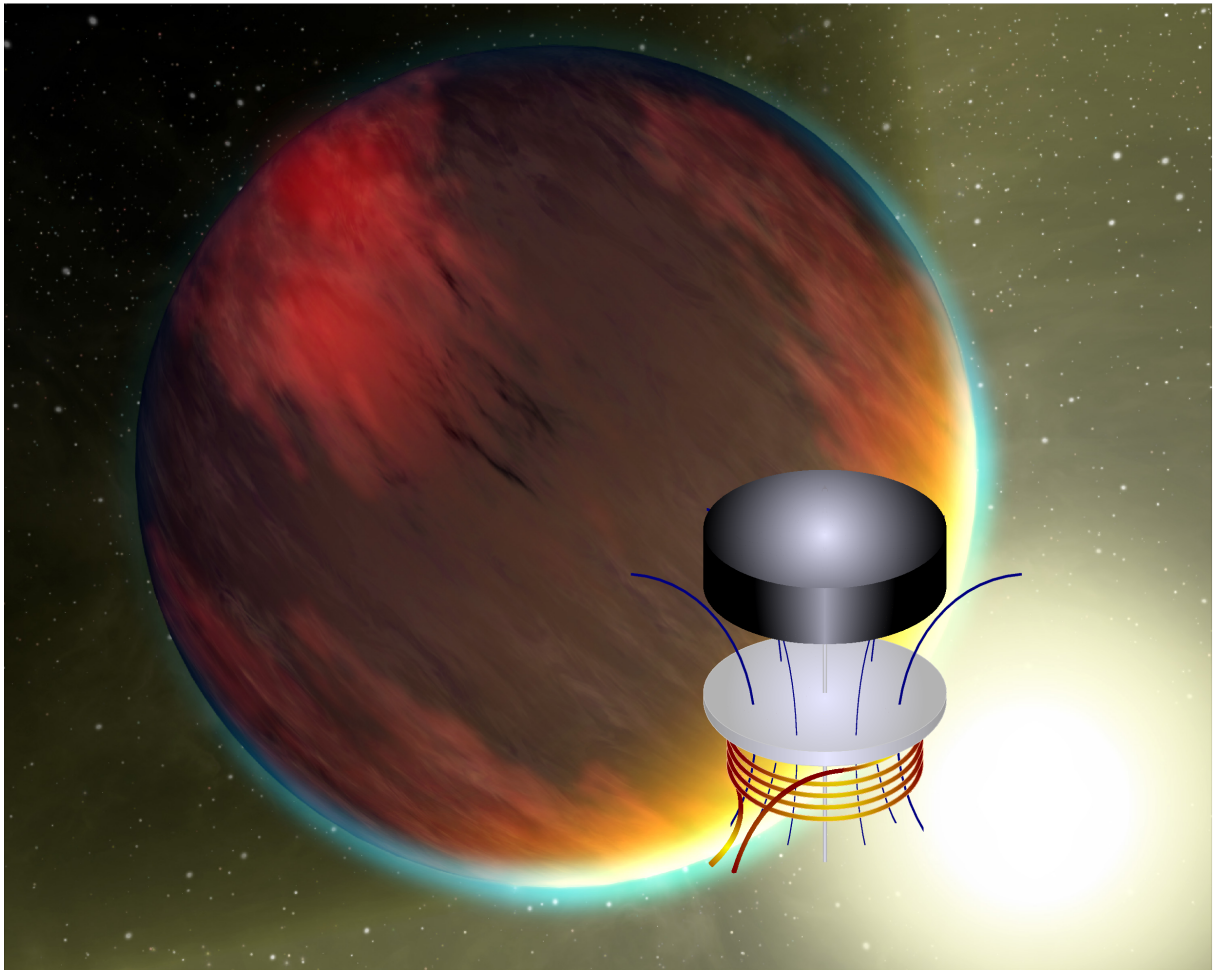# Current Research in Gravito-Electromagnetic Space Propulsion

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Abbreviated Version [2]

Figure 1. The figure shows a combination of two pictures. The first one shows an artist's concept of two Jupiter like planets, detected by NASA's Spitzer Space Telescope. Spitzer captured for the first time, February 2007, enough light to take the spectra of these two gas exoplanets, called HD 209458b and HD 189733b. These so-called "hot Jupiters" are like Jupiter, but orbit much closer to their sun. Molecules were identified in their atmospheres. HD 189733b is about 63 light years away in the constellation Vulpecula, and HD 209458b is approximately 153 light years away in the constellation Pegasus. The second picture, lower right, depicts the principle of gravito-magnetic space propulsion. For further explanations see Fig. 5 of this paper.

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[2] Mathematical derivations were omitted in this abbreviated version

Abstract: Spaceflight, as we know it, is based on the century old rocket equation that is an embodiment of the conservation of linear momentum. Moreover, special relativity puts an upper limit on the speed of any space-vehicle in the form of the velocity of light in vacuum. Thus current physics puts severe limits on space propulsion technology.

This paper presents both recent theoretical and experimental results in the novel area of propulsion research termed gravito-magnetic field propulsion comprising the generation of artificial gravitational fields. In the past, experiments related to any kind of gravity shielding or gravito-magnetic interaction proved to be incorrect. However, in March 2006 the European Space Agency (ESA) announced credible experimental results, reporting on the measurement of artificial gravitational fields (termed gravito-magnetic fields), generated by a rotating Niobium superconductor ring that was subjected to angular acceleration. These experiments were performed by M. Tajmar and colleagues from ARC Seibersdorf, Austria and C. de Matos from ESA, and recently were repeated with increased accuracy.

Extended Heim Theory (EHT), published in a series of papers since 2002, predicted the existence of such an effect, resulting from a proposed interaction between electromagnetism and gravitation. In EHT, which is a consequent extension of Einstein's idea of geometrization of all physical interactions, the concept of poly-metric developed by the German physicist B. Heim is employed. As a consequence of this geometrization, EHT predicts the existence of six fundamental interactions. The two additional interactions are identified as gravitophoton interaction, enabling the conversion of photons into a gravitational like field, represented by two hypothetical gravitophoton (attractive and repulsive) particles, and the quintessence particle, a weak repulsive gravitational like interaction (dark energy?). The experiments by Tajmar et al. (the artificial gravitational force, however, was observed only in the circumferential direction of the superconducting ring) can be explained by the joint generation of quintessence particles and gravitons. EHT is used to provide a physical model for the existence of the artificial gravitational field, and to perform comparisons with experimental data.

In the next step, it is shown that the gravitophoton interaction could be used to devise a novel experiment in which the artificial gravitational field would be directed along the axis of rotation, and thus this force could serve as the basis for a field propulsion principle working without fuel. Based on this novel propulsion concept, missions to the international space station (LEO), the planned moon basis, to Mars, and missions to the outer planets are analyzed. Estimates for the magnitude of magnetic fields and necessary power are presented as well as for trip times.

PRESENT CONCEPTS OF SPACE PROPULSION

Current space transportation systems are based on the principle of momentum generation, regardless whether they are chemical, electric, plasma-dynamic, nuclear (fission) or fusion, antimatter, photonic propulsion (relativistic) and photon driven (solar) sails, or exotic Bussard fusion ramjets. The specific impulse achievable from thermal systems ranges from some 500 s for advanced chemical propellants (excluding free radicals or metastable atoms), approximately 1,000 s for a fission solid-core rocket (NERVA program [1]) using hydrogen as propellant (for a gas-core nuclear rocket specific impulse could be 3,000 s or higher but requiring very high pressures), and up to 200,000 s for a fusion rocket [2]. Although recently progress was reported in the design of nuclear reactors for plasma propulsion systems [3] such a multimegawatt reactor has a mass of some 3×10^6 kg and, despite high specific impulse, has a low thrust to mass ratio, and thus is most likely not capable of lifting a vehicle from the surface of the earth. For fusion propulsion, the gasdynamic mirror has been proposed as highly efficient fusion rocket engine. However, recent experiments revealed magnetohydrodynamic instabilities [4] that make such a system questionable even from a physics standpoint, since magnetohydrodynamic stability has been the key issue in fusion for decades. The momentum principle combined with the usage of fuel, because of its inherent physical limitations, does not permit spaceflight to be carried out as a matter of routine without substantial technical expenditure.

At relativistic speeds, Lorentz transformation replaces Galilei transformation where the rest mass of the propellant is multiplied by the factor $(1/\sqrt{1 - v^2/c^2})$ that goes to infinity if the exhaust velocity v equals c, the speed of light in vacuum. For instance, a flight to the nearest star at a velocity of some 16 km/s would take about 80,000 years. On the other hand, a space vehicle with a mass of 10^6 kg at the high velocity of 10^5 km/s would take approximately 12.8 years to reach this star. Its kinetic energy would amount to about 5×10^{21} J. Supplied with a 100 MW nuclear reactor, it would take some 1.5 million years to generate this amount of energy. Current physics requires that energy conservation is strictly adhered to and does not permit to extract energy from the vacuum. However the physical properties of the

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vacuum are not known [18]. The energy density of the vacuum calculated by General Relativity (GR) and Quantum Field Theory (QFT) differ by a factor of 10^{108}, which means the error is in the exponent. Current physics clearly is open to question. Moreover, it is obvious that if the speed of light cannot be transcended, interstellar travel is impossible. We conclude with a phrase from the recent book on future propulsion by Czysz and Bruno [19]: *If that remains the case, we are trapped within the environs of our Solar System*. In other words, the technology of spaceflight needs to be based on novel physics that provides a novel propulsion principle. Most likely the physical properties of the vacuum play an important role, although unknown at present.

