Heim Quantum Theory for Space Propulsion Physics

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Abstract. This paper describes a novel space propulsion technique, based on an extension of a unified field theory in a quantized, higher-dimensional space, developed by the late B. Heim (1977) in the 50s and 60s of the last century, termed *Heim Quantum Theory* (*HQT*). As a consequence of the unification, *HQT* predicts s*ix fundamental interactions*. The two additional interactions should enable a completely different type of propulsion, denoted *gravitophoton field propulsion*. The fifth interaction, termed *gravitophoton* force, would *accelerate a material body without the need of propellant*. Gravitophoton interaction is a gravitational like force, mediated by gravitophoton particles that come in both types, attractive and repulsive. Gravitophoton particles are generated in pairs from the vacuum itself by the effect of vacuum polarization (virtual electrons), under the presence of a very strong magnetic field (photons). Due to gravitophoton pair production, the total energy extracted from the vacuum is zero. Attractive gravitophotons interact with matter, and thus can become real particles, exacting a force on a material body. Repulsive gravitophotons have a much smaller cross section and do not interact with matter. Consequently, the kinetic energy of the accelerated material body would come from the vacuum, satisfying the second condition, i.e., a *low energy budget for space propulsion*. The name gravitophoton has been chosen because a *transformation of photons into gravitational energy* should take place. The third condition for advanced spaceflight, *superluminal speed*, may be realized by transition into a *parallel space*, in which covariant laws of physics are valid, with a limiting speed of light *nc*, where *n* is an integer and *c* is the vacuum speed of light. In order to achieve such a transition, the sixth fundamental interaction would be needed, termed *vacuum field* (or *quintessence*), which is a weakly repulsive gravitational like force, mediated by the vacuum particle, being formed by the interaction of repulsive gravitophotons with the gravitons of the spacecraft. The paper discusses the source of the two predicted interactions, the concept of parallel space, and presents the physical model along with an experimental setup to measure and estimate the gravitophoton force. Estimates for the magnitude of magnetic fields are presented, and trip times for lunar and Mars missions are given.

SPACETIME AND SPACE PROPULSION

For effective and efficient lunar space transportation as well as interplanetary or interstellar space flight a *revolution* in space propulsion technology is needed. In this paper the physical principles for a novel propulsion scheme are presented, obtained from an extension of *HQT* (Heim, 1977). According to *HQT*, the goals of NASA's *Breakthrough Propulsion Physics Program (BPPP)* (Millis, 2004) may be satisfied. It should be expected that new physics leads to completely new technology (Thiemann, 2002). The requirements of *BPPP* for revolutionary space propulsion are that *no or a very limited amount of fuel* is used, a *low energy budget* is maintained, and *(possibly) superluminal speed is reached*. This immediately rules out any device flying today, or any concept that accelerates a vehicle close to the speed of light. A spacecraft moving only at a small fraction at the speed of light would require a tremendous energy input, rendering such an attempt impractical.

Physical Concepts of HQT

It is known that the general theory of relativity (*GR*) in a 4-dimensional spacetime delivers one possible physical

interaction, namely gravitation. Since *Nature* shows us that there exist additional interactions (EM, weak, strong), and because both *GR* and the quantum principle are experimentally verified, it seems logical to *extend the geometrical principle to a discrete, higher-dimensional space*. Furthermore, the spontaneous order that has been observed in the universe is opposite to the laws of thermodynamics, predicting the increase of disorder or greater entropy (Strogatz 2003). Everywhere highly evolved structures can be seen, which is an enigma for the science of today. Consequently, the theory utilizes an *entelechial* dimension, x^5, an *aeonic* dimension, x^6 (see glossary), and coordinates x^7, x^8 describing *information*, i.e., quantum mechanics, resulting in an *8-dimensional discrete space* in which a smallest elemental surface, the so-called *metron*, exists.

Poly-Metric and the Fundamental Physical Interactions in 8-D Quantized Heim Space

In GR the gravitational force is nothing but an effect of the geometric curvature of spacetime. The predictions of GR have been tested extensively. Therefore, there is some confidence that this concept can be extended to all physical forces, and that the structure of the equations of *GR* is valid for all *physical interactions* in a higher-dimensional space, termed the *Einsteinian Geometrization Principle (EGP)*. There are the subspaces $\mathbb{R}^3$ with real coordinates (x^1, x^2, x^3) that is + signature (Carroll 2004), T^1 with the – signature time coordinate (x^4), S^2 with - signature coordinates for organization of structures (x^5, x^6), and I^2 with -signature coordinates for information (x^7, x^8). In the following, a *Heim space* is a quantized space comprising elemental surfaces with orientation (spin), the *metron*, whose size is the Planck length (apart from a factor) squared, comprising 6 or 8 dimensions. A Heim space may comprise several subspaces, each equipped with its own special metric, whose signature is derived from the signature of the individual subspaces. It should be remembered that the *Lorentzian* metric of $\mathbb{R}^4$ has three spatial (+ signature) and one time-like coordinate (- signature) (Carroll 2004). Heim space H^8, where the superscript denotes dimension, comprises four subspaces or partial structures that form *semantic units*. Combining these semantic units by employing certain selection rules, a set of so called hermetry forms or partial metric tensors is obtained, forming a poly-metric that represents all known physical interactions. Considering the space $H^8 = \mathbb{R}^3 \cup T^1 \cup S^2 \cup I^2$, the theory predicts *six fundamental interactions*, instead of the four experimentally known ones. These interactions emerge in our spacetime and represent real physical fields carrying energy. According to the theory, a *transformation of photons into gravitational energy (gravitophoton)* should be possible. It is this conversion that is used as the physical basis for the *novel* space propulsion concept. This is a direct consequence of Heim space, and the interpretation of a partial metric (*hermetry* form, see glossary) as a physical interaction or particle.

