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Emerging Physics for Novel Field Propulsion Science

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Abstract. All space vehicles in use today need some kind of fuel for operation. The basic physics underlying this propulsion principle severely limits the specific impulse and/or available thrust. Launch capabilities from the surface of the Earth require huge amounts of fuel. Hence, space flight, as envisaged by *von Braun* in the early 50s of the last century, will not be possible using this concept. Only if novel physical principles are found can these limits be overcome. Gravitational field propulsion is based on the generation of gravitational (gravity-like) fields by manmade devices. In other words, gravity-like fields should be experimentally controllable. Present physics *believes* that there are four fundamental interactions: strong (nuclei), weak (radioactive decay), electromagnetism and Newtonian gravitation. As experience has shown for the last six decades, none of these physical interactions is suitable as a basis for novel space propulsion. None of the advanced physical theories like string theory or quantum gravity, go beyond these four known interactions. On the contrary, recent results from causal dynamical triangulation simulations indicate that wormholes in spacetime do not seem to exist, and thus even this type of exotic space travel may well be impossible. Recently, novel physical concepts were published that might lead to advanced space propulsion technology, represented by two additional long range gravitational-like force fields that would be both attractive and repulsive, resulting from interaction of gravity with electromagnetism. A propulsion technology, based on these novel long range fields, would be working without propellant.

Keywords: Six Fundamental Physical Forces, Three Different Gravitational Fields, Ordinary And Non-Ordinary Matter, Generation Of Gravity-Like Fields In The Laboratory, Interaction Between Electromagnetism And Gravitation, Propellantless Propulsion, Extended Heim Theory (EHT).
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INTRODUCTION

The 40th anniversary of the Moon landings has come and gone, but the future of humans going back to the Moon looks grim, not even considering a Mars mission, which seems next to impossible. The problem is inadequate propulsion. The current status of space propulsion is characterized by two contradicting scenarios. The first one, chemical propulsion delivers high thrust but for several minutes only at relatively low specific impulse, and is used today to lift heavy payloads from the surface of the Earth into nearby space (for instance LEO). The second one, electric and plasmadynamic propulsion, provides low thrust over longer periods of time (up to several months) at high specific impulse, and is employed in scientific interplanetary missions of long duration. Propulsion systems can be classified according to their physical principles as thermal propulsion systems or electromagnetic propulsion systems. Advanced versions of these systems are described in the recent book by Bruno and Accetura (2008), which performs a linear extrapolation of present technology, envisaged of being realizable in 2020. Another class of advanced concepts using photonic propulsion, solar sails, or laser propulsion has been suggested. Comparing these advanced concepts with the space propulsion concepts discussed in the books by Seifert (1959) and Corliss (1960) it becomes obvious that the **physical principles of all of these concepts have been around for several decades**, but with *regard to performance no significant progress* has been achieved. Even the much discussed wormholes most likely do not exist as was shown by Ambjorn (2008) and Loll (2008), and thus even this type of exotic space travel may well be impossible.

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The reason for this lack in progress is that physical *laws pose strict limits on the practicality and the performance of even the most advanced propulsion systems,* and in practice have *prevented the construction of efficient and effective propulsion systems*. First, all systems considered so far operate on the basis of expulsion of mass and energy, i.e., have to obey classical momentum conservation. Hence, some kind of propellant needs to be provided. Second, the speed of light in vacuum is limited by special relativity, so interstellar travel in general does not seem to be feasible in our spacetime. This, however, is not at all a concern at present, since our current chemical propulsion systems are delivering velocities of about 10 km/s.

The question naturally are there any, hitherto unknown, physical phenomena that might justify the existence of additional physical interactions? The answer *seems to be affirmative*. In March 2006, the European Space Agency (ESA), on their webpage, announced credible experimental results, reporting on the generation of both *gravitomagnetic* (termed frame dragging in *GR*, which, however, is too small to be measured in a laboratory on *Earth*) and *gravity-like* or *gravitoelectric* fields, which are acceleration fields, performed at AIT Seibersdorf, Austria. In analogy to electromagnetism, gravity-like fields are denoted as *gravitoelectric fields*, $\mathbf{E}_G$, since they actually produce an acceleration. One speaks of a *gravitoelectric force* if the $\mathbf{E}_G$ field is generated by a *stationary mass*. The term *gravitomagnetic force* is used if $\mathbf{E}_G = \mathbf{v} \times \mathbf{B}_G$, i.e. the field is produced by a *rotating mass together with a mass density current*. The field $\mathbf{B}_G$ is called gravitomagnetic field. Since then, numerous experimental results have been published by Tajmar *et al*. (2006, 2007a and 2007b) and Graham *et al*. (2007) whom published a paper on the generation of a gravitomagnetic field produced by a cryogenic lead disk, but using a completely different measurement technique. However, their results are not conclusive, since the sensitivity of their ring laser was about two orders of magnitude lower than the gyro employed at AIT, but they also clearly saw a change in sign of the gravitomagnetic field when the direction of rotation changed. In addition, in 2008 Tajmar *et al.* (2008) published a more comprehensive set of gravitomagnetic experiments. Furthermore, in 2007 results of the NASA Stanford Gravity-Probe B (GP-B) experiment (Kahn, 2008) became available, and *EHT* was used to model the gyro anomaly seen in this experiment as well as the acceleration and deceleration of the two gyro pairs (see Dröscher and Hauser, 2008).

GR predicts that any rotating massive body (*Earth*) drags its local spacetime around, called the frame dragging effect, generating the so-called gravitomagnetic field. This effect, predicted by Lense and Thirring in 1918, however, is far too small to be seen in a laboratory on *Earth*. For this reason the Gravity-Probe B (GP-B) experiment was launched in 2004. On the other hand, the values measured by Tajmar *et al.* (2007b and 2008) were about 18 orders of magnitude higher than predicted by *GR*, and therefore are outside *GR*. They cannot be explained by the classical frame dragging effect of *GR* and would represent a new kind of physical phenomenon. In other words, the **superconducting Nb ring in the laboratory, with a mass of about 500 grams, caused approximately the same gravitomagnetic effect as a white dwarf** (Dröscher and Hauser, 2008). In this context, it is highly interesting to compare this scenario with the so called *dipole gravitational field generator*, first conceived by Forward as recently described by Davis in Chapter 4 of Millis and Davis (2009). Instead of an electric current, Forward used a mass flow together with the Lense-Thirring effect, to produce a gravitomagnetic field $\mathbf{B}_G$. He showed that the mass of a white dwarf needed to be rotated to obtain an appreciable effect, see Davis. From an engineering standpoint his concept is totally unrealistic. However, compared to the recent experimental results of Tajmar, a **Tajmar-Forward dipole gravitational field generator** would invalidate these conclusions. Therefore, if the experiments by Tajmar *et al.* (2007b and 2008) are correct, their *physical roots must be outside GR*, and thus would *support the prediction of EHT* about the existence of additional long range force fields. In these experiments there seems to be something that increases the gravitational permeability of the vacuum, $16\pi G_g / c^2$, by many orders of magnitude. The control parameter is temperature T and a *phase transition seems to occur* at a certain, material dependent, critical temperature T_C, not necessarily identical with the formation of Cooper pairs.

Since this novel effect only occurs at cryogenic temperatures, it is surmised that a *phase change* takes place. *EHT* postulates that this phase change is leading to novel particles. These virtual particles are identified as *imaginary mass* electron pairs (Boson coupling, Bose-Einstein Condensate), interacting similar like Cooper pairs in superconductivity, but producing a final force that is gravity-like.

According to *EHT*, regarding the construction of an advanced propulsion device, a genuine base experiment might be feasible, in which the gravitoelectric field is directed along the axis of rotation, and thus could provide the required direct mechanism for a field propulsion principle working without propellant. In addition, it is argued that the experiment can be scaled such that a propulsion system can be constructed to lift a sizable mass from the surface of the *Earth*. Based on considerations of *EHT*, the technical requirements like magnetic induction field strength, current density, and supply power are calculated. The numbers obtained should be met with present technology.

