The General Principle of Interaction and the Fractal Spacetime Concept

"Truth is ever to be found in simplicity, and not in the multiplicity and confusion of things."
– *Isaac Newton*

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Abstract

It has long been expected that a quantum field theory (QFT) "beyond the Standard Model" (SM) will eventually unify gravitation with particle interactions. Unfortunately, this "Theory of everything" remains elusive. Alternatively, full unification could be based on a philosophical concept termed hereby as the General Principle of Interaction (GPI), which extends the Einsteinian understanding of vacuum and matter proposing the spacetime geometry-based unification. Assuming that geometry of the four-dimensional (4D) spacetime governs only gravitational forces, a geometry-based description of other forces is possible only with the assumption of undetectable compact extra dimensions, e.g. Kaluza-Klein approach. The assumption of extra dimensions being compactified down to microscopic radii would explain their undetectability and quantization of the forces they govern. The fifth dimension compactified down to an atomic size would be sufficient to explain the electromagnetism with the 5D spacetime geometry. Further addition of a set of three extra dimensions compactified down to a nuclear size would explain the nuclear forces. The 8D spacetime containing hidden subspaces of compactified dimensions, the geometry of which governs forces other than gravitation, comprises the fractal spacetime concept (FSC). Surprisingly, this simple unification approach remains undeveloped.

The GPI-based approach is expected to find a connection between the classical Kaluza-Klein theory and the two most fundamental QFTs, quantum electrodynamics (QED) and quantum chromodynamics (QCD). Generally, the leptons and photons should be understood as the elementary electric charge-induced wave-like 5D spacetime deformations with the "shadow" deformations (projections) in the ordinary 4D spacetime (induced masses); the quarks and gluons should be understood as the color charge-induced wave-like 8D spacetime deformations with the "shadow" deformations in the 5D spacetime (induced electric charges) and the "shadow" ordinary 4D spacetime deformations. The number of the fundamental field types should be reduced to three: strong, electroweak, and gravitational fields. The dark matter is hypothesized as the wave-like 4D spacetime deformations induced by yet unknown gravitational charges. The dark energy is the 4D spacetime background curvature defined by its size and shape. In general, it seems possible to describe all the four types of interaction with the fractal geometry of the multidimensional spacetime. However, the two methods (the GR and the SM) describing the two different geometries (large and compact, respectively) likely cannot be combined in a single unified framework.

1. Introduction

The Standard Model (SM) is presently the most useful theory describing the three types of interactions (electromagnetism, weak and strong nuclear forces) involving elementary particles [1]. It always shows ultimate reliability for experimental data analysis in particle physics. However, the SM is incompatible with the theory of general relativity (GR) [2]. The SM has no clear prediction about the dark matter and poorly explains the dark energy. In addition, the SM has a number of unexplained free parameters. It is a common belief that a certain more fundamental quantum field theory (QFT) exists "beyond the SM". This hypothetical unification theory should explain and unify all the four types of interaction. Unfortunately, this "Theory of everything" appears elusive for many decades. The present letter proposes an alternative approach, a simple philosophical concept, which allows explaining all types of forces solely via the geometry of the spacetime containing a number of undetectable extra dimensions.

1.1. Problems of the QFT-based unification

It has long been expected that a superstring theory, most likely the M-theory, will unify all the types of interaction [3]. Although the superstring theories have a clear potential for the full unification, they exhibit almost no predictive power and are not unique [4, 5], i.e. the number of possible mathematical descriptions they provide is unimaginably great with no clear way of choosing the one relevant to our Universe. This long-lasting theoretical crisis raises serious doubts about the ability of quantum theories to provide a self-consistent unique unified theory. The roots of this crisis are much deeper than just methodological and mathematical difficulties with the development of the unified quantum theory. It is an overwhelming fact that the two main pillars of modern physics, the GR and the SM stand on the two completely different fundamental philosophical principles. The basic definitions of matter, vacuum, and interaction used in the main theories of particle interactions (SM) and gravitation (GR) are completely different. In QFTs, an interaction is understood with the gauge transformation principle interpreted as the exchange of a field carrier quantum, gauge boson between two fermions. Notably, any QFT (including any superstring theory or loop quantum gravity) is based on the Newtonian definition of vacuum and matter understanding vacuum as an empty "set of coordinates" that is not involved in the interaction, while the interacting matter (particles, quarks, strings, etc.) possesses all the properties required for the interaction. Quantum vacuum is not an interacting object *per se* (even considering "spontaneous births" of virtual particle pairs that can interact). On the contrary, the GR is based on the concept of curved spacetime that requires no gauge bosons and involves the Einsteinian understanding of vacuum and matter [2]. Gravitational interactions are mediated directly and solely by the vacuum (spacetime) via its curvature. In the GR, vacuum is the primary interacting object, as its geometrical properties define the interaction directly, while the matter is involved only indirectly, via its ability to curve vacuum. In a logically defined theory, vacuum either mediates interaction or not, but not both. Hence, these two basic principles of interaction are mutually exclusive, and no unification theory could allow for both of these principles simultaneously. Thus, only one of these principles may be truly fundamental and support the full unification.

Therefore, the two different unification strategies can be considered:

1) Let the GR to be converted into a QFT, and all types of interaction including gravitation to be described with the gauge transformation principle philosophy, i.e. QFT-based unification, or

2) Let all the types of interaction to be understood with certain vacuum deformations (spacetime geometry), i.e. geometry-based unification.

Notably, the second approach relies solely on the Einsteinian understanding of vacuum and matter that is more advanced philosophically than the classical Newtonian understandings used in QFTs. Moreover, the phenomenon of dark energy (the origin of the Universe's expansion acceleration) shows an example of the vacuum (at the scale of the whole Universe) possessing a certain "interacting property" not fitting within the Newtonian definition. Surprisingly, the vast majority of active theorists continue to ignore the second approach.

Relying on the Newtonian understanding of non-interacting vacuum and interacting matter fields, QFTs provoke a number of fundamental questions. These include continuously debated philosophical problems of observational indeterminism, non-locality, and wave-particle duality. Another example is the renormalization problem, which appears when calculations of certain finite physical values result in infinities removed by a certain *ad hoc* procedure called renormalization. The reason why the theory requires this procedure remains unknown. Richard Feynman called this renormalization procedure a "hocus-pocus… prevented us from proving that the theory of quantum electrodynamics is mathematically self-consistent" [6]. It is a tantalizing mystery why the theory so beautiful mathematically and well confirmed experimentally yet remains inconsistent at the fundamental philosophical level.

Overall, the QFT-based understanding of interaction has a number of issues of a philosophical significance. The core problem is the incompatibility of the gauge transformation principle's common interpretation with the Einsteinian understanding of vacuum and matter. There is no doubt that the QED and the QCD are indeed the most useful descriptions of quantum interactions, however, they seem a bit incomplete philosophically. Until all these important issues are resolved, the QFT-based unification would hardly be possible.

