relies at times on its results in terms of stability and nonissue of singularities, stability, extremality and evaporation for black holes. A superficial overview of the Multi-fold theory is presented in Appendix A.

2. Microscopic Interpretation of the Multi-fold Gravity Electroweak Symmetry Breaking

We have earlier found how imaginary / complex mass for the Higgs field (and complex scalar field) just above the electroweak symmetry breaking may characterize its unstable equilibrium as in [181] and is causal, rather than tachyonic non-causal features (Around the vacuum where the Higgs field has vanishing expectation value, the full gauge symmetry is restored but the Higgs field has negative m^2) (6.14.24) in [182], [182-189]. The potential near where the field is zero implies that the field is tachyonic as illustrated in [185].

Furthermore, when looking at the Abelian Higgs mechanism, we see that the QFT Higgs field must be complex in order to have its phase define a gauge [189], to create a gauge invariant Lagrangian [182,186-189].

These complex features can also be seen as a property describing the Lévy walks ([62,148,174] and references therein), i.e., random walks with foraging [62], with fractional equations when modeled as particles.

So, in [62,162,170], we argue that the Higgs field is complex with an imaginary mass, a sign of causal instability before spontaneous symmetry breaking [162,170,181], but also a sign of coordinated crowd movements, i.e., a pattern of the 2D random walks of massless Higgs bosons [1,8-10-22,62,72,131,137,152,162,190,191], which is exactly what we predict[2] to be massless particles by random walk patterns induced by multi-fold space time matter induction and scattering for massless particles and including in particular all SM particles above the energy scales of the multi-fold gravity electroweak symmetry breaking (when condensation and Qballs are not an option) [1,4,23,29,35,36,72,124,130,137,170].

It also explains the possible apparent contradiction: are massless Higgs bosons with a mass? Are random walks following patterns. The answers are yes and yes, yet still no and no: it depend not just of the energy, but also of the spatial scale as explained in figure 1 of [72], or the energy level modeled by QFT. While they remain massless they present these mathematical apparent causal tachyonic features to capture instability of the field [178], and coordinated induced random walk pattern. This is in fact not totally a surprise, just as we show in [170] that mass

[2] Before this paper and [162], the reasoning was a combination of needing to extend the induction due to the multi-fold mechanisms to before above the energy scales of the multi-fold gravity electroweak symmetry breaking [1,4,23,29,35,36,72,124,130,137,170], when everything is massless, charge/colors disappear outside particles, etc., as shown in figure 1 of [72], and when spacetime is based on 2D random walks of massless Higgs bosons [1,62,63,72,124,137,170,176]. It was already the only plausible explanation. Now we show that it is also contained in the QFT models.

acquisition results from the confinement of massless particle. Before confinement, coordinated patterns create imaginary mass when modeled at larger scale[3] than the composing particles, so that the resulting soliton is stable under the underlying motions instead of falling apart due to the moves of the composing particles.

This is seen by relying on [185]: the imaginary mass near the stable maximum

$$\varphi \approx 0 \quad (1)$$

, which can be seen as the massless case [185], where the field has imaginary masses and seems to be (causal) tachyonic.

If everything is massless near (1), then we indeed capture something else than tachyons (which are imaginarily massive). So, there is no inconsistency at this level, and rather confirmation that tachyonic field in this case is about the instability[4], that superluminal behavior. Higgs bosons are also massless at

$$\varphi = 0 \quad (2)$$

Above this critical temperature T_c, or energy, i.e., the energy of the multi-fold gravity electroweak symmetry breaking, the phase is different. Indeed, for as long as massless particles are viable[5], patterns of random walks are encountered, and can be seen as interacting scalar fields as in QFT [192] or as in QFT in condensed matter solid state [234], i.e., with zero mass and a potential as in section 6.4 of [182], with V(φ) possibly including quadratic terms.

These interaction terms [192], and coupling constants, above T_c are to be understood as attractive. In multi-fold universes, at high energy but not high enough to destroy the random walk patterns, this attraction is, within massless SM particles, between the massless Higgs bosons; massless particle at lower temperatures are discussed later. We assert that key candidates for this attraction are the gravitation-like attractions between entangled massless Higgs bosons[6] [24,25]. Even if there may also be conventional gravity effects between the bosons, it is not dominant as the gravity breaking part of the multi-fold gravity electroweak symmetry breaking occurs at the lower energy scales of the gravity electroweak symmetry breaking [35]. Their attractions provide the centripetal forces needed to create stable orbits (and therefore per the Bertrand theorem [124,194,195] (and references therein) in ~ r^{-1} or r^2, between the massless Higgs bosons). The former matches gravity-like effects, and in 4D spacetime[7], orbits are roughly closed. The other terms account for motions of the particles and higher order interactions etc., as it is not exactly a central force due to the many particle and non-linear effects. Overall the interactions are not too strong before condensation, ensure alignment with BEC models [210].

Possible stable structures are solitons with energy minimum resulting from the multi-fold space time matter induction and scattering [1,4,33-35,63,137,139,140,144,150,155,157,161,198-206]. As explained in [23,35,36], massive particles can occasionally appear as fluctuations, higher than T_c. However, in general, the unstable state is

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[3] Collective movements, i.e., a many body problem at large enough scales, rather than while looking at the individually composing particles. It is suited for QFT.

[4] This is by analogy of comparing both case the causality breaking tachyon versus unstable oscillators [181] (Just as similar types of examples explain instanton as related to tunneling [166]).

[5] And so it remains the case below the multi-fold gravity electroweak symmetry breaking for massless gauge bosons. We will revisit later in the paper. Because they do not involve as many massless bosons in the random walks (massless gauge bosons are roughly at scales of the Planck spatial length), they are way stabler and attraction can remain valid for temperatures below T_c. That is why we keep on finding massless particles, and light is massless, as are gluons.

[6] Interesting that means the same effect as the multi-fold dark matter effect [1,5,7-10,22,24,25,30,54-59,106,131,137,149,152].

[7] This can only happen in 4D spacetime, aligned with [124].

not reached (as a new phase) at this time, because the energy of fluctuations destroy any subsequent condensation structure.

If temperature raises / is much higher, the fluctuations destroy the random walks as further discussed in section 9.3, which can be seen also as having the particles as extremal black hole split up per the previous sections and [1,4,33-35,63,139,140,144,150,161], and we reach the scales of the ultimate unification, populated by massless Higgs bosons random walks in (sometimes interacting) 2D random walks.

At (3) and T_c, and below, the potential is still attractive at (2) as moving away from (2) increases the density and decreases the potential. So, when there is already enough entangled massless Higgs bosons, e.g., storing now too much information / entropy (entangled Qubits) in the region[8] [1,66,137,196,197], fluctuations adding Higgs bosons and creating collisions between the Higgs bosons will create the needed Higgs field fluctuations to spontaneously break the symmetry, and evolve rapidly till reaching the minimum. At such a stage, the Higgs field is now with a positive mass (Higgs acquire masses in Higgs particles and within Qballs and outside due to the skin potential), and the potential is now repulsive, as increases in Higgs density increase to potential.

A repulsive potential can now satisfy the conditions to create a BEC (Bose Einstein Condensate) as modeled initially by Bogolubov [208-210]. Also, the mid-field Gross-Pitaevskii equation, which models the wave function of the condensate, shows that the stability of the condensate requires that weak interactions between the bosons be repulsive [193,210]. That potential is responsible for preventing collapse and lead to a spatially extended condensate.

With this, we disagree with [226] as significantly unstable state with a Lagrangian as in [185] will form and subsist only when the temperature is at and lower than T_c. Instability is then inevitable. See [179,188].

We postulate that the eventual repulsive potential comes from the elastic scattering between the massless Higgs bosons[9], as in analogy to [256] with bosonic atoms, as well as from the nature of the massless Higgs boson as dilaton. The high speed and non-atomic / neutral structure ensure repulsion and elasticity.

The shape of the Qball results from the multi-fold space time matter induction and scattering, as modeled in [1,4,33-35,63,137,139,140,144,150,155,157,161,198-206] and references therein. It defines the particles quantum numbers including charge. Rotation of the Qball skins, coming from the condensation of the random walk patterns, defines the spin [1,137,150,155,161,170]. The skin is defined as in [4,198-206] and references therein, and itself a condensate super conductor superfluid. More on this in [162].

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[8] As a result, the In-and-Out equilibrium discussed in [162], with more energy piling up, as more bosons get in, now attracted also by gravity, trying to enter the random walk orbit and the region that it encircles, than those escaping. This creates the opportunity for condensation in the Qballs and at its skin [4,35]. The Qball skin is formed by combining potentials as in [1,4,35,137,157,198-206] and references therein. The external one indicates that condensation can also occur outside the Qball, hence the Higgs particle can also exist with an mass acquired the same way, consistent with say [223]. Within the formed condensate, the repulsion continues because piling up too many Higgs boson at a same place is again limited by the maximal entropy within a spacetime region [1,66,137,196,197], and controlled by (elastic) collisions in the condensate increased as density increases. Other mechanisms could be involved like pseudo Nambu Goldstone bosons due to spontaneous symmetry breaking of a global symmetry, e.g., the scalar field shifting by a constant, which is indeed broken by the Qball shape [180], or as the dilaton, aka the massless Higgs boson may be considered as a dilaton, something we determined to be the case in multi-fold universes [23,29,64,66,72,170,179], can be seen as arising from a 5D gauged U(1) symmetry [180,207], but rather modeled massless first as massless and therefore better models with the axion example in [180]. Also it is interesting that [207] speaks of “A Higgslike Dilaton”, aligned and adding to the arguments we have in [23,29,64,66,72,170,178].