Naturally, such a propellantless propulsion system would be far superior over any existing propulsion technology, while its technology might be substantially simpler and cleaner than chemical, fission, or fusion rockets. There is, of course, insufficient knowledge at present, both theoretical and experimental, to guarantee the realization of such a device. However, the benefits of such a device are formidable.

GRAVITY AND GRAVITATIONAL FIELDS

In *EHT* it is argued that spacetime is the stage for physical processes, but it is to be complemented by the internal space H^8 that gives rise to the physical interactions and particles, because of the so called *double coordinate transformation* (see Dröscher and Hauser, 2006 and 2007b). If this picture is accepted, it turns out that, *surprisingly*, it is **classical physics that seems to be incomplete**, needed to be complemented by **two additional fundamental force fields** that are *gravity-like*. Consequently, the integration of classical physics and quantum mechanics appears in a new framework, and in this context the unification of physics might be possible. Another consequence of internal space H^8 is the existence of non-ordinary matter, see Figure 4, which has implications on both momentum as well as energy conservation.

For the subsequent discussion, a note on terminology seems to be in place. Any force field acting on a massive particle (rest mass different from zero) is termed gravitational *field*. Newtonian gravitation is the classical *attractive* force acting between two masses. Gravity-like *fields* are acceleration fields *produced and controlled by an apparatus* and may be both *attractive and repulsive*. The *gravitomagnetic field*, dimension (1/s), is the gravitational counterpart of the magnetic induction field. It can be generated by a large rotating mass (planet or star), Lense-Thirring effect, which follows from the linearized Einstein equations. The novel alternative is to use the experimental setup of Tajmar *et al.* (2007b and 2008) or Graham *et al.* (2007) and generate a gravitomagnetic field that is about 18 orders of magnitude larger than predicted by *GR*.

In *EHT* the existence of two additional gravity-like fields is predicted, and therefore a set of three coupled gravitational fields needs to be considered. Moreover, a conversion of photons γ into neutral gravitophotons ν_{gp} can take place, coupling electromagnetism with gravitation, which leads to the generation of the strong gravitomagnetic fields of the Tajmar effect in comparison with *GR*. Hence, **classical physics** may, under special experimental conditions, lead to hitherto unknown phase transitions, and thus exhibit completely novel physical phenomena in the form of long range force fields.

If spacetime is made of *discrete pieces* that is, atoms *of spacetime exist*, e.g. (Smolin, 2004), then spacetime might be susceptible to *collective modes*, representing a daunting many-body problem. A major rearrangement of the many-atom spacetime ground state could take place in the new symmetry-broken phase. Each phase of spacetime, similar to phenomena observed in condensed matter physics, may exhibit its proper fundamental symmetry, characterizing this phase. Hence, spacetime would assume the role of physical field(s) (particles), and therefore should be accounted for in all **physical processes of conservation of energy and momentum**. These remarks should only serve as general qualitative explanation for the recently observed large gravitomagnetic effects.

According to *EHT*, in the experiments of Tajmar *et al*. (2007b and 2008), the angular acceleration of the cryogenic Nb ring should lead to a gravitophoton (gravitomagnetic) force. The following predictions are made by *EHT* for the measured gravitational fields that are attributed to the conversion of photons into gravitophotons.

- For the actual experiment as done by Tajmar *et al*. (2007b and 2008), the gravitophoton force is in the azimuthal (tangential) direction, caused by the angular acceleration of the superconducting Nb disk. The

acceleration field is acting opposite to the angular acceleration, obeying some kind of gravitational Lenz rule.

- For the novel experiment of Figure 5 (*field propulsion experiment*), derived from *EHT*, a force component in the axial direction should be generated while the ring or disk is rotating at constant angular velocity.

Building Blocks of Physics

In order for physical events to manifest themselves in our four-dimensional spacetime three basic building blocks have to be present. The first one is the existence of *four-dimensional spacetime*, termed also external spacetime that acts as the stage on which all physical events occur. The second building block is an internal space, called Heim space, denoted H^8, which is responsible for the existence of the physical actors, namely the physical interactions and matter. Each of the interactions or material particles is described by its so called Hermetry form (hermeneutics of geometry, i.e., the physical meaning of geometry). A Hermetry form is a special metric tensor resulting from the double coordinate system transformation mandated by the existence of internal Heim space (Dröscher and Hauser, 2006 and 2007a). The third building block is the substructure or subgroup structure that each Hermetry form possesses, since it metric comprises a set of partial terms. The subgroup describes, for instance, the number of different particles in the group.

1. **Spacetime possesses an additional internal structure**, described by an **internal symmetry space**, **Heim space**, H^8, which is attached to each point of the spacetime manifold,
2. Polymetric tensor from which to construct Hermetry forms (metric subtensor that has physical meaning),
3. Symmetry breaking: alternative interpretation to spontaneous symmetry breaking, namely, instead of symmetry breaking, the existence of virtual particles of imaginary mass is postulated that, being generated in a solid at cryogenic temperatures, are not tachyons, but lead to the interaction between electromagnetism and gravitation,
4. The set of Hermetry forms predicts the existence of ordinary and non-ordinary matter, including a class of stable neutral leptons as well as virtual particles of imaginary mass,
5. Re-interpretation of conservation principles of momentum and energy to be applied to the complete physical system comprising both *ordinary and non-ordinary matter*.

Double Coordinate Transformation

In this section some of the details of constructing the polymetric tensor as used in *EHT* are presented. The polymeric tensor gives rise to a set of 15 metric subtensors that possess a physical meaning. Such a subtensor is also termed a Hermetry form. The concept of an internal 8D space, termed Heim space, which comprises four subspaces, leads to a major modification of the general transformation from general relativity *GR* and is assumed to account for all physical particles and their interactions.

In *GR* there are two sets of coordinates, Cartesian coordinates x and curvilinear coordinates η linked by a relation between their corresponding coordinate differentials. If Heim space did not exist, the polymetric of *EHT* collapsed to the mono-metric of *GR*.

Single Metric Tensor of GR

In *GR* there only four-dimensional spacetime exists, i.e. there is no internal space, comprising the time coordinate with negative signature (-) and three spatial coordinates with positive signature (+) that is, the Lorentzian metric of R^4 has one time-like (- signature) and three spatial (+ signature) coordinates (numbering of coordinates is 0, 1, 2, 3). Signatures are not unique and may be reversed. The corresponding metric is called Minkowski metric and the spacetime associated with this metric is the Minkowski space. The plus and minus signs refer to the (local) Minkowski metric (diagonal metric tensor). Therefore, the squared proper time interval is taken to be positive if the separation of two events is less than their spatial distance divided by c^2. Let coordinates x^μ with $\mu = 1,...,4$ denote

Cartesian coordinates $x^1 = x,\ x^2 = y,\ x^3 = z,\ x^4 = ct$. A general coordinate system for a spacetime manifold, M, needs to be described by curvilinear coordinates η^ν with $\nu = 1,...,4$ and $\eta = (\eta^\nu) \in \mathsf{M}$. In *GR* the equations relating the two systems of coordinates are given by $x^\mu = x^\mu(\eta^\nu)$ or $\eta^\nu = \eta^\nu(x^\mu)$. In *GR*, the distance between two neighboring events with coordinates η^ν and $\eta^\nu + d\eta^\nu$ is given by the square of the line element $ds^2 = g_{\nu\mu}\, d\eta^\nu d\eta^\mu, \nu, \mu = 1,...,4$ where the metric tensor is of the form

$$g_{\nu\mu} = \mathbf{e}_\nu \cdot \mathbf{e}_\mu = \frac{\partial x^\alpha}{\partial \eta^\nu}\frac{\partial x^\alpha}{\partial \eta^\mu} \tag{1}$$

and $\mathbf{e}_\nu = \partial \mathbf{x} / \partial \eta^\nu$ with $\mathbf{x} = x^\mu\, \hat{\mathbf{e}}_\mu$. The vectors $\mathbf{e}_\mu$ are the curvilinear (covariant) base vectors and $\hat{\mathbf{e}}_\mu$ denote the Cartesian unit vectors. Since there is only one metric tensor, *GR* describes one interaction only; associated with Newtonian gravity, see Figure 1a. The question arises, if this concept were valid for all physical interactions, how to construct a set of metric tensors or polymetric.