1.2. Problems of the GR-based unification

The spacetime geometry-based unification relying completely on the Einsteinian understanding of vacuum and matter is the only alternative to the QFT-based unification. It was the Einstein's dream to explain the "base wood" of all forces as manifestations of the "pure marble" of spacetime geometry. Einstein had studied the GR-based unification extensively [7, 8]; unfortunately, with no final success [9]. There are two fundamental questions related to the geometry-based unification: 1) How to explain forces other than gravitation with the spacetime geometry; and 2) How to build a quantum field theory starting from the classical field theory. Assuming that the 4D spacetime geometry governs gravitational forces only, these two problems cannot be solved without a fundamental revision of the spacetime concept assuming the existence of extra spatial dimensions responsible for the particles' interactions.

Notably, the unification of electromagnetism and gravitation within a classical theory was indeed achieved by the brilliant Kaluza's hypothesis of the undetectable fifth dimension [10]. Unfortunately, quantization of this theory remains problematic preventing the unification at the "quantum level". Surprisingly, neither Einstein nor others ever assumed that the electromagnetism is primarily defined by the 5D geometry, not by any type of the 4D spacetime geometry. Moreover, Kaluza had proposed the cylinder condition stating that physics does not depend on the extra coordinate. Oscar Klein [11, 12] had further developed the Kaluza's idea by hypothesizing that the extra dimension is compactified down to a microscopic radius. Since then, all the theories extending the GR by implementing the 5D spacetime (even with a noncompact fifth dimension) are called Kaluza-Klein (KK) models. Unfortunately, all the known KK models [13-14] are limited by the classical field methodology and cannot provide the geometry-based unification. Quantization remains problematic in all those models being rather unnatural and providing no connections to the QED. Quantization in the KK approach is further discussed in §3.1.1 below.

In general, the present ignorance of the geometry-based unification seems odd. If the spacetime has the inner structure (i.e. compact extra dimensions), the electromagnetism and nuclear forces can be explained with the extradimensional geometry. However, working on the geometry-based unification is hard due to the quantization problem making the unified QFT models (e.g. superstring theories) look more achievable.

In addition to the quantization problem, the GR has a number of other issues. The GR cannot explain inflation of the early Universe and the dark energy problem; it miscalculates the rotational curves of galaxies and clusters leading to the dark matter problem. The GR cannot avoid singularities describing black holes and the Big Bang. The GR lacks any technical ability to describe intrinsic angular momentum (e.g. spinning gas in galaxies) or an exchange of intrinsic and orbital angular momentum (spin-orbit exchange). Clearly, the GR cannot be used as a unification platform until all these questions are resolved.

Moreover, the GR is not a complete theory of gravitation even in the 4D spacetime. For the sake of simplicity, Einstein had disregarded any torsional deformation. Dealing with the gravitation alone, such approximation (justified by the reduction of calculation complexity) is acceptable, as the gravitational torsion is typically negligible. However, it is possible that the 5D spacetime torsion plays a substantial role in the particle interactions (see §3.1). In some cases, the theory of gravitation may need to consider both the curvature tensors (present in the GR) and the torsion tensors (disregarded in the GR). In 1922, Élie Cartan proposed a theory that includes non-zero affine torsion and known as the Einstein-Cartan (EC) theory [15]. According to the EC, 4D spacetime can undergo some torsional deformations induced by spinning matter in addition to the curvature deformations. This additional gravitational force is immeasurably small in the present Universe; however, it becomes testifiable at high densities of spinning matter, e.g. in black holes and the Big Bang. Recently, Nicodem Poplawski showed that gravitational torsion induced by spinning matter removes central singularities in black hole models [16] and explains inflation in the early Universe [17]. A similar approach had been applied in an attempt to explain the dark energy and the dark matter problems with torsion; however, it seems that the amount of spinning matter in the Universe is insufficient to induce the forces estimated in both cases [18, 19]. However, there is yet another possibility to explain the dark energy with the gravitational torsion in case vacuum itself has a certain small, but non-zero torsional deformation (not induced by any matter) due to the possible constant spin of the Universe. Could it be that the unexpected alignment of the large-scale fluctuations in the power spectrum of cosmic background radiation (the so-called cosmic "Axis of Evil") [20], as well as the unexpected alignment and preferred handedness of the galaxies' spins observed astronomically [21], are actually the signs of the Universe's spin? This torsion may contribute to the dark energy phenomenon. As for the dark matter, the hypothetical Weakly Interacting Massive

Particles (WIMPs) remain the leading candidates for the bulk of dark matter [22]. Unfortunately, both the GR and the EC neither predict nor reject purely gravitational particles.

Overall, the GR-based unification has a number of problems. Some of them can possibly be solved with a switch to the EC; however, the two main problems, the spacetime inner structure and quantization remain unsolved.

2. The General Principle of Interaction and the Fractal spacetime concept

Extending the Einsteinian understanding of vacuum and matter, the General Principle of Interaction (GPI) assumes that any physical interaction is governed by the spacetime geometry. As the 4D spacetime deformations are always of gravitational nature, the GPI assumes the existence of compact extra dimensions. The spacetime inner structure is explained by the fractal spacetime concept (FSC) postulating that the spacetime includes at least three sets of spatial dimensions (subspaces) and one time dimension. The three ordinary large spatial dimensions together with the time can be seen as the 4D ordinary spacetime (OST). The fifth spatial extra dimension is compactified down to the atomic size, and the 5D spacetime (electromagnetic spacetime or EMS) governs the electromagnetism. The additional set of three spatial dimensions is compactified down to the nuclear size, and the 8D spacetime (nuclear spacetime or NS) governs the nuclear forces.

This structuration of the spacetime explains the separation of the three types of interactions (gravitation, electroweak, and nuclear forces) by the subspace size differences. At the large scale, both the NS and EMS extra dimensions are negligible due to their compactness. Therefore, the electromagnetism and gravitation can be naturally unified within a classical field theory in the 5D spacetime applying the cylinder condition. As mentioned above, this unification scenario had been successfully implemented in the KK theories [13]. At the atomic scale, however, only the NS dimensions are negligible, hence the cylinder condition is no longer applicable to the 5D spacetime, and the classical theory breaks due to the inability to calculate both the 5D stress-energy tensors and the 5D metric tensors, which depend on the undetectable fifth coordinate. Thus, the classical KK approach is not applicable to the extradimensional geometry, which requires a completely different approach. To solve this problem, the 5D spacetime needs to be somehow translated into the complex projective space and time. Then, the 5D geometrical parameters can be replaced with the complex scalar fields that can be gauged. Presumably, this approach will bring the QED equations.