Although advanced propulsion concepts as the ones described above must be pursued further, a *research program to look for fundamentally different propulsion principles* is also both needed and justified, especially in the light of the recent experiments by Tajmar et al. concerning the measurements of artificial gravitational fields [5], [6], [7], [8]. For a popular description of this experimental work see [9], [10].

In addition, since 2002 ideas for a fundamental physical theory, termed Extended Heim Theory (EHT), predicting two additional physical interactions that might give rise to the generation of artificial gravitational fields, have been published, see for instance, [11], [12], [13], [14]. A popular description of this research may be found in [15], [16], [17]. In the subsequent sections, EHT will be used to reproduce experimental values measured by Tajmar et al. and to provide **guidelines for a novel experiment** that would serve as demonstrator for a **propellantless propulsion device**. Needless to say, these *ideas are highly speculative and their correctness can only be proved by experiment*. However, EHT makes precise predictions about the type and number of possible physical interactions. The proposed experiment can be carried out with current technology to verify theoretical predictions.

PHYSICAL INTERACTIONS AND GEOMETRIZATION

In this section the fundamental structure of spacetime is discussed. The main idea of EHT is that **spacetime possesses an additional internal structure**, described by an **internal symmetry space**, dubbed **Heim space**, denoted H^8, which is attached to each point of the spacetime manifold. The internal coordinates of H^8 depend on the local (curvilinear) coordinates of spacetime. This is analogous to gauge theory in that a local or gauge transformation is used. In gauge theory it is the particles themselves that are given additional degrees of freedom, expressed by an internal space. Consequently in the geometrization of physics, it is spacetime *instead of elementary particles* that has to be provided with internal degrees of freedom. The introduction of an internal space has major physical consequences. The structure of H^8 determines the number and type of physical interactions and subsequently leads to a poly-metric. This means that **spacetime comprises both an external and internal structure**. In general, only the external structure is observed, but as has long been known experimentally, matter can be generated out of the vacuum. This is a clear sign that spacetime has additional and surprising physical properties. Therefore, any physical theory that aims at describing physical reality, needs to account for this fact. Since GR uses pure spacetime only, as a consequence, only part of the physical world is visible in the form of gravitation.

This idea was first conceived by the German physicist B. Heim. A similar principle was mentioned by the Italian mathematician B. Finzi. The poly-metric tensor resulting from this concept is subdivided into a set of sub-tensors, and each element of this set is equivalent to a physical interaction or particle, and thus the **complete geometrization of physics** is achieved. This is, in a nutshell, the strategy chosen to accomplish Einstein's lifelong goal of geometrization of physics [6]. 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 [32]. In EHT, considered as the natural extension of GR, **matter simply is a consequence of the hidden physical features of spacetime**. 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 pointlike elementary particle is highly useful as a working hypothesis in particle physics.

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[6] There is of course a second aspect, namely the quantization of the spacetime field.

Geometrization of Space, Time, and Energy

In GR the geometrical structure of spacetime leads to a single metric that describes gravitational interaction. Einstein's pioneering efforts in the geometrization of physics revealed themselves unsuccessful [22] when more interactions were discovered, and attempts to geometrize physics were abandoned. Einstein did not succeed in constructing a metric tensor that encompassed all physical interactions. At almost the same time, B. Heim at the space congress in Stuttgart, Germany 1952 and in [23], and also B. Finzi, 1955, see the recent book [24], published similar ideas on the construction of a generalized metric tensor. Heim published further details of his theory in [25], [26] constructing a poly-metric tensor in a 6D space. In collaboration with Heim this idea was extended to 8D by the first author.

Einsteinian spacetime [20], [21] is indefinitely divisible and can be described by a differentiable manifold. In the following derivation, which relates the metric tensor to physical interactions, this classical picture is used, though most likely spacetime is a quantized field. The quantization of spacetime seems to play a role in the concept of **hyperspace or parallel space** [14], which might allow superluminal velocities, but is not treated in this paper. GR can be summarized by the single sentence: *matter curves spacetime*.

In curved spacetime the metric is written in the form

$$ds^2 = g_{\mu\nu}d\eta^\mu d\eta^\nu \tag{1}$$

where $g_{\mu\nu}$ is the metric tensor, η^1, η^2, η^3 are the spatial coordinates, and η^4 is the time coordinate. These coordinates can be curvilinear. Einstein summation convention is used, i.e., indices occurring twice are summed over. From the strong equivalence principle it is known (for instance see [27]) that at any point in spacetime a local reference frame can be found for which the metric tensor can be made diagonal, i.e., $g_{\mu\nu} = \eta_{\mu\nu}$ where $\eta_{\mu\nu}$ is the Minkowski tensor, [7] and reference coordinates are locally Cartesian $(x^1, x^2, x^3, x^4) = (x, y, z, ct)$. This is equivalent to a transformation between the two sets of coordinates, namely

$$dx^\mu = \Lambda^\mu_\nu \, d\eta^\nu \text{ and } \Lambda^\mu_\nu = \frac{\partial x^\mu}{\partial \eta^\nu} \tag{2}$$

In the free fall frame of the *x* coordinates the acceleration is 0, and thus the equation of motion simply is

$$\frac{d^2 x^\mu}{d\tau^2} = 0 \text{ and } ds^2 = \eta_{\mu\nu} \, dx^\mu dx^\nu \tag{3}$$

where τ denotes proper time, i.e., the time registered by a clock in its own reference frame. This means the clock is stationary in this frame, and the time measured is the time shown on the clock's dial. In order to obtain the equation of motion for curvilinear coordinates η, one only needs to insert the transformation relations, Eq. (2), into Eq. (3), which results in the geodesic equation

$$\frac{d^2 \eta^\alpha}{d\tau^2} + \Gamma^\alpha_{\mu\nu} \frac{d\eta^\mu}{d\tau} \frac{d\eta^\nu}{d\tau} = 0 \tag{4}$$

where the $\Gamma^\alpha_{\mu\nu}$ are the well known Christoffel symbols or affine connections. Rewriting the geodesic equation (4) in the form

$$\frac{d^2 \eta^\alpha}{d\tau^2} = f^\alpha \text{ with } f^\alpha = -\Gamma^\alpha_{\mu\nu} \frac{d\eta^\mu}{d\tau} \frac{d\eta^\nu}{d\tau} \tag{5}$$

and comparing Eq. (5) with the equation of motion for a free falling particle Eq. (3), the right hand side of Eq. (5) can be regarded as a force coming from a physical interaction, which has caused a curvature of the surrounding space, marked by the presence of nonzero Christoffel symbols. The left hand side of equation (5) can be written as $m_I \mathbf{a}$ where m_I denotes inertial mass and $\mathbf{a}$ is acceleration. Multiplying f^α by its proper charge results in the equation of motion for the respective physical interaction. In the case of gravity, because of the equality of inertial and gravitational mass, charges on the left and right hand sides cancel out. For all other physical interactions this is not the case. In that respect

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[7] Minkowski tensor $\eta_{\mu\nu}$ must not be confused with curvilinear coordinates η^μ

gravity has a unique role, namely that it curves also the surrounding space. For all other physical interactions, if pointlike charges are assumed (classical picture), **space is curved only at the location of the charge**.