Six Fundamental Interactions in HQT

The *two additional interactions* predicted in *HQT* 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 *quintessence*, a weak *repulsive gravitational* like interaction (*dark energy*). The interpretation of the physical equations for the gravitophoton field leads to the conclusion that this field could be used to both *accelerate* a material body and *to cause a transition* of a material body into some kind of *parallel space*, possibly allowing superluminal speed. According to Heim's theory, gravitation, as we know it, is comprised of *three* interactions, namely by *gravitons, gravitophotons (attractive and repulsive)*, and by the *quintessence or vacuum (repulsive)* particle that is, there exist *three quanta of gravitation*. This means that the gravitational constant *G* contains contributions from all three fields. The quintessence interaction, however, is much smaller than the first two contributions. Furthermore, in *GR* the *gravitational potential is associated with the metric tensor, and thus has a direct physical meaning*. In other words, if the *EGP* is extended to the poly-metric in Heim space H^8, the existence of *exactly six physical interactions* occurs as a natural consequence.

PHYSICAL PRINCIPLES OF GRAVITOPHOTON FIELD PROPULSION

In *GR* the metric has the meaning as physical potential for gravitation. As was mentioned before this view is extended to Heim space H^8. We now present the most general transformation that is responsible for all physical interactions. Most important is the double transformation as described in Eq. (1). A curve in $\mathbb{R}^4$ can be specified by either Cartesian coordinates x^m or by curvilinear coordinates η^i. However, since $\mathbb{R}^4$ is a subspace of Heim

space H^8 with so called internal coordinates ξ^α (Dröscher and Hauser, 2004), there exists a general coordinate transformation $x^m(\xi^\alpha(\eta^i))$ from $\mathbb{R}^4 \rightarrow H^8 \rightarrow \mathbb{R}^4$ resulting in the metric tensor (this is a major difference to *GR*)

$$g_{ik} = \frac{\partial x^m}{\partial \xi^\alpha} \frac{\partial \xi^\alpha}{\partial \eta^i} \frac{\partial x^m}{\partial \xi^\beta} \frac{\partial \xi^\beta}{\partial \eta^k} \,, \qquad g_{ik} =: \sum_{\mu,\nu=1}^{8} g_{ik}^{(\mu\nu)}, \qquad g_{ik}^{(\mu\nu)} = \frac{\partial x^m}{\partial \xi^{(\mu)}} \frac{\partial \xi^{(\mu)}}{\partial \eta^i} \frac{\partial x^m}{\partial \xi^{(\nu)}} \frac{\partial \xi^{(\nu)}}{\partial \eta^k} . \tag{1}$$

where indices α, β = 1,...,8 and *i, m, k* = 1,...,4. The Einstein summation convention is used. The above transformation *is instrumental for the construction of the poly-metric* utilized to describing all possible physical interactions. The metric tensor can be written in the form as expressed in the second term of Eq. (1). Parentheses indicate that there is no index summation. In Dröscher and Hauser (2004) it was shown that 12 hermetry forms can be generated having direct physical meaning, by constructing specific combinations from the four subspaces. The following denotation for the metric describing hermetry form H_ℓ with ℓ=1,...,12 is used:

$$g_{ik}(H_\ell) =: \sum_{\mu,\nu \in H_\ell} g_{ik}^{(\mu\nu)} \tag{2}$$

where summation indices are obtained from the definition of the hermetry forms. The expressions $g_{ik}(H_\ell)$ are interpreted as different physical interaction potentials caused by hermetry form H_ℓ, extending the interpretation of metric employed in *GR* to the poly-metric of H^8. Next, the hermetry forms pertaining to the three subspaces S^2, I^2, $S^2 \times I^2$ are investigated. Cosmological data clearly show that the universe is expanding, which indicates a *repulsive* interaction. Gravitational *attraction* is well known since Newton. Both interactions act on matter, so that there should be two hermetry forms having anti-symmetric properties. The spaces corresponding to these interaction are identified as S^2 and I^2. For the sake of simplicity, the following short form, omitting subscripts *ik*, is introduced $(\mu\nu) := g_{ik}^{(\mu\nu)}$. The gravitational field, as described by gravitons, is given by hermetry form H_{12}, and the vacuum field (quintessence) is given by H_{10}

$$g_{ik}(H_{12}) = (55)+(56)+(65)+(66), \quad g_{ik}(H_{10}) = (77)+(78)+(87)+(88). \tag{3}$$