With the GPI and FSC, it is assumed that the elementary electric charges induce the EMS elementary deformations, compact 5D waves, which can be described with the QED mathematical methods. Similarly, the elementary color charges induce the NS elementary deformations, more compact 8D waves, which in turn can be described with the QCD methods. Thus, all known elementary particles can be explained with the six truly elementary spacetime deformations: electron, positron, photon, quark, antiquark, and gluon. Both the NS and the EMS should have the three types of stable elementary deformations: 1) “positive” half wave having positive extradimensional curvature, 2) “negative” half wave having negative extradimensional curvature, and 3) “neutral” full wave (a combination of the two above-mentioned waves). In addition, it is possible that elementary spacetime deformations induced by hypothetical gravitational charges are present in the OST. These hypothetical OST deformations may represent WIMPs explaining the dark matter. It is hypothesized that any NS deformation induces “shadow” EMS and OST deformations, and any EMS deformation induces a "shadow" OST deformation. This effect is likely determined by the spacetime geometry. This effect explains naturally electric charges of quarks and gravitational masses of all fermions. The elementary spacetime deformations are discussed in Section 3 below.

According to the GPI and the FSC, the Universe contains nothing but vacuum geometrically altered in certain ways, and all types of matter are various elementary deformations of the vacuum. The geometrical separation of the three subspaces (NS, EMS, and OST) ensures the separation of the three types of forces (gravitational, electroweak, and strong). At the Big Bang, all the spacetime dimensions were compressed to the same size forming a uniform symmetrical manifold with only one geometrically unified interaction. Thus, the GPI and the FSC provide a simple self-consistent materialistic philosophical basis for the geometry-based unification of all forces.

According to the GPI, energy is a measure of spacetime deformation and increases with any curvature or torsion. This extends the Einsteinian understanding of the gravitational energy (as OST curvature) for electromagnetic, weak and strong forces, assuming that their potential energies are also determined by the spacetime curvature and torsion within the EMS and NS. Thus, all types of interaction are driven by the principle of minimum energy, i.e. minimal spacetime curvature/torsion. The GPI-based descriptions of particle interactions are discussed below (see §3.1 – §3.3).

Overall, the GPI and the FSC provide a philosophical basis to unify all types of physical forces. The number of fundamental fields reduces to just three, i.e. gravitational, electroweak and strong fields defined as geometrical alterations of the OST, EMS, and NS, respectively. The weak field is understood as a type of electromagnetic field. The FSC is expected to give the QED and QCD-matching descriptions of the elementary EMS and NS deformations based solely on the spacetime geometry. However, as an extension of the Einsteinian understanding of vacuum and matter, the GPI cannot allow the gauge transformation principle philosophy (see §1.1).

3. The GPI-based hypothesis of elementary vacuum deformations

3.1. The EMS elementary wave-like vacuum deformations

3.1.1. The KK approach problem. Let us extend the 4D spacetime (OS) with a closed circular fifth spatial dimension compactified down to an atomic size (classical KK model). Then, the 5D vacuum model, as well as the EMS elementary deformations induced by the electric charges, should satisfy the Einstein–Cartan field equations in five dimensions. In a very general form given by Sciama and Kibble [23] (with the addition of Λ), the equations are:

$$\check{R}_{ab} - \tfrac{1}{2} \check{R}\, \check{g}_{ab} + \Lambda\, \check{g}_{ab} = k\, \check{T}_{ab} \qquad (1)$$

where the symbol ˘ denotes 5D parameters; $\check{R}_{ab}$ is the Ricci tensor, and $\check{T}_{ab}$ is the canonical stress-energy-momentum tensor, which both contain certain asymmetric contributions due to a nonzero torsion tensor. $\check{R}$ is Ricci scalar, and $\check{g}_{ab}$ is metric tensor; Λ is cosmological constant in 5D, and *k* is coupling constant.

The cylinder condition ($\delta\check{g}_{ab} / \delta x^5 = 0$) is applicable when distances are much larger than the compactification radius. In such case, it is obviously possible to transform the 5D EC field equations (1) into the Maxwell equations and 4D EC equations (or Einstein equations) [13]. However, this unification cannot escape the frame of a classical field theory and hence is useless at the "quantum level".

At the atomic scale, the cylinder condition must be dropped ($\delta\check{g}_{ab} / \delta x^5 \neq 0$) as $\check{g}_{ab}$ (according to the GPI) depends on all the five coordinates. Then, the classical equations (1) are no longer useful due to the inability to calculate either the $\check{T}_{ab}$ or the $\breve{g}_{ab}$, which both depend on the undetectable fifth coordinate. Moreover, if the extradimensional curvature is induced by the electric charges, the 5D vacuum is never flat, hence $\check{R}_{ab} \neq 0$. These two conditions make the eq. (1) extremely difficult mathematically. Even worse, the calculations of the extradimensional tensors are impossible in principle due to the undetectable nature of the compact fifth dimension prohibiting one from determining actual changes of the extradimensional geometry.

In the OST, it seems logical to expect that $T_{\mu\nu}$ vanishes in the absence of mass. However, this is true only in the absence of charge. In the presence of charge, the EMS deformations will cause $T_{\mu\nu} > 0$, i.e. "induce" mass. This effect has been shown in the KK models with large fifth dimension, Ricci-flat 5D vacuum ($\check{R}_{ab} = 0$) and no torsion. Paul Wesson [24] has shown that even if $\check{T}_{ab} = 0$ in 5D spacetime, $T_{\mu\nu} \neq 0$ in 4D spacetime. In such case, the nonzero 4D stress-energy-momentum appears from the derivatives of the 5D metric with respect to the fifth coordinate. With the EMS deformations, a similar effect is expected for the cases when $\check{T}_{ab} \neq 0$. If so, the leptons' gravitating masses are indeed induced by their electric charges. Moreover, the 5D vacuum itself may induce a certain gravitational effect in the OST due to the EMS nonzero background curvature and torsion; i.e. the geometry of the 5D vacuum may in part determine the cosmological constant in the 4D spacetime. The T^{EMS} has two independent parts: the electrostatic field-related part (defined by the EMS curvature) and the magnetic field-related part (defined by the EMS torsion). These two tensors "induce" two separate parts of the $T_{\mu\nu}$ in the OST, and it is expected that the EMS torsion-induced part is negligibly small compared to the EMS curvature-induced part of the $T_{\mu\nu}$. Thus, the mass in the 4D spacetime is induced mostly by the vacuum curvature in the fifth dimension.

The 5D field equations (1) hardly can lead to the QED-like descriptions of the fermions. At most, they can be used to derive the "vacuum wave" Klein-Gordon equation, as shown by Wesson in the Ricci-flat 5D vacuum with no torsion [24]. Unfortunately, the Klein-Gordon equation cannot describe electron motion in the QED, because it only applies to zero-spin particles and, hence, calculates the electron's energy levels in the atom incorrectly [25].

A very important feature of the proposed 5D description is that the T^{EMS}, which defines the "original" electromagnetic field, as well as the metric tensor $\breve{g}_{ab}$ defining the 5D geometry, cannot have exact descriptions simultaneously (as they both depend on the hidden fifth coordinate). Thus, the undetectable nature of the EMS naturally creates the uncertainty of the electromagnetic interaction. For instance, if one sets a precise value for the T^{EMS}, the $\breve{g}_{ab}$ cannot be determined in principle, and vice versa. Hence, in the 5D spacetime, the field equations (1) likely not have exact solutions (however, the same is not true for the 4D OST). Thus, the EMS-originated interactions can only be described with the complex-valued mathematics, and hence, the 5D theory requires a transition to the quantum field description, whereas the same theory in 4D will remain classical.