One major point of course is that the relation $x = x(\eta)$ as used in GR delivers only a single metric, which Einstein associated with gravitation. The *fundamental question is, therefore, how to construct a metric tensor that gives rise to all physical interactions.* The answer **lies in the fact that in EHT there exists an internal space** H^8. Therefore, in EHT the relation between coordinates x and η is $x = x(\xi(\eta))$. In contrast to GR, **EHT employs a double transformation** as specified in Eq. (7). From this double transformation a set of different metric tensors can be constructed, which, in turn, lead to a set of individual geodesic equations having the same structure as Eq. (5), but depending on **the specific charge and Christoffel symbols** inherent to this specific physical interaction. An individual equation of motion will have the form

$$m_I \frac{d^2\eta^\mu}{d\tau^2} = e_c f_c^\mu \text{ with } \mu = 1,...,4 \tag{6}$$

where e_c denotes the specific charge of the interaction and quantities f_c^μ are the associated Christoffel symbols [8] i.e., they stand for the curvature of space generated by this interaction. The total number of physical charges e_c is determined by the subspace structure of H^8 in concert with combination rules to constructing a metric that has physical meaning. Eq. (6) describes a very difficult physical problem. First, the number of physical charges and their coupling constants need to be determined. Without further demonstration, only a few facts are stated. There exist, according to EHT, eight charges, namely three color charges for the quarks, two weak charges, one electric charge, and two charges for gravitation, where one naturally is the gravitational charge. The second charge could be inertia or the charge of the vacuum. This is not clear at present. The double transformation as given in Eq. (7) represents the particle aspect and leads to eigenvalue equations whose eigenvalues have dimension of inverse length. In these eigenvalue equations, the Christoffel symbols occur. Using the inverse of the Planck length expressed as $m_p c/\hbar$, results in a correspondence between inverse length and mass. Since particles and fields form a unity, the transformation from spacetime into internal space, $M \rightarrow H^8$, should represent the field aspect, because derivatives of internal coordinates $\xi^\alpha, \alpha = 1,...,8$ with respect to curvilinear coordinates η lead to an expression $\frac{e_c^\alpha}{m_I} h_{ik}^\alpha$. The h_{ik}^α denote deviation from the flat metric, and physically represent the tensor potential of the charge e_c^α with m_I as associated inertial mass. The metric coefficients thus assume energy character. This short discussion implies a comprehensive mathematical program, namely the determination and solution of the above mentioned eigenvalue equations as well as the derivation of the tensor potentials for the interactions. The task is not yet finished, but this brief discussion should have conveyed an idea how the introduction of an internal symmetry space leads to a correspondence between geometry and physical quantities. [9] [10]

This approach is substantially different from GR and leads to the complete geometrization of physical interactions.

Naturally, the number and type of interactions depend on the structure of internal space H^8 whose subspace composition is determined in the subsequent section. Contrary to the ideas employed in *String* theory, see for example [28], H^8 is an **internal space of 8 dimensions** that, however, governs all physical events in our spacetime.

The crucial point lies in the construction of the internal space whose subspace composition should come from basic physical assumptions, which must be generally acceptable. In other words, GR does not possess any internal structure, and thus has a very limited geometrical structure, namely that of pure spacetime only. Because of this limitation, GR cannot describe other physical interactions than gravity, and consequently needs to be extended. EHT in its present form without any quantization, i.e., not using a discrete spacetime, reduces to GR when this 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 (EGP) is equating the Einstein curvature tensor, constructed from the metric tensor, with the stress tensor, representing energy distribution. In this way, the metric tensor field has become a physical object whose behavior is governed by an action principle, like that

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[8] The equation of motion describes a particle of mass m_I with charge e_c, subjected to the respective field of this interaction, represented by its proper Christoffel symbols.

[9] The mathematical framework to determine the charges and to obtain the correspondence between geometry and physics is quite involved. In general internal coordinates are described by quaternions.

[10] There is an interesting question, namely: *What is the Hermetry form of the vacuum field* ? If the vacuum has an energy density different from zero, it should not be the case that its Christoffel symbols are 0. However, we feel, in order to answer this question, a quantization procedure for Eq. (6) has to be established.

of other physical entities. In EHT the internal space H^8 is associated with physics through the introduction of three fundamental length scales, constructed from Planck quantities.

FUNDAMENTAL INTERACTIONS AND HERMETRY FORMS

The introduction of basic physical units is in contradiction to classical physics that allows infinite divisibility. As a consequence, measurements in classical physics are impossible, since units cannot be defined. Consequently, *Nature* could not provide any elemental building blocks to construct higher organized structures, which is inconsistent with observation. Thus the quantization principle is fundamental for the existence of physical objects.

Next, we introduce four basic principles, from which the nature of H^8 can be discovered. In contrast to GR, EHT is based on the following four simple and general principles, termed the **GODQ** principle [11] of *Nature*. These principles cannot be proved mathematically, but their formulation is based on generally accepted observations and intend to reflect the workings of *Nature*.

    i. ***G**eometrization principle for all physical interactions*,

    ii. ***O**ptimization (Nature employs an extremum principle)*,

    iii. ***D**ualization (duality, symmetry) principle (Nature dualizes or is asymmetric, bits)*,

    iv. ***Q**uantization principle (Nature uses integers only, discrete quantities)*.

From the duality principle, the existence of additional internal symmetries in *Nature* is deduced, and thus a higher dimensional internal symmetry space should exist, whose exact structure will now be determined. In GR there exists a four dimensional spacetime, comprising three spatial coordinates with positive signature (+) and the time coordinate with negative signature (-). It should be remembered that the Lorentzian metric of $\mathbb{R}^4$ has three spatial (+ signature) and one time-like coordinate (- signature) [12]. 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, see Eq. (1). 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. A general coordinate system for a spacetime manifold, M, needs to be described by curvilinear coordinates η^μ with $\mu = 1, .., 4$ and $\eta = (\eta^\mu) \in$ M.

The set of 8 internal coordinates for H^8 is determined by utilizing the *GODQ* principle. There are three internal spatial coordinates, ξ^1, ξ^2, ξ^3, and the internal time coordinate ξ^4. The other four coordinates are introduced to describing the degree of organization and information exchange as observed in *Nature*.

In summary, internal coordinates ξ^i with $i = 1, ..., 4$ denote *spatial and temporal* coordinates, ξ^i with $i = 5, 6$ denote *entelechial and aeonic* coordinates, and ξ^i with $i = 7, 8$ denote the two *information coordinates* in H^8, mandating four different types of coordinates. With the introduction of a set of four different types of coordinates, the space of fundamental symmetries of internal space H^8 is fixed. In the next section, the set of metric subtensors of H^8 is constructed, each of them describing a physical interaction or particle. Thus the connection between physical space and physics (symmetries) is established in a way foreseen by Einstein. Physical space is responsible for all physical interactions. However, in order to reach this objective, spacetime had to be complemented by an internal space H^8 to model its physical properties. Once the internal space with its set of coordinates has been determined, everything else is fixed, because Eq. (7) is a direct consequence of H^8.

It should be noted that a dimensional law can be derived that does not permit the construction of, for instance, a space H^7 [26]. In order to determine the number of admissible Hermetry forms and their physical meaning, we proceed as follows. As was shown above, Heim space, H^8, comprises four subspaces, denoted as $\mathbb{R}^3$ with coordinates ξ^1, ξ^2, ξ^3, T^1 with coordinate ξ^4, S^2 with coordinates ξ^5, ξ^6, and I^2 with coordinates ξ^7, ξ^8. In order to construct a physically meaningful metric sub-tensor (also called **Hermetry form**), **it is postulated that coordinates of internal spaces S^2 or I^2 must be present** in any metric subtensor to generate a Hermetry form. 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 of the photon and the quintessence potential,

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[11] briefly stated: *God quantizes.*

[12] Signatures are not unique. Coordinate signatures may be reversed. Numbering of coordinates was chosen such that coordinates of positive signature are numbered first.

for details see Tables 2, 4 of ref. [11][13]. Hermetry form 16 is reserved for the *Higgs* particle that should exist, whose mass was calculated at 182.7 ± 0.7 GeV. For instance, the Hermetry form (photon metric) comprises only coordinates from subspaces T^1, S^2, and I^2 and is denoted by $H_7(\mathsf{T}^1 \times \mathsf{S}^2 \times \mathsf{I}^2)$. The neutral gravitophoton Hermetry form is given by $H_5(\mathsf{S}^2 \times \mathsf{I}^2)$. Since gravitophoton and photon Hermetry forms are described by different coordinates, they lead to different Christoffel symbols, and thus to different geodesic equations, see Eq. (6). Furthermore, if there were a physical process to eliminate the T^1 coordinates, i.e., the corresponding Christoffel symbols are 0, the photon would be converted into a gravitophoton. **This is how mixing of particles is accomplished in EHT**. We believe this to be the case in the experiments by Tajmar et al. The fundamental question, naturally, is how to calculate the probability of such a process, and to determine the experimental conditions under which it can take place. Hermetry forms alone only provide the potential for conversion into other Hermetry forms, but nothing is said about physical realization. In any case, if Hermetry forms describe physical interactions and elementary particles, a completely novel scenario unfolds by regarding the relationships between corresponding Hermetry forms. Completely new technologies could be developed converting Hermetry forms. In the section about the proposed gravito-magnetic field propulsion experiment, an experiment utilizing a rotating disk is described to convert photons into positive (repulsive) and negative (attractive) gravitophotons that should generate an *artificial gravitational field along the axis of rotation.*

Fig. (2) depicts the six fundamental forces predicted by EHT. From the neutral gravitophoton metric and from the forces measured in the experiments, it is deduced that the gravitophoton decays into a graviton (H_1) and a quintessence (H_9, repulsive) particle. Fig. (3) shows the set of metric-subspaces that can be constructed. The word Hermetry is a combination of *hermeneutics and geometry* that is, a Hermetry form stands for the physical meaning of geometry. Each Hermetry form has a direct physical meaning, for details see refs. [11], [13], [14].