[9] This does not play a role above T_c because then the density is too low in spacetime vacuum, and while higher in the massless particles as random walk patterns, the coordinated pattern minimizes scattering within the walks.

Note that as explained in [72] with figure 1, when considering higher energy scales or smaller spatial scales, massless bosons still exist concretizing the spacetime with their random walks. Massive Higgs can also be encountered everywhere as Higgs Condensate Qballs. Massive gauge bosons also become Qballs of Higgs condensates. The effects are equivalent but modeled differently in the QFT / SM electroweak symmetry breaking with the massive fermions[10] appearing to interact with the Higgs field, while the massive gauge bosons swallow the massless Goldstone particles resulting, per the Goldstone theorem, from the spontaneous symmetry breaking [223]. The photon is the remaining goldstone boson. This is in our view just the result of capturing interaction carrier vs. "matter", but in practice it is the same mechanism modeled differently in the SM Lagrangian of QFT vs. in the multi-fold microscopic interpretations. Below T_c, the massless gauge bosons still exist as smaller random walk patterns of massless gauge bosons. They do not condensate[11] because their density remains too light (only few massless bosons) to push for instability, and the potential remains attractive at zero, never moving away from the instability: the walk patter is small, of the Planck Length scale, and therefore very stable also at all temperature

$$T < T_c \tag{3}$$

This analysis comes from [162] where it is for the first time detailed beyond the story told in [4,35,63]. It provides a detailed microscopic interpretation to the SM, or rather SM_G, gravity electroweak symmetry breaking, and the origin of quantum numbers, mass, inertia, charges/colors and spin, as well as the SM symmetries [23].

Spacetime continues to be defined by, and expanding as concretized locations of the massless Higgs bosons in 2D random walks [1,27,32,62,72,170], which explains and supports that spacetime is bosonic [150,170,176], and matter are excitation of spacetime. Per the above, the field or its mass can always been seen as complex at the low level ,or within a range including the massless gauge bosons. However, the massless Higgs boson is not an explicit particle at the level of the SM, its scales or above, and it is rather modeling gravity, and GR at and above the SM spatial scales (below the energies of the multi-fold gravity electroweak symmetry breaking). They are irrelevant at the SM and macroscopic scales because it is not possible to model the scales where they matters (as discrete / non-commutative spacetime and massless gauge bosons or scalar bosons in 2D random walks) with 4D / Continuous QFT.

No interaction of the massless Higgs bosons takes place with the SM or SM_G, at the SM scales: they can be considered as just having condensed into Qballs, along with massless gauge bosons. They will matter only when going to higher energies or smaller spatial scales.

3. About the Massless Solitons

With the mechanisms described above, massless particles, as patterns of random walks of the massless Higgs bosons, have no mass, and do not form actual black holes. They have no singularity.

Massless gauge bosons never reach unstable states, and therefore, they do not form Qballs of Higgs condensates. Even if they did, it would result into negligible corrections at the scales of QFT and the SM.

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[10] Remember that, in a multi-fold universe, we have massive neutrinos as Dirac Fermions who acquired mass the same way. The right-handed neutrinos and their anti-particles are in the multi-fold behind the Higgs Bosons [1,8-10,22,42,47,67,119,131,137,152,157,165].

[11] They can't condensate into Qballs, or they would acquire a mass. If they were to condensate we would have infinitely small mass associated to all the massless gauge bosons and the QFT /SM model would be just an approximation, not really affected in its precision by that, as is in any case too hard to observe.

The multi-fold model of massless gauge boson is something that we may not have perfectly called out in past papers, including [1,137,224], where we were all the way discussing the microscopic black holes for say photons, or [4,35], where we did not discuss explicitly these considerations or the detailed microscopic interpretation described in section 6.1.1.

4. Particles as (Over) Extremal Microscopic Black Holes

4.1. Conventional Models of Particles as Black Koles

As discussed in [1,4,33-35,63,137,139,140,144,150,155,157,161,162,198-206,223,224] and references therein, based on Schwarzschild radius ad the Compton wavelength, SM particles, modeled as black holes can often mathematically appear to be extremal or over extremal. This is considered as an unexplained problem. Below, we will provide a path to address these concerns.

4.2. Fundamental Particles as Microscopic Black Hole-like Qballs of Massless Higgs Boson Condensate

4.2.1 Relativistic and Non-Relativistic Qballs

In a multi-fold universe, below the energy scales of the multi-fold gravity electroweak symmetry breaking, fundamental massive SM particles are Qballs of Higgs condensate with a Higgs superconducting skin [4,35]. With massless Higgs bosons, and (over)extremal charged/rotating Qballs, relativistic BEC behaviors have to be considered.

The BEC can be modeled as discussed in earlier sections, or as in for relativistic / ultra relativistic situations . The bosons are not charged but interacting, making the models in [262] suitable. One can also consider the models of [212,213], where the massless Higgs bosons are equivalent to the photons. There again, as for the graviton BEC proposal [162], we see that gravity effects (masses are the charges for gravity) spread, i.e., the black hole mass resides all over the BEC, ensuring no singularity. Therefore, we should have cessation of evaporation at the SM spatial scales, because of the mechanisms of [177] appearing at that scale with a discrete, non-commutative spacetime with quantum uncertainties.

Note that massless bosons requires confinement for the BEC to exist. It is provided by the Qball skin in analogy with the cavity in [212,213], and it is responsible for the Higgs mass acquisition (while the massless boson can still exist to concretize spacetime or induce massless gauge bosons) [170]. [211] models the coexistence of BEC and thermalized not condensed particles, which gives support to our assertions in section 2, that massless Higgs bosons can continue to model spacetime concretization and expansion [1,27,32,62,72,170], visible at small enough spatial scales, and produce the random walk patterns associated to massless gauge bosons.

It is worth nothing another difference between relativistic and non-relativistic BEC. The former adds a massive continuous excitation mode spectrum[12], not encountered with the non-relativistic BECs, along with a common gapless discrete excitation mode spectrum. Both BECs have their own Gross-Pitaevskii Equation derived from the Schrödinger or the Klein Gordon equations [210,214]. However, in the context of particle-size Higgs Qballs, it is not clear that these have any relevance. We may encounter needs for them in the future.

4.2.2 More About Evaporation as Tunneling Through the Qball Skin

The shapes of the Qballs result from the multi-fold space time matter induction and scattering, as modeled in [1,4,33-35,63,137,139,140,144,150,155,157,161,198-206] and references therein. It defines the particles quantum numbers including charge. Rotation of the Qball skins, coming from the condensation of the random walk patterns, and it defines the spin[13] [150,161]. The Qball skin is defined as in [4] and references therein, and it is itself a condensate super conductor / superfluid BEC.

Massless Higgs bosons can enter or exit the Qball via tunneling, with the Qball fluctuating to maintain its soliton quantum number properties (i.e., the barrier of the skin adapts to what is needed as imposed by the multi-fold space time matter induction and scattering). As a result evaporation may take place as tunneling.

We must note that quantum tunneling effects can be large, due to Klein Tunnelling[14], when / if the potential barrier created by the Qball skin is large vs the total energy [215-217] of a massless Higgs boson bosons in a Qball (and of others massless bosons like photons)[15]. So the cessation of the evaporation discussed in [162], must be understood as implying an In-and-Out equilibrium of absorption and evaporation rather than a strict suppression. The outcome is the same. Otherwise the cessation modeled in [177] would not hold, despite occurring at the SM, or SM_G, scales, where QFT is valid and extremely accurate.

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[12] The excitation spectrum of a Bose-Einstein condensate (BEC) describes the energy and momentum relationship of excitations (like sound waves) within the BEC.

[13] It is possible that inside the skin we have also rotation, however this complicates how to balance the angular momentum contributions from inside and at the skin. It is for further study. In any case, this explains why the spin is both an internal symmetry, and an angular momentum.

[14] The Klein Tunneling or Paradox effects comes from the introduction of potential barriers, i.e., a source of additional energy in a region of spacetime. If that barrier is larger than $2mc^2$, then pairs of particles and anti-particles can be created in the region of the barrier, and overall appear to traverse it, especially and even if the barrier is infinite. In a Qball, the energy of the barrier is lower than the particle mass equivalent, but that does not mean that it can't be high enough for smaller masses, and massless particles like the massless Higgs boson or photons.

[15] Note that this analysis warrants explaining why it did not trouble us when we used infinite barriers in [157] to justify that extremality could not be reached. The fundamental difference is that in the Klein paradox/tunneling, the energy steps are physical energy jumps present all the (relevant) time in a region. In [157], the potential is not an existing energy potential able to create pairs of particles and anti-particles. It is rather simulating a jump in energy that appears if the particle joins the black holes, and therefore affect the path integral contributions on such path, reducing dramatically their probability, and resulting in the particle bouncing away, when the black hole is ε-away from extremality. Here, or when considering Hawking radiation as tunneling, we do not have a dramatic change of energy distribution for the dominant paths. So large relativistic tunneling is not a Klein paradox when modeling quasi extremal black holes as in [157]. The proofs presented in [157] hold.

4.2.3 About extremality

Charge contributions

Charges (or whatever relevant interacting quantum number) are not due to charged bosons, the massless Higgs bosons are electromagnetically neutral, but the multi-fold space time matter induction and scattering. So charges are not really contributing to the extremality of black hole like Qballs [211].

This can be enough to address some of the challenges with the electron as black hole model [1,137,223].

Angular Momentum Consideration

The Qballs rotate to support spin of the Qball skin (see toy model in [1,137,150,157]), or maybe interior (See footnote [13]). Spin 0 can be modeled with two Qballs superposed and rotating in opposite direction. Extremality of a black hole (supposing no charge effect) occurs when the horizon must rotate at, or faster, than *c*.

