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PHYSICAL PRINCIPLES OF ADVANCED SPACE PROPULSION BASED ON HEIMS'S FIELD THEORY

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THE SUGGESTION THAT SPACESHIPS MAY EVENTUALLY TRAVEL FASTER THAN LIGHT WILL CAUSE MOST ASTRONOMERS TO THROW UP THEIR HANDS IN HORROR, AND FOR EXCELLENT MATHEMATICAL AND PHYSICAL REASONS OUTLINED IN EINSTEIN'S THEORY OF RELATIVITY. BUT SCIENCE IS STILL IN ITS EXTREME INFANCY. IT IS A BIT FATUOUS TO THINK THAT WE HAVE APPROACHED ANY ULTIMATE REALITIES, OR ARE VERY LIKELY TO UNTIL SCIENCE IS SEVERAL THOUSAND YEARS OLDER THAN IT IS NOW.

FROM SPACE FLIGHT *BY C. C. ADAMS, MCGRAW HILL, 1956, P. 236.*

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ABSTRACT

In this paper an overview is given of the results of a completely geometrized unified field theory that gives rise to a novel concept for an advanced space transportation technology, permitting, in principle, *superluminal* travel. This theory predicts the existence of a quasi anti-gravitational force, and allows the design of an experiment for the verification of this theory. This theory of quantum gravity, based on publications by B. Heim et al. [1-6], introduces new physics at the quantum scale, predicting that a transformation of electromagnetic wave energy at specific frequencies into gravitational like energy, is possible. This transformation thus is reducing the inertial mass of a material (ponderable) body. The theory was recently extended to 8 dimensions by the first author [4]. The predicted reduction of inertia (mass) can be used as the design principle for an innovative space transportation system. In this paper, Heim's field equations along with the extensions mentioned above, will be presented and discussed. In addition, the magnitude of the coupling constant between the conversion of electromagnetic energy and gravitational like energy (so called gravito-photons) will be given.

The authors have investigated the fundamental physical assumptions as well as some of the predictions of Heim's theory, and carefully checked its logical consistency [7]. Although several attempts of a formulation for a unified quantum field theory (including gravity) have been made, their success has been very limited. Therefore, because Heim's theory satisfies several modern theoretical requirements, unknown at the time of its development, there is evidence for the physical correctness of this work. In fact, cosmological data strongly suggest the possible existence of an anti-gravitational force (i.e. repulsive), and Heim's concepts, developed decades ago, may have striking solutions to this newly found experimental evidence. We believe that further investigation in this theory is justified in view of its compliance with recently established criteria for a general unified quantum field theory. Furthermore, the theory seems to be logically and physically consistent, and, if found to be correct, would offer an extremely high payoff. The particular coupling between gravitation and electromagnetism cannot be obtained from a manipulation of Einstein's equations of general relativity, e.g., by linearizing the equations of general relativity, or by extending Newton's gravitation law to a time dependent formulation, assuming that the gravitational equations are of the same form as the Maxwell equations [8]. The coupling obtained from Heim's theory is derived from fundamental principles, and is very different from the ones obtained by other ad-hoc approaches. Heim's theory is therefore much more interesting, since it may allow gravity manipulation at lower energy densities, and is based on new physics, thereby leading to new predictions. There may be several new and surprising physical phenomena with far reaching consequences that are predicted by Heim's theory. Some of these can be checked against presently available experimental data, both from cosmology and quantum physics. The physical principle is presented of how to construct a space propulsion device that does not use any propellant, instead is based on an energy transformation process. In a Gedanken experiment an order of magnitude estimate of the necessary energies will be given.

This interaction is rooted in the unification of quantum theory, gravitation and electromagnetism in an 8-dimensional discrete and spin-oriented space. In Einstein's 4-dimensional spacetime continuum that only contains gravitation, this effect cannot take place. Since the interaction between gravitation and electromagnetism reduces the inertial mass of a material object, it is called *inertial transformation.* Since conservation laws for momentum and energy are strictly adhered to, the theory requires *superluminal* velocities, without contradicting Einstein's theory of relativity. Heim's physical theory, provided it reflects physical reality, has the potential to lead to a completely new concept of space transportation.

Nomenclature and physical constants

c speed of light in vacuum 299,742,458 m s^{-1} ($c^2 = \varepsilon_0 \mu_0$.)

D diameter of the physical universe.

G *gravitational constant* 6.67259×10^{-11} m^3 kg^{-1} s^{-2}.

h Planck constant $6.6260755 \times 10^{-34}$ J s.

i, j, k indices in $\mathbb{R}_4$, ranging from 1 to 4.

l_p *Planck length* $(\hbar G/c^3)^{1/2} = 1.61605 \times 10^{-35}\,m$.

gab components of the Hermitian metric tensor in $\mathbb{R}_6$, or $\mathbb{R}_8$.

m_p proton mass, 1.672623×10^{-27} kg.

$R\_$, R_+ smallest and largest radii between which gravitational law, Eq. (24) is valid.

$\mathbb{R}_3$ *3-dimensional physical space* (3 real coordinates).

$\mathbb{R}_4$ *4-dimensional physical space-time* (1 imaginary coordinate).

$\mathbb{R}_6$ *6-dimensional physical space or 6D-Heim space,* $\mathbb{R}_4 \subset \mathbb{R}_6$, (discrete space, a 6D volume element is bounded by oriented metrons, in general an n - dimensional cube has $\binom{n}{k} 2^{(n-k)}$ k - dimensional surfaces) (3 imaginary coordinates).

$\mathbb{R}_8$ *8-dimensional space or 8D-Heim space* (5 imaginary coordinates).

$\mathbf{T}_{\alpha\beta}$ components of the Hermitian *energy-stress-momentum tensor in* $\mathbb{R}_6$ *or* $\mathbb{R}_8$.

$x_1,\ldots,x_6$ *Cartesian coordinates in 6D-Heim space.*

x_1, x_2, x_3 *spatial coordinates in physical space* $\mathbb{R}_3$.

x_4 time coordinate (imaginary).

x_5, x_6 entelechial and aeonic coordinates (imaginary) *in Heim space* $\mathbb{R}_6$.

x_7, x_8 information coordinates (imaginary) *in Heim space* $\mathbb{R}_8$.

α, β indices in $\mathbb{R}_6$, or $\mathbb{R}_8$ ranging from 1 to 6 or 1 to 8, respectively. In a Heim space, Greek indices (if possible) are used for tensor components.

ε_0 *permittivity constant* $8.854187817 \times 10^{-12}$ F m^{-1}.

μ_0 *permeability constant* $12.566370614 \times 10^{-7}$ N A^{-2}.

$\xi_1,...,\xi_8$ curvilinear coordinates in Heim space.

λ_p Compton wave length of the proton mass, $(\lambda_p = \hbar / m_p c)$, 2.10308937 10^{-16} m.

φ^i_{km} normalizable tensor fields for the microcosm that correspond to the Christoffel symbols in the macro realm.

ρ radius at which gravitational force is 0, see Eq. (24).

τ *Metron* area (minimal surface *$3Gh/8c^3$*)

6.15×10^{-70} m^2.

Source for physical constants: Cohen, E.R., Taylor B.N., *The fundamental Physical Constants*, Physics Today, August 1996, pp. BG9-BG13. Measurement uncertainties of constants not listed.

1. The Need for Advanced Space Propulsion

Space transportation, as we know it today, is based on the century-old rocket equation formulating momentum conservation in the framework of classical mechanics. Although there still is room for improvement in the current designs of space transportation systems, there are strict engineering limits associated with the use of the rocket equation. With this kind of propulsion system interplanetary missions are at best cumbersome, interstellar flights are impossible.

NASA[2] has the difficult task of evaluating and selecting candidate technologies for novel revolutionary space transportation systems, based on breakthrough physics. Very often, the potentially most valuable technologies are based on the most innovative theoretical concepts. The return on investment is more difficult to estimate, since it is basically the product of two quantities, one being very large (the usefulness for propulsion, e.g. anti-gravity, unlimited energy or superluminal travel) and the other being small (the likelihood of success). The product of infinity and zero being undetermined, the problem of selecting which concepts are worthy of further investigation is duly appreciated.

If we wish to have a revolutionary space transportation system, incremental improvements in the technology are not sufficient. We need to use different physical laws that are not subject to these barriers. Hence, the quest for breakthrough physics propulsion. If there were a unified quantum field theory, it would be straightforward to examine this theory for novel physical principles of advanced space flight. At present, such a theory is not available. Current, incomplete unified field theories allow for the remote physical possibility of transforming a so called wormhole into a time machine as described in [12-14]. However, deriving a proper space flight technology from these principles does not seem to be feasible in the near future.