Double Coordinate Transformation

In this section the mathematical details of constructing Hermetry forms are presented. The concept of an internal 8D space, comprising four subspaces, leads to a modification of the general transformation being used in GR. In GR there are two sets of coordinates, Cartesian coordinates x and curvilinear coordinates η linked by a relation between their corresponding coordinate differentials, Eqs. (1, 2). If Heim space were not existing, the poly-metric of EHT collapsed to the mono-metric of GR.

The existence of internal space H^8 demands a more general coordinate transformation from a spacetime manifold [14] M to a manifold N via the mapping M (locally $\mathbb{R}^4$) $\rightarrow \mathsf{H}^8 \rightarrow N$ (locally $\mathbb{R}^4$). In EHT, therefore, a double transformation, Eq.(7), involving Heim space H^8 occurs. The associated global metric tensor, Eq. (7), does not have any physical meaning by itself. Instead, by deleting corresponding terms in the global metric, the proper Hermetry form is eventually obtained. The global metric tensor is of the form

$$g_{ik} = \frac{\partial x^m}{\partial \xi^\alpha} \frac{\partial \xi^\alpha}{\partial \eta^i} \frac{\partial x^m}{\partial \xi^\beta} \frac{\partial \xi^\beta}{\partial \eta^k} \tag{7}$$

where indices $\alpha, \beta = 1, ..., 8$ and $i, m, k = 1, ..., 4$ and g_{ik} comprises 64 components. The tensor with all 64 terms does not have a physical meaning.

A single component of the metric tensor belonging to one of the four subspaces is given by Eq. (8). Only special combinations of the $g_{ik}^{\alpha\beta}$ reflect physical quantities. 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, Eq. ((7), are set to zero. Hence, each Hermetry form is marked by the fact that only a subset of the 64 components is present. Therefore each Hermetry form leads to a different metric in the spacetime manifold and thus describes different physics. This is why Eq. ((7) is termed the poly-metric tensor. It serves as a repository for Hermetry forms. This construction principle is totally different from Einstein's approach, and only in the special case of vanishing space H^8, EHT reduces to GR.

$$g_{ik}^{\alpha\beta} = \frac{\partial x^m}{\partial \xi^{(\alpha)}} \frac{\partial \xi^{(\alpha)}}{\partial \eta^i} \frac{\partial x^m}{\partial \xi^{(\beta)}} \frac{\partial \xi^{(\beta)}}{\partial \eta^k} \tag{8}$$

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[13] Tables 1-4 of ref. [11] were omitted from this paper because of lack of space
[14] in the concrete case of GR spacetime manifold M^4 would be used

The Six Fundamental Forces
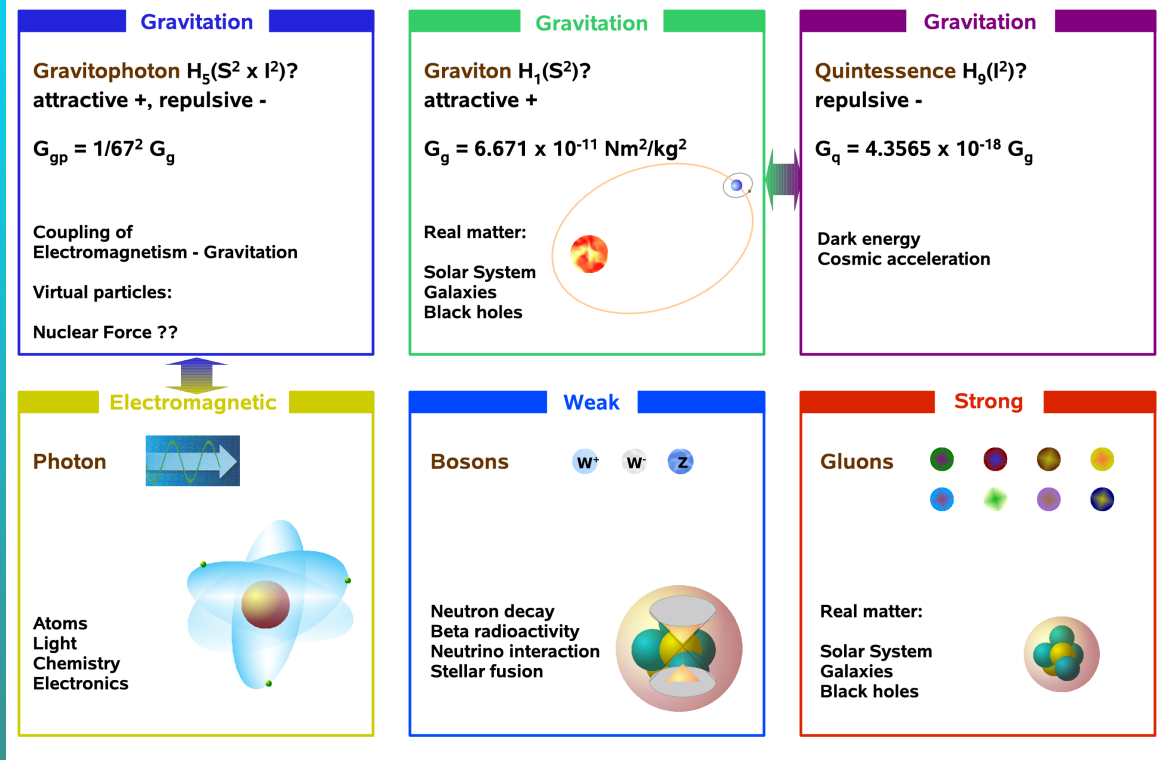
Figure 2. EHT predicts, as one of its most important consequences, two additional, gravitational like interactions and the existence of two messenger particles, termed gravitophoton and quintessence. That is, there is a total of six fundamental physical interactions. The name gravitophoton has been chosen because of the type of interaction, namely the transformation of the electromagnetic field (photon) into the gravitational field (gravitophoton). The arrow between the gravitophoton and electromagnetic boxes indicates the interaction between these messenger particles that is, photons can be transformed into gravitophotons. In the same way the quintessence interaction can be generated from gravitons and positive gravitophotons (repulsive force). It is assumed that first a neutral gravitophoton is generated that decays into a pair of negative (same sign as gravitational potential) and positive gravitophotons.

The poly-metric tensor can be written as

$$g_{ik} = \sum_{\alpha,\beta=1}^{8} g_{ik}^{\alpha,\beta} \tag{9}$$

A single Hermetry form is given by

$$g_{ik}(H_l) := \sum_{\alpha,\beta \in H_l}^{8} g_{ik}^{\alpha\beta} \tag{10}$$

It should be mentioned that each Hermetry form itself comprises a set of submetric tensors that are intrinsic to this Hermetry form. In how far this is an indication for further substructures is not known at the moment. In any case, there are three additional Hermetry forms that we denoted as **degenerate Hermetry form**. They are describing neutrinos and two novel fields that were identified as conversion (probability) amplitudes w_{ph_gp} and w_{gp_q}. The first amplitude stands for the probability of converting photons into gravitophotons, the second one denotes the probability for a

gravitophoton to decay into a graviton and quintessence particle. These conversion equations play a major role in the explanation of the experiments by Tajmar et al. as well as in the proposed field propulsion experiment.

Physical Meaning of Hermetry Forms

Here, we only can give a brief discussion of the meaning of Hermetry forms. Each of the 15 admissible combinations (not counting the Higgs particle) of metric subtensors (Hermetry forms) is ascribed a physical meaning, see Tables 1-4 in ref. ([11]). A Hermetry form is denoted by H_l with $l = 1, ..., 15$ is used. Indices 1-12 are obtained from the definition of the Hermetry forms, see Fig. (3). Each Hermetry form H_l is interpreted as physical interaction or particle, extending the interpretation of metric employed in GR to the poly-metric, coming from the combination of external physical spacetime and internal space that is, the interaction of space H^8 with four-dimensional spacetime M^4. Internal space H^8 is a factored space that is, it is represented as $H^8 = \mathbb{R}^3 \times T^1 \times S^2 \times I^2$. This factorization of H^8 into one space-like manifold $\mathbb{R}^3$ and three time-like manifolds T^1, S^2 and I^2 is inherent to the structure of H^8. Each subspace can be associated with a symmetry group. H^8 would be associated with group $O(8)$, which in turn is also factored. For the construction of the individual Hermetry forms, a selection rule is used, namely **any physically meaningful Hermetry form must contain space coordinates from S^2 or I^2**. This means, for a physical process to become manifest in spacetime, a pair of the transcoordinates (entelechial, aeonic or information coordinates) must occur in its metric, i.e., in its Hermetry form. Each individual Hermetry form is equivalent to a physical potential or a messenger particle. It should be noted that a Hermetry form in space $S^2 \times I^2$ describes gravitophotons, and a Hermetry form constructed from space $S^2 \times I^2 \times T^1$ represents photons, see Table 2 in ref. ([11]). This is an indication that, at least on theoretical arguments, photons can be converted into gravitophotons, if the time dependent part T^1 of the photon metric can be canceled. Fig. (3) shows the possible Hermetry forms in EHT.