Relativistic rotating BECs are studied in [218]. In particular, it shows that nonrelativistic rotating BECs have a discontinuous phase transition, and behave like non-rotating relativistic BECs. Also, we already mentioned the excitation mode differences in [162]. Rotating gas (relativistic or not) have a lower T_c, which means that they warm up when they rotate, but then cool as they accelerate. For the rest much of the behavior is similar.

Reaching supra luminosity would require particles moving at or faster than the speed of light. This is not happening because:

- Within the BEC, the BEC condensed particles are indistinguishable[16], and not traceable[17].
- With the W-type Multi-fold hypothesis [71], and knowing that a rotating (relativistic) BEC are not that different from non-relativistic ones, except for some different relationships between their thermodynamical evolutions, we know that particles in the BEC can jump from anywhere to anywhere in the BEC, i.e., anywhere the BEC macroscopic wavefunction is supported / nonzero.

Therefore, what seems to be supra luminous moves can rather be jumps with W-type multi-folds, and no information is conveyed in these jumps, as no particle is distinguishable. Conventionally, it means that the group velocity[18] of particles modeled in a BEC can have supra luminous group velocity with significant probabilities, just as we can encounter in the Klein Gordon or Dirac equations [129,219]. This applies at the edge of the BEC, or for the skin, where rotation may otherwise appear to require tangential speed larger than *c*.

It allows us to conclude that (over) extremality due to rotation is undefined for Higgs Qballs, especially at the level of the skin, is not actually encountered.

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[16] This is not to be confused with the ability to track other particles like a charged particles moving in a BEC [220]. There, they tracked an ion in a BEC of cold atoms. So other particles like Ions or photons (light) can be tracked, but that is not our concern here.
[17] Note that this is different from the QFT annihilation/creation of particles that create problems for particle based quantum mechanics as discussed in [1,86,137].
[18] This is not an issue as discussed in [129,219].

Evaporation of Rotating Qballs

Evaporation of rotating Qballs, exist due to tunnelling as discussed above, as is absorption, without the concerns and rules discussed in [157]. Again an In-and-Out equilibrium is to appear.

Yes, a priori, rotations change the barriers of potential, but then again, all this is captured in the soliton geometry: if the stable soliton rotates with a non-zero spin, then its skin potential barrier is correspondingly adjusted and defined via multi-fold space time matter induction and scattering.

4.3 Fundamental Massless Particles as Random Walk Patterns of Massless Higgs Bosons

In the regime where we have microscopic black hole-like patterns random walks of massless Higgs bosons, they all move at *c*, in an induced pattern of ~ closed orbits. In such a situation, just as before, no charge appears on the orbiting massless bosons, but it rather results from the induced shape via multi-fold space time matter induction and scattering. They do not contribute to any extremality.

On the other hand, the attractive interactions playing the role of centripetal forces prior to condensation, and due to entanglement, ensure that the orbitals are closed, or roughly closed, as already discussed in section 2. Under these conditions, it is guaranteed by the induced pattern of the soliton that *c* is not exceeded, just as argued earlier, so that the (quasi) orbits are stable, and the massless particle does not decompose. Otherwise, it wouldn't be a soliton, by definition, and it wouldn't correspond to an SM massless particle.

The random walk patterns are not black holes, They just appear well modeled as microscopic black holes. Therefore no singularity is involved either.

In terms of evaporation, random walks may have particles leaving the orbits, e.g., due to tunneling through the barrier created by the centripetal forces, random move, or other interaction/random collision while as soon that this happens others can be captured to fill the gaps. As for Qballs, stability of the SM massless particles, implies that this capture/escape is in equilibrium (In-and-Out equilibrium).

On the other hand, when the universe temperatures becomes too high, random fluctuations increase the escape, while capture is harder due to the higher energy distribution of the massless Higgs bosons: particles split up down to massless Higgs bosons as described in [1,8-10,16,22,23,28,29,30,35,36,64,66,72,89,130,131,137,151,152,157,170,176] and section 2. This is when we enter the UU regime.

5. SM Particle Life Cycle

The analysis presented in this paper helps us see what happens when particles interact:

- when particles are emitted due to acceleration [31], or de-excitation as electrons in atoms[19] [31,220,225-227]:
    - They have Qballs or massless particles created by split-up or tunnelling/escaping , and may then possible mutate (e.g., in weak interaction), or not, when reestablishing an In-and-Out equilibrium. In the former case they change to a different soliton induced by multi-fold space time matter induction and scattering.
    - Emissions of virtual particles, occur the same way, relying on quantum uncertainties. The previous case adds to then when the emitted particle becomes real, due to interaction, as discussed in [1,137].
- Absorption and excitation is equivalent but now with absorption of a Qball or massless particle and then get excited or mutate, while reestablishing Qball solitons and In-and-Out equilibriums .
- Excitation and deexcitation can also be seen as accelerations and decelerations [31,220,225-227].
- Particle and anti-particle creation, uses quantum uncertainty to generate space time fluctuations, i.e., fluctuations of massless Higgs bosons to create the massive or massless pairs out of the massless Higgs bosons that concretize spacetime and its expansion [150,176]
- Particle and anti-particle annihilation, combines the particles into a Qball, or a random walk pattern that is not a stable soliton, and so it split up into emitted particles, e.g., gamma pairs, and / or other gauge bosons and massless Higgs bosons, which are just nothing, i.e., spacetime vacuum.
- Etc.

This is an interesting take on these particle / QFT /SM processes that really concretizes the multi-fold particle view of QFT and SM / SM_G [1,8-10,22,131,137,152], and the notion that particles are just excitation of the field, with zero particle in the vacuum (except for the Higgs vev and its associated sea of Higgs, that we explain a bit differently here). It also confirmed [150,176] view that spacetime is bosonic, built on the 2D random walks of the massless Higgs bosons and concretized by their current and past positions.

11. Conclusions

This paper is derived from [162], for the purpose of making sure that the topic of microscopic interpretation of the (multi-fold) gravity electroweak symmetry breaking is noticed, and not obscured by the black hole regularity discussions that dominate [162].

We derived and presented for the first time a detailed microscopic interpretation of the massless Higgs boson BEC condensation events during, and at energies below, the multi-fold gravity electroweak symmetry breaking, and of massless particles as stable patterns of random walk of the massless Higgs bosons, at all temperature where they can exist. It includes addressing, in the regime above symmetry breaking, what happens when fluctuations of massive particles occur. We discussed what massless gauge bosons look like at energies after the symmetry breaking, etc. We motivated the interactions between the massless Higgs bosons that make this story possible, including the sources for an attractive potential, i.e., gravity like forces between entangled particles at temperature

[19] Which can also be seen as a deceleration as discussed in the next bullet.

above the BEC, and for repulsion below. The latter being also linked to dilaton, aka 2D massless Higgs boson gravity and the multi-fold space time matter induction and scattering in a 5+D space, and conformal/transition symmetry breaking due to the Qballs.

This also further detail the life cycle of multi-fold black holes and UU. Then, we extend the microscopic interpretation to the lifecycle of any SM particle, real or virtual.

Also, fundamental particles actually continue to evaporate and absorb massless Higgs bosons, and massless particles, however an In-and-Out equilibrium exists between the two.

We have argued here and in [162] about the consistency of the proposal of particles as Qballs of massless Higgs boson condensates: they have no singularity, they do not evaporates, and they can appear (over)extremal. This is on top of the usual conventional arguments [1,4,137]. Massless particles as patterns of random walks of massless Higgs boson have no inconsistencies either.

The analysis is predominantly for multi-fold universes, although some aspects are also conventional reasoning. In any case, having seen so far how the multi-fold theory often seem to apply, give hints or analogy to Physics in our real universe, and to potentially help address many open issues with the SM or the Standard Model of cosmology [1-157,161-176], we recommend that the proposals here be also considered as an analysis of our real universe.

Appendix A. A Superficial Overview of the Multi-fold Theory

In a multi-fold universe [1-157,161-176], gravity emerges from entanglement through the multi-fold mechanisms. As a result, gravity-like effects appear in between entangled particles [1,24,25], whether they are real or virtual. Long range, massless gravity results from entanglement of massless virtual particles [1,26]. Entanglement of massive virtual particles leads to massive gravity contributions at very small scales [1,27]. It is at the base of the E/G Conjecture [24], and the main characteristics of the multi-fold theory [22]. Multi-folds mechanisms also result in a spacetime that is discrete, with a random walk fractal structure and non-commutative geometry [62], in a range of spatial scales, which is Lorentz invariant and where spacetime nodes and particles can be modeled with microscopic black holes [1,4]. All these recover General Relativity (GR) at large scales, and semi-classical model remain valid till smaller scales 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. It can contribute to resolving several open issues with the Standard Model, and the standard cosmological model, without New Physics[20] other than gravity [1,4-157,161-176]. These considerations hint at an even stronger relationship between

[20] Conventional physicists may argue it is New Physica. We consider that it isn't because no new particles or interactions are introduced. We just add gravity, as we know it should be, and multi-fold mechanism and let conventional Physics unfold with the considerations. It does change conventional results or explanations, usually with same observables, and it does live in a discrete spacetime etc. as a result of conventional analysis of these consequences. We also do not cover stable field effects like Skyrmions [166], that we prefer to see as a collective effect for the theory. Beside the SM particles, there are other collective solutions/solitons in gauge theories, they have behaviors as particles but they are quasi-particles composed of collective effects of a large set of particles. We see them as Qballs or patterns that can appear by multi-fold space time matter induction and scattering, under specific circumstances, nothing more. They are topological solitons and can appear in BEC, as expected with massless Higgs boson condensates [171,172].

gravity and the Standard Model, as finally shown in [23]. It leads us to consider that the multi-fold theory gives good insight to conventional Physics, that our real universe may be well modeled as a multi-fold universe [1,4-157,161-176], something that we have done in this paper.