Polymetric Tensor and Double Coordinate Transformation

In this section, the set of metric subtensors is constructed from the concept of Heim space, H^8, each of them describing a class of physical phenomena (physical interaction or particles). This leads to the concept of Hermetry form, to be introduced later. Thus, the connection between physical space and physics (symmetries) is established in a way foreseen by Einstein, namely by the geometrical properties of spacetime. However, in order to reach this objective, spacetime had to be complemented by an internal space H^8 to *model its intrinsic physical properties*. Once the internal space with its set of coordinates has been determined, everything else is fixed, and equation (2) is a direct consequence of H^8. In contrast to *GR*, now the relation between the coordinate systems (x^i) and (η^j) is via the internal space with coordinates ξ^a that is $x^i = x^i(\xi^a(\eta^j))$ or $\eta^j = \eta^j(\xi^a(x^i))$ where index a is running from 1 to 8. This approach is fundamentally different form *GR,* Figure 1a, since **a set of 15 different** 4×4 **metric tensors** is constructed that all live in four-dimensional spacetime. The existence of internal space H^8 demands a more general coordinate transformation from a spacetime manifold. In the concrete case of *GR* spacetime manifold M^4 would be used M to a manifold N via the mapping M(locally R^4) $\rightarrow \mathsf{H}^8 \rightarrow \mathrm{N}$ (locally R^4). Therefore in *EHT,* a double transformation, equation (2), involving Heim space H^8 occurs. The global metric tensor is of the form

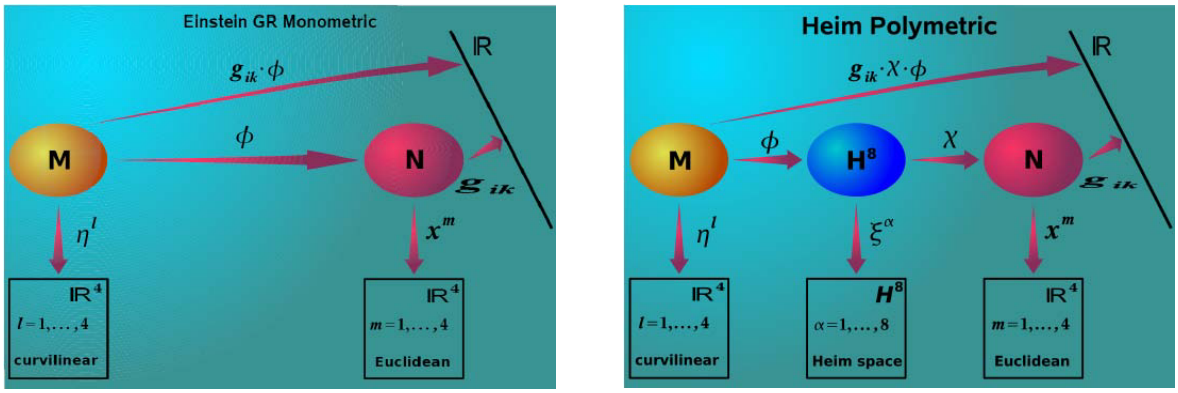
$$g_{\mu\nu} = \frac{\partial x^\alpha}{\partial \xi^a}\frac{\partial \xi^a}{\partial \eta^\mu}\frac{\partial x^\alpha}{\partial \xi^b}\frac{\partial \xi^b}{\partial \eta^\nu} \tag{2}$$

where indices $a, b = 1,.., 8$ and $\mu, \nu, \alpha = 1,., 4$, and thus $g_{\mu\nu}$ comprises **64 components,** see Figure 1b.

The length, being geometric, is invariant under reparametrization, and thus equations (1) and (2) described exactly the same geometric object. So it seems that nothing has been achieved by this double coordinate transformation, since, naturally, all other geometrical features of the manifold remain also invariant.

However, the associated complete metric tensor, equation (2), with its total of 64 terms, equation (3), *does not have any physical meaning by itself*. The construction process for the set of the Hermetry forms is accomplished as follows.

Extracting a certain number of terms from the global metric described by equation (2) by employing the selection rules to be stated later, the complete set of 15 different Hermetry forms is eventually obtained.



(a) **(b)**

Figure 1. In *GR* the metric tensor is computed using a mapping from manifold M to manifold N. (a) This type of mapping gives one metric tensor that was associated with Newtonian gravitation by Einstein. (b) In *EHT*, a double coordinate transformation is used incorporating internal space H^8 that leads to a polymetric tensor from which the individual Hermetry forms are constructed.

A single component of the metric tensor belonging to one of the four subspaces is given by equation (3). Only special combinations of the $g_{ik}^{\alpha\beta}$ reflect physical quantities, i.e. Hermetry forms. Because of the double transformation, each physically meaningful metric does comprise a different subset of the 64 components. In other words, depending on the Hermetry form, a specified number of components of the complete metric tensor in spacetime, equation (2), are set to zero. Hence, each Hermetry form is marked by the fact that only a subset of the 64 components is present. This subset is different for each Hermetry form. Therefore each Hermetry form leads to a different metric in the spacetime manifold, and thus describes a different physical phenomenon. In other words, this approach is equivalent to the solidarity principle of Finzi (see: Cardone and Mignani, 2004), namely each class of physical phenomena (Hermetry form) determines its proper curvature in four-dimensional spacetime. This is why equation (2) is termed the *polymetric tensor*. It serves as a repository for the 15 Hermetry forms. This construction principle is totally different from Einstein's approach. Only in the special case of vanishing space H^8, *EHT* reduces to *GR*,

$$g_{\mu\nu}^{ab} = \frac{\partial x^\alpha}{\partial \xi^{(a)}} \frac{\partial \xi^{(a)}}{\partial \eta^\mu} \frac{\partial x^\alpha}{\partial \xi^{(b)}} \frac{\partial \xi^{(b)}}{\partial \eta^\nu}. \tag{3}$$

The polymetric tensor can be written as

$$g_{\mu\nu} = \sum_{a,b=1}^{8} g_{\mu\nu}^{a,b}. \tag{4}$$

A single Hermetry form is given by

$$g_{\mu\nu}(H_\ell) := \sum_{a,b\in H_\ell} g_{\mu\nu}^{a,b} =: \sum_{a,b\in H_\ell} (a,b). \tag{5}$$

Any Hermetry form can be written as the sum of its symmetric and anti-symmetric part, where indices S and A denote the splitting of the partial metric terms into their symmetric and anti-symmetric parts

$$(a,b)_S := \frac{1}{2}[(a,b)+(b,a)] \quad , \quad (a,b)_A := \frac{1}{2}[(a,b)-(b,a)]. \tag{6}$$

For instance, the Hermetry form of the neutral gravitophoton field which, in the experiments by Tajmar *et al*. (2006, 2007a and 2007b), decays into a graviton and a quintessence particle, $\nu_{gp} \rightarrow \nu_g + \nu_q$, see Figure 3, is represented as

$$H(\nu_g + \nu_q) = H(\nu_g) + H(\nu_q) \tag{7}$$

where the Hermetry forms of the graviton and the quintessence particle can be written in the form

$$H(\nu_g) = (55)_S + (56)_S + (66)_S \quad , \quad H(\nu_q) = (77)_S + (78)_A + (88)_S. \tag{8}$$

The metric tensor representing any Hermetry form can therefore be written in general form

$$g_{\mu\nu}(H_\ell) = \sum_{a,b \in H_\ell} (a,b)_{S,A}. \tag{9}$$

Six Fundamental Physical Forces

The polymetric tensor constructed in *EHT* gives rise to **six fundamental forces** (interactions) that are depicted in Figure 2. Since *GR* uses pure spacetime only, as a consequence, there is only one metric tensor and hence only part of the physical world is visible in the form of Newtonian gravitation. In order to describe all physical forces, the **polymetric tensor** resulting from Heim space needs to be employed, see for instance (Dröscher and Hauser, 2006).