The alternative is to check for observed unusual physical effects that might give a hint to hitherto unknown physical laws, or to search for novel physical theories not widely known, but offering physical principles for advanced space flight. At present, such a theory cannot be found in mainstream physics. According to W. Pauli a theory must be crazy enough, but on the other hand must be logical. The authors, having studied Heim's theory for several years, feel that his theory satisfies Pauli's as well as Dirac's requirements for a unified field theory [7]. They also believe to have identified novel physical concepts that might have the potential to evolve into an advanced space flight technology. Heim's theory makes several predictions regarding cosmology, and also provides a formula for calculating the mass spectrum of elementary particles along with their lifetimes. In the section entitled *Speculative*

2 There is no activity at ESA or anywhere in Europe concerning a breakthrough physics space propulsion program.

Cosmology, some of these predictions will be presented to provide data for the experimental validation of the theory. In the space propulsion approach presented below, the vacuum speed of light is *not* the limiting velocity, although conservation principles are strictly adhered to.

2. Introduction to Heim's Field Theory

Heim's theory is a generalization and an extension of the GRT (General Theory of Relativity) to the microcosm in that it computes the physical properties such as lifetime, mass etc. of each microparticle and also unifies all physical forces. To this end, it geometrizes all physical interactions, but does account for, however, the principle of quantization of the physical quantity called *action* (energy × time). Heim extends the nonlinear equations of GRT to the quantum world. This is important, since the equations of GRT must be obtained in the transfer from to the micro- to the macrocosm. Hence his theory extends the *principle of geometrization of physics* to all physical interactions. In that respect, his approach is similar to *Gauge* theory that extends the classical theory of electromagnetism to a unified theory of the weak and the electromagnetic forces. However, in formulating his theory to unify quantum theory, gravitation, and electromagnetism, Heim uses a higher dimensional space that is quantized in a particular way (see below).

There is, however, an important, radically different view from Einstein's GRT. In GRT the physical picture of *matter curves spacetime* is used, and the coefficients of the metric tensor form a tensor potential for gravitation. In this regard, matter and spacetime curvature are equal. In Heim's view, the physical picture is totally different. The energy-stress-momentum tensor contains both the source (particle) and its gravitational field. This means, the components of the metric tensor cannot be interpreted as gravitational potentials, since they are already contained in the energy-stress-momentum tensor. Therefore, there is an equivalence between the metric and matter (including all fields). In other words, matter is caused by the metric and does not exist independently. In this respect, it would be correct to say that matter, as we are used to conceive it, is an illusion. All interactions or fields, namely gravitation, electromagnetics, weak and strong forces are a distortion of their proper Euclidean metrics in a higher-dimensional space. This idea was first presented by Heim in 1952 at the International Congress on Aeronautics in Stuttgart, Germany, and later on published in a series of three articles in 1959, in an obscure German journal on spaceflight. Heim's view is similar to Wheeler's *geometrodynamics* [16]. However, it seems that the first one who published this idea was Rainich in 1925 [17]. Heim claims to have developed a truly universal unified field theory along the lines suggested by Einstein, but including quantum gravity and all other physical interactions. The difficulties in deriving a theory of quantum gravitation are described by Isham in [10]. Isham suggests a program (only the outline is presented without any mathematical derivations) how these difficulties may be overcome, at least in principle. It is very interesting to learn that in Heim's theory, developed much earlier than 1991 (when Isham's article was published), the most important requirements, as identified by Isham, are already included. A state of the art discussion on multi-dimensional theories can be found in [22].

In the following the physical concepts that are underlying Heim's field theory are presented, along with the major cosmological predictions that follow from this geometrized theory. It should be noted that the essential parts of the theory were developed in the fifties and sixties[3], some 50 years ago.

The basic idea of Heim's theory is the representation of a quantum of matter, *Mq*, (elementary particles or resonances) as a geometrical entity. Space itself is assigned significant physical features. Space itself is quantized and is 6 or 8 dimensional, depending on the number of physical interactions to be considered. A 6-dimensional space is needed for a unification of gravitation and electromagnetic theory, while 8 dimensions are needed to represent all known interactions. Thus the space $\mathbb{R}_6$ needs to be extended to a space for $\mathbb{R}_8$ a unified theory that describes all known 4 interactions, but

3 Heim's work was supported for a about a decade by the CEO of MBB. MBB later became known as DASA, and is now called Astrium and part of EADS.

also gives rise to *2 additional interactions*. However, there are dimensional laws that exclude, for instance, spaces with 7 or 9 dimensions. Furthermore, there are only 3 real coordinates (the usual spatial coordinates) that are equivalent and thus interchangeable, all other coordinates are imaginary and are not interchangeable. This is important for the building of the poly-metric, see below, from the various subspaces. A more detailed discussion will be given in Chapter 3.

In contrast to current string theory, Heim is using so called *Metrons,* quantized minimal surfaces with orientation (spin) whose size has varied in time. From the beginning of the universe up to today, the *Metron* size has decreased, and is now approximately the size of the Planck length squared, i.e., its physical dimension is m^2. At the same time, the number of *Metrons* has increased. Thus, the beginning of the universe is identified with the event when there was only one *Metron*, whose surface covered the whole universe. According to this quantum picture, the universe started at a finite size without developing a singularity, naturally avoiding the problem of infinite self-energies. In other words, there are no spacetime points, a concept actually in conflict with Heisenberg's uncertainty principle.

According to Heim, the whole universe comprises a grid of *Metrons* or metronic lattice. Space that does not contain any information consists of a discrete uniform Euclidean grid, bounded by *Metrons* (e.g., a 6 dimensional volume element is bounded by 240 oriented *Metrons*). However, empty space must be **isotropic** with regard to spin orientation. If all metronic spins of a 6D volume pointed outward or inward, such a world would not have a spin potentiality. Therefore, cells with all spins outward have to have neighboring cells with all spins inward and vice versa. This alternating spin structure satisfies the isotropy requirement, but provides empty space with spin potentiality. If two neighboring volumes are interchanged, a spin structure has been realized. In other words, empty space is both isotropic with regard to its metric as well as its spin structures, but is is capable to develop *discrete structures*. Thus, empty space is void of physical events, but has inherent potentiality for physical events to happen. In order for an event to happen, a distortion of the Euclidean metric is necessary. In this sense, the theory is a geometric dynamic theory, a term coined by A. Wheeler. The whole theory as it is formulated by Heim, is based on geometrical language. It should be mentioned for matter to be existing, as we are used to conceive it, a distortion from Euclidean metric or **condensation**, a term used by Heim, is a necessary but not a sufficient condition.

Before we enter into some of the mathematical formulations, the main physical features of the theory are summarized below:

1. For a quantized unification of gravitation and electromagnetism a 6 dimensional space $\mathbb{R}_6$ is needed. If all known interactions are to be incorporated space becomes 8-dimensional. In $\mathbb{R}_6$ the two transcoordinates x_5 and x_6 are imaginary coordinates. Only the 3 spatial coordinates can be real. Any higher-dimensional space with real coordinates will not permit stable elliptical planetary orbits. Spacetime $\mathbb{R}_4$ is a subset of $\mathbb{R}_6$ Transcoordinates (in this context it does not matter that we use the Euclidean coordinates instead of the curvilinear coordinates) $x_5=0$ or $x_6=0$ denote virtual (latent) events and are outside manifest events $(x_5 \neq 0$ and $x_6 \neq 0)$ in 4 dimensional spacetime $\mathbb{R}_4$. The transcoordinate x_5 is denoted as *entelechial* coordinate, and x_6 is called the *aeonic* coordinate. The semantic meaning of these coordinates stems from the Greek word *entelechy,* governing the actualization of a form-giving cause, and *aeon,* denoting an indefinitely long period of time. The entelechial dimension can be interpreted as a measure of the quality of time varying organizational structures (inverse to entropy, e.g., plant growth) while the aeonic dimension is steering these structures toward a dynamically stable state. Any coordinates outside spacetime can be considered as steering coordinates. The 2 additional coordinates in $\mathbb{R}_8$ are denoted as *information coordinates*.
2. Spacetime itself is quantized. The current area of a *Metron*, τ, is $3Gh/8c^3$ where G is the gravitational constant, h denotes the Planck constant, and c is the speed of light

in vacuum. The *Metron* size is a derived quantity and is not postulated.