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, generated by 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 can be 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 below the energy scales of the multi-fold electroweak symmetry breaking [1,4], and as random walk patterns to realize massless particles at all scales [1,29,36,37], thereby providing a microscopic explanation for a the multi-fold kinematics and dynamics and associated unconstrained Kaluza Klein mechanisms [23,33,34,52,63,64,113,139], Higgs driven inflation [1,27], the electroweak symmetry breaking, the Higgs mechanism, the mass acquisition [139], and the chirality of fermions (and spacetime); all resulting from the multi-fold gravity electroweak symmetry breaking [1,4,17,23,29,32-34,52,64,66,72,74,124,139,140]. The multi-fold theory has concrete implications on New Physics like supersymmetry, superstrings, M-theory and Loop Quantum Gravity (LQG) [1,8-21,66,90,112,134].

Multi-folds are encountered in GR at Planck scales [5,6] and in Quantum Mechanics[21] (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 [1,52,94,104].

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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 viXra:2006.0088, (June 9, 2020). Errata/improvements/latest updates at https://zenodo.org/doi/10.5281/zenodo.7792911.

[2]: Wikipedia, "Reissner–Nordström metric", https://en.wikipedia.org/wiki/Reissner%E2%80%93Nordstr%C3%B6m_metric. Retrieved on March 21, 2020.

[3]: Wikipedia, "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", viXra: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, (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-conjecturein-general-relativity/, January 1, 2022.

[21] Standing in for Quantum Physics in general.

[6]: 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/, February 22, 2022.

[7]: 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/, February 7, 2022.

[8]: Stephane Maes, (2020-22), "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 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/, 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 tittle or URL/publication numbers.

[10]: Stephane H Maes, (2022), "Understanding the Multi-fold theory principles and the SM_G", osf.io/xc74t, https://shmaesphysics.wordpress.com/2022/03/11/understanding-the-multi-fold-theory-principles-and-the-sm_g/, March 11, 2022. Also as Stephane H Maes, (2022), "A tutorial on the Multi-fold theory principles and the SM_G", viXra:2303.0154v1, https://shmaesphysics.wordpress.com/blog-2/a-tutorial-on-the-multi-fold-theory-principles-and-the-sm_g/, March11, 2022.

[11]: 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.

[12]: 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.

[13]: 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://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.

[14]: Stephane H Maes, (2020), "Circular Arguments in String and Superstring Theory from a Multi-fold Universe Perspective", viXra: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.

[15]: Stephane H Maes, (2021), "The String Swampland and de Sitter Vacua: A Consistent Perspective for Superstrings and Multi-fold Universes", viXra: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.

[16]: Stephane H Maes, (2021), "Quantum Gravity Asymptotic Safety from 2D Universal Regime and Smooth Transition to Dual Superstrings", viXra: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.

[17]: Stephane H Maes, (2020), "A Non-perturbative Proof of the Asymptotic Safety of 4D Einstein Gravity, With or Without Matter", https://doi.org/10.5281/zenodo.7953796, 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, viXra:2305.0138.

[18]: Stephane H Maes, (2020), “Dualities or Analogies between Superstrings and Multi-fold Universe”, viXra:2006.0178v1, https://shmaesphysics.wordpress.com/2020/06/14/dualities-or-analogies-between-superstrings-and-multi-fold-universes/, June 14, 2020.

[19]: 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/, June 18, 2020.

[20]: 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/, July 5, 2020.

[21]: Stephane H Maes, (2022), “Oops For The Loops II: Real Oops; LQG Does Not Optimize the Hilbert Einstein Action”, viXra: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.

[22]: 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/, July 28, 2022.

[23]: Stephane H. Maes, (2022), “Justifying the Standard Model U(1) x SU(2) x SU(3) Symmetry in a Multi-fold Universe”, https://doi.org/10.5281/zenodo.8422911, 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, (viXra:2310.0040v1).

[24]: Stephane H Maes, (2020), “The E/G conjecture: entanglement is gravity and gravity is entanglement”, viXra:2010.0139v1, https://shmaesphysics.wordpress.com/2020/10/15/the-e-g-conjecture-entanglement-is-gravity-and-gravity-is-entanglement/, October 15, 2020.

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

[26]: 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/, June 19, 2020.

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

[28]: 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/, June 16, 2020.

[29]: Stephane H. Maes, (2022), “Invalidation and Proof of the Mass Gap, and Viability of The Standard Model on a Discrete Spacetime”, https://doi.org/10.5281/zenodo.8237456, 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. (viXra:2308.0059).

[30]: Stephane H. Maes, (2022), Stephane H. Maes, (2022), “A Conjecture: No Dark Matter will be discovered at LHC, or elsewhere”, (v2), https://doi.org/10.5281/zenodo.8175806, https://shmaesphysics.wordpress.com/2022/07/08/a-prediction-no-dark-matter-will-be-discovered-at-lhc-or-elsewhere/, July 8, 2022, viXra:2307.0119.

[31]: 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://doi.org/10.5281/zenodo.8306942, 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, (viXra:2309.0005).

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

[33]: 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/, August 20, 2020.

[34]: 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/, November 4, 2020.

[35]: 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/, March 16, 2021.

[36]: 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/, December 4, 2020.

[37]: Stephane H Maes, (2022), "Can Chirality Flips Occur in a Multi-Fold Universe? What About Conservation Laws? II", viXra: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 and Stephane H Maes, (2020), "Can Chirality Flips Occur in a Multi-Fold Universe? What About Conservation Laws?", viXra: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.

[38]: 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/, June 19, 2020.

[39]: 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/, June 12, 2020.

[40]: 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/, June 13, 2020.

[41]: 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/, 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/, June 15, 2020.

[42]: 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/, June 23, 2020.

[43]: 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/ , June 21, 2020.

[44]: 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/, June 24, 2020.

[45]: 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/, June 24, 2020.

[46]: 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/, July 5, 2020. (V2: April 8, 2021)

[47]: 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/, October 1, 2020.

[48]: 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/, March 29, 2021.

[49]: 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/, April 1, 2021.

[50]: Stephane H Maes, (2021), “New Physics is often not so new”, osf.io/z3sj6, https://shmaesphysics.wordpress.com/2021/04/27/new-physics-is-often-not-so-new/, April 27, 2021, https://zenodo.org/records/7791704.

[51]: Stephane H Maes, (2022), “Direction of Possible Multi-folds Corrections to the W Boson Mass”, osf.io/qvewa, https://shmaesphysics.wordpress.com/2022/04/08/direction-of-possible-multi-folds-corrections-to-the-w-boson-mass/, April 8, 2022, viXra:2304.0020.

[52]: Stephane H Maes, (2022), “Multi-folds in Yang Mills Feynman Diagrams”, osf.io/y8fpd, https://shmaesphysics.wordpress.com/2022/04/05/multi-folds-in-yang-mills-feynman-diagrams/, April 5, 2022, viXra:2303.0161.

[53]: Stephane H. Maes, (2022), “Time-Varying Multi-fold Dark Energy Effects and Implications for the Hubble Tension”, https://doi.org/10.5281/zenodo.10396357, https://shmaesphysics.wordpress.com/2022/11/13/time-varying-multi-fold-dark-energy-effects-and-implications-for-the-hubble-tension/, November 13, 2022, osf.io/g2vzy/, viXra:2312.0083v1. Also as Stephane H. Maes, (2022), “The Possibility of a Multi-fold Time-Varying Hubble Constant”, viXra:2312.0083v1.

[54]: Stephane H Maes, (2020), ”Explaining Dark Matter Without New Physics?”, viXra:2007.0006, https://shmaesphysics.wordpress.com/2020/06/21/explaining-dark-matter-without-new-physics/, June 21, 2020.

[55]: 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://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.

[56]: Stephane H Maes, (2020), ”Multi-Fold Universe Dark Matter Effects Survive Low-Mass Galaxies with Dark Matter Deficits and Excesses”, viXra: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.

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

[58]:]: Stephane H Maes, (2022), “Hints of Multi-fold Dark Matter Effects in the Universe”, osf.io/krw7g, https://shmaesphysics.wordpress.com/2022/03/14/hints-of-multi-fold-dark-matter-effects-in-the-universe/, March 14, 2022, https://zenodo.org/record/7791678.

[59]: 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, (https://osf.io/mahsu, viXra:2311.0018v1).

[60]: Stephane H. Maes, (2022), “Explaining Imbalance of Tidally Ejected Stars from Open Stars Clusters Without MOND”, https://doi.org/10.5281/zenodo.10421124, https://shmaesphysics.wordpress.com/2022/11/19/explaining-imbalance-of-tidally-ejected-stars-from-open-stars-clusters-without-mond/, November 19, 2022, https://osf.io/bp64c.

[61]: Stephane H. Maes, {2022), “Black holes effects outside the black holes do not mean that Hawking radiation is not occurring at its horizon”, https://shmaesphysics.wordpress.com/different-approaches-to-compute-hawking-black-holes-decay/#comment-5027, November 23, 2022.

[62]: Stephane H Maes, (2022), “Multi-fold Discrete Fractal Spacetime, and the Viability of Local vs. Non-Local Hidden Variables”, https://doi.org/10.5281/zenodo.10344634, 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, osf.io/qevys, viXra:2312.0065v1.

[63]: 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”, viXra: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.

[64]: Stephane H. Maes, (2022), “A Better Quantum Extremal Surface and Island Interpretation that explains the Associated Massive Gravity”, https://doi.org/10.5281/zenodo.10437116, https://shmaesphysics.wordpress.com/2022/12/03/a-better-quantum-extremal-surface-and-island-interpretation-that-explains-the-associated-massive-gravity/, December 3, 2022, (https://osf.io/dn3kh).