There is a third hermetry form whose metric is in the space $S^2 \times I^2$. Since this metric is a combination of an attractive and a repulsive interaction, it is assumed that there are exist two types of particles, termed attractive and repulsive *gravitophotons*. The particle for mediating this interaction is called *gravitophoton* because of the possible interaction with the electromagnetic field. It is postulated from the metric of Eqs. (4) that there are two types of gravitophotons associated with the attractive and the repulsive gravitophoton potentials. Their respective coupling constants are denoted by G_{gp}^- and G_{gp}^+ that will be described below. The attractive or negative gravitophoton particle is described by the first term in Eq. (4), the minus sign denoting negative energy density, because it contains the metric of the graviton, which is directly visible from Eq. (3). The repulsive gravitophoton particle is described by the second term in Eq. (4), the plus sign denoting positive energy density, because it contains the metric of the vacuum or quintessence particle that describes a repulsive force.

$$g_{ik}(H_{11}^-) = (55)+(56)+(65)+(66)+ \quad g_{ik}(H_{11}^+) = (77)+(78)+(87)+(88)+$$
$$(57)+(67)+(58)+(68), \quad\quad\quad (75)+(76)+(85)+(86). \tag{4}$$

Therefore, in Heim space H^8 there exist three physical interactions acting on material particles, namely, gravitation represented by hermetry form H_{12} (S^2) (attractive), the *quintessence or vacuum field* hermetry form H_{10} (I^2) repulsive), and the *gravitophoton field*, hermetry form H_{11} (S^2, I^2) (both attractive and repulsive). Negative and positive gravitophotons are generated simultaneously in pairs from the vacuum *without extracting any energy from*

the vacuum. H_{11} is the only hermetry form that is identically 0 that is

$$g_{ik}(H_{11})=g_{ik}(S^2\times I^2)=0. \tag{5}$$

It seems to be strange that a hermetry form that is zero should have any physical effect at all. This reflects the fact that the total energy being extracted from the vacuum by pair production of gravitophotons is zero. However, the physical effect lies in the different absorption coefficients of negative and positive gravitophotons. As it turns out in, gravitophotons are generated by virtual electrons, that is, they are generated by vacuum polarization. H_{11} is the only hermetry form that is comprised by space $S^2 \times I^2$, the so called transcoordinates. None of the other hermetry forms is identical to 0, since this is the only hermetry form associated with creating pairs of particles from the vacuum. Hence, the gravitational constant G is comprised of the three individual coupling strengths of these interactions, $G=G_g+G_{gp}^-+G_q=6.6736918\times10^{-11}$ (calculated value) where $G_{gp}^-\approx1/67^2G_g$ and $G_q\approx4\times10^{-18}G_g$.

The three gravitational forces interact with different types of matter as shown Table 2. In Eq.(6) we compare the photon metric given by hermetry form H_5 (T^1, S^2, I^2), and the gravitophoton metric, observing that the gravitophoton metric is contained in the photon metric.

$$g_{ik}^{(ph)}:=g_{ik}(H_5)=\sum_{\mu,\nu=4}^{8}g_{ik}^{(\mu\nu)} \quad \text{and} \quad g_{ik}^{(gp)}:=g_{ik}(H_{11})=\sum_{\alpha,\beta=5}^{8}g_{ik}^{(\alpha\beta)}=0. \tag{6}$$

In comparison with the first term of Eq. (6), the metric for the photon can be written in the form

$$g_{ik}^{(ph)}=g_{ik}^{(gp)}+g_{ik}^{(44)}+\sum_{\alpha,\beta=5}^{8}(g_{ik}^{(\alpha4)}+g_{ik}^{(4\beta)}). \tag{7}$$

TABLE 1. The Three Gravitational Interactions are Related to Different Types of Matter.

Generated by	Messenger particles	Force	Coupling constant
real particles	graviton	*attractive*	G_g
virtual particles	gravitophoton	*repulsive and attractive*	$G_{gp}^+, G_{gp}^-=1/67^2$
Planck mass vacuum	quintessence or vacuum particle	*repulsive*	$G_q=4.3565\times10^{-18}\,G$

In Table (1) it is shown that gravitons (attractive) are exchanged between real particles, gravitophotons (attractive and repulsive) are exchanged between virtual particles, and the quintessence or vacuum particle is due to the vacuum itself. Therefore, for real charged particles in an accelerator the additional tensor potential does not exist. The tensor potential only occurs if virtual particles, e.g., virtual electrons are present. This fact is important in the experiment to measure the gravitophoton force. In the presence of virtual electrons and a suitable magnetic field, pairs of attractive and repulsive gravitophotons can be generated from the vacuum. Only attractive gravitophotons can interact with real particles. According to *HQT*, repulsive gravitophotons and gravitons can be converted into quintessence particles. The second and third terms at the RHS of Eq. (7), can be associated with the electric force (electric scalar potential) and the Lorentz force (vector potential). The first term represents the combined metric for the negative and positive gravitophoton particles. If an experiment or a physical device can be conceived which causes the metric of the photon to become 0 and make the second and third terms cancel, then the metric for the gravitophoton particles remains. The resulting gravitational force from these pairs of gravitophotons is the basis for the propulsion concept, termed gravitophoton field propulsion or field propulsion.