3. Novel Cosmology and poly-metrics. In $\mathbb{R}_6$ the metric tensor, $g_{\alpha\beta}$ (α, β= 1,...,6) is **Hermitian** (symmetric in complex space), and is the union of a set of non-Hermitian metric tensors of subspaces $\mathbb{R}_3$ formed by spatial coordinates (x_1, x_2, x_3), space T_1 generated by the time coordinate (x_4), and the structural space S_2, built from the two trans-coordinates (x_5, x_6). Formally, $\mathbb{R}_6$ is the union $\mathbb{R}_3 \cup T_1 \cup S_2$. This is an important point, since the various metrics resulting from a combination of these subspaces are the generators of the physical interactions (or forces). In $\mathbb{R}_8$ there are 2 additional imaginary coordinates. The respective subspace is denoted as I_2. Hence, $\mathbb{R}_8$ is the union $\mathbb{R}_3 \cup T_1 \cup S_2 \cup I_2$. Therefore, there are 4 different coordinate groups in $\mathbb{R}_8$. It will be shown below, that the metric tensor for the 8 space can be written as a composition of subtensors that are functions of the coordinates from these subspaces. Associated with each metric subtensor is a physical interaction, and thus a correspondence principle between the metric and the actual physics is established.

   In this context, space and time are not the container for things, but are, due to their dynamic (cyclic) nature, the things themselves. This is an entirely different physical picture from the approach of simply adding the stress-energy-momentum tensor of the electromagnetic field to the right-hand side of Einstein's field equations, for instance, see [15] in order to obtain a geometrization of gravity and electromagnetism. Other attempts by H. Weyl (modifying the Christoffel symbols by adding a 4-vector to be interpreted as the electromagnetic 4-vector potential), Kaluza and Klein (5 dimensional space), or Einstein-Schrödinger (unsymmetric metric tensor) have not been successful either. Instead of regarding the field equations, as established by Heim, as a set of differential equations for the $g_{\alpha\beta}$, they are to be regarded as a set of equations for the components of the stress-energy-momentum equations, $T_{\alpha\beta}$, see also Wheeler [16]. However, Heim eventually derives a set of *eigenvalue* equations.

4. Geometrization of elementary particles and the physical interpretation of geometric structure. Einstein's field equations are extended to the micro area. The energy-stress-momentum tensor is proportional to geometrical entities termed tensor fields,, that $\varphi^{l}{}_{km}$ are normalizable and correspond to the Christoffel symbols in the macro realm. Eigenvalue equations of purely geometrical character are set up, using the quantization principle.

5. The only empirical constants (non-derived quantities) are G, h, ϵ_0, μ_0. All other constants are derived quantities. This includes the coupling constants, too.

6. Interpretation of elementary particles as geometrical entities that possess an internal dynamic structure which is changing cyclically in time. Elementary particles do possess an internal spatial structure (zones), but are elementary in a sense that they are not composed of subparticles. Elementary particles are not point entities, but do consist of *Metrons.*

7. Derivation of strictly enforced symmetry laws for elementary particles. The mass spectrum and the life times of elementary particles are computed.

As an empirical and logical basis for Heim's field theory the following assumptions are made:

1. There exist general conservation principles, for example, for mass, momentum, energy, or electrical charge.

2. There are extremum principles, for instance, the entropy law in the macroscopic world that can be described by variational theorems.

3. The principle of quantization of action, i.e., there is a smallest unit of action, *h,* and all all other actions are multiples of *h*. Thus matter is not continuous, but is quantized (i.e., discrete). The quantization of charge, light, and energy is a consequence of this quantization principle.

4. As a logical basis it is assumed that both in the macroscopic and the microscopic realms

material structures interact through action fields : in the micro- and macroscopic area there exist electromagnetic and gravitational fields, while on nuclear distances short range fields are present.

3. The Field Equations According to Heim

Einstein's 1915 theory explained gravity as nothing more than a property of spacetime, namely its intrinsic curvature. The distribution of energy (i.e., the 4-vector of energy and momentum) causes spacetime curvature. This geometrical style of physics, is extended by Heim to all physical interactions but, as was stated before, with a radically different physical interpretation, namely that spacetime curvature is equivalent to the combined (source and field) energy-stress-momentum tensor. In other words, there are geometrical explanations for electromagnetism, as well as for the weak and strong forces. As already mentioned, however, the approach is different in that the metric gives rise to an energy-momentum distribution in a higher dimensional, so called Heim space. A purely discrete and uniform Cartesian grid will not provide any information that could be interpreted as energy-momentum distribution, and hence is a sign of an empty space. The physical laws that cause a distortion from this uniform grid, are the generators of all physical phenomena.

From Einstein's theory of relativity it is known that spacetime curvature gives rise to 10 gravitational potentials. Furthermore, Einstein's equations have been verified for several decades [20], and were found to be correct. In other words, it is an established empirical fact that the deviation from a Cartesian metric in spacetime gives rise to gravitational interaction. Heim's idea was to extend this principle of geometrization to all other physical interactions. This means that the structure of the equations of general relativity should be retained, being valid also in the quantum range. Since the curvature of spacetime is responsible for gravitation, a higher dimensional space is needed whose curvature accounts for all further physical interactions. In addition, the principle of quantization has to be taken into account, giving rise to a set of eigenvalue equations.

According to Heim, since a particle has a nonlinear, completely geometrized structure, a nonlinear operator is necessary to produce a set of geometrical eigenwert equations. In GRT, the relation between the curvature tensor and Christoffel symbols is $R^i_{kml} = K_l \Gamma^i_{k\,m}$, where K_l denotes the well known differential operator for the curvature tensor. In analogy to GRT, we write $C_l\,\varphi^i{}_{km}$, when going from the macro- to the microcosm, describing the field of a microparticle. Because of the correspondence principle from the macro- to the microcosm, $C_l{=}K_l$. The Christoffel symbols $\Gamma^i_{k\,m}$ become the so called normalizable **condensor** functions, $\varphi^i{}_{km}$. This denotation is derived from the fact that these functions represent condensations of the spacetime metric. The fundamental idea in Heim's theory is that matter can be explained as a geometrical phenomenon and thus, Einstein's field equations should be valid in the microcosm, too. On the other hand, it is well known that Schrödinger's equation describes the probability amplitude for the location of a microparticle. The stationary Schrödinger equation is an eigenvalue equation for the probability amplitude, ψ , with discrete energy values as eigenvalues. This equation, however, does not make any statements about the physical properties of the microparticle.

Therefore, if, in contrast, one wants to have an eigenvalue equation for the particle itself, to describe its geometrical structure as well as its physical properties that are independent of an external field, only depending on the *underlying spacetime metric*, a different set of eigenvalue equations needs to be conceived.

These equations can be obtained by observing that the Christoffel symbols can be interpreted as physical fields, and consequently Heim associates the condensor functions $\varphi^i{}_{km}$ with physical fields in the microcosm. Einstein's theory is in excellent agreement with observation in the limiting case of a spacetime continuum on a macroscopic level. Any unified theory ought to agree with his theory in this limiting case. Furthermore, since particle and wave are a unity, it is concluded that the eigenvalue equations for the condensor functions should have a form similar to Schrödinger's equation and are written in the form

$$C_{(l)}\varphi^{(l)}_{k\,m} = \lambda_{(l)}\varphi^{(l)}_{k\,m} = \epsilon^{l}_{k\,m} \qquad (1)$$

The LHS is a tensor of 4th rank (the operator and the condensor functions considered separately), λ_l is a vector of eigenvalues, and φ^{l}_{km} is a tensor of 3rd rank. The Christoffel symbols and thus the condensor functions are 3rd rank tensors only with respect to affine (linear) coordinate transformations. Any index in parentheses is not summed over. The RHS represents quantized energy densities, denoted by ε^{l}_{km}. The 3 indices independently run from 1 to 4, representing a set of 64 eigenvalue equations. As Heim shows by symmetry considerations, 28 of the eigenvalue spectra are empty. Rearranging the remaining 36 eigenvalue spectra in a 6×6 tensor, Heim eventually constructs a 6-dimensional space. Since Eqs. (1) are eigenvalue equations, not subject to any external field, there will be no curvilinear transformations, leaving the tensor character of these functions intact.

3.1 Eigenvalue Equations in Heim's Theory

In order to give physical meaning to the various metrics obtained from the metrics of subspaces of $\mathbb{R}_8$, some kind of hermeneutics is needed. The ***hermeneutics*** of the $\mathbb{R}_8$ geometry (abbreviated in the following as ***hermetry***) means the study of the methodological principles of interpreting the metric tensor and the eigenvalue vector of the subspaces. This semantic interpretation of geometrical structure is called hermeneutics (from the Greek word to interpret).