[65]: Stephane H Maes, (2021), “Pointers to Nowhere with Geometric Unity Theory, or Some Ways Forward in Multi-fold Universes?”, viXra: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.

[66]: 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://doi.org/10.5281/zenodo.10207057, 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, (osf.io/xwf6q/). Also published as: Stephane H Maes, (2022), “The Replica Trick, Wormholes, Island formula, and Quantum Extremal Surfaces”, September 26, 2022 (viXra:2311.0154v1).

[67]: Stephane H Maes, (2021), “Right-handed Neutrinos and Traversable Wormholes: the key to entanglement, gravity and multi-folds extensions to ER=EPR?”, viXra: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-erepr/, April 3, 2021.

[68]: 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/, April 11, 2021.

[69]: Stephane H Maes, (2022), "Trans-Planckian Censorship Conjecture: Factual in Multi-fold Universes as well as GR Universes", viXra: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.

[70]: Stephane H Maes, (2021), "Spacetime and Gravity are 2D around Planck Scales: A Universal Property of Consistent Quantum Gravity", viXra:2211.0001v1, https://shmaesphysics.wordpress.com/2021/03/23/spacetime-and-gravity-are-2d-around-planck-scales-a-universal-property-of-consistent-quantum-gravity/, March 20, 2021.

[71]: 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/, December 20, 2020.

[72]: 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://doi.org/10.5281/zenodo.10467452, 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, (osf.io/udhbf). Also published as: Stephane H. Maes, (2022), "2D Random Walks of Massless Higgs Bosons", viXra:2401.0073v1, 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.

[73]: Stephane H Maes, (2020), "No Gravity Induced Wave Function Collapse in a Multi-fold Universe", viXra:2012.0152v1, https://shmaesphysics.wordpress.com/2020/09/11/no-gravity-induced-wave-function-collapse-in-a-multi-fold-universe/, September 11, 2020. Also as: Stephane H Maes, (2020), "No Gravity Superposition Induced Wave Function Collapse in a Multi-fold Universe", viXra:2012.0152v1, https://shmaesphysics.wordpress.com/2020/09/11/no-gravity-induced-wave-function-collapse-in-a-multi-fold-universe/, September 11, 2020.

[74]: 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://doi.org/10.5281/zenodo.10443847, 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. Also published as Stephane H. Maes, (2022), "Multi-fold Gravity can Violate Parity Symmetry", 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.

[75]: Stephane H Maes, (2021), ""Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe": 2D or 2+1D spacetime at small scales", viXra:2103.0142, https://shmaesphysics.wordpress.com/2021/03/20/quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe-2d-or-21d-spacetime-at-small-scales/, March 20, 2021.

[76]: 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.

[77]: Stephane H. Maes, (2021), "Comment on 4D spacetime and follow-up comments", 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. Retrieved on February 21, 2021.

[78]: Stephane H. Maes, (2021), "Comment on 4D spacetime and follow-up comments: 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-1579, February 18, 2021. Retrieved on February 21, 2021.

[79]: Stephane H. Maes, (2021), "Comment on 2D spacetime and follow-up comments", 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-1695, March 3, 2021. Retrieved on March 31, 2021.

[80]: Stephane H. Maes, (2021), "Comment on 4D spacetime and follow-up comments", 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-1891, March 30, 2021. Retrieved on March 31, 2021.

[81]: Stephane H. Maes, (2021), "Comment on 4D spacetime and follow-up comments", 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-1906, April 1, 2021. Retrieved on December 27, 2022.

[82]: Stephane H. Maes, (2022), "Additional arguments for 4D spacetime for our real universe", 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-4679, September 21, 2022. Retrieved on December 27, 2022.

[83]: Stephane H Maes, (2020), "Call for Collaboration", https://shmaesphysics.wordpress.com/2020/09/07/do-you-want-a-phd-or-who-knows-a-nobel-price-in-physics/, September 6, 2020.

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

[85]: Stephane H Maes, (2022), "Gravitational Bootstrap, S-matrix, Superstrings, and The Plausible Unphysicality of Gravitons", viXra:2301.0155v1, https://shmaesphysics.wordpress.com/2022/02/06/gravitational-bootstrap-s-matrix-superstrings-and-the-plausible-unphysicality-of-gravitons/, February 6, 2022.

[86]: Stephane H Maes, (2020), "Particles, Especially Virtual Particles, in a Multi-fold Universe vs. QFT", viXra:2010.0133v1, https://shmaesphysics.wordpress.com/2020/07/11/particles-especially-virtual-particles-in-a-multi-fold-universe-vs-qft/ , July 10, 2020.

[87]: 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.

[88]: 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/, August 1, 2022. (Originally published July 11, 2020).

[89]: 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/, October 31, 2020.

[90]: 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/ , June 26, 2020.

[91]: 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/, August 10, 2020.

[92]: Stephane H. Maes, (2022), "Comments on radiation black hole simulation on a lattice", 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/#comment-5099, December 2, 2022.

[93]: Stephane H. Maes, (2021), "Neutrons are forming an external skin in Nuclei and Neutron Stars", https://zenodo.org/doi/10.5281/zenodo.14582585, https://shmaes.wordpress.com/2021/05/08/neutrons-are-forming-an-external-skin-in-nuclei-and-neutron-stars/, May 8, 2021. (V1) (V3 is January 7, 2024). (osf.io/zdy4s/, viXra:2501.0029).

[94]: 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", v1.1, https://doi.org/10.5281/zenodo.7827248, 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. (v1: at zenodo.7827249).

[95]: Stephane H. Maes, (2022), "Schwinger effect and charged black holes", https://shmaesphysics.wordpress.com/2020/11/01/multi-fold-black-holes-entropy-evolution-and-quantum-extrema/#comment-4686, September 25, 2022.

[96]: Stephane H. Maes, "Comments on asymmetry of distributions of ejected star from gas clusters", https://shmaesphysics.wordpress.com/2020/06/21/explaining-dark-matter-without-new-physics/#comment-4813 and subsequent comments, October 27, 2022

[97]: 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/, September 12, 2020.

[98]: 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/, September 14, 2020.

[99]: 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/, December 25, 2020.

[100]: Wikipedia, "Lambda-CDM model", https://en.wikipedia.org/wiki/Lambda-CDM_model. Retrieved on August 14, 2022.

[101]: Stephane H. Maes, (2022), "CO2 and CH4 absorption powered by nuclear fusion, via fission, is the only way to manage climate change and the Planet's trigger points", viXra:2211.0154v1, https://shmaes.wordpress.com/2022/04/09/co2-and-ch4-absorption-powered-fission-is-the-only-way-to-manage-climate-change-and-the-planets-trigger-points/, April 9, 2022.

[102]: Stephane H Maes, (2021), "Oops For The Loops: Mounting LQG Woes And A Challenge To The LQG Community", viXra:2212.0168, https://shmaesphysics.wordpress.com/2021/12/30/oops-for-loops-mounting-lqg-woes-and-a-challenge-to-the-lgq-community/, December 29, 2021.

[103]: 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.

[104]: Stephane H Maes, (2021), "Multi-fold gravity and double copy of gauge theory", osf.io/xun82, https://shmaesphysics.wordpress.com/2021/05/04/multi-fold-gravity-and-double-copy-of-gauge-theory/, May 4, 2021, viXra:2303.0114.

[105]: 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/, 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/, June 28, 2020.

[106]: Stephane H Maes, (2021), "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!", viXra:2111.0144v2, https://shmaesphysics.wordpress.com/2021/11/28/how-the-er-epr-gr-qm-and-ads-cft-correspondence-conjectures-can-be-explained-in-multi-fold-theory-and-the-e-g-conjecture-explains-and-realize-in-a-multi-fold-universe-a-call-to-the-physics-comm/, December 28, 2021.

[107]: 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/, January 12, 2021.

[108]: Stephane H. Maes, (2022), "JWST and the Big Bang invalidation", 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, and following comments. August 21, 2022.

[109]: Stephane H. Maes, (2022), "Schwinger effect dominates near the horizon of charged black holes near extremality and reduces the charge", 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/#comment-4687, September 23, 2022.

[110] Stephane H Maes, (2022), "Charm of the proton", https://shmaesphysics.wordpress.com/2021/03/29/new-physics-with-lhcb-to-explain-loss-of-lepton-universality-or-just-gravity/#comment-3791, March 27, 2022.

[111]: Stephane H. Maes, (2022-2023), "Confusing mathematical duality to predict quantum computing algorithm, with building a wormhole", https://shmaesphysics.wordpress.com/2020/10/11/circular-arguments-in-string-and-superstring-theory-from-a-multi-fold-universe-perspective/comment-page-1/#comment-5093, and following related comments, November 30, 2022.

[112]: Stephane H. Maes, (2023), "No supersymmetry", https://shmaesphysics.wordpress.com/2023/11/21/no-supersymmetry/, November 21,2023.

[113]: Stephane H. Maes, (2023), "Justification for the multi-fold mappings, and dynamic multi-fold mechanism", https://shmaesphysics.wordpress.com/2020/12/24/the-w-type-multi-fold-hypothesis-and-quantum-physics-interpretation-of-wave-functions-and-qft/comment-page-1/#comment-8092, October 29, 2023.