Although the GPI-based description of the electromagnetism with the 5D spacetime deformations seems promising, it cannot be achieved with any KK extension of either the GR or the EC. The 5D field equations have a tremendously increased complexity compared to both the GR and the EC. Moreover, the classical field descriptions of the KK theory is built on are clearly irrelevant to the compact extradimensional geometry, as the tensors depending on the fifth coordinate are indeterminable in principle. This is likely the main reason why all the known KK models were not able to provide a successful quantized unification theory. Thus, the GPI-based approach to electromagnetism requires completely different methods describing the extradimensional geometry. If found, these methods should lead to the QED equations building a bridge between the spacetime geometry and quantum physics.

3.1.2. The predicted EMS vacuum deformations. At present, the mathematical description of the elementary EMS vacuum waves is beyond the author's scope. Nevertheless, it seems logical to predict the three types of such waves and analyze their behavior in general.

The elementary 5D vacuum waves induced by the electric charges can be seen as uniform local deformations of the geometrically-altered spacetime. They interact according to the principle of minimum energy, i.e. minimizing the resulting deformation. Thus, in general, a positively curved EMS deformation tends to cancel a negatively curved one but escapes another positively curved EMS deformation. This is a simplified description of the electrostatic field-driven interaction. A similar pattern is valid for the EMS torsion-induced spin-spin interaction related to the magnetic field.

Let us assume that an elementary electric charge deforms the EMS vacuum inducing an oscillating standing wave with the curvature and the torsional components: a curve (positive or negative) identified with its electrostatic field (5D curvature) and a twist (left or right) identified with its magnetic field (5D torsion). Thus, only three parameters would describe this local EMS deformation (let's call it half wave): curve, twist, and frequency. The curve is unchangeable, which ensures the law of charge conservation; the twist has a constant value, but its direction can change during interactions. Thus, the elementary charged particles have a magnetic moment and induce both electrostatic and magnetic fields. This assumption excludes an existence of a magnetic monopole, as both the two fields (electrostatic and magnetic) are induced by the same charge.

In the simplest case, there are only three types of the 5D elementary EMS deformations:

1) electron, a 5D half wave with a "negative" curve, 2) positron, a 5D half wave with a "positive" curve, and 3) photon, a 5D full wave, the combination of the two half waves with opposite curves and twists (Fig. 1). The signs of the curves here are chosen arbitrarily, as there is no correlation between the elementary electric charge sign and the "geometrical sign" of the induced curvature.

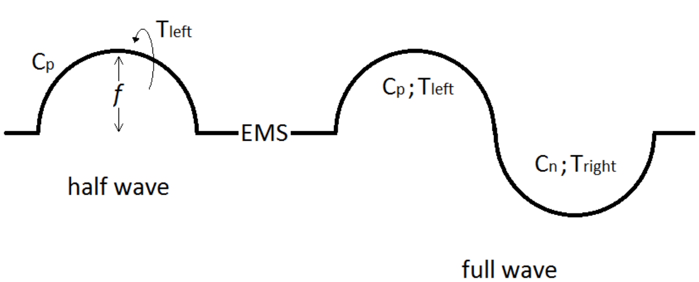

Figure 1: Schematic representations of the elementary EMS wave-like vacuum deformations. The half waves (electron and positron) have three main parameters: curve **C** (positive or negative), twist **T** (left or right) and frequency ***f*** (as they oscillate as shown by the arrows). The horizontal line depicts a fragment of the fifth dimension (EMS). The EMS full wave (photon) is a combination of the two EMS half waves (electron and positron) with opposite curves and twists oscillating with the same frequency in counterphase.

All the waves oscillate with a certain frequency. The photon wave components oscillate with the same frequency in counterphase. Thus, a photon can be seen as a stable electron-positron pair. The half waves induce nonzero local EMS curvature identified with the electrostatic field and nonzero EMS torsion identified with the magnetic field. In the OST, the EMS half wave induces a secondary deformation, a projection ("shadow") OST half wave identified with the lepton's gravitating mass. The full wave induces zero average EMS curvature and zero average EMS torsion as it combines two half waves completely canceling each other's effects in time. This concept explains why leptons have charges and masses, but photons are chargeless and massless. The half waves can bind the full waves interacting with the full wave component having an opposite curve explaining the photon absorbance. The full waves cannot attract or repel each other due to the zero average EMS curvature and torsion. However, the full waves can co-localize together in a resonance state (laser). These interactions require the interacting waves to have the same frequency. The leptons and photons also interact with the EMS deformations induced by the quark triplets (see §3.2).

In addition to the EMS curvature-mediated interaction, the leptons' interactions can be driven by the EMS torsion. This ensures the Pauli Exclusion Principle. If the curves of the two electrons oscillate in counterphase, they can share the same orbital; however, if their twists have the same direction, the torsional EMS deformation increases forcing one of the electrons to change the twist direction. The separation of the curvature and the torsional effects also explain the fact that a macroscopic electrostatic field can exist in the absence of a magnetic field (even if electrons in a substance are rearranged so they induce an electrostatic field, the electrons' twists can counter-orient canceling their magnetic fields). A macroscopic magnetic field is also possible in the absence of an electrostatic field when the electrons' electrostatic fields are canceled by the protons' fields, but the electrons' twists are in order (mostly left or mostly right) and induce a nonzero average EMS torsion. This concept also allows explaining electromagnetic induction with the EMS geometry. (A magnetic field induces electric current when, for example, a magnetized body with co-oriented electron twists is moving about a metal rod. Then, the rod's electron twists also become co-oriented but in an opposite direction. As the rod's electrons are now bound with the body's electrons via the magnetic field, the rod's electrons will follow the body's movement producing an electric current in the rod. An electric current induces a magnetic field if moving electrons tend to have their magnetic twists co-oriented with the direction of motion.)

3.2. The NS elementary wave-like deformations

Strong interaction is governed by the three types of color charge, has extremely short action distance and high power. It is expected that by extending the 5D spacetime (see §3.1) with an additional subspace ("nuclear space" or NS) with three extra spatial dimensions, both strong and electromagnetic interactions can be understood with the spacetime geometry. Thus, the 8D vacuum model supporting the full unification should include the OST, the EMS, the NS subspaces and a time dimension, together forming the fractal spacetime. The three subspaces are separated by their sizes reflecting the differences in their action powers. According to the FSC, the NS can be simply viewed as a 3D spherical extension at each point of the EMS 1D circle extension of the 4D OST.