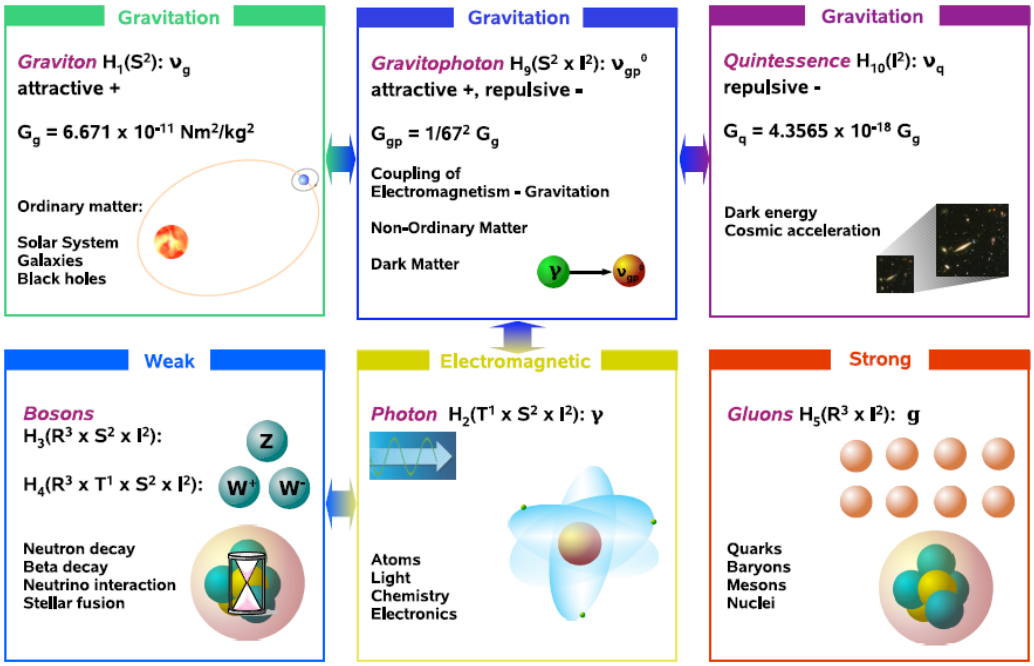


Figure 2. Six fundamental forces are predicted by *EHT*. Three of them are gravity-like (acceleration) fields (upper row, coupling strengths), mediated by three field quanta termed graviton (attractive), gravitophoton (attractive and repulsive), and quintesssence particle (repulsive). The second row shows the electromagnetic, weak, and strong interactions. Arrows indicate possible coupling between interactions. Corresponding Hermetry (metric tensors) forms are listed in Tables 1 and 2.

This idea was first conceived by Heim (1977), a German physicist. A similar principle was mentioned by the Italian mathematician Finzi (see: Cardone and Mignani, 2004). The polymetric tensor of *EHT,* resulting from the concept of H^8 internal symmetry space and its four subspaces, is subdivided into a set of metric sub-tensors. Each element of this set, denoted as Hermetry form, is equivalent to a physical interaction (e.g. gluons, see Table 1) or class of particles (e.g. charged leptons, see Table 1), and thus the **geometrization of physics** may be achieved. Of course, the question remains how to construct the energy-momentum tensor from the metric tensor in order to close the system of equations. There is of course a further aspect, namely the quantization of the associated metric fields that should result in the respective mediator bosons.

It must be noted that this approach is in stark contrast to elementary particle physics, in which particles possess an existence of their own, and spacetime is just a background staffage (Veltmann, 2003). In *EHT*, considered as the natural extension of *GR*, **matter seems to be a consequence of the internal space** H^8. These two physical pictures are mutually exclusive, and experiment will show which view ultimately reflects physical reality. It is, however, well understood that the concept of a point-like elementary particle is highly useful as a working hypothesis in particle physics.

Hermetry Forms: Ordinary and Non-Ordinary Matter

Naturally, the number and type of interactions depend on the structure of internal space H^8 whose subspace composition along with the physical meaning of the individual subspaces was discussed in (Dröscher and Hauser, 2008, 2007a, 2007b and 2006). Contrary to the ideas employed in string theory, see for example (Zwiebach, 2009), H^8 is an **internal space of 8 dimensions comprising four subspaces denoted** R^3, T^1, S^2 and I^2.

The Nature of Internal Space H^8

In mathematical terms, H^8 is the direct sum of its four subspaces, i.e., $\mathsf{H}^8 = \mathrm{R}^3 \oplus \mathrm{T}^1 \oplus \mathrm{S}^2 \oplus \mathrm{I}^2$. This means that

$$\dim\ \mathsf{H}^8 = \dim\ \mathrm{R}^3 + \dim\ \mathrm{T}^1 + \dim\ \mathrm{S}^2 + \dim\ \mathrm{I}^2 = 3 + 2 + 2 + 1.$$

Furthermore, the decomposition for any vector $|a\rangle \in \mathsf{H}^8$ is unique. With the introduction of the four subspaces of H^8 a *symmetry breaking has been introduced ad hoc*, which is causing the *formation of physical entities as well as physical structures* via Hermetry forms, see below. Furthermore, this subspace structure of H^8 leads to a group, termed Heim group, $H = O(3,q) \oplus O(2,q) \oplus O(2,q) \oplus O(1,q)$ over the set of quaternions that is $q \in \mathbb{H}$. Quaternions possess the simplest non-commutative algebra. This is deemed to be necessary to reflect the fact that spacetime ultimately is not a continuum, but instead is assumed to be a non-commutative Riemannian space. Quaternionic probability amplitudes, according to Heim space H^8, are subject to gauge transformations which results in $15 + 6 + 6 + 1 = 28$ generators, to which potentials or particles are assigned. The $O(3,q)$ delivers 15 fundamental groups of particles (here group is not a group in the mathematical sense) of gravitational or non-gravitational nature, while the $O(2,q) \oplus O(2,q)$ stands for the 6 Higgs and 6 anti-Higgs bosons, responsible for all types of charges that fundamental particles can possess. It is believed that all particles of OM or NOM, see Tables 1 and 2, interact with its respective Higgs particle and gain charge (e.g mass or electric charge etc.), but their inertia (energy) should come from group $O(1,q)$, which denotes a special Hermetry form, H_{16} from subspace T^1, related to energy (mass) via $\Delta E\, \Delta t = \hbar$.

With regard to Heim space H^8, in physical terms, the R^3 **subspace coordinates are responsible for the existence of mass**, S^2 **for the formation of organizational structures (neg-entropy),** I^2 **for information structures (entropy), and the** T^1 **subspace coordinate for the existence of charges**.

The introduced *symmetry breaking* is necessary to account for the observational facts, namely that the *Universe*, during its evolution, has *produced massive particles as well as charges*.

To each Hermetry form (metric subtensor), whose metric tensor is composed from the coordinates of the four subspaces, its proper symmetry group is associated, leading to a *hierarchical group structure*. That is, there seems to be no single monster group comprising all conceivable physics. In turn, each Hermetry form comprises its own specific set of partial metric terms. So far the correspondence between these terms and their symmetry group has not been worked out.

For instance, the graviton ν_g Hermetry form H_1, is described by the group of spacetime symmetries (Lorentz and Poincare) $SO(3,1)$ and $P(3,1)$. The photon, γ, denoted by H_2, has symmetry $U(1)$ etc., for the complete representation see Table 1.

However, there is also the table of non-ordinary matter whose Hermetry forms lead to novel groups, such as for the neutral gravito-photon, ν_{gp} denoted by Hermetry form H_9 and represented by symmetry group $SO(4)$, see Table2.