In Dröscher and Hauser (2004) an experiment was suggested to measure the gravitophoton force. Above a stationary superconducting magnetic coil there is a rotating torus like a flywheel of some 100 kg. Due to the *Heim-Lorentz* formula, Eq. (15), there should be a gravitophoton force generated in the rotating torus. From the Lorentz force, $\boldsymbol{F} = q\,\boldsymbol{E} + q\,\boldsymbol{v}^T \times \boldsymbol{B}$, in our experiment v^T denotes the velocity of the rotating torus), there follows the existence of a scalar electric potential ϕ and a vector potential $\boldsymbol{A}$ with components $A_i = \mu_0 Q v_i / R$ where $Q v_i$ denotes the total current in the magnetic coil and i=1,2,3. However, as can be seen from Eq. (7), the metric tensor for the photon comprises an electric potential, a vector potential, and *a tensor potential*, representing a new force applying the geometrization principle of Einstein to Heim space H^8. The complete electromagnetic interaction is therefore given by a 4-dimensional tensor potential (ϕ, A_i, A_{ik}) with i,k =1,2,3. The tensor potential plays a crucial role in providing the acceleration concept by converting photons into gravitophoton pairs as will be outlined in the following section.

Acceleration Principle of Gravitophoton Field Propulsion

In the following the *physical mechanism* of the gravitophoton force is presented, responsible for the conversion of photons into gravitophotons. This description is the key for devising an experiment and to providing the guidelines for the construction of a gravitophoton propulsion device. The mechanism for the generation of the postulated negative and positive gravitophoton particles is based on the concept of vacuum polarization, known from Quantum Electrodynamics (*QED*). In *QED* the vacuum behaves like a dielectric absorbing and producing virtual particles, and the Coulomb potential is associated with the transfer of a single virtual photon. Vacuum polarization in form of the electron-photon interaction changes the Coulomb potential of a point charge for distances within the electron Compton wavelength with respect to a nucleus. The velocities v_i, v_i^T in combination with the total charge Q in the current loop or magnetic coil need to be chosen such that $r_N < \lambda_C$, otherwise vacuum polarization does not occur. The concept of vacuum has changed with the development of *GR* and it is treated now as a a field that can have its own quantized states (Rovelli, 2003). One of its features is that it is stable and energy cannot be extracted from it. Because of the quantum mechanical uncertainty relation new particles may spontaneously appear out of the vacuum, termed virtual particles, e.g. Lamb shift 1947. A virtual particle *may become real* (Krauss, 2000) by absorbing energy through a collision with a real particle, i.e., it does not disappear back into the vacuum after a short period of time. Such a process is required in *QFT* (Quantum Field Theory) (Zee, 2003).

1. *Virtual electrons:* Let us consider a virtual electron produced by the nucleus of an atom in the rotating torus. Such a virtual electron is produced according to the *Heisenberg* uncertainty relation.

2. *Vacuum polarization:* At a distance from the nucleus r_N the virtual electron sees an electric potential generated by the protons. A magnetic coil is used to generate a magnetic vector and tensor potential in the rotating torus that is placed above the magnetic coil.

3. *Unshielded electron charge:* It is well known that for distances $r_N < \lambda_C = \dfrac{h}{m_e c} = 2.43 \times 10^{-12} m$, the Compton wavelength of the electron, the electron charge increases because it is no longer completely shielded. The electron potential can therefore be split into two terms, namely the shielded electron charge -e and the additional charge -Δe.

4. *Cancellation of shielded electron potential by magnetic vector potential:* The terms for the electric and magnetic potentials are of different signs as shown in Eq. (32) in Dröscher and Hauser (2004). Considering the nucleus of one of the atoms in the material comprising the torus, there is a location r_N for which the shielded electric and magnetic potentials cancel, namely for

$$r_N = \frac{Z\,e}{Q} R \frac{c}{v_i} \frac{c}{v_i^T} \tag{8}$$

where the constant charge value Ze was used. In addition, the material in the torus should contain hydrogen atoms to get a value of Z as small as possible, that is close to 1.

5. *Linearized metric of the photon expressed by vacuum polarization constant A:* With $\Delta e = Ae$ where the value of *A is derived from vacuum polarization,* as shown in (Landau, 1991), and a value r_N smaller than the Compton wavelength of the electron as well as using step 4., the linearized photon potential takes the form

$$h_{44}^{(ph)} = \frac{1}{4\pi\epsilon_0} \frac{1}{m_e c^2} \frac{eQ}{R} \frac{v_i}{c} \frac{v_i^T}{c} \left(A - \frac{v_k}{c} \frac{v_k^T}{c}\right). \tag{9}$$