It is expected that the 8D elementary deformations have an effect of induced electric charge, in addition to the effect of induced mass (see §3.1.2). As with the 5D spacetime, the 8D spacetime deformations cannot be described with a GR (or EC) extension theory due to the undetectable nature of these two subspaces. Hence, the NS vacuum deformations can only be described by the QCD equations. At this time, the detailed description of the transition from the NS geometry to the QCD equations remains beyond the author's scope.

Similar to the elementary EMS deformations (Fig. 1), the elementary NS deformations induced by color or anticolor charges should include three main types: 1) **uuu** quark triplet, a 8D half wave with a "positive" curve, 2) **ūūū** antiquark triplet, a 8D half wave with a "negative" curve and 3) gluon or **uuuūūū** quark sextet, a 8D full wave with zero average curvature and torsion, a combination of the two half waves. The curve signs are chosen arbitrarily. All the waves oscillate with a certain frequency. The gluon wave components oscillate in counterphase.

The simplest geometrical description of the half wave elementary NS deformation would be a compactified oscillating 8D hypersphere with a constant radius (amplitude), an analog of the EMS half waves. Thus, the NS half wave (baryon) is an 8D compact object with one EMS projection (5D "shadow" wave) and one OST projection (3D "shadow" wave). The former defines baryonic electric charge, and the latter defines baryonic gravitating mass. The NS deformation can have only the same curvature (either positive or negative) in all the three NS dimensions. Hence, no **uūu** or **ūuū** quark triplets exist. Geometrically, only a symmetrical NS curvature can make a stable 8D hypersphere or inverted hypersphere. Therefore, no 7D or 6D NS half waves (i.e. double or single quark states) exist, unless the NS dimensions are separated. This speculation explains the confinement. The NS full wave (gluon) is a combination of a hypersphere and an inverted hypersphere having opposite curves and twists. The gluon has a projection in the EMS (a "shadow" photon), and thus it is a photon with a mass and a short action range when interacts electromagnetically.

As explained above (see §3.1.2), the EMS half waves with the same curves repel. Surprisingly, the NS half waves, baryons show different behavior and always attract. This phenomenon can be explained by taking into the account an important difference between the NS and the EMS subspaces. Assumingly, the NS half waves' sizes match the size of the NS subspace, whereas the EMS waves are much smaller that the EMS subspace size. When co-localized, the two like EMS half waves tend to change local EMS curvature while the background EMS curvature prevents that and drives them apart. The two like NS half waves, however, do not work against the background NS curvature, as the NS wave size and the background curvatures are equal. Thus, multiple NS hyperspheres (baryons) can combine within the NS and form a slightly smaller NS hypersphere consequently having the size of entire NS.

In addition to the NS-originated interactions, the NS waves interact via the "shadow" deformations they induce in the EMS. Thus, the "naked" **uuu** quark triplet does not exist in a free state due to its EMS "shadow" (electric charge +2e) and always bound to one or two electrons appearing as a proton or a neutron, respectively. Proton, antiproton, and neutron interacting in the EMS can be described as positron, electron, and photon (respectively) of special kinds, i.e. having big masses due to the quark "attachments". Their electromagnetic interactions are the origins of weak forces. The **uud** triplet (proton) is more stable than the **uuu** triplet. Thus, the proton cannot decay spontaneously. However, the neutron (**udd**) is less stable than the proton. This inconsistency can be explained by the fact that the "shadow" EMS half wave induced by the quark triplet cannot be perfectly canceled with the two EMS "half waves" induced by the two electrons. In order to cancel the former half wave, the latter two half waves should form a more energetic single wave with a higher frequency (Fig. 2). An additional energy required for this transformation reflects the neutron instability.

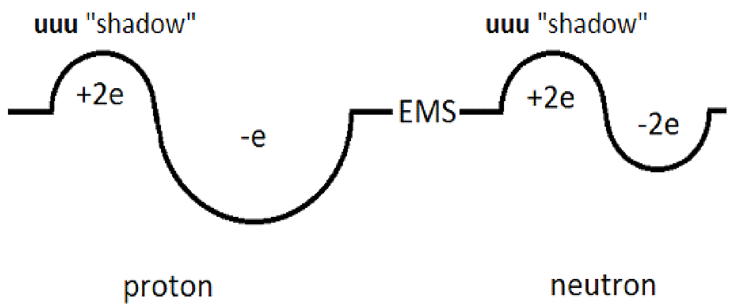

Figure 2. Schematic representations of the EMS deformations induced by the proton and the neutron. When proton binds an electron and forms a neutron, its "shadow" EMS half wave (+2e charge) induced by the **uuu** triplet is completely canceled by the (two -e charges) induced by the two electrons. That is possible only after the latter two EMS half waves induce a single EMS half wave (-2e charge), which is more energetic than the two original half waves (-e charge) and hence requires an additional energy.

The heavy **c**, **s**, **t** and **b** quarks can be explained as excited states of **u** or **d** quarks when a quark triplet is bound to an energetic gluon. In the NS, all the quarks are three-dimensional, and these are actually **uuu**, **uud** or **udd** triplets in resonance with a gluon, which increases the hadrons' energy making them more massive.

In particle physics, there is a special class of strongly interacting particles, mesons consisting presumably of a quark-antiquark pair. As shown above, no double-quark state is geometrically possible; hence, a quark-antiquark pair cannot exist. Mesons can be explained as NS full waves (gluons) associated with EMS half waves (electrons or positrons) and/or EMS full waves (photons). For instance, π^+ pion is a gluon, which EMS "shadow" is bound to a positron (e^+), i.e. **uuuūūđ** sextet, and π^- pion is a gluon bound to an electron (**uudūūū**). Then, π^0 pion is a gluon, which EMS "shadow" is bound to a photon (e^+e^-), i.e. **uudūūđ** sextet (in the EMS, it appears as a pair of photons, one "shadow" and one original). Charged mesons are obviously not stable; in the EMS, they can be seen as excited states of electron or positron with an absorbed "shadow" photon. Neutral mesons are gluon-photon combinations with various energies. As the meson energy can vary widely with the bound gluon and/or photon, the mesons have numerous states (mass-energies).

In general, it seems possible to describe both the strong and the electromagnetic interactions with the 8D spacetime model. The future GPI-based theory should describe strongly interacting NS full waves (gluons), NS half waves (baryons), and their projections: secondary EMS deformations (induced electric charges and induced magnetic moments) and secondary OST deformations (induced masses). The theory is expected to match the QED, however, requiring certain changes for the electroweak theory (see below).

3.3. The weak interaction

Historically, the weak nuclear force was introduced as a special type of interaction in order to explain neutron decay. However, there is no special charge identified with the weak interaction. For protons and electrons, the weak forces are calculated based on the electric charges. Hence, it is logical to assume that the weak interaction is actually a kind of electromagnetic interaction involving electric charges and color charges. In the hadron-lepton interactions, color charges interact indirectly, via the induced "shadow" electric charges (see §3.2). A simple explanation of the neutron instability is given above (see §3.2). When the neutron decays, the extra energy (proton-neutron mass defect) is first transferred to the electron, and later, emitted as a photon. A more detailed description of this interaction should come with the future GPI-based theory.