Hence, H^8 allows the construction of a polymetric, while in *string* theory only a higher-dimensional mono-metric exists. Although this mono-metric tensor can be further subdivided (broken symmetry) in order to give the four

known physical forces, its ad-hoc construction does not provide the stringent fundamental physical insights from which the complete set of physical interactions can be derived.

The crucial point for the polymetric tensor lies in the construction as well as the substructure (responsible for the number of Hermetry forms) of the internal space H^8. The subspace composition should be derived from basic physical assumptions, which must be generally acceptable. In other words, as *GR* does not employ any internal space, it thus has limited geometrical structure, namely that of pure spacetime only. Because of this limitation, *GR* cannot describe other physical interactions than Newtonian gravity, and consequently needs to be extended to reflect a more comprehensive physical reality. *EHT* in its present form without any quantization, i.e., not using a discrete spacetime, reduces to *GR* when the internal space is omitted. The metric tensor, as used in *GR*, has purely geometrical means that is, it is of immaterial character only, and does not represent any physics. Consequently, the Einsteinian geometrization principle is equating the Einstein curvature tensor, constructed from the metric tensor, to the energy-stress tensor, representing energy-momentum distribution. In this way, the metric tensor field has become a physical object whose behavior is governed by an action principle, like that of other physical fields. H^8 is an internal gauge space of 8 dimensions, responsible for physical interactions in our spacetime. As it turns out this space admits 15 different Hermetry forms H_ℓ with $\ell = 1,.,15$. It is mentioned that *six* Higgs fields for ordinary matter and six anti-Higgs fields for non-ordinary matter (see Tables 1 and 2) should exist, see next section. In quantum field theory, once the Lagrangian is known, the rate of a physical process can be calculated. This is very general, because it is not known why certain Lagrangians describe *Nature* and how many are needed. In *EHT*, it is claimed that from the set of 16 Hermetry forms all physically possible Lagrangians can be determined. In this way, Hermetry forms are the standard building blocks of physics, and from knowing their number and meaning, it is concluded that *six fundamental interactions* exist.

Ordinary and Non-Ordinary Matter

The two matter tables depict the classification scheme for physical interactions and particles as obtained from the polymetric of space H^8 or *Heim* space. Superscripts for subspaces indicate dimension. A Hermetry form characterizes either a physical interaction or class of particles, and is represented by the metric of an admissible subspace (a space thus has real physical meaning) of H^8, which is a combination of the four elementary subspaces as mentioned above. Any admissible subspace combination needs S^2 or I^2 coordinates to be present in order to realize physical events in our spacetime. Employing this selection rule leads to 12 admissible Hermetry forms, plus three so called degenerated Hermetry forms, and together with the special Hermetry form of the inertia field (see below) there exists a *total of 16 Hermetry forms*. The four different colors in the messenger particle column indicate the four known fundamental interactions. Any Hermetry form containing subspace R^3 is associated with ordinary (real matter), see Tables 1 and 2. Although gluons are supposed to have zero mass, the mass of the proton, about 1 GeV, is much larger than the sum of the masses of its three quarks, *uud*, which amount to some 10 MeV. Within the proton radius the interaction energy between the three quarks, as permeated by the gluons, i.e. their color fields, contributes the missing mass. Therefore, it is reasonable to assume that subspace R^3 occurs in the Hermetry form for gluons H_5. Moreover, *the presence of* R^3 *in the neutrino Hermetry form* H_7 *requires that neutrinos have real mass*. Furthermore, the combination of subspaces R^3 and T^1 *indicates charged particles of real mass*. The correspondences between Hermetry forms of Tables 1 and 2 should be noted, in particular the correspondence between neutrinos and dark matter.

The two additional gravitational fundamental forces are mediated by **gravitophotons** (*attractive* ν_{gp}^{+} and *repulsive* ν_{gp}^{-}) as well as the **quintessence particle** (repulsive ν_q dark energy). The *quintessence particle* ν_q is assumed to be responsible for the *interaction between the spacetime field (vacuum field) and ordinary matter*. The H_1 Hermetry form for the graviton occurs in both tables, since gravitons can be generated by both ordinary matter as well as by non-ordinary matter (Hermetry form H_9), which is believed to be the case in the experiments Tajmar *et al.* (2006 and 2008) The graviton field is equivalent to an acceleration field, which, in turn, is associated with inertia,

i.e., Hermetry form H_1. Furthermore, the table contains three Hermetry forms marked by a $*$, which indicates that some of the partial terms in its associated metric tensor are zero.

Table 1. Table of Hermetry forms for ordinary matter (*OM*) describing all messenger particles (gauge bosons[1]), namely graviton, *photon*, *vector bosons*, and *gluons* as well as all known types of matter (last three blue rows), i.e., leptons and *quarks*.

Hermetry Forms of Ordinary Matter (OM)			
Hermetry form Lagrange density	***Messenger particle***	***Symmetry group***	***Physical interaction***
$H_1(S^2)$, L_g	ν_g *graviton*	$SO(3,1)$	**gravitation** +
$H_2(T^1 \times S^2 \times I^2)$, L_{em}	γ *photon*	U(1)	**electromagnetic** $\gamma \rightarrow \nu_{gp}^0$ *only the photon interacts with NOM*
$H_3(R^3 \times S^2 \times I^2)$, L_{we}	Z^0 *boson*	SU(2)	**weak**
$H_4(R^3 \times T^1 \times S^2 \times I^2)$	$W^{\pm}$ *bosons*	SU(2)	**weak**
$H_5(R^3 \times I^2)$, L_s	g gluons	$SU(3)$	**strong**
$H_6(R^3 \times T^1 \times S^2)$	e, μ, τ		**charged leptons**
$H_7(R^3 \times S^2)$	ν_e, ν_μ, ν_τ *neutrinos*		**neutral leptons**
$H_8(R^3 \times T^1 \times I^2)$	q		**quarks**

[1]The gauge bosons comprise the four known fundamental forces. However, these forces are not sufficient to explain the experiments by Tajmar *et al*. (2006 and 2008) and Graham *et al*. (2007) (as was shown in Dröscher and Hauser (2008)) nor can they account for *dark matt*er or *dark energy*.

Table 2. Table of Hermetry forms for **non-ordinary matter** (NOM).

Hermetry Forms of Non-Ordinary Matter (NOM)			
Hermetry form Lagrange density	***Messenger particle***	***Symmetry group***	***Physical interaction***
$H_1(S^2)$, L_g	ν_g *graviton*	$SO(4)$	**gravitation** +
$H_9(S^2 \times I^2)$, L_{gp}	$\nu_{gp}^0 \rightarrow \begin{cases} \nu_g + \nu_q \\ \nu_{gp}^+ + \nu_{gp}^- \end{cases}$ *gravitophotons*		**gravitation** $\pm$
$H_{10}(I^2)$, L_q	ν_q *quintessence particle*		**gravitation** − **dark energy**
$H_{11}(T^1 \times S^2 \times I^2)^*$	γ_I	$U(1)$	**interaction bosons for charged** Im**-leptons**
$H_{12}(I^2)^*$	g_I	$U(1)$	**interaction bosons for** Im**-quarks**
$H_{13}(T^1 \times S^2)$	e_I^-, e_I^+		**charged** Im**-leptons**
$H_{14}(R^3 \times S^2)^*$	e^0, μ^0, τ^0 *dark matter*		Re**-leptons**
$H_{15}(T^1 \times I^2)$	q_I		Im**-quarks**

This table contains **imaginary matter** in the form of *imaginary electrons and positrons (imaginary mass, but real charge)*, which, however, are virtual particles, denoted as $e_I^{\pm}$ together with its *messenger particle* γ_I, where the existence of neutral leptons is postulated.