6. *Condition for vanishing photon potential:* From the nature of *A*, it is obvious that the first term in the above potential is generated from the vacuum, while the second term comes from the tensor potential generated in the coil. The total energy extracted from the vacuum is, however, always zero. According to (Krauss, 2000) the cosmological constant is $5\times10^{-10} \ J/m^3$. The third condition is, according to Eq. (9), to make the photon potential vanish, i.e., to trigger the conversion of a photon into negative and positive gravitophotons, which requires that *A* takes on a value $\tilde{A}$ that is

$$\tilde{A} = \frac{v_k}{c} \frac{v_k^T}{c}, \tag{10}$$

where the value of $\tilde{A}$ depends on the velocities of the charges in the coil and the rotating torus. This conversion takes place at a larger value of r, since the product on the RHS of Eq. (10) is some 10^{-11}. *This means that the conversion of photons into gravitophotons begins to occur as soon as the condition* $h_{44}^{(ph)} \approx 0$ *is satisfied*.

7. *Conversion of photons into pairs of gravitophotons:* A conversion of photons into gravitophotons is possible according to Eqs. (11). The first equation describes the production of N^2 gravitophoton particles from photons. This equation is obtained from Heim's theory in 8D space in combination with considerations from number theory, and predicts the conversion of photons into gravitophoton particles. The second equation is taken from (Landau, 1991)

$$\begin{aligned} w_{ph}(r) - w_{ph} &= Nw_{gp} \\ w_{ph}(r) - w_{ph} &= Aw_{ph}. \end{aligned} \tag{11}$$

8. *Conversion amplitude:* The physical meaning of Eqs. (11) is that an electromagnetic potential (photon) containing probability amplitude Aw_{ph} can be converted into a gravitophoton potential (pair of gravitophotons) with associated probability amplitude Nw_{gp}. From Eqs. (11) the following relation holds for gravitophoton production, requiring the *existence of a shielding potential*

$$Nw_{gp} = Aw_{ph}. \tag{12}$$

The function A(r) can be calculated from Landau's (Landau, 1991) radiation correction with numerical values for A ranging from 10^{-3} to 10^{-4}.

9. *Three conditions for gravitophoton production:* There are the following three conditions to be satisfied in order to convert a photon into a pair of negative and positive gravitophotons, insuring that the total energy extracted form the vacuum in form of gravitophoton particles is zero.

$$\tilde{A} = \frac{v_k}{c} \frac{v_k^T}{c}$$

$$r_N < \lambda_C = \frac{h}{m_e c} \tag{13}$$

$$r_N = \frac{Z e}{Q} R \frac{c}{v_i} \frac{c}{v_i^T}$$

The *crucial* point in the interpretation of Eq. (13) is that the first equation provides a value of $\tilde{A} \approx 10^{-11}$. This value is needed to start converting photons into gravitophotons. However, for this value of $\tilde{A}$ the conversion process is not efficient, i.e., the number of gravitophotons produced is too small to result in an appreciable force. Equations two and three determine the conditions at which, according to Eq. (14) as explained below, an effective gravitophoton potential exists for which the respective value r_N is determined. The corresponding value for $A > \tilde{A}$ is some 10^{-3}. It should be noted that Eq. (10) is *not* interpreted as a *resonance phenomenon*, but sets a condition for the photon potential to disappear and the gravitophoton potential to appear that is, for the onset of the conversion of photons into gravitophotons. Once this happened, the value of A can be increased further, giving rise to an efficient and effective gravitophoton potential for field propulsion.

10. *Metric for gravitophoton pairs generated from the vacuum:* Replacing A by Eq. (12) and ensuring that the potential of Eq. (12) identically vanishes, the converted gravitophoton field takes the form

$$h_{44}^{(gp)\mp} = \mp \left(\frac{N w_{gp}}{w_{ph}} \right) \left(\frac{N' w_{gp}}{w_{ph}} \right) \frac{1}{4 \pi \epsilon_0} \frac{1}{m_e c^2} \frac{eQ}{R} \frac{v_i}{c} \frac{v_i^T}{c}. \tag{14}$$

The $\mp$ sign in Eq. (14) represents the fact that there are both attractive and repulsive gravitophotons as described by the two metric forms in Eq. (4). The sum of the two potentials adds up to 0. The gravitophoton field is a gravitational like field, except that it can be both attractive and repulsive.

11. *Different coupling constants for attractive and repulsive gravitophotons:* However, the coupling constants of the two particles are different, and only the negative (attractive) gravitophotons are absorbed by protons and neutrons, while absorption by electrons can be neglected. This can be made plausible since the negative (attractive) gravitophoton contains the metric of the graviton*,* while the positive repulsive gravitophoton contains the metric of the quintessence particle that does only interact extremely weakly with matter. Through the interaction of the attractive gravitophoton with matter it becomes a real particle and thus a measurable force is generated.

12. *Two-stage gravitophoton propulsion:* Any gravitophoton propulsion device therefore works as a two-stage system, first *accelerating the spacecraft* by the gravitophoton force and then, for certain values of the magnetic field and torus properties, causes a *transition into parallel space*.