Interactions in Heim's theory are causing a modification of the underlying space time metrics. Although there is an 8-dimensional Heim space, we need to consider that the actual physics takes place in 4-dimensional spacetime. In order to see physical events happen, a deviation from empty space, i.e., from the uniform grid must occur. The uniform grid is given by an Euclidean space using coordinates $x_1,...,x_4$. Originally, Heim arrived at a 6-dimensional space with coordinates $x_1,...,x_6$. For a physical event to happen, a 4-dimensional curvilinear coordinate system needs to be introduced, $\xi_1,...,\xi_4$ that denotes the deviation from Euclidean metric and, according to our interpretation, gives rise to physical interactions. The four additional curvilinear coordinates in $\mathbb{R}_8$, $\xi_5,...,\xi_8$ are termed transcoordinates and are imaginary. It should be noted that the Heim space $\mathbb{R}_8$ can also have a Euclidean structure with coordinates $x_1,...,x_8$. A physical interaction taking place in $\mathbb{R}_4$, not only changes coordinates $\eta_1,...,\eta_4$ in physical spacetime, but also influences the transcoordinates in $\mathbb{R}_8$. In other words, there exists a mapping from $\mathbb{R}_4$ to $\mathbb{R}_8$. This means, coordinates ξ_i depend upon spacetime coordinates η_k or $\xi_i = \xi_i(\eta_k)$. The modified coordinates ξ_i in turn influence the spacetime metric. Hence, there is a mapping from $\mathbb{R}_4$ to $\mathbb{R}_8$ and back to $\mathbb{R}_4$. This double coordinate transformation can be written as $x_l = x_l(\xi_i(\eta_k))$

From the structure of the metric tensor it follows that Heim's theory postulates the existence of two additional interactions, denoted as field Ψ_1 (transformation of photons into gravito-photons, hermetry form H_{11}, see Sec. 3.4) and Ψ_2 (transformation of gravito-photons into the probability field, hermetry form H_{10}, see Sec. 3.4) so that there are now 6 different fundamental interactions. In addition, there exist two conversion fields allowing for the transformation of photons into gravito-photons (Ψ_1 field), provided proper external conditions are generated, and subsequently these gravito-photons are converted via the conversion field, Ψ_2 , into the probability field, see below.

In Eq. (2) the structure of the energy-stress-momentum tensor for Heim space $\mathbb{R}_6$ is shown. The tensor contains 12 vanishing components, as shown by Heim in [1]. Since $T_{\alpha5}=T_{\alpha6}= 0$ and $T_{5\alpha}=T_{6\alpha}= 0$, the transspace (with regard to $\mathbb{R}_4$), namely the components T_{55}, T_{56} and T_{65}, T_{66}, interact only via time components $T_{\alpha4}$ and $T_{4\alpha}$ with spacetime $\mathbb{R}_4$. This means that in the microcosm where Heim's equations are valid, the future is not predetermined, i.e., only probabilities for future possibilities are possible. Causality is appearing only in the case of a superposition of many microstates, forming a collective macrostate.

Zero entries in $T_{\alpha\beta}$ may become non-zero according to Heisenberg's uncertainty principle.

$$
T_{\alpha\beta} = \begin{pmatrix} T_{11} & T_{12} & T_{13} & T_{14} & 0 & 0 \\ T_{21} & T_{22} & T_{23} & T_{24} & 0 & 0 \\ T_{31} & T_{32} & T_{33} & T_{34} & 0 & 0 \\ T_{41} & T_{42} & T_{43} & T_{44} & T_{45} & T_{46} \\ 0 & 0 & 0 & T_{54} & T_{55} & T_{56} \\ 0 & 0 & 0 & T_{64} & T_{65} & T_{66} \end{pmatrix} \tag{2}
$$

3.2 Poly-metrics and Physical Forces

We mentioned that the metric tensor is comprised of several components, such that each component is responsible for a different physical interaction. There are several subspaces in in $\mathbb{R}_8$ in which individual metric tensors are specified, that in turn are the cause of different physical forces. The association of each coordinate group (or subspace) follows certain selection rules. Its corresponding physical interaction is listed below. The physical meaning of a coordinate or a group of coordinates is responsible for the physical interaction. First, four groups of coordinates are discerned:

spatial coordinates (real) (ξ_1, ξ_2, ξ_3),

time coordinate (imaginary) (ξ_4),

entelechial and aeonic coordinates (imaginary) (ξ_5, ξ_6),

information coordinates (imaginary) (ξ_7, ξ_8).

As was outlined before, empty space is a discrete uniform Euclidean space. We now ask the following question: let us suppose that only coordinates (x_5, x_6) undergo a deformation $\delta\xi_5$ and $\delta\xi_6$, rendering these coordinates curvilinear. The change in these coordinates has an impact on the 4-dimensional spacetime geometry, too and appears as some kind of physical phenomenon. In order to calculate this change of spacetime metric, we write

$$
g_{ik} = \frac{\partial x_m}{\partial \xi_\alpha}\frac{\partial \xi_\alpha}{\partial \eta_i}\frac{\partial x_m}{\partial \xi_\beta}\frac{\partial \xi_\beta}{\partial \eta_k} \tag{3}
$$

where indices α, β = 1,...,6 and i, m, k = 1,...,4. This follows directly from the transformation rule given in Sec. 3.1. The same structure holds for the metric tensor of $\mathbb{R}_8$ where indices α, β = 1,...,8. The terms on the RHS can be written in the form

$$
\kappa^{(\alpha)}_{im}\kappa^{(\beta)}_{mk} = \frac{\partial x_m}{\partial \xi_{(\alpha)}}\frac{\partial \xi_{(\alpha)}}{\partial \eta_i}\frac{\partial x_m}{\partial \xi_{(\beta)}}\frac{\partial \xi_{(\beta)}}{\partial \eta_k}\ . \tag{4}
$$

where indices in parentheses are not summed over, and the definition of the factors $\kappa^{(\alpha)}_{i,m}$ and $\kappa^{(\beta)}_{m,k}$ follows directly from the above formula. Since the function occurs as the kernel in the integral

$$
x^{(\alpha)}_m = \int \kappa^{(\alpha)}_{im}\, d\eta_i \tag{5}
$$

it is denoted as **fundamental kernel** of the **poly-metric**. The term poly-metric is used with respect to the composite nature of the metric tensor as well as the twofold mapping $\mathbb{R}_4 \rightarrow \mathbb{R}_8 \rightarrow \mathbb{R}_4$. Using the fundamental kernels, we can write the metric tensor in $\mathbb{R}_8$ in the form

$$
\begin{gathered}
g_{ik} = \sum_{\alpha=1}^{8}\kappa^{(\alpha)}_{im}\sum_{\beta=1}^{8}\kappa^{(\beta)}_{mk} = \\
\left(\sum_{\alpha=1}^{3}\kappa^{(\alpha)}_{im} + \kappa^{4}_{im} + \sum_{\alpha=5}^{6}\kappa^{(\alpha)}_{iim} + \sum_{\alpha=7}^{8}\kappa^{(\alpha)}_{im}\right) \\
\left(\sum_{\beta=1}^{3}\kappa^{(\beta)}_{mk} + \kappa^{4}_{mk} + \sum_{\beta=5}^{6}\kappa^{(\beta)}_{mk} + \sum_{\beta=7}^{8}\kappa^{(\beta)}_{mk}\right)
\end{gathered} \tag{6}
$$

In the next step, we write the components of the metric tensor in such a way that there is a correspondence with the four subspaces I_2, S_2, T_1, and $\mathbb{R}_3$.

$$
g_{ik} = \sum_{\alpha=0}^{3}\chi^{(\alpha)}_{im}\sum_{\beta=0}^{3}\chi^{(\beta)}_{mk} \tag{7}
$$

where the relationship between the new functions χ and the fundamental kernels κ is obtained from the comparison with the previous formula of g_{ik}. That is,

$$
\chi^{(0)}_{i,m} = \sum_{\alpha=7}^{8}\kappa^{(\alpha)}_{i,m}, \qquad \chi^{(1)}_{im} = \sum^{6}\kappa^{(\alpha)}_{im} \tag{8}
$$

$$
\chi^{(2)}_{im} = \kappa^{(4)}_{im} \text{ and } \qquad \chi^{(3)}_{im} = \sum_{\alpha=1}^{3}\kappa^{(\alpha)}_{im}.
$$

It should be noted that $\chi^{(\alpha)}_{im} \neq \chi^{(\alpha)}_{mi}$.

