Physics of Extreme Gravitomagnetic and Gravity-Like Fields for Novel Space Propulsion and Energy Generation

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Abstract - *Gravity in the form of Newtonian gravity is the weakest of the four known fundamental forces, though there is no proof for the existence of exactly four fundamental interactions. In 2006 Tajmar et al. reported on the measurements of extreme gravitomagnetic fields from small Nb rings at cryogenic temperatures that are about 18 orders of magnitude larger than gravitomagnetic fields obtained from GR (general relativity). Cifuolini in 2004 and the NASA-Stanford Gravity Probe-B experiment in 2007 confirmed the Lense-Thirring effect as predicted by GR (gravitomagnetic fields generated by a rotating massive body, i.e. Earth) within some 10%. In 2007 gravitomagnetic fields generated by a rotating cryogenic lead disk were measured by Graham et al. Though these measurements were not conclusive (the accuracy of the laser gyrometer was not sufficient to produce a standard deviation small enough) their experiment seems to have seen the same phenomenon reported earlier by Tajmar et al., termed parity violation. This means that gravitomagnetic fields produced by the cryogenic rotating ring or disk vary substantially and change sign for clockwise and counter-clockwise directions of rotation. The experimental situation therefore occurs to be contradictory. On the one hand GR has been confirmed while at the same time, there seems to be experimental evidence for the existence of extreme gravitomagnetic fields that cannot be generated by the movement of large masses. If these experiments can be confirmed, they give a clear indication for the existence of additional gravitational fields of non-Newtonian nature. As was shown by the GP-B experiment, measuring gravitomagnetic fields from GR poses extreme difficulties. In GP-B overall measuring time was about 10 months and the mass of the Earth acted as a test body. In contrast, Tajmar et al. measure for a few seconds only and the mass of the ring is some 400 g. Their gravitomagnetic field generated is equivalent to that of a white dwarf. Therefore a novel physical mechanism should exist for the generation of gravity-like fields, which might also provide the key to gravitational engineering similar to electromagnetic technology. Furthermore, gravity-like fields may be the long sought enabling technology for space propulsion without fuel. In addition, a combination of axial gravity-like fields and magnetic induction fields might stabilize the plasma in a magnetic mirror and thus could lead to to a realizable fusion reactor.*

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), Energy Generation.

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Contents

Nomenclature

$\alpha = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{\hbar c} = 1/137$	= coupling constant for electromagnetic force, fine structure constant
$\alpha_{gp} = \frac{1}{\pi\sqrt{\lambda}} = 1/212$	= coupling constant for gravitophoton force
$\alpha_g^2 = 1/67^2$	= ratio of coupling constants of Newtonian gravity and gravitophoton force
α_q	= coupling constant (weak) for the force mediated by quintessence particle ν_q
α_e^{th}	= radiative correction used in Lande factor
$\gamma, \gamma_{IR}, \gamma_I$	= photons (interaction real-real matter), imaginary-real, imaginary-imaginary
λ	= coupling constant for quartic term of potential V
$\nu_{gp}^{01}, \nu_{gp}^{01}$	= two types of neutral gravitophotons (gravitational gauge boson)
$\nu_{gp}^{01} \rightarrow \nu_{gp}^{+} + \nu_{gp}^{-}$	= positive (attractive) and negative (repulsive) gravitophoton (Heim experiment)
$\nu_{gp}^{02} \rightarrow \nu_g + \nu_q$	= graviton (attractive) and quintessence particle (repulsive) (Tajmar experiment)
ν_g	= graviton (gravitational gauge boson, attractive)
ν_q	= quintessence particle (gravitational gauge boson, repulsive)
$\rho_D, \rho_{0D}, h_D, h_{0D}, A_C, A_{0C}$	= density and geometric parameters for disk in Heim experiment, Eq.(22)
ϕ	= scalar function in Lagrangian, real or complex
ω_I	= quantum mechanical angular velocity of imaginary electrons
$\mathbf{A}_{e_I}$	= electromagnetic vector potential from bosons by coupling of imaginary electrons
$\mathbf{B}_G$	= general gravitomagnetic field vector
$\mathbf{B}_{G_N}$	= gravitomagnetic field vector from moving masses
$\mathbf{B}_{gp}^{+}$	= attractive gravitomagnetic field in Heim experiment, interaction with OM
$\mathbf{B}_{gp}^{-}$	= repulsive gravitomagnetic field in Heim experiment, interaction with spacetime
$\mathbf{B}_{gp}$	= gravitomagnetic field vector from gravitophotons
$\mathbf{E}_G$	= general gravitoelectric field vector
$\mathbf{E}_{G_N}$	= gravitoelectric field vector from stationary masses
$\mathbf{E}_{gp}$	= gravitoelectric field vector from gravitophotons
$e_{e_I}^{B}$	= electric charge of boson formed by coupling an even number of electrons of imaginary mass by phase transition at cryogenic T
$g = 2(1+\alpha_e^{th})$	= Lande factor
G	= gravitational constant comprising three parts, G_N, G_{gp}, G_q
$\mathbf{g}_g$	= axial gravitophoton acceleration: Heim experiment
$\mathbf{g}_{gp}$	= tangential gravitophoton acceleration: Tajmar and GP-B (quartz gyroscopes)
H^8	= Heim space, eight-dimensional internal space attached to each point of spacetime
$I_L = 416$ A	= limiting real electric current in disk in Heim experiment, Eq.(24)
$\mathbf{j}_{gp}$	= current density resulting from imaginary bosons (London equation)
$\mathscr{L}$	= Lagrangian density
R^3 , T^1 , S^2 , I^2	= subspace structure of H^8 (mass, electric charge, organization, information)
N	= number of turns of superconducting coil : Heim experiment
$n_{e_I}^{B}$	= number density of bosons formed by coupling an even number of electrons of imaginary mass by phase transition at cryogenic temperature
$V(\phi)$	= potential function in Lagrangian, sometimes denoted as $\Phi(\phi)$
$\mathbf{v}$	= circumferential velocity of rotating disk or ring
$\mathbf{v}_A$	= average circumferential velocity of rotating disk or ring