Heim-Lorentz Equations for Space Propulsion

The Heim-Lorentz equations, Eqs. (15, 16), (Dröscher and Hauser, 2004) describe the acceleration of a material body by the gravitophoton force. Negative gravitophotons are subsequently absorbed by the protons and neutrons in the torus which have a much larger absorption cross section compared to positive gravitophotons (Dröscher and Hauser, 2004). The *Heim-Lorentz* equations that describe the *gravitational interaction resulting from negative gravitophotons* are of the form (Dröscher and Hauser, 2004)

$$\boldsymbol{F_{gp}} = -\Lambda_p e \mu_0 \boldsymbol{v}^T \times \boldsymbol{H}, \tag{15}$$

where the index p in Λ_p indicates that only proton and neutron absorption processes are considered. From (Dröscher and Hauser 2004)

$$\Lambda_p = \frac{32}{3}\left(\frac{Nw_{gpe}}{w_{ph}}\right)^2 \left(Nw_{gpa}\right)^4 \left(\frac{\hbar}{m_p c}\right)^2 \frac{d}{d_0^3} Z \, . \tag{16}$$

Since the first equation in Eqs. (11) describes the conversion of photons into N^2 gravitophoton pairs, α_{gp} needs to be replaced by $N^2\alpha_{gp}$. Λ_p (dimensionless) is a *highly nonlinear* function of the probability amplitude of the gravitophoton particle. The kinetic energy of the spacecraft is *not* provided by the magnetic field that acts as a catalyzer in the conversion process in providing photons. In this process, no energy is extracted from the vacuum, since gravitophoton particles are produced in pairs, attractive and repulsive.

Gravitophoton Field Propulsion Force from Acceleration

Formulas (15, 16) will be used to calculate the strength of the gravitophoton field. To increase the strength of the interaction, a material containing hydrogen atoms should be used, because of the small value of *r*. A transition into parallel space requires a magnetic induction of some 30 T and torus material different from hydrogen.

TABLE 2. The right most column shows the total gravitophoton force in Newton that would act on the rotating ring. The force results from the absorption of attractive gravitophotons by protons.

n	$N\,w_{gpe}$	$\mu_0 H$ (T)	F_{gp} (N)
10^4	2.6×10^{-14}	2.0	7.14×10^{-43}
10^5	1.1×10^{-5}	6.3	3×10^1
10^6	1.5×10^{-4}	20.0	4.5×10^7
10^6	2.5×10^{-4}	50.0	1.45×10^9

The interaction of a gravitophoton with an electron, regardless whether real or virtual, can be neglected. The number of turns of the magnetic coil is denoted by n, the magnetic induction is given in Tesla, and the current through the coil is 100 A, except for the last row where 250 A were used. The mass of the rotating torus is 100 kg, its thickness, d (diameter) 0.05 m, and its circumferential speed is 10^3 m/s. The wire cross section is 1 mm². The meaning of the probability amplitude is given in the text. For instance, if a larger spacecraft of 10^5 kg with a rotating ring of 10^3 kg needs to have a constant acceleration of 1g, a magnetic induction $\mu_0 H$ of some 13 T is needed together with a current density of 100 *A/mm²* and a coil of 4×10^5 turns for a value $N\,w_{gpe}=4.4\times10^{-5}$. The resulting force would be 10^6 *N*. Thus a launch of such a spacecraft from the surface of the earth seems to be technically feasible. The high current in the superconducting coil produces a magnetic field *H*. Velocity v_k is the speed of the charge, some 10^3 m/s, in the superconducting magnetic coil. Together with the velocity v_k^T of the rotating torus, this magnetic field generates the photon conversion potential according to Eq. (9). As a *future validation activity*, the magnitude of the gravitophoton force obtainable from the pulsed Sandia Z-machine (60 T) should be calculated, and the overall experimental framework should be determined.

Space Flight using Gravitophoton Propulsion

Gravitophoton propulsion takes place in two phases. In phase one a spacecraft is subject to acceleration in $\mathbb{R}^4$. Acceleration is achieved by the absorption of negative gravitophotons through the protons and neutrons in the torus material. Covering large interplanetary distances, would require the transition into parallel space, which is

phase two of the field propulsion, involving the repulsive quintessence particle. A transition into a parallel space leads to an increase in speed by a factor n, compared to our spacetime $\mathbb{R}^4$, Eq. (18). Following the arguments by Krauss in Millis (ed.) (1999) (a signal is needed to tell spacetime to warp, but its speed itself cannot exceed c), *GR* clearly does not allow to travel faster than the speed of light in spacetime $\mathbb{R}^4$. Interaction of positive gravitophotons with spacecraft gravitons is reducing its gravitational potential, Φ, which either requires the mass of the spacecraft to be reduced in $\mathbb{R}^4$, or the gravitational constant G to become smaller. For reduced mass, conservation of momentum would require a velocity $c' > c$ in $\mathbb{R}^4$. Due to quantum gravity theory, a quantized minimal area $\tau = 8\sqrt{3}\pi\hbar G/c^3$ exists. Therefore any physical phenomenon requiring a gravitational constant $G' < G$ or a speed of light $c' > c$ in $\mathbb{R}^4$ has to be ruled out, violating the fact that τ is the minimum surface. On the other hand, because of positive gravitophoton action, Φ is actually reduced, and thus the concept of *parallel space* (or parallel universe or multiverse) is introduced, denoted as $\mathbb{R}^4(n)$ with $n \in \mathbb{N}$. For n=1, v(1):=v (velocity of the spacecraft) and $\mathbb{R}^4(1):= \mathbb{R}^4$. It is postulated that a spacecraft, under certain conditions, stated below by Eq.(18), will be able to transition into such a parallel space. For *G(n)=G/n, M(n)=nM*, and *c(n)= nc*, the spacecraft would transition into n^{th}-parallel space $\mathbb{R}^4(n)$. A parallel space $\mathbb{R}^4(n)$, in which covariant physical laws with respect to $\mathbb{R}^4$ exist, is characterized by the scaling transformation