From Eq. (7) it can be seen that the metric tensor in $\mathbb{R}_8$ is composed of 16 different terms where each term belongs to one of the 4 subspaces of $\mathbb{R}_8$. The metric tensor can also be expressed as

$$g_{ik} = \sum_{\alpha,\beta=0}^{3} g_{ik}^{(\alpha\beta)} \tag{9}$$

where

$$g_{ik}^{(\alpha\beta)} = x_{im}^{(\alpha)} x_{mk}^{(\beta)} \quad . \tag{10}$$

As was mentioned before, values of α, β are associated with the subspaces of $\mathbb{R}_8$. The following relationship holds:

$$\begin{aligned} &\alpha,\beta=0: I_2=(\xi_7, \xi_8), \\ &\alpha,\beta=1: S_2=(\xi_5, \xi_6), \\ &\alpha,\beta=2: T_1=(\xi_4), \\ &\alpha,\beta=3: \mathbb{R}_3=(\xi_1, \xi_2, \xi_3). \end{aligned} \tag{11}$$

If the eigenvalue vector, λ_p, of Eqs. (1) is different from 0, not all of its components need to be different from 0 in $\mathbb{R}_8$.The spectrum of λ_p may refer to a k-dimensional subspace V_k , denoted as $\lambda_p(V_k)$, such that its k coordinates are **hermetric** (curvilinear), while the remaining *8-k* coordinates are Euclidean. If the k coordinates of the subspace are hermetric, i.e., give rise to a hermetric form as described in Eq. (13), the remaining 8-k Euclidean coordinates outside V_k are termed **anti-hermetric**. A subspace V_k of $\mathbb{R}_8$ could be built by combining coordinates from any of the four spaces I_2, S_2, T_1, and $\mathbb{R}_3$. The number of physically relevant subspaces is, however, restricted, because the real coordinates are interchangeable and are taken as a semantic unit. All other coordinates are not interchangeable and thus are separate semantic coordinate entities. In addition, transcoordinates can only occur in pairs, that is both coordinates from S_2 or I_2 must be present simultaneously. Otherwise $\lambda_p = 0$, as Heim shows in [2, pp. 192-195]. If both the transcoordinates of S_2 and I_2 are anti-hermetric, then the coordinates of $\mathbb{R}_4$ must be anti-hermetric as well. In other words, transcoordinates must always be present in a subspace in order that a physical event can take place. Stated somewhat differently, at least **one** of the two **transcoordinate groups S_2 or I_2 must** be present in order to steer physical processes in $\mathbb{R}_4$.

Next, using these rules it can be determined which of the **subspaces correspond to physical structures in the microcosm**. In addition, these subspaces need to be assigned their proper physical interaction. This semantic interpretation or *hermeneutics* has to be performed in a way to reflect physical processes. We have seen that Heim space $\mathbb{R}_8$ comprises four semantic entities, namely the subspaces I_2, S_2, T_1, and $\mathbb{R}_3$. Employing the above rule there are 12 physically meaningful combinations of the four subspaces in $\mathbb{R}_8$, describing either physical particles or interactions. Ten of these subspaces can be identified with known virtual particles or physical interactions. They can be associated with the four known physical interactions (strong, electromagnetic, weak, gravitation) and the four types of known virtual particles (gluons, photons, bosons, gravitons). The hermetry forms H_2, H_6, H_8, and H_9 correspond to the four known interactions, namely the strong, weak, gravitational, and electromagnetic forces, respectively.

There are, however, **two additional interactions** (fields) that have not been known before. In the light of recent cosmological observations, they could possibly be associated with *dark matter* and *dark energy,* described by hermetry forms H_{10} and H_{11}. Since H_{10} contains only the space, I_2, this field is termed *probability field.* In H_{11} both types of transcoordinates are present, and the particle associated with this hermetry form is termed *gravito-photon*. Perhaps these two fields are the explanation for *dark matter* and *dark energy* or *quintessence*. Quintessence [23], [24] has the striking physical characteristic that it causes the expansion of the universe to speed up. Energy, either in form of matter or radiation, causes the expansion to slow down due to the attractive force of gravity. For quintessence, however, the gravitational force is repulsive, and this causes the expansion of the universe to accelerate. In addition, it is interesting to compare, see Sec. 5, with Heim's modified Newtonian law, derived in the fifties of the last century.

Below are listed the 12 hermetry forms that result from the *8-dimensional* Heim space $\mathbb{R}_8$. Arguments in parentheses specify the subspace

V_k in which the physical interaction takes place.

$$H_1 = H_1(I_2, T_1) \quad \text{gluons}$$
$$H_2 = H_2(I_2, T_1, R_3) \quad \text{color charges}$$
$$H_3 = H_3(I_2, S_2, T_1, R_3) \quad W^{+-} \text{ bosons}$$
$$H_4 = H_4(I_2, S_2, R_3) \quad Z^0 \text{ boson} \tag{12}$$
$$H_5 = H_5(I_2, S_2, T_1) \quad \text{photons}$$
$$H_6 = H_6(I_2, T_1) * H_7 = H_7(S_2, T_1)$$
weak charge
$$H_8 = H_8(S_2, R_3)$$
neutral field (particle) with mass
$$H_9 = H_9(S_2, T_1, R_3)$$
field (particle) with electric charge and mass
$$H_{10} = H_{10}(I_2) \text{ probability field}$$
$$H_{11} = H_{11}(I_2, S_2) \text{ gravito-photon}$$
$$H_{12} = H_{12}(S_2) \quad \text{graviton.}$$

The hermetry forms can also be represented by the components of the metric tensor of the corresponding subspace V_k. The superscripts, ranging from 0 to 3, in the χ quantities refer to the respective coordinate groups.

$$H_1 = (\chi_{im}^{(0)}, \chi_{im}^{(3)}) \quad \text{gluons}$$
$$H_2 = (\chi_{im}^{(0)}, \chi_{im}^{(2)}, \chi_{im}^{(3)}) \quad \text{color charges}$$
$$H_3 = (\chi_{im}^{(0)}, \chi_{im}^{(1)}, \chi_{im}^{(2)}, \chi_{im}^{(3)}) \quad W^{+-} \text{ bosons}$$
$$H_4 = (\chi_{im}^{(0)}, \chi_{im}^{(1)}, \chi_{im}^{(3)}) \quad Z^0 \text{ boson}$$
$$H_5 = (\chi_{im}^{(0)}, \chi_{im}^{(1)}, \chi_{im}^{(2)}) \quad \text{photons} \tag{13}$$
$$H_6 = H_6(\chi_{im}^{(0)}, \chi_{im}^{(2)}) * H_7 = H_7(\chi_{im}^{(1)}, \chi_{im}^{(2)})$$
weak charge
$$H_8 = (\chi_{im}^{(1)}, \chi_{im}^{(3)})$$
neutral field (particle) with mass
$$H_9 = (\chi_{im}^{(1)}, \chi_{im}^{(2)}, \chi_{im}^{(3)})$$
field (particle) with electric charge and mass
$$H_{10} = (\chi_{im}^{(0)}) \quad \text{probability field}$$
$$H_{11} = (\chi_{im}^{(0)}, \chi_{im}^{(1)}) \quad \text{gravito-photon}$$
$$H_{12} = (\chi_{im}^{(1)}) \quad \text{graviton.}$$

It is reasoned that hermetry forms H_{10} and H_{11} are similar to the graviton field H_{12}, since they are both caused by transcoordinates, and thus will have a small coupling constant. The important point is that in Heim's theory there are transformation operators, S_1 or S_2 (not to be confused with space S_2), that, when applied to one hermetry form can transform it into another one. Mathematically, these operators transform the respective coordinate from a non Euclidean to a Euclidean one. For instance, S_2 applied to hermetry form H_{11} will transform electromagnetic radiation into gravito-photons.

4. Physical Principles of Space Flight

Heim's field theory predicts - provided one is in the low energy range since in the energy range of some 10^{16} GeV all interactions are of the same strength - the four known coupling constants (gravitation, weak, electromagnetic, strong), but predicts the existence of two additional, hitherto unknown interactions, namely the hermetry forms H_{10} and H_{11} (see Eqs. (13)). His analysis, like most discussions of gravitational radiation, proceeds by analogy with electromagnetic radiation. Just as changes in an electric or magnetic field trigger electromagnetic waves, changes in a gravitational field trigger gravitational waves.

The theory of the coupling constants is most important for the physical interactions. If one measures the product of two charges in units of $\hbar c$ and uses the proton mass, m_p, as a reference mass, the following relations hold for the four known interactions:

$$G\frac{m_p^2}{\hbar c}=5.9\times10^{-38}$$
$$\lambda_p\frac{c_\beta}{\hbar c}=2\times10^{-8}$$
$$\frac{e^2}{\hbar c}=\frac{1}{137}=7.3\times10^{-3} \tag{14}$$
$$\frac{g^2}{\hbar c}=15$$

where Eq. (14) denotes the relative strength of the gravitational, weak, electromagnetic, and strong interactions, respectively, and c_β is the coupling constant of the beta decay and $\lambda_p=\hbar/m_p c$ is the Compton wavelength of the proton. The relative strength of the forces is approximately 1: 10^{-3}: 10^{-9}: 10^{-40}, the strong force assigned the value 1. According to Feynman coupling constants can be interpreted as a probability for the exchange of virtual particles. Heim's eigenvalue equations allow to compute the spectrum of the ponderable particles. The physical constants that determine the coupling constants are depending on the eigenvalues. The set of eigenvalues itself is determined by geometrical symmetries. These symmetries are related to the coordinates of the Heim space. The sets of eigenvalues can be characterized by their cardinal numbers. The cardinal numbers, therefore, point out a way to the mathematical description of all coupling constants, and hence a set algorithm was constructed that is behind the derivation of the magnitude of the coupling constants[4].