Conversion Equations for Hermetry Forms

In the section above, the physical meaning of Hermetry forms was discussed. Regarding the Hermetry forms for the photon, H_7, and the gravitophoton, H_5, see Table 2 in [11], it is straightforward to see that if all metric subcomponents containing the time coordinate in the metric tensor of the photon are deleted, the metric of a neutral [15]gravitophoton is generated. The fundamental question is, of course, how this mathematical process can be realized as a physical phenomenon.

Regarding further the Hermetry form of the neutral gravitophoton, it should be possible that under certain circumstances this neutral gravitophoton becomes unstable and decays. According to its metric form, a neutral gravitophoton can decay through two channels. In one case, a graviton and a quintessence particle can be generated. In the second case, a positive (repulsive) and a negative (attractive) gravitophoton can be produced. The former seems to occur in Tajmar's experiments, see section below, and the latter case should happen in the proposed field propulsion experiment outlined, see corresponding section.

A conversion of photons into gravitophotons should be possible in two ways, namely via *Fermion* coupling according to Eqs. (12), (13) and through *Boson* coupling, described by Eqs. (14), (15). These equations are termed conversion equations. The three conversion amplitudes have the following meaning: The first equation, Eq. (12) is obtained from EHT in combination with considerations from number theory, and predicts the conversion of photons into gravitophoton particles, published already in 1996 [35] while the second equation, Eq. (13), is taken from Landau [36] where the probability amplitude w_{gp} for the photon coupling is given by the well known relation

$$w_{ph}^2 = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{\hbar c}.$$
(11)

The physical meaning of Eqs. (12), (13) lies in the production of N^2 **gravitophoton particles through the polarization of the vacuum**. This conversion process is termed **Fermion coupling**, because it is assumed that the production of gravitophotons takes place at the location of a virtual electron. This process is described in detail in references [11], [13], and [12]. As was further discussed in these references, the magnitude of the necessary magnetic induction, $\mu_0\mathbf{H}$,

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[15] a gravitophoton is termed neutral if it does not interact with matter
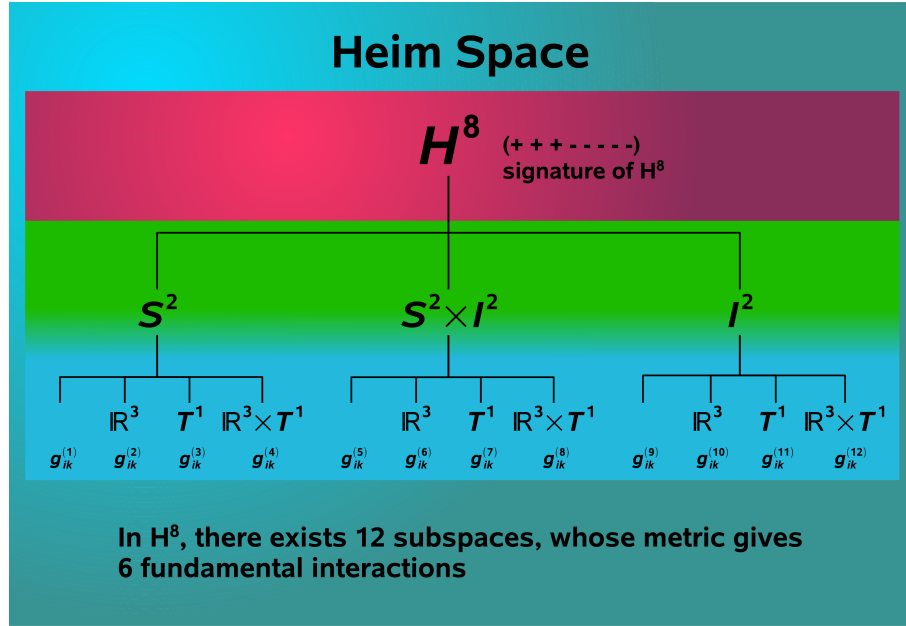
Figure 3. In EHT, each point in spacetime is associated with an internal Heim space H^8 that has eight internal coordinates. These coordinates are interpreted as energy coordinates. The Planck length l_p is associated with spatial coordinates of space $\mathbb{R}^3$, the Planck length l_t with the time coordinate of space T^1, and Planck length l_{m_p} with the four additional organization and information coordinates (negative) signature, which give rise to two additional subspaces denoted as S^2 and I^2, respectively. Hence, Heim space H^8 comprises four subspaces, namely $\mathbb{R}^3$, T^1, S^2, and I^2. The 8 coordinates ξ^n of H^8 themselves are functions of the curvilinear coordinates η^m that is, $\xi^n = \xi^n(\eta^m)$ of physical spacetime, manifold M^4. The picture shows the complete set of metric-subspaces that can be constructed from the poly-metric tensor, Eq. (7). Each submetric is denoted as Hermetry form, which has a direct physical meaning, see Table 2 in [11]. In order to construct a Hermetry form, either internal space S^2 or I^2 coordinates must be present. In addition, there are three degenerated Hermetry forms, see Table 4 in [11] that are only partial metric forms of the photon and the quintessence potential. They allow the conversion of photons into gravitophotons as well as the decay of gravitophotons into gravitons and quintessence particles.

in order to obtain sufficient gravitophoton production to generate a sizeable gravitophoton force (or Heim-Lorentz force), is in the range of 20 to 50 T, and thus is most likely beyond current technology.

$$w_{ph}(r) - w_{ph\_gp} = N w_{gp} \tag{12}$$
$$w_{ph}(r) - w_{ph\_gp} = A w_{ph} \tag{13}$$

Eq. (13) and the function $A(r)$ can be obtained using Landau's [36] radiation correction with numerical values for A ranging from 10^{-3} to 10^{-4}. Eqs. (12) and (13) can be interpreted such that an electromagnetic potential (photon) containing probability amplitude $A w_{ph}$ can be converted into a neutral gravitophoton with associated probability amplitude $N w_{gp}$. Landau's equation, Eq. (13), is responsible for the additional charge, coming from the reduced shielding of the vacuum.

When we analyzed the experiments by Tajmar et al. it became clear that there seems to be a **second way to generate a gravitophoton force**, namely using **Cooper pairs** to trigger the production of neutral gravitophotons. Because of the coupling through Cooper pairs, this conversion is dubbed **Boson coupling**, and is specified by Eqs.(14) and (15). It turned out that the conversion of photons into gravitophotons through Boson coupling has substantially lower technical requirements. Instead of changing the conversion amplitude $w_{ph}(r)$ by reducing the distance between virtual electron and proton below the Compton wavelength, λ_C, (for mathematical details see the above mentioned references), it is now the value of the probability amplitude w_{ph_gp} that changes. In general, i.e., *without the presence of Cooper pairs*, $w_{ph\_gp} = w_{ph}$ and, according to Eq. (15), *the probability for gravitophoton production is* 0. For the production process to take place, it is assumed that the onset of superconducting - with its formation of Cooper pairs - has an effect similar to the creation of electron-positron pairs responsible for an increased coupling, and therefore an increase in the

magnitude of the coupling constant or charge. This is in analogy to vacuum polarization where the magnetic field is strong enough to produce virtual electron-positron pairs, creating an excess charge. It should be noted that coupling values k and a were derived some ten years ago, and were published by Heim and Dröscher 1996 in [35], see Eq. (11) p. 64, Eq. (15) p. 74, and Eq. (16) p. 77.

$$w_{ph} - w_{ph\_gp} \quad = \quad \pm iN w_{gp} \tag{14}$$

$$w_{ph} - w_{ph\_gp} \quad = \quad \pm i \left(\frac{1}{(1-k)(1-ka)} - 1 \right) w_{ph} \tag{15}$$

where i denotes the imaginary unit. Eqs. (13) and (15) reflect the basic difference between Fermion and Boson coupling. In Fermion coupling the additional charge is produced by the vacuum of spacetime, while in Boson coupling the additional charge comes from an increase of charge of the Cooper pairs through the Higgs mechanism. The Boson coupling therefore is a condensed matter phenomenon. This means that for Boson coupling the probability amplitude (charge) w_{ph} remains unchanged, which is in contrast to Fermion coupling. Instead, as can be seen from Eq. (15), it is the probability amplitude w_{ph_gp} that is modified when the superconducting state is reached. Through the Higgs mechanism, as was first stated by P.W. Anderson (1958) and later by Higgs, the photon assumes mass [16] and thus via Eq. (11) the electromagnetic coupling gets stronger, and, in turn, the electric charge e becomes larger. Therefore, Cooper pairs are subjected to an increase in charge.

EHT AND GRAVITO-MAGNETIC EXPERIMENTS

In a recent experiment (March 2006), funded by the European Space Agency and the Air Force Office of Scientific Research, Tajmar et al. [7] report on the generation of a toroidal (tangential, azimuthal) gravitational field in a rotating accelerated (time dependent angular velocity) superconducting Niobium ring. In July 2006, in a presentation at Berkeley university, Tajmar showed improved experimental results that confirmed previous experimental findings. Very recently, October 2006 [6] and February 2007 [5] the same authors reported repeating their experiments employing both accelerometers as well as laser ring-gyros that very accurately measured the gravito-magnetic field. The acceleration field was clearly observed, and its rotational nature was determined by a set of four accelerometers in the plane of the ring.