Therefore, such a Hermetry form is designated as *degenerated*. Tables 1 and 2 provide a total of 16 Hermetry forms. There is only one charged lepton for NOM, whose mass should be the electron mass. Comparison with the corresponding Hermetry form H_6 of charged leptons for OM shows that subspace R^3 is missing. The presence of R^3 (cardinal number 3) seems to be responsible for the variety of different types of matter (cardinal number of T^1 is 1 only). Subspace dimensions may play a role in computing the coupling constants (set algebra). Of particular importance is the Hermetry form H_{15} (compare with Hermetry form H_6, which describes *neutral leptons* e^0, μ^0, τ^0. Since they do not carry any electric charge they are not subject to electromagnetic interaction, and thus cannot decay in the same way through the weak interaction as their charged counterparts, and hence *might be stable*. Their masses could be close to those of the charged leptons. Thus, they could be *candidates for dark matter*. Their *interaction with ordinary matter is mediated through gravito-photons*.

Imaginary Matter

The *concept of imaginary matter* in Table 2 should not be taken as if there existed a new type of matter (except for the proposed neutral leptons, who might be associated with dark matter), since these particles are assumed to be *virtual particles of imaginary mass* that is, they do *not occur* in the initial and final states of a reaction. They might, however, act as a catalyst, enabling a novel interaction, namely the *conversion of electromagnetic into gravitational fields* as seen in recent gravitomagnetic experiments. This means that all *observed* particle masses and charges are still considered *real*. From Table 2 it can be seen that the neutral gravitophoton, ν_{gp} (note that in Tables 1 and 2 the neutral gravito-photon is denoted as ν_{gp}^0 instead of ν_{gp}), can decay in two different ways. The first one, in which the ν_{gp} decay (see Figure 3) results in positive and negative gravitophotons, should produce a vertical gravity-like field in the presence of an induced current in the superconducting rotating disk (Figure 5), caused by the external magnetic induction field. The second decay scheme, giving a graviton and a quintessence particle, is assumed to take place in the experiments by Tajmar *et al*. (2006 and 2008), when a circumferential gravity-like field in the plane of the ring is produced by mechanically accelerating the cryogenic Nb ring.

In *EHT*, dark matter is composed of a new class of particles, the *NOM: neutral leptons (fermions)*, but *these are not WIMPS* (Weakly Interacting Massive Particles) whose masses are supposed to be hundreds of GeV, and thus have elucidated present accelerators. The inertial masses of e^0, μ^0, τ^0 have not been calculated, but are assumed to be close to their charged counterparts, *i.e.*, $0.511\,MeV/c^2$ for electrons, $105.66\,MeV/c^2$, and $1.78\,GeV/c^2$ (compared to $938\,MeV/c^2$ for protons). Their gravitational interaction occurs, however, through the gravito-photon field with coupling strength G_{gp}. The coupling between dark matter and ordinary matter therefore should be given by $\sqrt{G_g G_{gp}} = 1/67 G_g$.

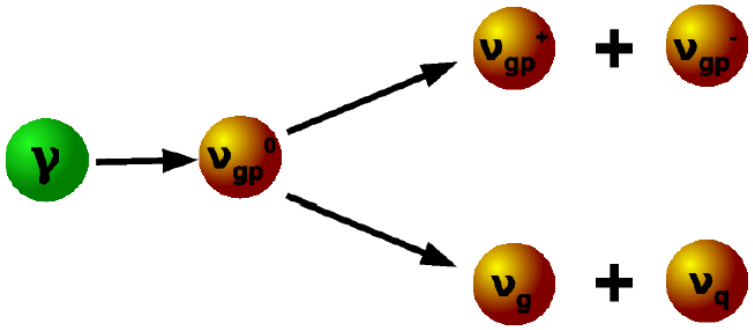


Figure 3. Hermetry form H_9 stands for the neutral gravitophoton ν_{gp} produced by photon conversion, which can decay via two different channels, depending on experimental conditions. The first one, upper branch, seems to take place in the generation of the axial (vertical) acceleration field, called the Heim experiment. The second branch is assumed to occur in the gravitomagnetic experiments by Tajmar *et al.* (2006, 2007a and 2007b) and Graham *et al.* (2007).

If e^0, μ^0, τ^0 existed in *Nature*, the question naturally arises: why did not accelerators already long ago produce these particles? Accelerators or colliders produce beams of high-energy electrons or protons that are driven onto a target or two beams are colliding from opposite directions. According to Table 1 and also in accordance with the *Standard Model*, there is no place for OM neutral leptons, except for the almost massless neutrinos, which cannot contribute more than 1 \% to dark matter. In *EHT*, however, the *NOM* counterpart to neutrinos, as can be seen from comparing Tables 1 and 2, actually are the neutral leptons e^0, μ^0, τ^0.

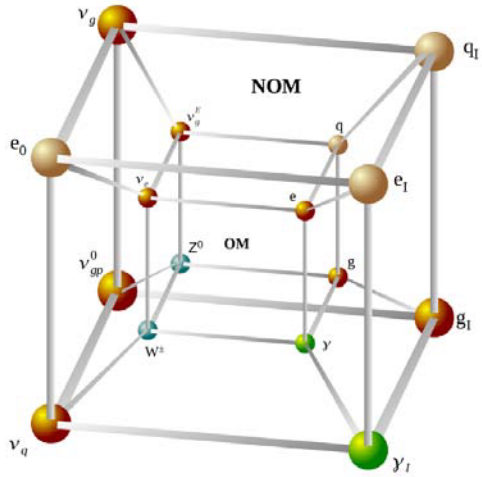


Figure 4. In *EHT*, there exist two types of matter, OM (inner cube) and NOM (outer cube), which are represented each by eight Hermetry forms, see Tables 1 and 2. Thus, the four-dimensional hypercube should represent all forms of matter that do appear in the *Universe*.

In order to construct the physically meaningful set of metric sub-tensors that is, Hermetry (which stands for the physical meaning of geometry, combined from hermeneutics and geometry) forms, **it is postulated that coordinates of internal spaces S^2 (organization coordinates) or I^2 (information coordinates) must be present** in any metric sub-tensor to generate a Hermetry form as stated in (Heim, 1977). From this kind of selection rule, it is straightforward to show that 12 Hermetry forms can be generated, having direct physical meaning. In addition, there are three degenerated Hermetry forms that describe partial forms occurring in *NOM*, namely of the photon, gluon, and dark matter. Hermetry form 16 is reserved for the *inertia field*. The interpretation of the meaning of Hermetry forms was already given in Tables 1-4 of Dröscher and Hauser (2006), but has changed since then, based on new physical facts derived from the interpretation of the experiments by Tajmar *et al.* (2006 and 2008) In Tables 1 and 2 Hermetry forms were also renumbered to better reflect their belonging to either OM or NOM.

Because of the double coordinate transformation underlying the construction of the polymetric tensor, see for instance (Dröscher and Hauser, 2006 and 2005), any metric tensor describing a Hermetry form is composed of a partial sum of metric terms, selected from the 64 components that comprise the complete polymetric tensor, which in turn results from the inclusion of internal space H^8.

If space H^8 is omitted, *EHT* is reduced to *GR*, and only gravitation remains. It is obvious that a double coordinate transformation as employed in Dröscher and Hauser (2007) does not change, for instance, the curvature of a surface, since it is an invariant (intrinsic to the surface). However, *this fact is not relevant* in the construction process of the polymetric. The physical reason for the double transformation is to provide spacetime with the additional degrees of freedom, expressed by the individual components of the metric tensor from which the various Hermetry forms are constructed.

Only metric tensors representing Hermetry forms are of physical relevance, and it is clear from their construction principle that all these tensors, derived from this underlying polymetric tensor, are different. Consequently, their respective Gaussian curvatures K_ℓ, where ℓ denotes the index of the corresponding Hermetry form, must also be different. This is *straightforward to observe*, since Gaussian curvature is only a function of the first fundamental

form (metric tensor components) as well as their first and second derivatives, but does not depend on the second fundamental form. Therefore, each *Hermetry form* H_ℓ *determines its proper Gaussian curvature* K_ℓ, and thus curves *space according to its own specific metric*. Following the rule of *GR* that interprets spacetime curvature as gravitational interaction, the appropriate Hermetry forms are thus interpreted as physical interactions, as shown in Tables 1 and 2.