It turns out that for Heim space $\mathbb{R}_8$ not only the values for the 4 known coupling constants are obtained, but *four additional probability amplitudes* occur. In other words, there exists a set of 8 probability amplitudes, w_i, where w_1 to w_4 describe the 4 known interactions, whose carrier particles are gravitons, vector bosons, photons, and gluons. Probability amplitudes w_5, w_6 are interpreted as *transmutation fields* (mathematically represented as *transformation operators* S_1 and S_2). The other two coupling constants, w_7, w_8 are interaction fields, and are interpreted as *gravito-photon* and *probability fields.* They are *gravitational like* fields, characterized by hermetry forms H_{10} and H_{11}, see Eqs.(13).

The physical meaning of the transmutation fields is that photons, characterized in $\mathbb{R}_8$ by the hermetry form H_5, are transformed by the action of the transmutation operator S_2 (not to be confused with space S_2) into gravito-photons (hermetry form H_{11}). In a more formal way, one could write $S_2 H_5 = H_{11}$. The relation between the corresponding probability amplitudes is

$$3w_3 - w_5 = 3w_7 \tag{15}$$

where operator S_2 is associated with w_5, hermetry form H_5 with w_3, and hermetry form H_{11} with probability amplitude w_7. It should be noted that the equations were slightly simplified.

In a second step, the gravito-photon field (hermetry form H_{11}), under the action of transmutation operator S_1, is transformed into the probability field described by hermetry form H_{10}. This can be written as $S_1 H_{11} = H_{10}$ or

$$w_7 - w_1 w_6 = w_8. \tag{16}$$

The value of w_7 is 1.14754864×10^{-21} and w_8 is calculated as $1.603810891\times10^{-28}$. Again, the equations were slightly simplified. Because the value of the probability amplitude w_7 is similar to the value of w_1, (graviton, value 7.6839×10^{-20}), the denotation of the gravito-photon field as a *gravitational like* field seems to be appropriate. It should be remembered that w-values denote probability amplitudes, i.e., their square gives a probability, which is the respective coupling constant for the corresponding interaction.

4.1 Lorentz Matrix and Inertial Transformations

Under the physical conditions specified above, an electromagnetic field can be transformed into a gravitational like field, such that the gravitational field around a space vehicle is reduced, according to Eqs. (15) and (16). With the reduction of the gravitational potential, Φ, in each area of space where this transformation takes place, gravitational mass density ϱ_g and

4 A complete theory was derived by the first author calculating the exact values of the coupling constants, based on the theory of cardinal numbers. A paper on the derivation of the coupling constants is in preparation. The theory comprises some 50 pages and cannot be presented in this paper.

thus gravitational mass m_g must be reduced, too. This follows directly from

$$\Phi(\boldsymbol{x}) = \int \frac{\rho_g(\boldsymbol{x}')}{|\boldsymbol{x}-\boldsymbol{x}'|} d^3x' \qquad (17)$$

where the integration is over the volume in physical space in which the transformation takes place. According to the equivalence of inertial mass (Newton's second law) and gravitational mass (Newton's gravitational law), a reduction in gravitational mass is equivalent to a reduction in inertial mass. Therefore, $m > m'$ where m and m' denote the inertial masses before and after the transformation. Let us now consider the 4-momentum vector in spacetime

$$\begin{aligned}\boldsymbol{P} &= m_0(1-v^2/c^2)^{-1/2}(\boldsymbol{v}, ic) \\ &= (m\boldsymbol{v}, imc) = (\boldsymbol{p}, imc)\end{aligned} \qquad (18)$$

where $\boldsymbol{p} = m\boldsymbol{v}$ is the classical momentum and i is the imaginary unit. Since the magnitude of $\boldsymbol{P}$ is an invariant, both momentum and energy conservation hold. For a space vehicle with initial inertial mass m and reduced mass m', the following relations are therefore valid,

$$m v = m' v' \quad \text{and} \quad m c = m' c' \qquad (19)$$

that is $c' > c$ and $v' > v$, since $m > m'$. Quantities with a prime indicate the transformed system. We denote this kind of transformation as **inertial transformation**. Dividing the first equation by the second one, it immediately follows that

$$v'/c' = v/c. \qquad (20)$$

Therefore, the corresponding Lorentz transformations, namely for the first system, in which c is the speed of light and the spacecraft is moving with velocity v, and the second system, in which the speed of light is c' and the vehicle speed is v', are described by the same Lorentz matrix , that is

$$A = \begin{pmatrix} \frac{1}{\sqrt{(1-\beta^2)}} & 0 & 0 & \frac{i\beta}{\sqrt{(1-\beta^2)}} \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \frac{-i\beta}{\sqrt{(1-\beta^2)}} & 0 & 0 & \frac{1}{\sqrt{(1-\beta^2)}} \end{pmatrix} \qquad (21)$$

where $\beta = v/c$, $x_4 = ict$ or $b = v'/c'$, $x'_4 = ic't$. The movement is in the x (that is x_1) direction only. Since a transformation of inertial mass only changes c to c' (with $c' > c$), the other spatial coordinates remain unchanged, and only coordinates x_1 and x_4 are changing, respectively. There is no contradiction to special relativity, since an inertial transformation is not considered in SRT. The argument in SRT is, that if $v > c$, then β becomes imaginary. Thus, it is concluded that no observer can possess a velocity greater than that of light relative to any other observer. In an inertial transformation, however, β remains positive. Such a transformation is not possible in SRT or GRT, since it is a **consequence of the unification** of physical interactions and the polymetric in $\mathbb{R}_8$.

If it were technically possible to generate a sufficiently strong field for the reduction of inertial mass in the vicinity of a moving space vehicle, the velocity of the space vehicle will increase from v to $v' = \alpha\ v$, where $\alpha := c'/c$ is the velocity gain factor, and $1/\alpha$ gives the factor at which the graviton field of the space vehicle is reduced. In addition, the transformation field for the inertial mass may by itself have a repulsive effect and thus further accelerate the space vehicle. The action of this transformation field is such that the space vehicle disappears from the usual spacetime with c = constant, and enters a spacetime in which c' = constant is valid. If the transformation field disappears, the space vehicle returns to its original spacetime. It is interesting to note that during the transition phase from $\alpha = 1$ to $\alpha > 1$, the acceleration can be arbitrarily large without the occurrence of a force, caused by this acceleration. This simply follows from the conservation of momentum, namely the fact that $m\, v = m'\, v'$ = constant ($m = \alpha\, m'$), which means that the force, responsible for the acceleration, is 0. Owing to the invariance of the Lorentz matrix with respect to an inertial transformation, which is rooted in the fact that $v'/c' = v/c$, ***superluminal* velocities should be possible**. Most interesting, this fact is not in contradiction with GRT, allowing, in principle space flight at superluminal velocities. Although superluminal velocities have been conjectured for some time, the difference now is that there is a physical theory, according to which this phenomenon can be computed.

It goes without saying, that there remain two important questions to be settled. First, an experimental proof of the validity of Heim's theory, and second, this validity assumed, what are the technological challenges to construct a viable propulsion system from this inertial transformation principle. In the subsequent section, an order of magnitude estimate for the energies to be supplied, is presented.

4.2 Estimating the Order of Magnitude of Transformation Effect and Gedanken experiment

In the previous section it was shown that electromagnetic radiation can be converted into a gravitational like field, thus reducing the gravitational mass of a body that is under the influence of this radiation. First, it was observed that the corresponding coupling constant is weak, i.e., the interaction and thus the actual force will be small. Second, the frequency of the radiation needs to be determined at which this transformation takes place.

From the theory of the coupling constants a value of 28.66 keV is computed for the photon energy at which, according to Eq. (15), photons are completely converted into gravitophotons (w_7 field) by the transmutation field, w_5, that is present in vacuum. The photon density has to satisfy an additional constraint. For example, this could be achieved by oscillating electrons in a free electron laser. Interpreting Eq. (16), one sees that the generated w_7 field is transformed by a graviton field (w_1) into a probability field (w_8). In this process the necessary gravitons are converted at the same location at which they were generated, i.e., the graviton field, associated with a spacecraft, is reduced in its strength. This means a decrease of the inertial mass of the spacecraft. As long as the gravito-photon field exists, the space craft is accelerated from velocity v to v', as calculated in Eq. (20). A speculative interpretation would be that the spacecraft disappears from our spacetime, characterized by speed of light c, and enters the spacetime of speed of light c', and returns to the original spacetime if the gravito-photon field disappears. We now give an estimate for the two most interesting questions, concerning the technical usefulness as well as the technical feasibility of a space transportation system based on inertial transformation:

Question 1: If we want a velocity n-times the initial velocity as well as a limiting velocity n-times the vacuum speed of light, what is the required mass reduction of the spacecraft?