Since the experiment generates an artificial gravitational field, which is in the plane of the rotating ring, see below, it cannot be used as propulsion principle. It is, however, of great importance, since it shows for the **first time that a gravitational field can be generated other than by the accumulation of mass**.

In this section we will present a theoretical derivation based on EHT to both qualitatively and quantitatively explain the experiments. In addition, a comparison with the measured data will be presented. The experimental outcome was explained by Tajmar and de Matos, postulating that the Higgs mechanism were responsible for the graviton to gaining mass. This effect, [7], was termed the *gyro-magnetic London* effect. According to these authors, this phenomenon is the physical cause for the existence of the measured gravitational field. We will discuss these arguments and compare with the explanation given by EHT, which assumes the artificial gravitational field to be caused by the two gravitational additional interactions predicted by EHT.

In the following, a derivation from first principles is presented, using the concept of neutral garvitophoton and its subsequent decay into graviton and quintessence particles, which can be seen directly from the Hermetry form of the neutral gravitophoton and the direction of the artificial gravitational field. However, for this experiment a coupling to bosons (Cooper pairs) occurs. Deriving this effect from gravitophoton interaction, a physical interpretation can be given that explains both qualitatively and quantitatively the experimental results. Moreover, theoretical considerations obtained from EHT lead to the conclusion that an experiment should be possible to generate a **gravitational field acting parallel to the axis of rotation of the rotating ring**, see Fig. 5, and thus, if confirmed, could serve as a demonstrator for a **field propulsion principle**.

In this field propulsion experiment the superconducting rotating ring of the experiments by Tajmar et al. is replaced by an insulating disk of a special material in combination with a special set of superconducting coils. According to

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[16] There is an alternative explanation. In a very recent article by Kane [38] the existence of electrically charged Higgs bosons is assumed. Due to the Higgs mechanism there might be an interaction of these bosons with Cooper pairs, increasing their electric charge.
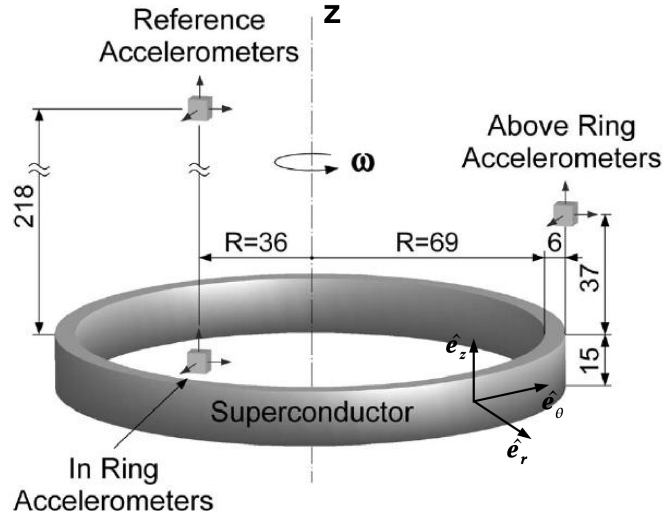
Figure 4. Rotating superconducting torus (Niobium) modified from Tajmar et al., see ref. [5]. All dimensions are in mm. A cylindrical coordinate system (r, Θ, z) with origin at the center of the ring is used. *In-Ring* accelerometers measured a gravitational acceleration of $-1.4 \times 10^{-5}g$ in the azimuthal (tangential, Θ) direction when the ring was subjected to angular acceleration, see Fig. 8(a) ref. [5] for the so called curl configuration that comprises a set of four accelerometers. In an earlier publication, see Fig. 4a) in [7], an acceleration field of about $-10 \times 10^{-5}g$ was measured for a single accelerometer. According to M. Tajmar, the curl value should be used. The acceleration field did not depend on angular velocity ω. No acceleration was measured in the z-direction (upward). The more recent experiment employed a set of 4 in-Ring accelerometers and confirmed the rotational character of this field. When the direction of rotation was reversed, the acceleration field changed sign, too.

EHT, the physical mechanism is different in that the neutral gravitophoton now decays into a positive (repulsive) and negative (attractive) gravitophoton, which causes the artificial gravitational field to point in the axis of rotation. EHT is used to calculate the magnitude and direction of the acceleration force and provides guidelines for the construction of the propulsion device. The coupling to bosons is the prevailing mechanism. Experimental requirements, i.e., magnetic induction field strength, current densities, and number of turns of the solenoid, are substantially lower than for fermion coupling (here the vacuum polarization is employed to change the coupling strength via production of virtual pairs of electrons and positrons) that was so far assumed in all our papers, see, for instance, refs. [12], [13], [14]. Fig. 4 depicts the experiment of Tajmar et al., where a superconducting ring is subject to angular acceleration and an artificial gravitational field was measured in the plane of the ring in circumferential direction, counteracting the angular acceleration, i.e., following some kind of gravitational Lenz rule. Fig. 5 describes the experimental setup for the field propulsion device where an insulating disk rotates directly above the superconducting solenoid. In both cases an artificial gravitational field arises, generated by gravitophoton interaction. The major difference between the two experiments is that Tajmar et al. need to accelerate the rotating superconducting ring producing the gravitational field in azimuthal direction, while the field propulsion experiment uses a uniformly rotating disk, generating an artificial gravitational field in the axis of rotation. It is the latter experiment that could serve as the basis for a novel propulsion technology - *if EHT is correct.*

The Gravito-Magnetic Experiment

In the experiments by Tajmar et al. it is shown that the acceleration field vanishes if the Cooper pairs are destroyed. This happens when the magnetic induction exceeds the critical value $\mathbf{B}_C(T)$, which is the maximal magnetic induction that can be sustained at temperature T, and therefore dependents on the material. For temperatures larger than the critical temperature T_C superconductivity is destroyed, too. The rotating ring no longer remains a superconductor and the artificial gravitational field disappears.

Considering the Einstein-Maxwell formulation of linearized gravity, a remarkable similarity to the mathematical form of the electromagnetic Maxwell equations can be found. In analogy to electromagnetism there exist a gravitational scalar and vector potential, denoted by Φ_g and $\mathbf{A}_g$, respectively [34]. Introducing the corresponding gravitoelectric and gravitomagnetic fields

$$\mathbf{e} := -\nabla\Phi_g \ and \ \mathbf{b} := \nabla \times \mathbf{A}_g \tag{16}$$

the linearized version of Einstein's equations of GR can be cast in mathematical form similar to the Maxwell equations of electrodynamics, the so called gravitational Maxwell equations, Eqs. (17) and (18)

$$\nabla \cdot \mathbf{e} := -4\pi G_N \rho, \quad \nabla \cdot \mathbf{b} := 0 \tag{17}$$

$$\nabla \times \mathbf{e} := 0, \quad \nabla \times \mathbf{b} := -\frac{16\pi G_N}{c^2}\mathbf{j} \tag{18}$$

where $\mathbf{j} = \rho\mathbf{v}$ is the mass flux and G_N is Newton's gravitational constant. The field $\mathbf{e}$ describes the gravitational field from a stationary mass distribution, whereas $\mathbf{b}$ describes an extra gravitational field produced by moving masses. Fig. (4) depicts the experiment of Tajmar et al., where a superconducting ring is subjected to angular acceleration, which should lead to a gravitophoton force. EHT makes the following predictions for the measured gravitational fields that are attributed to photon-gravitophoton interaction.

- For the actual experiment, shown in Fig. 4 (*Tajmar et al.*), the gravitophoton force is in the azimuthal direction, caused by the angular acceleration of the superconducting niobium disk. The acceleration field is opposite to the angular acceleration, obeying some kind of Lenz rule.
- For the novel experiment of Fig. 5 (*field propulsion*), a force component in the vertical direction would be generated.

It will be shown in the following that the postulated gravitophoton force completely explains the experimental facts of the experiment by Tajmar et al., both qualitatively and quantitatively. It is well known experimentally that a rotating superconductor generates a magnetic induction field, the so called *London moment*

$$\mathbf{B} = -\frac{2m_e}{e}\omega \tag{19}$$

where ω is the angular velocity of the rotating ring. It should be noted that this magnetic field is produced by the rotation of the ring, and not by a current of Cooper pairs that are moving within the ring.

Gravito-Magnetic Effect Predicted by EHT

In this short version of the paper, only the final result for the acceleration field is stated without derivation. Comparisons of theoretical and experimental values for their most recent gravito-magneto measurements are shown below. A coupling between electromagnetism and gravitation is basic to EHT, because of the fifth and sixth fundamental interactions, which foresee a conversion of Hermetry form H_7, describing the photon, into the Hermetry form H_5, describing the gravitophoton. The gravitophoton then, according to EHT, decays into a graviton and a quintessence particle. The two additional interactions predicted by EHT, are identified as gravito-magnetic interaction and quintessence. The quintessence messenger particle causes a weak repulsive gravitational like interaction, which might be identified with dark energy.