[114]: Stephane H. Maes, (2023), "Yeah or Nay on Black Holes as Explanation for Dark Energy?", osf.io/369pd, https://shmaesphysics.wordpress.com/2023/03/01/yeah-or-nay-on-black-holes-as-explanation-for-dark-energy/, V3, March 26, 2023. (V2: March 12, 2023, V1: Stephane H. Maes, (2023), "Yeah or Nay on Black Holes as Explanation for Dark Energy?", viXra:2303.0031, https://shmaesphysics.wordpress.com/2023/03/01/yeah-or-nay-on-black-holes-as-explanation-for-dark-energy/, March 1, 2023).

[115]: Stephane H. Maes, (2023), "Dynamic sources, Dynamic Multi-folds, and General Relativity Lense-Thirring and Frame Dragging Effects", https://doi.org/10.5281/zenodo.14737010,

https://shmaesphysics.wordpress.com/2023/03/12/dynamic-sources-dynamic-multi-folds-and-general-relativity-lens-thirring-and-frame-dragging-effects/, March 12, 2023, https://osf.io/ytmw6_v1/download/

[116]: Stephane H. Maes, (2023), “The Multi-fold Least Action Principle, a Quasi Theory Of Everything”, https://doi.org/10.5281/zenodo.14542569, https://shmaesphysics.wordpress.com/2023/02/19/the-multi-fold-least-action-principle-a-quasi-theory-of-everything/, February 19, 2023. (osf.io/2ncqf/, viXra:2412.0145v1).

[117]: Stephane H. Maes, (2023), “Maybe, black holes do not systematically decohere quantum states”, https://shmaesphysics.wordpress.com/2020/11/01/multi-fold-black-holes-entropy-evolution-and-quantum-extrema/#comment-6315, March 7, 2023.

[118]: Stephane H. Maes, (2023), “No electroweak / Higgs mass hierarchy problem in multi-fold theory”, https://shmaesphysics.wordpress.com/2021/03/28/multi-fold-gravity-electroweak-theory-and-symmetry-breaking/#comment-6794, March 30, 2023.

[119]: Stephane H. Maes, “Right-handed neutrinos in the multi-fold stabilize the multi-fold unconstrained KK space time matter induction and scattering”, https://shmaesphysics.wordpress.com/2021/04/03/right-handed-neutrinos-and-traversable-wormholes-the-key-to-entanglement-gravity-and-multi-folds-extensions-to-erepr/comment-page-1/#comment-6875, April 8, 2023.

[120]: Stephane H. Maes, (2023), “No lack of clumpiness, just as needed”, https://shmaesphysics.wordpress.com/2020/06/21/explaining-dark-matter-without-new-physics/comment-page-1/#comment-6974. April 12, 2023.

[121]: Stephane H. Maes, (2023), “Multi-fold Universes, Multiverses and Many Worlds”, https://shmaesphysics.wordpress.com/2023/04/08/multi-fold-universes-multi-folds-and-many-worlds/, April 8, 2023.

[122]: Stephane H. Maes, (2023), ‘Comment on black hole decoherence”, https://shmaesphysics.wordpress.com/2020/11/01/multi-fold-black-holes-entropy-evolution-and-quantum-extrema/#comment-6315, March 7, 2023.

[123]: Stephane H Maes, (2023), “Comments of the universe is too smooth”, https://shmaesphysics.wordpress.com/2020/06/21/explaining-dark-matter-without-new-physics/#comment-6086, February 9, 2023, and https://shmaesphysics.wordpress.com/2020/06/21/explaining-dark-matter-without-new-physics/#comment-6974, April 12, 2023.

[124]: Stephane H Maes, (2023), “Our real universe is macroscopically 4D. Hints come from every direction & show that it had to be so”, https://shmaesphysics.wordpress.com/2023/04/23/our-real-universe-is-macroscopically-4d-hints-come-from-every-directions-show-that-it-had-to-be-so/, April 23, 2023.

[125]: Stephane H Maes, (2023), “No Gravitational Evaporation of Everything à la Schwinger, only for Black Holes”, https://shmaesphysics.wordpress.com/2023/07/15/no-gravitational-evaporation-of-everything-a-la-schwinger-only-for-black-holes/, July 15, 2023.

[126]: Stephane H Maes, (2023), “Unstable QFT and SM with Gravity except in a Multi-fold Universe”, https://shmaesphysics.wordpress.com/2023/07/19/unstable-qft-and-sm-with-gravity-except-in-a-multi-fold-universe/, July 19, 2023.

[127]: Stephane H. Maes, (2023), “Comments about massive galaxies without dark matter”, https://shmaesphysics.wordpress.com/2020/10/14/multi-fold-universe-dark-matter-effects-survive-low-mass-galaxies-with-dark-matter-deficits-and-excesses/#comment-7430, July 20, 2023.

[128]: Stephane H Maes, (2023), "Less Cracks in the Standard Cosmology in a Multi-fold Universe with its Quantum Random walks", https://shmaesphysics.wordpress.com/2023/06/20/less-cracks-in-the-standard-cosmology-in-a-multi-fold-universe-with-its-quantum-random-walks/, June 19, 2023.

[129]: Stephane H. Maes, (2023), "Ad Astra With Warp Drives? Probably Not", https://shmaesphysics.wordpress.com/2023/12/09/ad-astra-longe-with-warp-drives-probably-not/, December 9, 2023.

[130]: Stephane H Maes, (2023), "2D gravity and 2D Yang Mills Physics is all what matters", https://shmaesphysics.wordpress.com/2023/04/23/our-real-universe-is-macroscopically-4d-hints-come-from-every-directions-show-that-it-had-to-be-so/comment-page-1/#comment-7588, August 5, 2023.

[131]: Stephane H Maes (2023), "The Multi-fold Theory – Draft Raw Compendium of Research Papers (till August, 2023)", https://doi.org/10.5281/zenodo.8242021, https://shmaesphysics.wordpress.com/2023/08/12/the-multi-fold-theory-draft-raw-compendium-of-research-papers-till-august-2023/, August 12, 2023, (https://osf.io/swqmb).

[132]: Stephane H Maes, (2023), "Barnett's resolution of the Minkowski – Abraham dilemma holds, no 4-vector issue", https://zenodo.org/records/10071847, https://shmaes.wordpress.com/2023/08/11/barnetts-resolution-of-the-minkowski-abraham-dilemma-holds-no-4-vector-issue/ August 13, 2023, (https://osf.io/bd8ju, viXra:2311.0023v1).

[133]: Stephane H. Maes, (2023), "Persisting on No Decoherence due to Gravity, Black Holes, or Spacetime Curvature Superpositions", https://shmaesphysics.wordpress.com/2023/08/18/persisting-on-no-decoherence-due-to-gravity-black-holes-or-spacetime-curvature-superpositions/, August 18, 2023.

[134]: Stephane H. Maes, (2023), "No supersymmetry at D<=4 with a positive cosmological constant", https://shmaesphysics.wordpress.com/2022/07/08/a-prediction-no-dark-matter-will-be-discovered-at-lhc-or-elsewhere/#comment-7563. July 23, 2023.

[135]: Stephane H. Maes, (2023), "The universe is exactly the only thing that it could be if it is a 4D multi-fold universe! No fine-tuning problem, no invocation of God or multiverses", https://shmaesphysics.wordpress.com/2023/04/08/multi-fold-universes-multi-folds-and-many-worlds/comment-page-1/#comment-8037, October 7, 2023.

[136]: Stephane H. Maes, (2020-2023), "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe – V3: Update to section 4.1 – Multi-folds for Entanglement and EPR", https://shmaesphysics.wordpress.com/quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe-v3-update-to-section-4-1-multi-folds-for-entanglement-and-epr/.

[137]: Stephane H. Maes, (2020-2023), "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe", V3, https://zenodo.org/doi/10.5281/zenodo.7792911, October 29, 2023.

[138]: Stephane H. Maes, (2023), "Path integrals and wormholes impact on the cosmological constant", 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/comment-page-1/#comment-7978, September 3, 2023.

[139]: Stephane H. Maes, (2023), "Microscopic interpretation of mass acquisition from massless Higgs bosons", https://shmaesphysics.wordpress.com/2021/02/28/more-on-multi-fold-particles-as-microscopic-black-holes-with-higgs-regularizing-extremality-and-singularities/#comment-8412, November 5, 2023.

[140]: Stephane H. Maes, (2023), "Justifying the Multi-folds Mechanisms, Mapping, Tenancy and More", https://shmaesphysics.wordpress.com/2023/11/10/justifying-the-multi-folds-mechanisms-mapping-tenancy-and-more/, November 10, 2023.

[141]: Stephane H. Maes, (2023), "In multi-fold theory, the expansion of the universe is not a mirage", https://shmaesphysics.wordpress.com/2020/06/19/explaining-dark-energy-small-cosmological-constant-and-inflation-without-new-physics/#comment-7242, June 20, 2023.

[142]: Stephane H. Maes, "Multi-fold dark energy is also a fluctuation of quantum vacuum fluctuations", https://shmaesphysics.wordpress.com/2020/06/19/explaining-dark-energy-small-cosmological-constant-and-inflation-without-new-physics/#comment-6111, February 18, 2023.

[143]: Stephane H. Maes, (2023), "It's experimentally validated: antimatter falls down, no antigravity", https://shmaesphysics.wordpress.com/2020/07/05/more-matter-than-antimatter-all-falling-down/#comment-8018 and subsequent comments, September 27, 2023.

[144]: Stephane H. Maes, (2023), "Particle internal symmetries and anti-particles when modeled as microscopic black holes or random walk patterns", https://shmaesphysics.wordpress.com/2021/02/28/more-on-multi-fold-particles-as-microscopic-black-holes-with-higgs-regularizing-extremality-and-singularities/#comment-8634, November 28, 2023.