Having established the qualitative physical relationship between Hermetry forms and spacetime curvature; all physical interactions are connected to spacetime curvature, similar to *GR*, and thus physics has been geometrized. Some additional remarks between the connection of geometry and physics are in place. Internal coordinates of subspace R^3 of Heim space H^8 have dimension of length, and via the Compton wavelength are connected to mass, and the internal coordinate of space T^1 is responsible for charge. In Dröscher and Hauser (2006), it was already shown that spacetime must be quantized at about the Planck length scale (maybe the length scale is somewhat larger). Moreover, it is well known that in the case of gravitation in the Newtonian limit, metric element g_{00} (time has coordinate index 0 in spacetime coordinates) is proportional to the gravitational potential equation.

EHT and Conservation Principles

The rocket principle requires that momentum is taken from the fuel and transferred to the space vehicle. According to *EHT*, the space vehicle is *acquiring velocity by imparting an equal and opposite momentum to the spacetime field*. A simple analogy is used to differentiate between the *classical rocket principle* (including all other means of propulsion) and the novel *field propulsion concept* of *EHT* incorporating spacetime as a physical quantity.

Suppose a boat is in the middle of a large lake or ocean. In order to set the boat in motion, a force must be mediated to the boat. The classical momentum principle requires that a person in the boat is throwing, for instance, bricks in the opposite direction to push the boat forward. However, everybody is well aware of the fact that there is a much better propulsion mechanism available. Instead of loading the boat with bricks, it is supplied with sculls, and by rowing strongly the boat can be kept moving as long as rowing continues. The important point is that the **medium itself is being utilized**, *i.e*., the water of the lake or ocean, which amounts to a completely **different physical mechanism**. The rower transfers a tiny amount of momentum to the medium, but the boat experiences a substantial amount of momentum to make it move. For space propulsion **the medium is spacetime** itself. Thus, if momentum can be transferred to spacetime by field propulsion, a repulsive or recoil force would be acting on the space vehicle moving it through the medium, like a rowing boat. The medium, spacetime, is a physical quantity, namely a field, and if properly quantized, the respective particles mediating forces should also be present. Thus, in principle, spacetime should have the capability to interact with a space vehicle. If this effect somehow can be experimentally established, the principles of momentum and energy conservation require that the combined system, *i.e*., both spacetime and space vehicle, are considered. According to *EHT*, this actually is the physical mechanism occurring in the experiments by Tajmar *et al.* (2006 and 2008) and Graham *et al*. (2007) Important to note, this mechanism does not extract momentum from the spacetime field and transfers it to the space vehicle. Instead, an active process has to be triggered for the creation of gravito-photons, i.e., first generating a strong gravitomagnetic field, $\mathbf{B}_{gp}$. Second, in order to produce the gravity-like field seen in the experiments at AIT, experimental conditions have to be such that the $\mathbf{B}_{gp}$ field can decay, producing gravitons and quintessence particles.

The important point is that in this scheme not only gravitons exist, but also gravito-photons as well as quintessence particles. The important fact is that in the generation of the gravitomagnetic force via the decay of the gravito-photon, *as is assumed to be the case in the gravity-like experiments by Tajmar et al.* (2006 and 2008), both the *OM* (**graviton**, negative gravitational energy density) and *NOM* (**quintessence particle** positive gravitational energy density) are generated, see Figure 3. The total energy in the generation of these two particles is therefore zero. *Gravitons interact with the space vehicle*, i.e. they are absorbed by the space vehicle, while the *quintessence particles are reabsorbed by spacetime itself.* This effect causes an acceleration of the space vehicle, while the momentum of the quintessence particle is not felt by the space vehicle, but by the surrounding **spacetime and leads to its expansion**, because of the repulsive force, and thus total momentum is being conserved. This effect is most likely too small to be observed, but this kind of space propulsion should contribute to the expansion of the *Universe*.

In the same way the momentum change of the ocean would not be discernible from the presence of a rowing boat. Perhaps a local disturbance of spacetime might be measurable in the experiments by Tajmar *et al*. (2008)?

In the Heim experiment (vertical gravity-like field), see Figure 5, the neutral gravito-photon ν_{gp} decays into the positive ν_{gp^-} and negative ν_{gp}^{+} gravito-photons, Figure 3, which follows from the construction of the set of Hermetry forms that, in turn, are a direct consequence of internal Heim space and its four subspaces. Again it is assumed that the negative gravito-photons act on the spacecraft and the positive gravito-photons act on space such that total momentum is conserved. As long as the experimental conditions for the production of gravito-photons along with their respective decay are maintained, the proper acceleration field will be generated. For the same period of time the interaction between space vehicle and surrounding spacetime remains. As soon as the gravito-photon production and its subsequent decay stop, the acceleration field ceases to exist.

Field propulsion needs to interact with spacetime in order to work without propellant. The rocket principle is only concerned with the energy and momentum balance of the physical system comprising the space vehicle and its fuel. Therefore, regardless of the technology employed, this system is bound by the momentum that can be extracted from the stored fuel. Therefore this principle, by definition, cannot produce a viable propulsion system delivering high speed, long range, or high payload ratio.

An interesting question that so far has not been pondered is under what circumstances gravito-photons were or are currently being produced on the cosmological scale and how this production might have influenced the expansion of the *Universe*.

GRAVITATIONAL SPACE PROPULSION DEVICE

In the experiments by Tajmar *et al*. (2006, 2007a, 2007b and 2008) designed for the generation of gravity-like fields, the *gravitational force is acting in the plane of rotation in circumferential direction, opposing the original mechanical acceleration of the ring or disk*. The same holds true for GP-B, which was designed to measure the Lense-Thirring effect.

Therefore, *EHT* was used to investigate whether a technically more convenient gravity-like field can be generated whose force component is vertical, i.e., along *the axis of rotation*, while the *rotation speed remains constant*.

The experimental setup by Tajmar *et al.* (2006 and 2008) comprises an aluminum (Al) sample holder together with a cryogenic rotating Nb ring fixed to the sample holder, which therefore is rotating at the same angular velocity. The component in the z-direction, responsible for the acceleration field, is given by

$$\mathbf{B}_{gp} = B_{gp;z}\hat{\mathbf{e}}_{\mathbf{Z}} = \frac{1}{\pi} k\, k_{Nb}\, k_{Al} \frac{m_e}{m_p} \omega_F \hat{\mathbf{e}}_{\mathbf{Z}} \; ; \mathbf{g}_{gp} = g_{gp;z}\hat{\mathbf{e}}_{\mathbf{Z}} = \frac{v_{sh}^2}{c} B_{gp;z}(\hat{\mathbf{e}}_\theta \times \hat{\mathbf{e}}_{\mathbf{Z}}) \times \hat{\mathbf{e}}_\theta . \tag{10}$$

The factor π comes from averaging over the area of the Al disk. The other constants have the following values: $k = 3,\ k_{Nb} = 1/20.49,\ k_{Al} = 1$ denoting material constants, and ω_F is the angular velocity of the imaginary electron pairs derived from the Fermi energy where a value of $v_F \approx 2.76 \times 10^5\, m/s$ was used. v_{sh} denotes the mechanical velocity of the rotating sample holder, and $B_{gp;z}$ is the component of the gravito-photon field $\mathbf{B}_{gp}$ (dimension 1/s) in the z-direction, see Figure 5. It should be noted that, in contrast to the acceleration field $\mathbf{g}_{gp}$, *the magnitude of the gravitomagnetic field* $\mathbf{B}_{gp}$ *should not depend on the mechanical angular velocity at which the Al sample holder and Nb ring are moving*. Experimental requirements for boson coupling are substantially lower than for fermion coupling, which was calculated in Dröscher and Hauser (2004). It should be noted that for the gravitomagnetic field generated in the experiments by Tajmar *et al*. (2006 and 2008) the term ω_F should be replaced by ω_{Nb}, and thus a dependence on the rotation speed of the Nb ring, at least within a certain range, should be observed.