$$x_i(n)=\frac{1}{n^2}x(1), i=1,2,3 \, ; t(n)=\frac{1}{n^3}t(1)$$

$$v(n)=n\,v(1)\,;c(n)=nc(1)\,;\; G(n)=\frac{1}{n}G\,;\hbar(n)=\hbar\,;n\in\mathbb{N}.$$

(17)

The fact that n must be an integer stems from the requirement in Loop Quantum Theory (*LQT*) for a smallest length scale. The Lorentz transformation is invariant with regard to the transformations of Eqs. (17) that is, physical laws are *covariant* under discrete (quantized) spacetime dilatations (contractions). There are two important questions to be addressed, namely how the value n can be influenced by experimental parameters, and how the back-transformation from $\mathbb{R}^4(n) \rightarrow \mathbb{R}^4$ is working. The value of n is obtained from Eq. (18), relating the field strength of the gravitophoton field, g^+_{gp}, with the gravitational field strength, g_g, produced by the spacecraft itself,

$$n=\frac{g^+_{gp}}{g_g}\frac{G_{gp}}{G}.$$

(18)

In the rotating torus, the positive and negative gravitophoton fields are generated together, and, because of energy conservation, their strengths are equal and can be directly calculated from Eq. (15). Assuming a magnetic induction of 30 T, a current density of 230 A/mm², and 4×10^5 turns for the magnetic coil, the positive gravitophoton field should result in an acceleration of 3×10^2 m/s², in direct vicinity of the torus. Some 10 m away from the torus the acceleration is down to some 0.1 g or 1 m/s². This value for g^+_{gp} is being used in calculating the value of n for interplanetary missions. For a transition into parallel space, positive gravitophotons do interact with the gravitons of the spacecraft, being converted into vacuum particles (sixth interaction), thus reducing the gravitational potential of the spacecraft. Eq. (18) then determines the condition for transition into parallel space $\mathbb{R}^4$ (n). Since n is an integer, the effect is quantized and requires a threshold value for g^+_{gp}. The result of the back-transformation must not depend on the choice of the origin of the coordinate system in $\mathbb{R}^4$. As a result of the two mappings from $\mathbb{R}^4 \rightarrow \mathbb{R}^4(n) \rightarrow \mathbb{R}^4$, the spacecraft has moved a distance $n\,v\,\Delta t$ when reentering $\mathbb{R}^4$. The value Δt denotes the time difference between leaving and reentering $\mathbb{R}^4$, as measured by an observer in $\mathbb{R}^4$. This mapping for the transformation of distance, time and velocity differences cannot be the identity matrix that is, the second transformation is not the inverse of the first one. A quantity $v(n)=nv(1)$, obtained from a quantity of $\mathbb{R}^4$, is not transformed again when going back from $\mathbb{R}^4$(n) to $\mathbb{R}^4$. This is in contrast to a quantity like $\Delta t(n)$ that transforms into ΔT. The reason for this non-symmetric behavior is that $\Delta t(n)$ is a quantity from $\mathbb{R}^4(n)$ and thus is being transformed. The spacecraft is assumed to be leaving $\mathbb{R}^4$ with velocity v. Since energy needs to be conserved in $\mathbb{R}^4$,

the kinetic energy of the spacecraft remains unchanged upon reentry. From the numbers provided, it is clear that gravitophoton field propulsion, is far superior compared to chemical propulsion, or any other currently conceived propulsion system. For instance, an acceleration of 1g could be sustained during a *lunar mission*. For such a mission only the acceleration phase is needed. A launch from the surface of the earth is foreseen with a spacecraft of a mass of some 1.5×10^5 kg. With a magnetic induction of 20 T, compare Table (2), a rotational speed of the torus of $v^T = 10^3$ m/s, and a torus mass of 2×10^3 kg, an acceleration larger than 1g is produced and thus the first half of the distance, d_M, to the moon is covered in some 2 hours, which follows from $t = \sqrt{2 d_M / g}$, resulting in a total flight time of 4 hours. A *Mars mission*, under the same assumptions as a flight to the moon, would need an acceleration phase of 414 hours. The final velocity would be $v = gt = 1.49 \times 10^6$ m/s. The total flight time to Mars with acceleration and deceleration is 34 days. Entering parallel space, a transition is possible at a speed of some 3×10^4 m/s that will be reached after approximately 1 hour at a constant acceleration of 1g. In parallel space the velocity increases to 0.4 c, reducing total flight time to some 2.5 hours. For an interstellar mission see (Dröscher and Hauser, 2004).