[145]: Stephane H. Maes, (2023), "Information has no mass", https://shmaesphysics.wordpress.com/2023/12/14/information-has-no-mass/, December 14, 2023

[146]: Stephane H. Maes, (2023), "Gravity is Quantum", https://shmaesphysics.wordpress.com/2023/12/19/gravity-is-quantum/, December 19, 2023.

[147]: Stephane H. Maes, (2023), "Multi-folds for Entanglement and EPR", https://zenodo.org/doi/10.5281/zenodo.10059877, https://shmaesphysics.wordpress.com/2023/11/01/multi-folds-for-entanglement-and-epr/ October 29, 2023, (viXra:2311.0001v1), also as "Update to section 4.1 of "Quantum Gravity Emergence from Entanglement in a Multi-Fold Universe" – Multi-folds for Entanglement and EPR", https://shmaesphysics.wordpress.com/2023/10/29/update-to-section-4-1-of-quantum-gravity-emergence-from-entanglement-in-a-multi-fold-universe-multi-folds-for-entanglement-and-epr/, (https://osf.io/54ycm/).

[148]: Stephane H. Maes, (2023), "A Fractal spacetime just leads to rescaled cosmological constant. Yet that may provide a time varying effect", https://shmaesphysics.wordpress.com/2022/10/30/multi-fold-discrete-fractal-spacetime-and-the-viability-of-local-vs-non-local-hidden-variable-viability/comment-page-1/#comment-8896. December 14, 2023.

[149]: Stephane H. Maes, (2023), "Multi-Fold dark Matter effects & Rotation Curve Differences in Galaxies in Clusters, Yet Respect of the Strong Equivalence Principle", https://doi.org/10.5281/zenodo.13766006, https://shmaesphysics.wordpress.com/2023/01/29/multi-fold-dark-matter-effects-rotation-curve-differences-in-galaxies-in-custers-yet-respect-of-the-strong-equivalence-principle/, January 29, 2023, (osf.io/texvj, vixra:2409.0088v1).

[150]: Stephane H. Maes, (2022), "Multi-folds, Non-Commutative Spacetime, Spin, and All That", https://doi.org/10.5281/zenodo.11114501, https://shmaesphysics.wordpress.com/2022/12/31/the-principles-of-quantum-mechanics/, December 31, 2022. Also as https://shmaesphysics.wordpress.com/2022/12/31/multi-folds-non-commutative-spacetime-spin-and-all-that/, (osf.io/au7wc, viXra:2405.0022v1).

[151]: Stephane H. Maes, (2024), "Collapses, Singularities, Censorship, Conjectures, and More", https://shmaesphysics.wordpress.com/2024/07/16/collapses-singularities-censorship-conjectures-and-more/, July 16, 2024.

[152]: Stephane H. Maes, (2024), "June 2024 Status of the Multi-fold Theory", https://doi.org/10.5281/zenodo.13345964, https://shmaesphysics.wordpress.com/2024/08/19/june-2024-status-of-the-multi-fold-theory/, June 22, 2024.

[153]: Stephane H. Maes, (2024), "About binaries alleged gravity anomalies", https://shmaesphysics.wordpress.com/2023/01/29/multi-fold-dark-matter-effects-rotation-curve-differences-in-galaxies-in-custers-yet-respect-of-the-strong-equivalence-principle/#comment-9726, September 10,

[154]: Stephane H Maes, (2024), "A different and more generic proof based on the multi-fold theory, that confinement implies mass effects and chiral symmetry breaking", https://shmaesphysics.wordpress.com/2021/02/28/more-on-multi-fold-particles-as-microscopic-black-holes-with-higgs-regularizing-extremality-and-singularities/comment-page-1/#comment-9952, November 3, 2024.

[155]: Stephane H. Maes, (2024), "A discrete multi-fold spacetime realized by random walk, implies a non-commutative spacetime", https://shmaesphysics.wordpress.com/2022/12/31/multi-folds-non-commutative-spacetime-spin-and-all-that/#comment-9820, September 23, 2024.

[156]: Stephane H Maes, (2021), "Comments on "No issue of unnaturalness and mass hierarchy with the Higgs mass"", https://shmaesphysics.wordpress.com/2021/04/27/new-physics-is-often-not-so-new/comment-page-1/#comment-3026, December 24, 2021.

[157]: Stephane H. Maes, (2024), "Physics Salvages The Third Law Of Black Hole Thermodynamics", https://shmaesphysics.wordpress.com/2024/11/24/physics-salvages-the-third-law-of-black-hole-thermodynamics/, November 24, 2024.

[158]: Stephane H. Maes, "No Issue with the Quantization of Electrostatic Fields", https://shmaesphysics.wordpress.com/2024/12/31/no-issue-with-the-quantization-of-electrostatic-fields/, December 31, 2024.

[159]: Stephane H. Maes, (2025), "Looks like we were right. Neutrinos are probably not Majorana Fermions", https://shmaesphysics.wordpress.com/2020/06/21/right-handed-neutrinos-ask-gravity/#comment-10501, March 23, 2025.

[160]: Stephane H. Maes, (2024), "Gödel's incompleteness theorems implies no full theory is possible", https://shmaesphysics.wordpress.com/2023/02/19/the-multi-fold-least-action-principle-a-quasi-theory-of-everything/#comment-10066, November 30, 2024. Based on: Stephane H. Maes, (1989), "Feynman Path Integrals", and communication to Prof. J. Weyers, Quantum Physics Seminar as part of BS in Physics, FYMA, UC Louvain.

[161]: Stephane H. Maes, (2024), "Spin as angular momentum of massless Higgs bosons in Higgs condensate or random walks", https://shmaesphysics.wordpress.com/2022/12/31/multi-folds-non-commutative-spacetime-spin-and-all-that/#comment-10027, November 26, 2024.

[162]: Stephane H. Maes, (2025), "No Extremality or Singularity for Particles as Multi-fold Black Holes", https://shmaesphysics.wordpress.com/2025/03/27/no-extremality-or-singularity-for-particles-as-multi-fold-black-holes/, March 27, 2025.

[163]: Stephane H. Maes, (2024), "Explaining the mass anisotropy of certain semi-Dirac Fermions in semimetals", https://shmaesphysics.wordpress.com/2021/02/28/more-on-multi-fold-particles-as-microscopic-black-holes-with-higgs-regularizing-extremality-and-singularities/comment-page-1/#comment-9951, November 3, 2024.

[164]: Stephane H. Maes, (2024), "Gravity in SM_G contributes in the right direction to the discrepancies of CP violation in B-mesons with the SM", https://shmaesphysics.wordpress.com/2022/07/08/a-prediction-no-dark-matter-will-be-discovered-at-lhc-or-elsewhere/#comment-10078, December 6, 2024.

[165]: Stephane H. Maes, (2024), “As we predicted, still no sterile neutrino”, https://shmaesphysics.wordpress.com/2020/10/02/no-conventional-sterile-neutrinos-in-a-multi-fold-universe-just-smg-business-as-usual/#comment-10039, November 26, 2024.

[166]: David Tong, (2018), “Gauge Theory”, Cambridge University, https://www.damtp.cam.ac.uk/user/tong/gaugetheory/gt.pdf.

[167]: Stephane H. Maes, (2024), “Comments on the Alena tensor as Grand Unification by mapping all interactions to flat spacetime”, https://shmaesphysics.wordpress.com/2023/02/19/the-multi-fold-least-action-principle-a-quasi-theory-of-everything/#comment-10087, December 10, 2024.

[168]: Stephane H. Maes, (2024), “Continuous mathematics to model Physics are just degenerate approximations of finite / discrete mathematics”, https://shmaesphysics.wordpress.com/2023/11/21/no-supersymmetry/#comment-9457, July 13, 2024.

[169]: Stephane H. Maes, (2022), “Background independence implies discreteness”, https://shmaesphysics.wordpress.com/2021/04/18/multi-fold-non-commutative-spacetime-higgs-and-the-standard-model-with-gravity/comment-page-1/#comment-3304, January 11, 2022.

[170]: Stephane H. Maes, "Consistencies and Implications of 2D Massless Random Walks: Discrete Non-commutative Spacetime, and No Flat Supersymmetry", https://shmaesphysics.wordpress.com/2024/12/12/consistencies-and-implications-of-2d-massless-random-walks-discrete-non-commutative-spacetime-and-no-flat-supersymmetry/, December 12, 2024.

[171]: nLab, “Skyrmions”, https://ncatlab.org/nlab/show/skyrmion. Retrieved for this paper on December 10, 2024.

[172] : Wikipedia, “Skyrmion”, https://en.wikipedia.org/wiki/Skyrmion. Retrieved for this paper on December 10, 2024.

[173]: Stephane H. Maes, (2024), “QFT on discrete spacetime is OK”, https://shmaesphysics.wordpress.com/2020/12/13/viable-lattice-spacetime-and-absence-of-quantum-gravitational-anomalies-in-a-multi-fold-universe/comment-page-1/#comment-10322, December 30, 2024.

[174]: Stephane H. Maes, (2025), “Mathematics, Physics / QFT on discrete spacetime is more general than Mathematics and Physics / QFT on continuous spacetime”, https://shmaesphysics.wordpress.com/2022/10/30/multi-fold-discrete-fractal-spacetime-and-the-viability-of-local-vs-non-local-hidden-variable-viability/#comment-9455, July 13, 2024.

[175]: Stephane H. Maes, (2025), “QFT on discrete and / or non-commutative spacetime”, https://shmaesphysics.wordpress.com/2024/12/12/consistencies-and-implications-of-2d-massless-random-walks-discrete-non-commutative-spacetime-and-no-flat-supersymmetry/#comment-10326, January 7, 2025.

[176]: Stephane H. Maes, (2025), “Preons as Massless Higgs Bosons”, https://shmaesphysics.wordpress.com/2025/01/09/preons-as-massless-higgs-bosons/, January 9, 2025.