The laboratory generation of gravity has been under active research for the last fifteen years and numerous experiments were carried out. So far, only the experiments by Tajmar et al. have sufficient credibility. None of the other experiments have stood the test of time, and therefore are not investigated.

Without further demonstration, the gravitophoton acceleration for the in-Ring accelerometer for as derived from EHT is presented. It is assumed that the accelerometer is located at distance r from the origin of the coordinate system. From Eq. (19) it can be directly seen that the magnetic induction has a z-component only. Applying Stokes law it is clear that the gravitophoton acceleration vector lies in the $r - \theta$ plane. Because of symmetry reasons the gravitophoton acceleration is independent of the azimuthal angle θ, and thus only has a component in the circumferential (tangential) direction, denoted by $\hat{\mathbf{e}}_\theta$. Since the gravitophoton acceleration is constant along a circle with radius r, integration is

over the area $A = \pi r^2 \hat{\mathbf{e}}_z$. Using the values for Nb, k and a, and carrying out the respective integration, the following expression for the gravitophoton acceleration is eventually obtained

$$\mathbf{g}_{gp} = -(0.04894)^2 \frac{m_e}{m_p} \dot{\omega} r \hat{\mathbf{e}}_\theta \tag{20}$$

where it was assumed that the **B** field is homogeneous over the integration area.

Comparison of EHT and Gravito-Magnetic Experiments

The experiments by Tajmar are interpreted such that a conversion from photons into gravitophotons takes place as outlined above.

For comparisons of the predictions from EHT and the gravito-magnetic experiments, the most recent experimental values taken from the paper by Tajmar et al. [5] were used. The following values were utilized:

$$\dot{\omega} = 10^3 \text{rad/s}^2; r = 3.6 \times 10^{-2} \text{m}; \frac{m_e}{m_p} = 1/1836$$

$$g_{gp} = -(0.04894)^2 \times 10^{-4} \times 3.610^{-2} \times 10^3 \times 9.81^{-1} g \tag{21}$$

resulting in the computed value for the circumferential acceleration field

$$g_{gp} = -4.79 \times 10^{-6} g \tag{22}$$

For a more accurate comparison, the coupling factor [17] k_{gp} for the in-Ring accelerometer, as defined by Tajmar, is calculated from the value of Eq. (22), resulting in $k_{gp} = -4.79 \times 10^{-9} g \text{ rad}^{-1}\text{s}^2$. The measured value is $k_{gp} = -14.4 \pm 2.8 \times 10^{-9} g \text{ rad}^{-1}\text{s}^2$. This means that the theoretical value obtained from EHT is underpredicting the measured value by approximately a factor of 3. The agreement between the predicted gravitophoton force is *reasonable but not good*. Comparisons for lead are not made, since according to Tajmar [18] these measurements [7] need to be repeated. Using the postulated equation from Tajmar et al. [5]

$$\mathbf{g}_{gp} = -1/2 b_{gp} r \hat{\mathbf{e}}_\theta = -\frac{\rho^*}{\rho} r \dot{\omega} \hat{\mathbf{e}}_\theta \tag{23}$$

results in a value $k_{gp} = -7.16 \times 10^{-9} \text{grad}^{-1}\text{s}^2$.

It should be kept in mind that the present derivation from EHT does give a dependence on the density of Cooper pairs for coupling values k and a, but, according to our current understanding, such a coupling occurs only for two materials, namely Nb and Pb.

In [5] a second set of measurements were taken using laser gyroscopes to determine the b_{gp}. The formula used in this paper employing the actually measured value has the form

$$b_{gp} = -1.95 \times 10^{-6} \omega \text{ rad s}^{-1} \tag{24}$$

Comparing this with the equation derived from EHT, Eq. (22), it is found that the theoretical prediction is overpredicting the measured results by a factor of 1.34, which is in *good agreement with experiment*. The value computed from Eq. (23), see [5], is overpredicting the measured value by about a factor of 2.

Experiment for Gravitomagnetic Field Propulsion by Gravitophoton Acceleration

There exists a major difference between the experiment of Fig. (4) and a gravito-magnetic field propulsion device. Present experiments only show the existence of a gravitational field as long as the ring undergoes an angular acceleration. The artificial gravitational field is directed opposite to the applied angular acceleration, following some kind

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[17] This coupling factor, as defined by Tajmar [5], is the ratio of the magnitudes of observed tangential acceleration g_{gp} and applied angular acceleration $\dot{\omega}$.

[18] e-mail communication February 2007
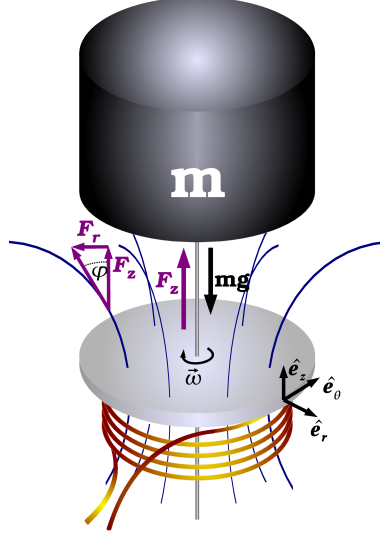
Figure 5. This experiment, derived from EHT, is fundamentally different from the experiment by Tajmar et al. in two ways. First, EHT predicts the neutral gravitophoton to decay in a negative (attractive) and a positive (repulsive gravitophoton that is, the physical mechanism is different. Second, the artificial gravitational field generated would be directed in the axis of rotation. Hence, this acceleration field would be used as propulsion mechanism. In other words, this experimental setup would serve as a demonstrator for a propellantless propulsion system. It comprises a superconducting coil and a rotating disk of a special material. The black cylinder is meant to be the space vehicle, while the coil and the disk are the propulsion system that are mechanically attached to the space vehicle. The acceleration field would be generated directly above the rotating disk.

of gravitational Lenz rule. For a propulsion device, however, the force must be directed along the axis of rotation, and not in the circumferential direction of the rotating ring. Therefore, a fundamentally different experiment must be designed to obtain a field along the axis of rotation. While the experiments by Tajmar et al. demonstrate the possibility of generating artificial gravitational fields, emphasizing the importance of a condensed state (Cooper pairs, bosons), a novel experiment is needed to demonstrates the feasibility of gravito-magnetic field propulsion. The experimental setup for such a device is pictured in Fig. (5).

Two acceleration components are generated: one in the radial r direction, and the second one in the z- direction. These components are given by

$$a_r \hat{\mathbf{e}}_{\mathbf{r}} = v_\theta^T b_z \hat{\mathbf{e}}_\theta \times \hat{\mathbf{e}}_{\mathbf{z}}, \qquad a_z \hat{\mathbf{e}}_{\mathbf{z}} = \frac{(v_\theta^T)^2}{c} b_z (\hat{\mathbf{e}}_\theta \times \hat{\mathbf{e}}_{\mathbf{z}}) \times \hat{\mathbf{e}}_\theta \tag{25}$$

where v_θ^T denotes the velocity of the rotating disk or ring, and b_z is the component of the (gravitational) gravitophoton field $\mathbf{b}_{gp}$ (dimension 1/s) in the z-direction, see Fig. (5). In contrast to the fermion coupling, ref. [14], experimental requirements are substantially lower.

According to our current understanding, the superconducting solenoid of special material (red), see Fig. (5), should provide a 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 gravitophoton field is responsible for the gravitational field above the disk. This experimental setup could also serve as field propulsion device, if appropriately dimensioned. Fig. (5) describes the experimental setup utilizing a disk rotating directly above a superconducting solenoid. In the field propulsion experiment of Fig. (5), the gravitophoton force produces a gravitational force above the disk in the z-direction only. The following assumptions were made: $N = 10$, number of turns of the solenoid, current of about $1A$ (needed to calculate b_z), diameter of solenoid 0.18m, and $v_\theta^T = 25$ m/s. The disk should be directly above the solenoid to produce a magnetic field in z-direction only. This experiment should give an acceleration field $\mathbf{g}_{gp} = 6 \times 10^{-3} g \hat{\mathbf{e}}_z$, which is an appreciable field acting directly above the rotating disk.

From these numbers it seems to be feasible that, *if our theoretical predictions are correct*, the realization of a space propulsion device that can lift itself from the surface of the Earth is within current technology.

CONCLUSIONS AND FUTURE ACTIVITIES

It has been shown that even with an advanced fission propulsion system (most likely the only feasible device among the advanced concepts within the next several decades), space travel will both be very limited regarding, speed, range, and payload capability as well as cost. Travel time to other planets will remain prohibitively high. Interstellar travel is impossible. To fundamentally overcome these limitations, novel physical laws are needed. It was also shown that the status of current physics leaves many important questions unanswered and, concerning the role of the vacuum, severe contradictions exist. The nature of spacetime is not clear.