Question 2: What is the total photon energy required that delivers this inertial reduction?

The transmutation equations, Eqs. (15), (16), are valid for single photons and gravito-photons. Both, the strength of the electromagnetic field and its energy density are much larger than the respective values of the gravito-photon field, which can be seen directly by the coupling constants. Therefore, energy will be taken from the vacuum, in accordance with Heisenberg's uncertainty principle, that needs to be returned to the vacuum, so that energy conservation is satisfied. To reduce a spacecraft with mass M, gravito-photon (w_7) particles have to be generated. Rewriting Eq. (16) using the value for w_6 from the theory of coupling constants

$$w_7 - 0.014\, w_1 = w_8 \tag{22}$$

shows that some 67 w_7-particles convert 1 w_1-particle. In addition, only 1 out of 4 w_7-particles can be used to converting w_1- particles, hence the factor 67. That is, the photon energy must be increased by a factor of 67 to compensate a w_1 field. Let the spacecraft have a spherical body of radius $R = 1\ m$ and mass $M = 10^4\ kg$. Let us furthermore consider that the spacecraft is not subject to any external gravitational field. Its gravitational self-energy is

$$E=\frac{1}{2}\int \rho(\boldsymbol{x})\Phi(\boldsymbol{x})d^3x= \frac{GM^2}{2R}=\frac{6.67\times10^{-11}\times10^{8}}{2}= 3.365\times10^{-3}J \quad (23)$$

where the factor of œ is introduced to avoid double counting of pairs of mass particles in the distribution, and $\Phi(\boldsymbol{x})$ is the potential produced by the mass distribution. The resulting energy is fairly small. The photon energy needed would therefore be a mere 0.9 J, no losses assumed. This result holds for the conversion using a free electron laser. Using a second solution, requiring a lower photon energy, employing an electrically charged rotating torus, an energy of some 10^5 J would be necessary. According to our present calculations, the situation changes drastically if we were to launch from the surface of a planet. Let us assume that both planet and spacecraft are spherical bodies, and a launch from the surface of the earth is intended. The mass of the earth is 5.98×10^{24} kg and the radius is 6.378×10^6 m. Eq. (23) (without factor œ) results in an energy of some 6.25×10^{11} J and a photon energy of $67\times6.25\times10^{11}$ J. It was assumed that all of the potential energy resides in the field. We would like to emphasize that this extremely large value might not be the last word, since we cannot claim at present that all consequences of the theory are fully understood.

To eventually reach a velocity n-times the initial veleocity, v, we need to reduce the inertial mass such that $m = n\, m'$ where m' is the reduced inertial mass. That means, in order to travel at a limiting speed that is 10-times the speed of light, $c' = 10\, c$, the inertial mass m must be reduced to 10% of its original value.

The theory allows superluminal flight in principle, however, the technical realization of the inertial transformation to achieve this goal is a problem to be solved in the future. Further research will be needed to establish criteria for the effort needed.

5. Speculative Cosmology

Since the higher dimensional space used in Heim's theory comprises a discrete metronic *lattice*, there are no singularities. Hence, the beginning of the universe is clearly defined. The actual starting point for the universe was, when the size of a single *Metron*, τ, which is a function of time, $d\tau/dt < 0$, covered the surface of the universe, assumed to be spherical. During the expansion phase of the universe, the number of *Metrons* increased.

Eq. (16) has an interesting consequence for the *inflationary phase* of the universe. An existing w_7 field transforms a gravitational field w_1 into a w_8 field. A vanishing w_1 field causes, because of the equivalence of inertial and gravitational masses, a reduction of the inertial mass of the universe. Owing to the conservation of momentum and energy, the speed of light c during this phase will have increased to a much higher speed c', according to Eq. (18). The same principle that might be used for superluminal space transportation, could have caused the inflationary phase of the universe.

According to Heim [1, 2] (the derivation of the formula below was not calculated independently by the authors), Newton's law needs to be modified for large distances by a negative term and thus becomes repulsive:

$$a=G\frac{m(r)}{r^2}(1-\frac{r^2}{\rho^2})\ ,\ \rho=\frac{h^2}{G\,m_0^3} \quad (24)$$

m_0 being the mass of a single nucleon comprising the mass of the field source. Mass $m(r)$ is the total mass and comprises the ponderable and the field mass. According to Heim, the value of ρ is some 10 to 20 million light-years. This modified law has severe consequences, since the observed redshift would, at least partially, be a gravitational redshift.

Heim also calculates a lower bound for the range of validity of the gravitational law, which is in the microscopic range, and whose value is approximately given as

$$R_{-}=\frac{3e}{16}\frac{G\,M_0}{c^2} \quad (25)$$

M_0 denoting the (ponderable) mass without the field mass. This threshold is practically equivalent to the *Schwarzschild* radius. The gravitational force is attractive for distances $R\_ < r < \rho$. For $r = \rho$, the gravitational force is 0.

There is a third distance, R_+, depending on the mass in the universe, so that for $\rho < r < R_+$ the gravitational force is repulsive and goes to 0 for $r = R_+$. R_+ is some type of Hubbleradius, but is not the radius of the universe, instead it is the radius of the optically observable universe. All optical signals are subject to a redshift due to the anti-gravitational effect from Eq. (24). For distances larger than R_+, the redshift becomes infinite, and thus signals cannot be received. R_+ would be largest if the universe contained only a single particle of minimal mass which could be a neutral particle of a mass 1% less than the electron mass that might exist. Then one would obtain the largest radius possible, R_{max} or $D = 2\ R_{max}$ as maximal diameter of the physical universe, computed from the following formulas, see also [6]

$$\sqrt{\frac{3}{2}}f\left(\frac{1}{4}\sqrt{\frac{3}{2}}\frac{Df^3}{\sqrt{\tau}}\sqrt{3}-1\right)^2=\frac{D}{\sqrt{\tau}}$$

$$\left(\frac{e\,D\,\sqrt{\tau}}{\pi\,E}-1\right)f^2=\sqrt{\frac{e\,D\,\sqrt{\tau}}{\pi\,E}} \qquad (26)$$

e and E being the basis of the natural logarithm and a unit surface, respectively. The reader may wish to calculate the present diameter of the universe himself. To calculate the diameter D_0 at the beginning of time, the relation $\pi D_0^2 = \tau_0$ has to be inserted into the second equation of Eq. (26). τ_0 denotes the metronic size at the origin of the universe. The resulting equation of 7[th] order for f_0 has 3 real roots. This results in 3 different positive values of D_0 and three different negative values for D_0. Heim interprets this as a trinity of spheres, separated in time by a chronon, the quantum time interval. At the end of its life cycle, the universe collapses into a trinity of spheres, determined by the negative values for the diameter.

Since spacetime is quantized, black holes in form of a singularity should not exist. It should be noted that for dimensions for which the *de Broglie* wave length is small quantum theory should be incorporated and the extension of GRT to microscopic dimensions may be incorrect.

According to Heim the age of the universe is some 10^{127} years. Matter as we know it was generated only some 15 billion years ago, when τ, the *Metron* size, became small enough. The phenomenon of *gamma ray bursts* may be an indication of the creation of matter. At that time the universe was already almost flat, i.e., $\dot{\tau}/\tau \approx 0$ and $\dot{D}/D \approx 0$. In other words, the universe is expanding, but at a slower rate as presently believed and is at present almost flat.

It should be noted, that Heim's theory [1,2] also provides formulas for the mass spectrum of the elementary particles as well as their lifetimes.

Conclusions and Future Work

We are aware of the fact that the present article has several shortcomings. First, we stated several important physical assertions without proper mathematical proof. However, the derivations of the coupling constants and the hermetry forms are a subject of their own, which is beyond the scope of this paper. Second, Heim's legacy contains a large body of unpublished work. The authors were not able to check all of his calculations. In particular, the derivation of the nonlinear potential equation, see Chap. 5, has not been derived independently [5]. Third, Heim, being visually impaired, used his own physical terminology, necessitating a translation into the language of contemporary physics. In addition, several completely novel concepts needed to be introduced that may require additional physical interpretation. Last but not least, since this is work in progress on a challenging topic, both, errors in Heim's theory as well as those introduced by the authors, cannot be excluded. Thus, none of the new physics presented here should be taken for granted.