I. Introduction to the Physics of Extreme Gravitomagnetic Fields

In this paper the physical mechanism for both the qualitative and quantitative description of extreme gravitomagnetic and gravity-like fields, described in a series of recent papers[2–5] , is further refined. In particular, the **coupling constants** for the conversion of photons into gravitophotons are calculated and an updated formula for the extreme gravitomagnetic field is presented. In Sec. III this formula is used to compare theoretical predictions with five recent experiments of extreme gravitomagnetic fields, showing astonishingly close agreement. This is remarkable since coupling constants are obtained from *QFT* (Quantum Field Theory) and are not subject to any modification to fit the experimental data.

The theoretical approach chosen is pragmatic in that no attempt is made to investigate the meaning of three gravity-like fields with regard to the leading theories of everything like M-theory or loop quantum gravity. None of these theories foresees additional fundamental forces, however. The focus is exclusively on the enabling technology that might be achievable from gravitational engineering and its application to (space) transport as well as energy generation, in a way similar to electromagnetic technology.

In 2006 Tajmar et al. reported on the measurements of extreme gravitomagnetic fields from small Nb rings at cryogenic temperatures that are about 18 orders of magnitude larger than gravitomagnetic fields obtained from *GR*. In 2004, Cifuolini and in 2008, the NASA-Stanford Gravity Probe-B (GP-B) experiment confirmed the Lense-Thirring effect of *GR* (i.e. gravitomagnetic fields generated by a rotating massive body) within 10-15%. Furthermore, in 2007 gravitomagnetic fields generated by a rotating cryogenic lead disk were measured by Graham et al. Though these measurements were not conclusive (the accuracy of the laser gyro-meter was not sufficient to produce a standard deviation small enough) their measurements also saw the phenomenon reported earlier by Tajmar et al., termed parity violation, that is, gravitomagnetic fields produced by the cryogenic ring or disk vary substantially and are changing sign for the clockwise and counter-clockwise directions of rotation.

In addition, the GP-B experiment reported a large misalignment of their four gyroscopes (gyro) once they were in orbit. In this experiment Nb coated quartz spheres are rotated at cryogenic temperatures to use the London effect (i.e. a rotating superconductor is generating a magnetic induction field along its axis of rotation) to provide a coordinate system in space oriented toward a fixed star. There were two gyro pairs, with a gyro separation distance of a few centimeters. When we were analyzing the GP-B experiment in 2008[18,19] , employing ideas published since 2002 about the existence of six fundamental forces (three of them of gravitational nature both attractive and repulsive), it turned out that an *interaction between the gyros in each pair should have occurred*. The gravitomagnetic field generated by one sphere is seen by the second sphere and vice versa. This should have lead to a *spindrift anomaly, i.e. in this case the gyro axis is rotated in a plane perpendicular to its orbital plane*, which is given by $1/2\, B_{gp}\, sin(\psi)$ where ψ is the gyro misalignment angle of the gyroscope (the gyroscopes are initially oriented toward the guide star IM Pegasi). If a spinning sphere (gyroscope) generates an extreme gravitomagnetic field of similar magnitude as observed by Tajmar et al., this should be leading to a torque, causing a substantial frame-dragging effect, resulting in a spindrift. The second effect that should have occured, would cause a gravitomagnetic force in tangential direction, *slowing down one sphere and accelerating the other*.[18] This, in principle should have led to an effect much larger than measured from the Lense-Thirring effect produced by the rotating *Earth*. From the GP-B data, however, it cannot be concluded that such a theoretical effect actually occurred, though there might be room for it. The Stanford scientists attributed the misalignment to an electrostatic patch effect, i.e., the surfaces of the Nb spheres, not being perfectly spherical electrically, would have exhibited slight deviations from an equipotential surface, thus leading to electrostatic forces.

Regarding the **experimental situation** there seems to be an **irreconcilable situation**. On the one hand *GR has been confirmed*, while at the same time there is experimental evidence for the existence of extreme gravitomagnetic fields that are clearly *outside the range of GR*. In addition Tajmar et al. reported on the *existence of an acceleration field* acting in the plane of the Nb ring in circumferential direction. Such a field occurred when the ring was not rotating at uniform angular velocity, but was subject to angular acceleration. The gravity-like field produced was acting against the mechanical acceleration, following some kind of Lenz rule.