Although the GPI-based concept explains the weak interaction simpler than the SM, this comes with a price of rejecting W and Z bosons and neutrinos. The weak bosons should be replaced with the "shadow" EMS deformations "attached" to the NS ones (nucleons). Thus, the "shadow" leptons "attached" to the quark triplets replace the two W bosons, and the "shadow" photon replaces the Z boson. Due to the massive quark "attachments", these pseudo-particles have masses by definition, without any additional (Higg's) mechanism. If the neutrino has neither electric nor color charge and is not a boson, it cannot interact via EMS deformation. Hence, the neutrino can interact with other particles only via gravitation, which makes no sense. Notably, the above-stated rejections do not contradict any experiments, as the weak bosons and neutrinos are undetectable in principle. In bubble chambers and all other types of detectors, weak bosons and neutrinos make no visible track, and, therefore, cannot be distinguished from photons. Thus, the neutrino telescopes actually detect high-energy photons, but not neutrinos. The neutrino was originally suggested by Wolfgang Pauli in order to explain the continuous energy spectrum of beta-rays in the beta decay. However, this spectrum [26] can be explained by the Bremsstrahlung effect when the emitted electrons (beta-rays) are deflected by the neighbor atomic nuclei and emit photons (gamma-rays). The electrons show a continuous energy spectrum because they lose various amounts of energy when passing the nuclei at various angles. The Bremsstrahlung radiation was completely ignored even in the early beta decay experiments as the detectors were typically shielded from gamma-rays [26]. Therefore, the present concept of the weak interaction requires careful re-evaluation.

3.4. The OST elementary wave-like deformations

A number of problems that remains unsolved by the GR are discussed above (see §1.2). Some of those issues can be solved with the switch to the EC; however, the two fundamental questions, the spacetime structure and quantization still remain. As mentioned above, both the GR and the EC have no predictions regarding the dark matter and the dark energy. However, the GPI-based reasoning does lead to some interesting suggestions.

First, even if there is no material source (special field) of the dark energy, it can be explained simply by the 4D vacuum geometry. If the Universe (the OST in this case) tends to retain the spherical shape only changing its size, it will always have the cosmological constant (which is actually variable), i.e. the OST background curvature.

Secondly, for the sake of symmetry, it is logical to assume that there are three types of purely gravitational elementary OST deformations: $\mathbf{G_p}$, positively curved OST half wave; $\mathbf{G_n}$, negatively curved OST half wave; and $\mathbf{G_0}$, OST full wave ($\mathbf{G_0} = \mathbf{G_p}\mathbf{G_n}$). It is possible that the "gravitational charges" ($\mathbf{G_p}$ or $\mathbf{G_n}$) might have been already observed indirectly and interpreted as dark matter particles, WIMPs. The dark matter is cold and collisionless (i.e. it does not interact strongly or electromagnetically), and must be stable or at least metastable [22]. Indeed, the elementary OST half wave induced by the $\mathbf{G_n}$ "gravitational charge" inducing "negative" mass might be an ideal candidate for the WIMP. As it has no projection deformations in the NS and EMS, it cannot interact strongly or electromagnetically. The $\mathbf{G_n}$ “particles” are attracted to the baryonic “positive” masses (OST “shadow” deformations) tending to form with them a full OST wave. This interaction may partially cancel baryons’ gravitational masses (given the latter are bigger than the $\mathbf{G_n}$ rest mass). Considering the observed excess of the dark matter in the Universe, all baryons should be bound to the $\mathbf{G_n}$ WIMPs. This hypothesis assumes the following hierarchy of the gravitational masses: baryon’s OST effect > lepton’s OST effect > WIMP’s OST effect. However, it is not fully clear how those hypothetical “gravitational charges” interact with each other. Are they fully attractive like NS half waves or both repelling and attractive like EMS half waves?

As there is an excess of positive color charges (baryons) and negative electric charges (electrons) in the Universe, it is logical to assume that there is also an excess of certain “gravitational charges”, e.g. $\mathbf{G_n}$. The latter is gravitationally attracted to the baryonic “shadow” OST deformations making the dark matter haloes around the galaxies. Advances in the astronomical methods will soon allow for a direct detection of the dark matter, thus making the WIMPs discovery highly expectable.

3.5. Big Bang or Big Unroll?

According to the present widely accepted theory of the Big Bang and cosmic inflation, the Universe has started from an infinitesimally small point. It is still not clear what force has driven the Big Bang, and what force has driven the inflation. The GPI-based logic suggests that the Universe has started from a fully compactified symmetrical 8D spacetime, the “primordial ball” (hypersphere) with a very small but finite size. As the actual size of the “primordial ball” was very small, its initial (assumingly positive) curvature and torsion (and hence the energy) were tremendously high. This energy excess was likely the driving force for the followed expansion. For some unknown reason the expansion did not occur symmetrically for all the dimensions, and the primordial 8D spacetime had separated into the three subspaces (NS, EMS, and OST) expanded differentially. The OST had expanded to the size of the Universe, while the EMS and the NS expansions were limited, and they remain compact. The OST had expanded to an almost flat state, however retaining the spherical shape, and continue expanding according to the astronomical observations. The EMS has a relatively high background curvature and assumingly is expanding as well. For an unknown reason, the NS cannot expand beyond its size. As the OST and the EMS continuously expanded with no NS expansion, they ripped the NS apart into multiple compactified objects thus creating an excess of the positively curved NS half waves (**uuu** baryons).

In addition to the baryons, the Universe appears to have an excess of the negatively curved EMS half waves, electrons and (hypothetically) the positively curved OST half waves, $\mathbf{G_n}$ WIMPs. The origin of the electron/WIMP excess is not known. As a possible scenario, the “primordial ball” with a positive curvature (proto-universe) had absorbed another 8D primordial object with a negative curvature of a lower value. The inequality of the two primordial curvatures had created the further asymmetry of the Universe’s expansion in the three subspaces. In the NS, the **uuu** baryons were partially converted into full waves, gluons by absorbing the second primordial object’s NS curvature, however, some baryons had remained intact. In the EMS, the baryons’ geometrical projections (“shadow” EMS deformations) had “anchored” the negative EMS curvature of the second primordial object creating negatively curved EMS half waves, electrons (two per a baryon). Thus, the baryons formed neutrons, and later, protons and atoms. Similarly, the baryons’ “shadow” OST deformations created an excess of the $\mathbf{G_n}$ WIMPs by “anchoring” the positive OST curvature of the second primordial object. The details of this Big Unroll scenario should be addressed in the future cosmological research.