On the other hand, it has been shown that the current status of both experimental and theoretical gravito-magnetic research indicates that a novel coupling between electromagnetism and gravitation might exist, which could result in the generation of artificial gravitational fields. Such an effect is not predicted by current physics. The experiments by Tajmar et al. cannot be explained by the well known frame dragging effect of GR, since measured values are more than 20 orders of magnitude larger than predicted by GR, and thus should not be visible at all in the laboratory. In particular, these recent experiments , if confirmed, show that such an artificial gravitational field may be generated with current technology. Therefore, the search for novel physical phenomena is both justified and necessary.

As was shown, *Extended Heim Theory* (EHT) predicts a coupling between electromagnetism and gravitation that directly leads to the generation of artificial gravitational fields. Predictions of EHT were compared with experimental data obtained from gyroscope and acceleration measurements, and satisfactory agreement with experimentaldata was demonstrated. However, it is one thing to come up with a theory that fits the measured data. It is quite another, to show that EHT unambiguously predicts two additional interaction that actually occur in the natural world. Therefore, in order to confirm EHT, a *novel experiment must be carried, and an artificial gravitational field along the axis of rotation of a rotating disk* needs to be produced, Finally the propellantless propulsion device must be constructed and its working demonstrated.

In EHT, which can be considered as the natural extension of GR, **matter is a consequence of the internal physical features of spacetime** and thus, with each point in spacetime, an internal symmetry space, termed H^8, is associated. In GR the metric tensor is obtained from a transformation between Cartesian and curvilinear coordinates. This metric tensor then is associated with gravitation. In EHT, a double transformation is used involving also the internal coordinates of the 8-dimensional space H^8. Since H^8 comprises four subspaces and only certain combinations of these subspaces are admissible to obtain a metric that has physical significance, a poly-metric is constructed. Each metric tensor is associated with an interaction or particle. According to EHT, six fundamental interactions should exist. The two additional forces are gravitational like, but can be both attractive and repulsive. Moreover, an interaction between electromagnetism and gravitation should exist. In particular, EHT predicts that superconductivity with a high density of Cooper pairs is an essential part for the (boson) coupling between electromagnetism and gravitation.

The coupling constants of the interactions were obtained from number theory, and thus are calculated theoretically. It is interesting to note that they were published in 1996 and used without modification to explain and quantitatively compare with the experiments by Tajmar et al. EHT was used to calculate the dependence on the coupling constants of the superconductor material, namely for lead and niobium.

Furthermore, guidelines were established by this theory to devise a novel experiment for a field propulsion device working without propellant. In this experiment an artificial gravitational field should be generated along the axis of the rotating disk (ring). Initial calculations show that experimental requirements are well within current technology. Boson coupling seems to substantially alleviate experimental requirements like magnetic field and current density.

Research should focus on this experiment, because of its potential applications in the field of transportation.

The recent experiments by Tajmar et al. provide credible experimental evidence for these laws. In conjunction with the theoretical framework of EHT, the construction of a technically feasible field propulsion device might be achievable. This propulsion principle would be far superior compared to any device based on momentum generation from fuel, and would also result in a much simpler, far cheaper, and much more reliable technology. Such a technology would revolutionize the whole area of transportation.

REFERENCES

1. Zaehringer, A.: *Rocket Science*, Apogee Books, Chap. 7, 2004.
2. Mallove, E. and G. Matloff: *The Starflight Handbook*, Wiley, Chap. 3, 1989.
3. Jahnshan, S.N., and T. Kammash: *Multimegawatt Nuclear Reactor Design for Plasma Propulsion Systems*, Vol 21, Number 3, May-June 2005, pp.385-391.
4. Emrich, W.J. And C.W. Hawk: *Magnetohydrodynamic Instabilities in a Simple Gasdynamic Mirror Propulsion System* , Vol 21, Number 3, May-June 2005, pp. 401-407.
5. M. Tajmar et al.: *Measurement of Gravitomagnetic and Acceleration Fields Around Rotating Superconductors*, STAIF AIP, February 2007. It should be noted that the values of the gyroscope output (b_g field), plotted in Figs. (11, 12) of this reference, have changed with regard to ref. [6]. We used the more recent values of the STAIF paper.
6. M. Tajmar et al.: *Measurement of Gravitomagnetic and Acceleration Fields Around Rotating Superconductors*, preprint October 2006.
7. M. Tajmar et al.: *Experimental Detection of the Gravitomagnetic London Moment*, http://arxiv.org/abs/gr-qc/0603033, 2006.
8. de Matos, C. J., Tajmar, M.: *Gravitomagnetic London Moment, and the Graviton Mass Inside a Superconductor*, PHYSICA C 432, 2005, pp.167-172.
9. T. Regitnig-Tillian: *Antigravitation: Gibt es sie doch ?*, P.M. 3/2007, pp. 38-43 and www.pm-magazin.de/audio.
10. S. Clark: *Gravity's Secret*, 11/11 2006, New Scientist, pp.36-39, archive.newscienist.com.
11. Dröscher,W., J. Hauser: *Spacetime Physics and Advanced Propulsion Concepts*, AIAA 2006-4608, 42nd AIAA/ASME/SAE/ASE, Joint Propulsion Conference & Exhibit, Sacramento, CA, 9-12 July, 2006, 20 pp., (available as revised extended version 20 August 2006 at www.hpcc-space.de).
12. Dröscher,W., J. Hauser: *Magnet Experiment to Measuring Space Propulsion Heim-Lorentz Force*, AIAA 2005-4321, 41st AIAA/ASME/SAE/ASE, Joint Propulsion Conference & Exhibit, Tuscon, Arizona, 10-13 July, 2005, 10pp.
13. Dröscher,W., J. Hauser: *Heim Quantum Theory for Space Propulsion Physics*, AIP, STAIF, 2005, 10pp.
14. Dröscher,W., J. Hauser: *Guidelines for a Space Propulsion Device Based on Heim's Quantum Theory*, AIAA 2004-3700, 40th AIAA/ASME/SAE/ASE, Joint Propulsion Conference & Exhibit, Ft. Lauderdale, FL, 7-10 July, 2004, 21pp.
15. H. Lietz: *11 Lichtjahre in 80 Tagen. Von der Feldtheorie Burkhard Heims und ihrer Anwendung für einen Raumfahrtantrieb*, Telepolis Special 1/2005, Heise Verlag: Hannover, S.47-51.
16. H. Lietz: *Hyperdrive*,7-13 January, 2006, New Scientist.,
17. H. Lietz: *Plus Vite que la Lumière*, Scilogic, 2006, pp. 89-94.
18. Schiller, C.: *Motion Mountain, The Adventure of Physics (Chap. XI)*, 20th ed. January 2007, www.motionmountain.net.
19. Czysz, P., Bruno, C.: *Future Spacecraft Propulsion Systems*,Springer 2006.
20. Liddle, A.: *An Introduction to Modern Cosmology*, Wiley, 2003.
21. Witten, E: *Reflection on the Fate of Spacetime*, Physics Today, 1996.
22. Einstein, A.: *On the Generalized Theory of Gravitation*, Scientific American, April 1950, Vol 182, NO.4.
23. Heim, B.: *Das Prinzip der Dynamischen Kontrabarriere,* Flugkörper, Heft 6-8, 1959.
24. Cardone, F. and R. Mignani: *Energy and Geometry*, World Scientific, 2004.
25. Heim, B.: *Vorschlag eines Weges einer einheitlichen Beschreibung der Elementarteilchen*, Zeitschrift für Naturforschung, 32a, 1977, pp. 233-243.
26. Heim, B.: *Elementarstrukturen der Materie, Band 1*, 3. Auflage, Resch Verlag, Innsbruck, 1998.
27. Bergström, L, A. Goobar: *Cosmology and Particle Astrophysics*, Springer,2004.
28. Zwiebach, R.: *Introduction to String Theory*, Cambridge Univ. Press, 2004.
29. Anderson, P.W., Science 177, pp. 393-396, 1972.
30. Altland, A., B. Simons: *Condensed Matter Field Theory*, Cambridge Univ. Press, 2006.
31. Heim, B.: *Elementarstrukturen der Materie, Band 2*, 2. Auflage, Resch Verlag, Innsbruck, 1996.
32. Veltmann, C.: *Facts and Mysteries in Elelementary Particle Physics*, World Scientific, 2003.
33. Strogatz, S.: *Sync*, Hyperion Books, New York, 2003.
34. Hobson, M.P., G. Efstathiou, A.N. Lasenby: *General Relativity*, Cambridge Univ. Press, 2006.

35.   Heim. B., Dröscher, W.: *Strukturen der Physikalischen Welt und ihrer nichtmateriellen Seite* , Resch Verlagg, Innsbruck, Austria, 1996.

36.   Landau, L., Lifschitz, E.: *Lehrbuch der Theoretischen Physik, Volume IV*, Akademischer Verlag, Berlin, 1991, pp.114.

37.   Kaku, M.: *Quantum Field Theory, Chaps. 1, 2, 19*, Oxford, 1993.

38.   Kane, G.: *Das Geheimnis der Materie*, Spektrum der Wissenschaft, Februar 2007.