CONCLUSIONS

In this paper a novel two stage propulsion concept, termed field propulsion, was presented that does not require fuel and has a low energy budget. A spacecraft might attain superluminal speed by entering parallel space. The physics of field propulsion is based on an extension of the unified field theory by B. Heim, predicting two additional, gravitational like fundamental interactions, indicated by their messenger particles, attractive or repulsive *gravitophotons* and the repulsive *quintessence particle*. The physical mechanism for generating these particles together with an experimental set-up was discussed. It was calculated that the gravitophoton force for a magnetic induction of some 20 T should be able to launch a spacecraft of 10^5 kg from the surface of the earth, resulting in a flight time of some 4 hours for a lunar mission. Also, the conditions for a spacecraft to transition into postulated parallel space were presented, allowing to reach higher velocities that may eventually become superluminal. As to the credibility of *HQT*, it is most remarkable that most recent quantum gravity (Rovelli, 2003; Smolin, 2004) also uses a background independent, non-perturbative formulation but currently is restricted to gravity in 4D that is, no other forces are incorporated so far, while *HQT* lives in a quantized 8D space with a poly-metric, unifying all fundamental physics, but requiring two additional interactions, i.e., there are three quanta of gravitation.

NOMENCLATURE

$\tilde{A}$ = value for the onset of conversion of photons into gravitophotons, see Eq. (10)

A = the strength of the shielding potential caused by virtual electrons

c = 2.997 924 58 $\times 10^8$ ms^{-1}, vacuum speed of light

d = diameter of the torus [m]

d_0 = diameter of the atom in its ground state [m]

-e = electron charge -1.602 $\times 10^{-19}$ C

F_{gp} = gravitophoton force, also termed Heim-Lorentz force, see Eq. (16)

G = $G_g + G_{gp} + G_q$ = 6.6736918 $\times 10^{-11}$ m^3 kg^{-1} s^{-2}, gravitational constant (computed) with G_g =graviton constant, $G_g \approx G$ that is G_g = 6.6722037 $\times 10^{-11}$ m^3 kg^{-1} s^{-2} (computed) describes the gravitational interaction without the postulated gravitophoton and quintessence interactions. G_{gp} gravitophoton constant, $G_{gp} \approx (1/67)^2 G_g$ and G_q quintessence constant, $G_q \approx 4 \times 10^{-18} G_g$

$g_{ik}^{(gp)}$ = metric subtensor for the gravitophoton in subspace $I^2 \cup S^2$

$g_{ik}^{(ph)}$ = metric subtensor for the photon in subspace $I^2 \cup S^2 \cup T^1$

H = magnetic field strength [Am^{-1}]

$\hbar$ = 1.054 572 66 $\times 10^{-34}$ Js, Planck's constant

m_e = 9.109 389 7 10$\times 10^{-31}$ kg, electron mass

m_p = 1.672 623 1$\times 10^{-27}$ kg, proton mass

$Nw_{gp} = Aw_{ph}$, see Eqs. (12, 16), i.e., gravitophoton production needs a shielding potential

$N' w_{gp} = w_{ph}$, factor introduced into Eq. (14) to demonstrate that F_{gp} is a purely gravitational force

n = number of turns of magnetic coil

$n\,c$ = integer multiple of c, valid in parallel space, see Eq. (18)

R = distance from center of magnetic coil to location of virtual electron in torus [m]

Q = total electric charge of electrons moving in magnetic coil

r_N = distance from nucleus to virtual electron in torus [m]

v = velocity vector of charges flowing in the magnetic coil, some 10^3 ms^{-1} for superconductors

v^T = bulk velocity vector for rigid rotating ring (torus) (see Sections. 3 and 4), some 10^3 ms^{-1} in circumferential direction, modern flywheels can reach 1,800 ms^{-1}

w_{gp}, w_{gpe}, w_{gpa}, w_{g_q}, w_{ph_qp}, w_q = probability amplitudes (the square is the *coupling coefficient*) for, respectively, the *gravitophoton force* (fifth fundamental interaction), the *emission of a gravitophoton by an electron* $w_{gpe}=w_{gp}$, *absorption of a gravitophoton* by a proton or neutron, *transformation of gravitophotons and gravitons* into the quintessence particle (rest mass of some 10^{-33} eV, corresponding to dark energy), *transformation of photons into gravitophotons* (see Eq. (11)), and *quintessence particle* (sixth fundamental interaction, corresponding to dark energy)

Z = atomic number

α = coupling constant for the electromagnetic force or fine structure constant 1/137

α_{gp} = coupling constant for the gravitophoton force

ε_0 = 8.854 187 817$\times 10^{-12}$ AsV^{-1}m^{-1}, vacuum permittivity

μ_0 = $4\pi\times 10^{-7}$ Nm^{-2}, vacuum permeability

τ = metron area (minimal surface, according to Heim $3Gh/8c^3$), current value is 6.15×10^{-70} m^2

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