According to current understanding, the (superconducting) solenoid of special material (red), see Figure 5, should provide an imaginary magnetic induction field, in the z direction at the location of the rotating disk (gray), made

from a material different than the solenoid. The z-component of the gravito-photon field is responsible for the gravitational field above the disk.

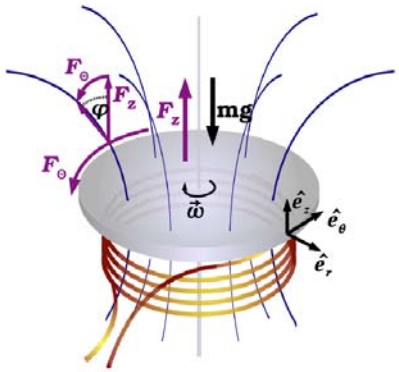


Figure 5. In this gravity-like field experiment the artificial gravitational field generated would be *directed along the axis of rotation*. The second component is in azimuthal direction and should accelerate the ring or disk. Therefore, energy needs not to be supplied to keep the angular velocity of the ring or disk constant. This experimental setup could serve as field propulsion device, if a non-divergence free field were generated (the physical nature of the gravity-like field is not known at present). The divergence of the field is believed to be different from zero.

This experimental setup could also serve as field propulsion device, if, as assumed, a non-divergence free field was generated (the physical nature of the gravity-like field is not known at present), and if appropriately dimensioned. Figure 5 describes the experimental setup utilizing a disk rotating directly above a (superconducting) solenoid. In the field propulsion experiment of Figure 5, the gravito-photon force produces a gravitational force above the disk in the z-direction.

The following assumptions were made for the experiment producing the vertical gravity-like field: $N = 10$, number of turns of the solenoid, current of about $\approx 8\,A$ (needed to calculate the component of the magnetic induction field B_z), diameter of solenoid 0.15 m, and rotation speed $v_{sh} = 50$ m/s. The disk should be placed directly above the solenoid to produce a magnetic field in z-direction only. This experiment should give an acceleration field of about $\mathbf{g}_{gp} = 6\times10^{-2}\mathrm{g}\hat{\mathbf{e}}_z$, which is an appreciable field acting directly above the rotating disk. The value for the achievable acceleration should show a resonance behavior and should be strongly material dependent. The cross section area of the Nb ring should be larger than in the experiments by Tajmar *et al.* (2006 and 2008).

From these numbers it seems to be feasible that the realization of a space propulsion device that can **lift itself from the surface of the Earth is within current technological limits**.

For a space vehicle with a total mass of 1.5×10^5 kg and a desired acceleration of 1.3 g, a force of about 1.98×10^6 N is needed. Therefore, if a mass of $3.15\times10^3 kg$, is placed above the disk, i.e., is acting as charge in this acceleration field, see Figure 5, such a force would be generated. Here it was assumed that the field is acting in the z-direction and all of the mass sees the same acceleration field. In this regard, high-density material would be advantageous, because of its smaller volume. Adding more mass would increase the force, which follows directly from Newton's law. %In this regard, the ultimate propulsion system could be built, if matter from a neutron star could be used. This follows directly from the fact that gravitation is represented by the curvature of spacetime and any mass located in such a region would experience a force proportional to its mass. According to our calculations the acceleration field is extending uniformly in the *z*-direction up to a height three times the radius of the disk, and after that should assume a dipole character that is, the divergence of the field is different from zero. In order to generate the acceleration field a rotation speed of 200 m/s, a coil of 1 m diameter with 2,500 turns and a current of ≈ 8 A was calculated, using, however, a different material than Nb. In addition, the material of the coil also should have an influence on the strength of the acceleration field.

All trip times given in Dröscher and Hauser (2004) remain unchanged, but as can be seen from the specifications above, technical requirements were substantially reduced and should be feasible employing current technology. The reason for this change is boson instead of fermion (vacuum polarization) coupling.

CONCLUSIONS AND FUTURE ACTIVITIES

Since 2002 ideas of a geometric approach for describing physical interactions, termed Extended Heim Theory (*EHT*), were published. This approach predicts **six fundamental physical interactions**, three gravitational fields, electromagnetism as well as the weak and strong interactions (Dröscher and Hauser, 2008, 2007b and 2006). In *EHT* gravitation can be both attractive and repulsive. *EHT* also predicts the existence of **virtual particles of imaginary mass**, responsible for the conversion of electromagnetic energy into gravitational energy. In addition to the existence of ordinary matter (fermions and bosons), non-ordinary matter in the form of above virtual particles of imaginary mass as well as **stable neutral leptons** should exist, which might be accountable for dark matter.

Numerous experiments by Tajmar *et al.* (2006, 2007a, 2007b and 2008) *at AIT Seibersdorf* carried out since 2003, and first published in 2006, report on the laboratory generation of gravitomagnetic as well as gravity-like fields. The *gravitomagnetic effects measured were about 18 orders of magnitude larger than predicted by the so-called Lense-Thirring effect of GR*. In other words, the rotating niobium ring, having a mass of some 500 grams utilized by Tajmar, produces a frame dragging effect similar to the mass of a white dwarf (Dröscher and Hauser, 2008). These experiments were repeated by Graham *et al*. (2007), and more recently Tajmar *et al.* (2007b) provided a comparison between the two experiments. If the experiments of Tajmar and Graham are correct, a similar effect should have been observed in the NASA-Stanford Gravity-Probe B experiment as was calculated in Dröscher and Hauser (2009 and 2008). Indeed, a large gyro anomaly was observed in GP-B.

On the theoretical side *EHT* was used to analyze these experiments and also to approximately predict the magnitude of the gyro misalignment in the GP-B experiment resulting from spin-spin interaction, caused by the generation of gravity-like fields acting between the gyros in each of the two gyro pairs. The GB-P experiment utilized two counter-rotating gyro pairs that, while in space, exhibited asymmetric misalignment, depending on the direction of rotation. Theoretical predictions by *EHT* and measured misalignment were compared and gave reasonable agreement. Hence, it remains to be seen whether the electrostatic patch effect, used in the post-flight analysis to predict gyro misalignment by the Stanford team, is capable to completely account for both the magnitude and the type of anomaly observed. According to *EHT* this anomaly should not be totally explainable by classical effects, *i.e*., electrostatic forces, etc. The Lense-Thirring (frame dragging) effect seems to exist exactly as predicted by *GR*. Therefore, there is no room using a modification of the Lense-Thirring effect to explaining the large observed gravitomagnetic fields.

In summary, the present situation is characterized by the fact that numerous experiments were performed over a period of four years, employing different measurement techniques, showing similar, but unexpected results. Measurement techniques in all experiments are clearly state of the art, in particular for the GP-B experiment.

Furthermore, gravity-like fields most likely would lead to novel technologies in the field of (space) transportation, and thus should be of major interest to the public and to industry.

In addition, these fields might also be usable in several ways for clean energy generation leading, for instance, to *modified fusion energy research* that could be highly relevant to the future, because a linear reactor geometry might be feasible. In addition, several possibilities have been considered in generating electric energy directly from gravity-like fields.

How to proceed? The experiments performed so far, if confirmed, will serve as demonstrators for the existence of **novel physical effects**. However, in order to *produce a propellantless space propulsion system*, the experiment generating a **vertical gravity-like field** needs to be carried out. According to *EHT*, the effect should be large enough to be detectable with relatively simple measuring equipment, in contrast to the experiments performed so far, which need extremely sensitive equipment to measure a small effect, and thus are susceptible to background noise. Moreover, a vertical field might directly lead to some kind of *gravity control*. In particular the materials composition of the disk and coil are of prime importance, since the magnitude of the vertical field seems to strongly depend on it.

A further significant question is, whether it will be possible to increase the critical temperature to room temperature to avoid working with liquid He. Here it should be noted that even after more than 100 years of research, superconductivity has elucidated a solution. Substantial theoretical efforts are needed both for a basic understanding of the novel underlying physics as well as providing guidelines for revolutionary technologies.

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