3.6. Reduction of the elementary particle set

The SM elementary particle set presently includes 61 components: 36 quarks (2 flavors x 3 generations x 3 colors x 2 quark-antiquark pairs), 12 leptons (2 types x 3 generations x 2 particle-antiparticle pairs) and 13 gauge bosons (8 gluon types, photon, W^+, W^-, Z, and H bosons, not including graviton). From materialistic philosophical grounds, some quarks and leptons are not truly elementary as they decay into other elementary particles or transform into each other. In addition, the SM requires a number of *ad hoc* parameters and a special Higg’s mechanism explaining masses of hadrons and leptons.

The FSC and the GPI-based concept of particle interactions assume the 8D fractal spacetime with three separate subspaces and one shared time dimension (Table 1) understanding the elementary particles as elementary wave-like spacetime deformations of the three subspaces (vacuum types). This approach reduces the number of fundamental interactions and fields down to three (Table 2). The list of elementary objects is reduced to six half waves and three full waves (Table 3 and Fig. 3). The two elementary baryons (**uuu** and **ūūū**) are 8D NS deformations (half waves) induced by the elementary color charges. The two elementary leptons (electron and positron) are 5D EMS deformations (half waves) induced by the elementary electric charges. In addition to the curve (elementary curvature deformation), these elementary NS or EMS wave-like deformations have a twist (torsional deformation) and frequency (as they oscillate). The NS half waves (baryons) always induce secondary ("shadow") deformations in the EMS identified with the baryons’ electric charges. Both the NS and the EMS half waves induce “shadow” deformations in the OST identified with the gravitating masses of hadrons and leptons. As particles’ masses come naturally with the secondary effect of the extradimensional deformations, no Higg’s mechanism is needed. The experimentally discovered massive particle interpreted as the Higg’s boson is either a kind of heavy baryon (a quark triplet–gluon combination with high mass-energy), in case it is a fermion or a kind of extremely heavy meson, in case it is a boson.

Table 1: Three subspaces of the 8D spacetime (1 time and 7 spatial dimensions total)

Subspace	Description	Projections	Dimensions
OST	almost flat, closed, noncompac	none	3 spatial
EMS	curved, closed, compact	into OST	1 spatial
NS	extremely curved, closed, compact	into EMS and OST	3 spatial

Table 2: Fundamental interactions

Interaction	Field origin	Primary entities
Gravitational	OST deformations	Hypothetical "gravitational charges" (2 types)*
Electroweak	EMS deformations	electric charges (2 types)
Strong	NS deformations	color charges (2 types)

***** - No "gravitational charges" inducing OST half waves have been discovered yet

Table 3: Elementary deformations of the 8D spacetime

Elementary object	Description	Curve* (average)	Twist** (average)	Primary effect	Secondary effects (induced)
Baryon (**uuu**), Antibaryon (**ūūū**)	NS half waves	nonzero	nonzero	strong field	electromagnetic field, gravitational field
Gluon (**uuuūūū**)	NS full wave	zero	zero	strong field (zero average)***	electromagnetic field, gravitational field (zero average***, both)
Electron (e^-), Positron (e^+)	EMS half waves	nonzero	nonzero	electromagnetic field	gravitational field
Photon (e^+e^-)	EMS full wave	zero	zero	electromagnetic field (zero average)***	gravitational field (zero average)***
G_n WIMP, hypothetical **G_p** WIMP, hypothetical	OST half waves	nonzero	nonzero	gravitational field	none
G_0 WIMP, hypothetical	OST full wave	zero	zero	gravitational field (zero average)***	none

***** - Curvature deformation averaged in time (as the waves oscillate)
****** - Torsional deformation averaged in time (as the waves oscillate)
******* - The two parts of a full wave cancel each other's effect in time, however, the actual deformation still exist promoting interactions

Any virtual particles are avoided as all interactions are driven solely by the 8D spacetime geometry. Photons and gluons are the only two types of elementary bosons; all the weak bosons are rejected. Neutrinos are substituted with photons, the only uncharged EMS waves interacting with the charged EMS waves. Spontaneous births of particle-antiparticle pairs are prohibited, as the full waves (photons or gluons) are stable and cannot decay spontaneously.

Thus, all particles except the elementary baryons (**uuu** and **ūūū**), the elementary leptons (positron and electron), and the hypothetical gravitational WIMPs (**G$_n$** and **G$_p$**) are either composite or excited states of these elementary half waves. The full waves are stable combinations of two half waves with opposite curves and twists and same frequency. The proton (**uud**) and the neutron (**udd**) resemble the bound states of the elementary baryon (**uuu**) with one or two electrons. Quarks and leptons of the second and the third generations cannot be considered elementary as they decay into the first-generation quarks and leptons. The baryons (quark triplets) containing higher generation quarks (**c**, **s**, **t** and **b**) can be alternatively explained as excited states of the **uuu**, **uud** or **udd** triplets bound to a high-energy gluon. Mesons can be explained as NS full waves associated with EMS waves, i.e. gluon-lepton or gluon-photon combinations (see §3.2). The muon and tau leptons are two special excited states of an electron in-resonance with a high-energy photon.

The reduced elementary "particle" set (Fig. 3 and Table 3) includes three hypothetical elementary OST deformations. The GPI and the FSC allow for the elementary OST waves induced by hypothetical "gravitational charges", i.e. purely gravitational "particles" (with no projections in the NS or EMS) matching the description of WIMPs. No such WIMPs have been detected yet; however, if exist, they should perfectly fit within the GPI-based theory. If our Universe has an excess of certain NS and EMS half waves (i.e. baryons and electrons), it is logical to assume that there is also an excess of certain OST half waves, e.g. **G$_n$** WIMPs (see §3.4), which represent the dark matter.

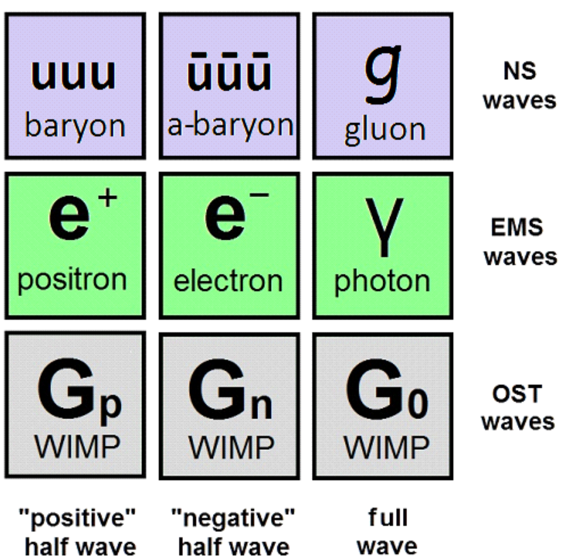

Figure 3: The GPI-based complete set of elementary wave-like spacetime deformations. The 8D NS waves induce "shadow" waves (projections) in the EMS and OST, the 5D EMS waves induce "shadow" waves in the OST only, and the 3D OST waves have no "shadows". The photon and the gluon are full waves, i.e. $\gamma = e^+e^-$ and g = uuuūūū (see §3.1 and §3.2, respectively). As the full waves are composite, they are not truly elementary, however, they might be considered elementary due to their stability. As the masses of hadrons and leptons are "induced", the Higg's mechanism and Higg's boson are avoided (see §3.1.4). As the weak interaction is a type of electromagnetic interaction, W, Z bosons and neutrinos are avoided (see §3.3). The hypothetical elementary OST waves (WIMPs) are induced by the hypothetical gravitational charges (see §3.4).