The so called *Standard Model*, see for instance [19], is an amalgam of experimental observations and theoretical derivations, but needs some 30 adjustable parameters to be determined from experiments. Spacetime is con-

5 Heim left some 4,000 pages, now at the university library in Salzgitter, of unpublished material, providing, in many cases, the detailed calculations not found in his published work. His work also includes treatises on cosmology, elementary particle physics, mathematical logic as well as on bioscience.

tinuous and therefore leads to singularities and infinite self energies. The lifetimes and the spectrum of elementary particles cannot be predicted. It also is, according to these authors, logically inconsistent that 6 quarks and 6 leptons are the basic ingredients of matter, but free quarks are per definition unobservable. No physical explanation is provided for this fact. Furthermore, there is no quantum gravity in the context of the Standard Model. There is also no explanation for the existence of these basic constituents, and it could well be that quarks need to be comprised of even more fundamental particles, which then might lead to the conclusion that it is *turtles all the way down*.

In this respect, Heim's theory seems to be logically more consistent, based on verified physical principles, and the idea of a higher dimensional, discrete space, composed by oriented, minimal surface elements. It leads, however, to a radically different view of matter and space, and predicts a cosmology that substantially differs from the current model of the big bang.

Heim derived the theory without the fitting of any experimental parameters, making decisive predictions about cosmological phenomena, and delivers a formula for the life times and the mass spectrum of elementary particles as well as specifying appropriate selection rules. It also contains a formulation for a quantum gravity, based on the aesthetic and elegant idea that the metric is the generator for all physical interactions, leading to a poly-metric. The theory makes several remarkable predictions, namely the existence of two additional interactions, hitherto unknown, that are the basis for advanced space travel.

Whether Heim's geometrized field theory reflects physical reality is, at present, undecided. If the theory were true, an entirely new concept of the universe would emerge. Moreover, Heim's theory is a definite non-mechanistic concept of nature, in contrast to our present view of the world, initiated in the 15th century by Leonardo da Vinci.

Heim's theory unifies all known interactions in a 8-dimensional space and allows for a special Lorentz transformation, named *inertial transformation*, permitting, at least in principle, for *superluminal travel.*

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Glossary

aeon Denoting an indefinitely long period of time. The aeonic dimension can be interpretedis as steering structures governed by the *entelechial* dimension toward a dynamically stable state.

anti-hermetry Coordinates are called anti-hermetric if they do not deviate from Cartesian coordinates, i.e., in a space with anti-hermetric coordinates no physical events can take place.

condensation For matter to exist, as we are used to conceive it, a distortion from Euclidean metric or condensation, a term used by Heim, is a necessary but not a sufficient condition.

condensor The Christoffel symbols Γ^i_{km} become the so called condensor functions, $\varphi^i{}_{km}$, that are normalizable. This denotation is derived from the fact that these functions represent *condensations* of spacetime metric.

coupling constant Value for creation and destruction of messenger (virtual) particles, relative to the strong force (whose value is set to 1 in relation to the other coupling constants).

entelechy (Greek *entelécheia*, objective, completion) used by Aristotle in his work *The Physics.* Aristotle assumed that each phenomenon in nature contained an intrinsic objective, governing the actualization of a form-giving cause. The entelechial dimension can be interpreted as a measure of the quality of time varying organizational structures (inverse to entropy, e.g., plant growth) while the aeonic dimension is steering these structures toward a dynamically stable state. Any coordinates outside spacetime can be considered as steering coordinates.

fundamental kernel (Fundamentalkern) Since the function $\kappa^{(\alpha)}_{im}$ occurs in $x^{(\alpha)}_m = \int \kappa^{(\alpha)}_{im} d\eta_i$ as the kernel in the integral, it is denoted as fundamental kernel of the *poly-metric*.

geodesic zero-line process This is a process where the square of the length element in a 6- or 8-dimensional Heim space is zero.

gravito-photon field Denotes a gravitational like field generated by a neutral mass with a smaller coupling constant than for gravitons, but allowing for the possibility that photons are transformed into gravito-photons. This field can be used to reduce the gravitational potential around a spacecraft.

graviton (Graviton) The virtual particle responsible for gravitational interaction.

hermetry form (Hermetrieform) The word hermetry is an abbreviation of *hermeneutics*, in our case the semantic interpretation of the metrics. To explain the concept of a hermetry form, the space $\mathbb{R}_6$ is considered. There are 3 coordinate groups in this space, namely $s_3=(\xi_1,\xi_2,\xi_3)$ forming the physical space $\mathbb{R}3$, $s_2=(\xi_4)$ for space T_1, and $s_1=(\xi_5,\xi_6)$ for space S_2. The set of all possible coordinate groups is denoted by $S=\{s_1, s_2, s_3\}$. These 3 groups may be combined, but, as a general rule (stated here without proof, but derived by Heim from conservation laws in $\mathbb{R}_6$, see p. 193 in [2]), coordinates ξ_5 and ξ_6 must always be curvilinear, and must be present in all combinations. An allowable combination of coordinate groups is termed *hermetry form*, and denoted by *H*, sometimes annotated with an index, or sometimes written in the form $H=(\xi_1,\xi_2,...)$ where $\xi_1,\xi_2,...\in S$. This is a symbolic notation only, and should not be confused with the notation of an n-tuple. From the above it is clear that only 4 hermetry forms are possible in $\mathbb{R}_6$. Thus, a 6 space only contains gravitation and electrodynamics. It needs a Heim space $\mathbb{R}_8$ to incorporate all known physical interactions. Hermetry means that only those coordinates denoted in the hermetry form are curvilinear, all other coordinates remain Cartesian. In other words, *H* denotes the subspace in which physical events can take place, since these coordinates are non Euclidean. This concept is at the heart of the geometrization of all physical interactions, and serves as the *correspondence principle* between geometry and physics.

hermeneutics (Hermeneutik) The study of the methodological principles of interpreting the metric tensor and the eigenvalue vector of the subspaces. This semantic interpretation of geometrical structure is called hermeneutics (from the Greek word to interpret).

hermitian matrix (self adjoint, selbstadjungiert) A square matrix having the property that each pair of elements in the *i*-th row and *j*-th column and in the *j*-th row and *i*-th column are conjugate complex numbers ($i \to -i$). Let *A* denote a square matrix and A^* denoting the complex conjugate matrix. $A^\dagger := (A^*)^T = A$ for a hermitian matrix. A hermitian matrix has real eigenvalues. If A is real, the hermitian requirement is replaced by a requirement of symmetry, i.e., the transposed matrix $A^T = A$.

homogeneous The universe is everywhere uniform and *isotropic* or, in other words, is of uniform structure or composition throughout.

inertial transformation (Trägheitstransformation) Such a transformation, fundamentally an interaction between electromagnetism and gravitational like field, reduces the inertial mass of a material object using electromagnetic radiation at specific frequencies. As a result of momentum and energy conservation in 4-dimensional spacetime, $v/c = v'/c'$, and thus the Lorentz matrix remains unchanged. It follows that $c < c'$ and $v < v'$ where v and v' denote the velocities of the test body before and after the inertial transformation, and c and c' denote the speeds of light, respectively. In other words, since c is the vacuum speed of light, an inertial transforemation allows for *superluminal speeds*. An inertial transformation is possible only in a 8-dimensional Heim space, and is in accordance with the laws of SRT. In an Einsteinian universe that is 4-dimensional and contains only gravitation, this transformation does not exist.

isotropic The universe is the same in all directions, for instance, as velocity of light transmission is concerned measuring the same values along axes in all directions.

partial structure (Partialstruktur) For instance, in $\mathbb{R}_6$, the metric tensor that is Hermitian comprises three non-Hermitian metrics from subspaces of $\mathbb{R}_6$. These metrics from subspaces are termed partial structure.

poly-metric The term poly-metric is used with respect to the composite nature of the metric tensor. In addition, there is the twofold mapping $\mathbb{R}_4 \rightarrow \mathbb{R}_8 \rightarrow \mathbb{R}_4$.

transformation operator (Sieboperator) The direct translation of Heim's terminology would be *sieve-selector*. A transformation operator, however, converts a photon into a gravito-photon by making the coordinate ξ_4 Euclidean.

unitary matrix (unitär) Let A denote a square matrix, and A^* denoting the complex conjugate matrix. If $A^\dagger := (A^*)^T = A^{-1}$, then A is a unitary matrix, representing the generalization of the concept of orthogonal matrix. If A is real, the unitary requirement is replaced by a requirement of orthogonality, i.e., $A^{-1} = A^T$. The product of two unitary matrices is unitary.

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