Independent and prior to the experiments of extreme gravitomagnetic fields, physical ideas were published predicting the existence of three gravity-like fields under the name *EHT* (Extended Heim Theory). Recently a comprehensive, but entertaining to read biography on the scientific work of Burkhard Heim was published by von Ludwiger (2010)[6] . The source of these gravity-like fields, however, is not the mass flux flux of planets or stars, but is supposed to originate from a new type of matter, namely electrically charged fermions of imaginary mass and their subsequent conversion into gravitational bosons, see next section and[2–5] .

If the above experiments can be confirmed, they would serve as proof for the existence of additional gravitational fields whose existence is of *non-Newtonian nature* that is, these fields cannot be generated by the movement of large masses. As has been shown by the GP-B experiment, measuring gravitomagnetic fields poses extreme difficulties. For instance, in GP-B overall measuring time was about 10 months and the mass of the *Earth* acted as test body. In contrast, Tajmar et al. measure for a few seconds only and the mass of the ring is some 400 g. However, the gravitomagnetic field reported by Tajmar et al. is equivalent to that of a white dwarf.

The physics of these novel gravity-like fields might provide the *key technology for space propulsion without fuel*. Today's space transportation systems are based on the principle of momentum conservation of classical physics. Therefore, all space vehicles need some kind of fuel for their 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, has not been possible. Only with *novel physical principles*, providing the proper engineering principles for propellantless propulsion, can these limits be overcome.

The concept of gravitational field propulsion represents such a novel principle, being based on the generation of gravitational fields, not by moving extremely large masses (e.g., planets or stars) around, but by the capability of building devices providing the technology for the generation of gravity-like fields in a way similar to electromagnetism. In other words, gravity fields should be technically controllable. At present, physicists *believe* that there are four fundamental interactions: strong (nuclei, short range), weak (radioactive decay, short range), electromagnetic (long range), and gravitational (long range). As experience has shown over the last six decades, none of these physical interactions, in their present form, are suitable as a basis for novel space propulsion. Furthermore, 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 appears to be impossible.

The forces representing the two additional long range gravity-like fields would be both attractive and repulsive, resulting from the interaction of electromagnetism with gravity. In the following, the physical concepts of *Extended Heim Theory* are employed for the explanation of the novel gravitomagnetic experiments. Moreover, the physical ideas of *EHT* suggest that it seems to be feasible to generate gravity-like (acceleration) fields that should be strong enough for general propulsion purposes. Experimental setups along with respective technical requirements for such devices are outlined in Section IV.

II. Modified Einstein-Maxwell Equations for Extreme Gravitomagnetic Fields

In a series of papers[2–5] it has been discussed that **none of the four known fundamental forces can explain the existence of extreme gravitomagnetic and gravity-like fields**.

The concept of geometrization of physics as introduced by Einstein was extended by B. Heim[15] in the 1950s, and in[2–5] this approach was employed to construct a so called poly-metric with the aim to encompass all known interactions. Therefore, in the following only a summary is presented. From general physical considerations, it was argued that four-dimensional spacetime (geometrical symmetries) should be complemented by an inner (gauge) space H^8 (dynamical symmetries) to account for the physical properties of spacetime, for instance, the existence of fermions, bosons, and fields in general. Therefore this inner space, termed H^8 , is attached to each point of the external four-dimensional spacetime manifold. Moreover, in (*EHT*), the **inner space** H^8 is comprising four subspaces (representing matter, charge, organization, and information), whose existence leads to the so called **double transformation**, see[4,5] . This results in a **master metric field** that, through specified selection rules, is broken down into a total of **16 sub-metric fields**, each having its proper physical meaning , also providing its own group structure. Such a sub-metric is also called a *Hermetry* form, a term coined by B. Heim, because it is describing the hermeneutics (physical meaning) of geometry. In other words, *GR* leads to a single metric (mono-metric) that is associated with gravity, while the presence of inner space H^8 together with its sub-space structure leads to a poly-metric, predicting, **six fundamental interactions**, three of them of gravitational nature. It should be noted that once the existence of space H^8 and its subspace structure is accepted, the number of fundamental forces and particles (fields) are fixed.

A. Fermions and Bosons of Imaginary Mass

Analyzing the various Hermetry forms[2–5] lead to the unforeseen conclusion that **fermions of imaginary mass** (electrons and quarks) should exist. It is argued that these imaginary fermions might be generated experimentally through a **phase transition** at cryogenic temperatures in special materials, for instance Nb and Pb as is discussed further in Sec. A. Similar to the case of superconductivity, imaginary bosons might be formed from an even number of imaginary electrons together with imaginary quarks that are, however, coupled to the protons of the solid, i.e. remain stationary, while the imaginary bosons take on the role of the Cooper pairs.

These imaginary particles are **not behaving like Feinberg's tachyons**, since they are interacting with the charged particles of real mass in the lattice of the solid. As a con-