4. Conclusion

Despite all the great achievements of quantum physics, complete unification of the four fundamental forces of nature remains elusive. The main theoretical effort is currently concentrated on the development of a superstring unified QFT. In the quest for the "Theory of everything", the mainstream theorists continue to ignore the second possible approach, the spacetime geometry-based unification. Following this second path remains challenging as even Einstein himself was unable to unify gravitation and electromagnetism by the "pure geometry" of spacetime. It is likely that the Einsteinian concept of spacetime limited by its four-dimensionality is unable to explain the quantum world. Unfortunately, neither Einstein nor other theorists had ever assumed that the electromagnetic and nuclear interactions actually occur in the "unseen" extra dimensions being driven by the extradimensional (not just 4D) geometry. The FSC (see §2) extends the Einsteinian definition of spacetime with compact extra dimensions promising a philosophically consistent way to unify all four types of interaction. This definition of spacetime includes three separate subspaces: 3D OST, 1D EMS and 3D NS (all "bound" to one time dimension) providing that each type of interaction is separately governed by certain geometrical alterations originated in the corresponding subspace. The geometrical separation of these subspaces allows preserving the general differences between the interaction types (action distance and power). The assumption that all the nongravitational interactions primarily occur in the undetectable extra dimensions allows for the universal definition of interaction (given by the GPI) equally applicable to gravitational and particle interactions. The GPI has a great capability to resolve the two major problems of the vacuum geometry-based unification: 1) define the spacetime deformations that are responsible for each type of particle interactions without confusing them with the 4D OST (gravitational) deformations, and 2) adopt the quantum physics methodology without relying on the gauge transformation principle philosophy. Thus, the FSC and the GPI do promise the full unification.

In the early years of quantum physics, Einstein and others had claimed it is incomplete due to the breaking of the determinism and causality, the two fundamental materialistic principles of scientific observation [27]. It was expected that a complete theory of particle interactions eventually reveals the "local hidden parameters" always missing in the quantum theories. However, the Bell's theorem proven experimentally [28] stated that no "local hidden variables" are able to bring another theory repeating the quantum theory's predictions [29]. Even if quantum mechanics does violate both locality and realism, it is nevertheless the best possible theory matching the observations. However, taking into the account the "unseen" extra dimensions, the Bell's theorem may be interpreted quite differently. The "local hidden parameters" may exist, but are immeasurable in principle. Thus, the determinism and causality are actually not broken, although they seem to be broken for the observer due to the principal limitations of the observation.

Surprisingly, the introduction of the compact extra dimensions makes the spacetime geometry compatible with the quantum physics. The undetectability of the extra coordinates naturally explains the uncertain nature of particle interactions without breaking determinism and causality. Moreover, the undetectability justifies the quantum field mathematical description of interaction as the only acceptable method, consequently making any classical field theory (e.g. the GR or the EC) a limiting case relevant only to the "detectable part" of the spacetime. For instance, one cannot describe an electron with a classic field approach, as the EMS geometry does not allow the exact tensor-based description. Hence, one inevitably needs the complex-valued quantum-mechanical descriptions. With these descriptions, one should have the QFT equations, however, avoiding the gauge transformation principle philosophy and a number of related problems (see §1.1). Thus, the GPI may resolve the famous argument between Einstein and Bohr. If the extra dimensions exist, the Copenhagen interpretation is completely inappropriate, as the particles do have definite properties, and the uncertainty is not the nature of the interaction but is an observational limitation. Then, Einstein was right, as nature always remains completely deterministic at all levels, however, our observational abilities may be strictly limited by our four-dimensionality. In case of the famous EPR paradox [27] in particular, the GPI justifies the absence of any “spooky action at a distance”, as the quantum entanglement phenomenon is caused by the unavoidable measurement limitations, not by the particles’ abilities to interact in a “spooky” way.

The GPI-based unification strategy promises to fulfill the Einstein’s vision of reducing physics to the "pure geometry" of spacetime. Following the general Einsteinian definitions, the GPI unifies matter and vacuum at a very basic level. Philosophically speaking, the "true vacuum”, i.e. the 8D spacetime in the absence of any deformation, is the only one primary entity, the background and the origin of everything, and all types of matter are its geometrical alterations induced by the three types of charges: color, electric, and hypothetical gravitational charges. All known elementary particles can be understood with various combinations of just six elementary extra-dimensional wave-like spacetime deformations, with an addition of the three hypothetical OST deformations explaining the dark matter (Fig. 3).

The GPI-based approach seems to allow for a background-independent unified field theory describing all four types of interaction. However, the two types of spacetime geometry, the large OST geometry and the compact extradimensional geometry require the two very different mathematical methods realized in the GR and the SM. The 8D GR/EC extensions cannot have exact solutions for the extra-dimensional interactions due to their undetectable nature. Hence, the GPI-based theory of particle interactions will have to adopt the QFT methods. Obviously, the GPI does unify the interaction types at the philosophical level, however, being unable to unify the GR (or EC) with the SM in a single self-consistent theoretical framework. Alas, such unification may be impossible in principle.

On the bright side, the GPI-based approach should simplify the SM and bring a number of advantages: 1) fully deterministic understanding of all interactions with the 8D spacetime deformations; 2) the induced electric charges of quarks and the induced masses of hadrons and leptons without the Higg’s mechanism; 3) reduction of the elementary particle set (Fig. 3); 4) simplified understanding of the electroweak interaction with consequent avoidance of neutrinos and weak bosons; 5) simple explanation of the confinement; 6) explanation of WIMPs as elementary OST deformations; and 7) understanding of the cosmological constant as a consequence of the spherical shape of the Universe.

Overall, the GPI and the FSC provide a simple materialistic basis for the spacetime geometry-based full unification at the philosophical level. However, it is impossible in principle to overcome the methodological incompatibility of the GR and the SM. The two types of spacetime geometry (large and compact) require two completely different mathematical methods rendering the “Theory of Everything” impossible. The understanding of elementary particles as extradimensional vacuum waves combines the Einsteinian view of interaction as driven by the spacetime geometry with the quantum field methodology. Adopting the quantum field methods in general, the GPI-based theory of particle interactions will, however, reject the gauge transformation principle philosophy, avoid virtual bosons, and prohibit spontaneous births of particle-antiparticle pairs. Notably, the geometry-based descriptions of particle interactions would bring only slight mathematical improvements to the SM, and the GPI does not promise a groundbreaking step “beyond the SM”. However, the GPI-based approach does promise solving the fundamental philosophical problems of the quantum mechanics and making the SM completely self-consistent. Mathematical development of this theory remains an open question.

5. References

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