[177]: Paul C. W. Davies, Damien A. Easson, Phillip B. Levin, (2024), “Nonsingular black holes as dark matter”, arXiv:2410.21577v1.

[178]: Aharonov, Y., Komar, A., & Susskind, L., (1969), “Superluminal Behavior, Causality, and Instability”, Physical Review, 182(5), 1400–1403.

[179]: Wikipedia, “Dilaton”, https://en.wikipedia.org/wiki/Dilaton. Retrieved May 13, 2020.

[180]: JiJi Fan, (2016), “Ultralight Repulsive Dark Matter and BEC”, arXiv:1603.06580v2.

[181]: Y. Aharonov, A. Komar, and L. Susskind, (1969), “Superluminal Behavior, Causality, and Instability”, Phys. Rev. 182, 1400 – 25 June, 1969.

[182]: Edouard B. Manoukian, (2016), “Quantum Field Theory I. Foundations and Abelian and Non-Abelian Gauge Theories”, Springer.

[183]: Bibhushan Shakya, (2023), “The Tachyonic Higgs and the Inflationary Universe”, arXiv:2301.08754v1.

[184]: Ahmed Abokhalil, (2023), “The Higgs Mechanism and Higgs Boson: Unveiling the Symmetry of the Universe”, arXiv:2306.01019v2.

[185]: Jerzy Paczos, Szymon Cedrowski, Krzysztof Turzyński, Andrzej Dragan, (2024), “Higgs field as a source of tachyons”, arXiv:2407.06640v1.

[186]: Wikipedia, “Higgs boson”, https://en.wikipedia.org/wiki/Higgs_boson. Retrieved on November 7, 2019.

[187]: Wikipedia, “Tachyonic field”, https://en.wikipedia.org/wiki/Tachyonic_field. Retrieved on April 5, 2019.

[188]: Wikipedia, “Scalar field theory”, https://en.wikipedia.org/wiki/Scalar_field_theory. Retrieved on October 5, 2020.

[189]: Wikipedia, “Higgs mechanism”, https://en.wikipedia.org/wiki/Higgs_mechanism. Retrieved on November 6, 2020.

[190]: Okinawa Institute of Science and Technology, (2025), “Study finds soccer teams move as though they are a single person, offering new insights into collective behavior”, https://phys.org/news/2025-03-soccer-teams-person-insights-behavior.html, March 11, 2025.

[191]: Ivan Shpurov, Tom Froese, Takashi Ikegami, (2024), “Football as Foraging? Movements by Individual Players and Whole Teams Exhibit Lévy Walk Dynamics”, Complexity, December 19, 2024.

[192]: David Tong, (206-2007), “Quantum Field Theory. University of Cambridge Part III Mathematical Tripos”, Cambridge University, http://www.damtp.cam.ac.uk/user/tong/qft.html.

[193]: Marino, Eduardo C., (2017), “Quantum field theory approach to condensed matter physics”, Cambridge University Press.

[194]: Wikipedia, “Bertrand's theorem”, https://en.wikipedia.org/wiki/Bertrand%27s_theorem. Retrieved for this paper on March 16, 2025.

[195] Physics Stack Exchange, (2013), “No stable closed orbits for a Newtonian gravitational field in d≠3 spatial dimensions”, https://physics.stackexchange.com/questions/66417/no-stable-closed-orbits-for-a-newtonian-gravitational-field-in-d-neq-3-spatial/. Retrieved on March 16, 2025.

[196]: Raphael Bousso, (2002), “The holographic principle”, arXiv:hep-th/0203101v2.

[197]: Ahmed Farag Ali, Aneta Wojnar, (2024), “A covariant tapestry of linear GUP, metric-affine gravity, their Poincaré algebra and entropy bound”, arXiv:2401.05941v3.

[198]: Burinskii, Alexander, (2008), “The Dirac-Kerr-Newman electron”, arXiv:0507109v4.

[199]: Alexander Burinskii, (2020), “The Kerr–Newman Black Hole Solution as Strong Gravity for Elementary Particles”, https://www.researchgate.net/publication/343811848.

[199]: Alexander Burinskii, (2015), “Gravitating lepton bag model”, arXiv:1505.03439v1.

[200]: A. Burinskii, (2010), “Regularized Kerr-Newman Solution as a Gravitating Soliton”, J. Phys. A: Math. Theor. 43 (2010) 392001.

[201]: A. Burinskii, (2014), “Kerr-Newman electron as spinning soliton”, Int. J. of Mod. Phys. A 29 1450133.

[202]: Alexander Burinskii, (2019), “Features of spinning gravity in particle physics: supersymmetric core of the Kerr-Newman electron “, IOP Conf. Series: Journal of Physics: Conf. Series 1275, 012031.

[203]: Nima Arkani-Hamed, Yu-tin Huang, Donal O'Connell, (2019-2020), “Kerr Black Holes as Elementary Particles”, arXiv:1906.10100v2.

[204]: E.T. Newman, J. Winicour, (1974), “A Curiosity Concerning Angular Momentum”, J. Math. Phys. 15, 1113, (1974)

[205]: Alexander Burinskii, (2020), “Gravitating Electron Based on Overrotating Kerr-Newman Solution”, Universe 8(11):553

[206]: Alexander Burinskii, (2020), “The bare and gravitationally dressed electron formed from radiative Kerr-Newman black hole”, https://www.researchgate.net/publication/374587192_The_bare_and_gravitationally_dressed_electron_formed_from_radiative_Kerr-Newman_black_hole, October 2023.

[207]: Brando Bellazzini, Csaba Csáki, Jay Hubisz, Javi Serra, John Terning, (2012-2013), “A Higgslike Dilaton”, arXiv:1209.3299v2.

[208]: N. N. Bogolubov, (1946), “On the theory of superconductivity”, J. Phys. USSR. 1947. V. 11. P. 23, https://www.ufn.ru/dates/pdf/j_phys_ussr/j_phys_ussr_1947_11_1/3_bogolubov_j_phys_ussr_1947_11_1_23.pdf.

[209]: D. P. Sankovich, (1991), “Bogolyubov's theory of superfluidity”, in Physics of Particles and Nuclei, (SP MAIK Nauka/Interperiodica), Vol. 41, (7), 2010.

[210]: Yoshihisa Yamamoto, “Bose-Einstein Condensation and Matter-Wave Lasers”, QIS385, https://www.nii.ac.jp/qis/first-quantum/e/forStudents/lecture/.

[211]: Luca Salasnich, (2002), “Particles and Anti-Particles in a Relativistic Bose Condensate”, arXiv:math-ph/0207030v1.

[212]: Eberhard E. Müller, (2018), “Note on Bose-Einstein condensation of photons”, arXiv:1801.05220v1.

[213]: Jan Klaers, Julian Schmitt, Frank Vewinger, Martin Weitz, (2010), “Bose-Einstein condensation of photons in an optical microcavity”, arXiv:1007.4088v2.

[214]: S Fagnocchi, S Finazzi, S Liberati, M Kormos, and A Trombettoni, (2010), “Relativistic Bose–Einstein condensates: a new system for analogue models of gravity”, New Journal of Physics 12, 095012.

[215]: Wikipedia, “Klein paradox”, https://en.wikipedia.org/wiki/Klein_paradox. Retrieved on March 20, 2025.

[216]: Dombey, N., (1999), “Seventy years of the Klein paradox”, Physics Reports, 315(1-3), 41–58.

[217]: Cheng, T., Su, Q., & Grobe, R., (2010), “Introductory review on quantum field theory with space–time resolution”, Contemporary Physics, 51(4), 315–330.

[218]: E. Siri, N. Sadooghi, (2024-2025), “Bose-Einstein condensation in a rigidly rotating relativistic boson gas”, arXiv:2411.12581v2.

[219]: M V Berry, (2012), “Superluminal speeds for relativistic random waves”, J. Phys. A: Math. Theor. 45 185308.

[220]: Thomas Dieterle, Moritz Berngruber, Christian Hölzl, Robert Löw, Krzysztof Jachymski, Tilman Pfau, Florian Meinert, (2020), “Transport of a single cold ion immersed in a Bose-Einstein condensate”, arXiv:2007.00309v2.

[221]: Wikipedia, “Weak gravity conjecture”, https://en.wikipedia.org/wiki/Weak_gravity_conjecture. Retrieved on May 29, 2020.

[222]: Nima Arkani-Hamed, Lubos Motl, Alberto Nicolis, Cumrun Vafa, (2006), “The String Landscape, Black Holes and Gravity as the Weakest Force”, arXiv:hep-th/0601001v2.

[223]: Wikipedia, “Black hole electron”, https://en.wikipedia.org/wiki/Black_hole_electron. Retrieved on April 13, 2020.

[224]: Radhakrishnan C. Nair, (2006), “Photon as a black hole”, SFIN A 1 (2007) 321-326.

[225]: Carver A. Mead, (2000), “Collective Electrodynamics. Quantum Foundations of Electromagnetism”, MIT.

[226]: Christopher S. Baird, (2014), “How can an electron leap between atomic levels without passing through all the space in between?”, https://www.wtamu.edu/~cbaird/sq/2014/06/18/how-can-an-electron-leap-between-atomic-levels-without-passing-through-all-the-space-in-between. Retrieved on July 25, 2022.

[227]: Philip Ball, (2019), “Quantum Leaps, Long Assumed to Be Instantaneous, Take Time. An experiment caught a quantum system in the middle of a jump — something the originators of quantum mechanics assumed was impossible”, https://www.quantamagazine.org/quantum-leaps-long-assumed-to-be-instantaneous-take-time-20190605/. Retrieved on July 3, 2019.