The geometrization of the electromagnetic field

Ilija Barukčić [1, 2]
[1] Internist, Horandstrasse, DE-26441 Jever, Germany
[2] Email: Barukcic@t-online.de

Received October 19, 2016. Accepted; Published

Abstract

Einstein used the term 'unified field theory' in a title of a publication for the first time in 1925. Somewhat paradoxically, an adequate historical, physical and philosophical understanding of the dimension of Einstein's unification program cannot be understood without fully acknowledging one of Einstein's philosophical principles. Despite many disappointments, without finding a solution besides of the many different approaches along the unified field theory program and in ever increasing scientific isolation, Einstein insisted on *the unity of objective reality as the foundation of the unity of science*. Einstein's engagement along his unification program was burdened with a number of difficulties and lastly in vain. Nevertheless, a successful geometrization of the gravitational and the electromagnetic fields within the framework of the general theory of relativity is possible. Thus far, it is a purpose of the present contribution to geometrize the electromagnetic field within the framework of the general theory of relativity.

Keywords

Quantum theory, Relativity theory, Unified field theory, Causality

1. Introduction

It is very easy to get lost in the many [1] and conceptually somewhat very different attempts at the unified field theories. Lastly, the progress [2] at unification has been very slow. Therefore, in this paper in order to "geometrize" the electromagnetic field I will follow neither the scalar gravitational theory of electromagnetism and its introduction of an additional (four spatial and one time dimension) space dimension (Nordström [3], Kaluza [4]), nor Weyl's trial for generalising Riemannian geometry and his concept of "gauging" (Weyl [5]), nor will I use an asymmetric Ricci tensor (Eddington [6]), nor will I try to add an antisymmetric tensor to the metric (Bach [7], Einstein [8]), nor will I use the framework of quantum field theory et cetera as the point of departure to "geometrize" the electromagnetic field. Theoretically, it seems to be possible to approach unification in the framework of quantum field theory. Still, a satisfactory inclusion of gravitation into the scheme of quantum field theory is not in sight. From this point of view, Finsler [9] geometry introduced by Randers [10], as a kind of a

How to cite this paper: Ilija Barukčić. (2016). The geometriziation of the electromagnetic field. *Vixra, 1-40.*

generalization of Riemann geometry, is another and alternative approach to the geometrization of electromagnetism and gravitation. Taken all together, the point of departure for including the electromagnetic field into a geometric setting will be general relativity. In this context, at least one point has to be considered.

Taken Einstein for granted, we must give up general relativity theory. Einstein himself in his hunt for progress at the unification went so far to force us to give up his own general theory of relativity and the successful geometrization of the gravitational field. According to Einstein, a generalization of the theory of the gravitational field is necessary with the consequence that we must go beyond the general theory of relativity. In this context, Einstein's position concerning the unified field theory is very clear and strict.

> "The theory we are looking for must therefore be a generalization of the theory of the gravitational field. The first question is: What is the natural generalization of the symmetrical tensor field? ... What generalization of the field is going to provide the most natural theoretical system? The answer ... is that the symmetrical tensor field must be replaced by a non-symmetrical one. This means that the condition $g_{ik} = g_{ki}$ for the field components must be dropped. " [11]

Figure 1. Einstein and the problem of the unified field theory.

Anyhow, if we follow Einstein's proposal at this point to account for a classical unified field theory of the gravitational and electromagnetic fields with the conceptual unification of the gravitational and electromagnetic field into one single and unique *hyper-field* [12], it appears to be necessary and justified on a foundational level to concentrate at the heart of general relativity, the crucial mathematical concept of the metric tensor field $g_{\mu\nu}$.

The following paper can be characterized as follows. The attempt to develop some new, basic and fundamental insights is grounded on a deductive-hypothetical methodological approach. In the section *material and methods* the basic mathematical objects and tensor calculus rules needed to achieve the "geometrization" of the electromagnetic field will be defined and described.

In this context, physicists should be able to follow the technical aspects of this paper without any problems, while reader without prior knowledge of general relativity or of the mathematics of tensor calculus might gain an insight into the new methods and the scientific background involved. In general, it is necessary to decrease the amount of notation needed. Thus far, I will restrict myself as much as possible to *covariant* second rank tensors. I apologize for the shortcoming.

Especially, to enable the fusion of quantum theory and relativity theory into a new and single conceptual formalism the starting point of all theorems in the section *results* is axiom I or *+1 = +1* (*lex identitatis*). The same axiom I possess the strategic capacity to serve as a common ground for relativity and quantum theory with regard to unified field theory. The section *discussion* examines some the consequences of the theorems proved. This paper does not provide any proof, whether Einstein's general theory of relativity is correct or not, this publication assumes only that Einstein's general theory of relativity is correct.

In this context, from the conceptual point of view of the unified field theory, it is the purpose of this publication to in find a convincing formulation of *a geometrization of the electromagnetic fields* under conditions of the validity of the general theory of relativity.

2. Material and Methods

2.1. Definitions

Einstein's general theory of relativity

Definition: Einstein's field equations

Einstein field equations (EFE), originally [13] published [14] without the extra 'cosmological' term $\Lambda\times g_{\mu\nu}$ may be written in the form

$$G_{\mu\nu} + \Lambda \times g_{\mu\nu} = R_{\mu\nu} - \frac{R}{2} \times g_{\mu\nu} + \Lambda \times g_{\mu\nu} = R_{\mu\nu} - \left(\frac{R}{2} \times g_{\mu\nu} - \Lambda \times g_{\mu\nu} \right) = \frac{4 \times 2 \times \pi \times \gamma}{c \times c \times c \times c} \times T_{\mu\nu} \tag{1}$$

where $G_{\mu\nu}$ is the Einsteinian tensor, $T_{\mu\nu}$ is the stress-energy tensor of matter (still a field devoid of any geometrical significance), $R_{\mu\nu}$ denotes the Ricci tensor (the curvature of space), R denotes the Ricci scalar (the trace of the Ricci tensor), Λ denotes the cosmological "constant" and $g_{\mu\nu}$ denotes the metric tensor (a 4×4 matrix) and where π is Archimedes' constant (π = 3.14159265358979323846264338327950288419716939937510582 09…), γ is Newton's gravitational "constant" and the speed of light in vacuum is c = 299 792 458 [m/s] in S. I. units.

Scholium.

The stress-energy tensor $T_{\mu\nu}$, still a tensor devoid of any geometrical significance, contains all forms of energy and momentum which includes all matter present but of course any electromagnetic radiation too. Originally, Einstein's universe was spatially closed and finite. In 1917, Albert Einstein modified his own field equations and inserted the cosmological constant Λ (denoted by the Greek capital letter lambda) into his theory of general relativity in order to force his field equations to predict a stationary universe.

"Ich komme nämlich zu der Meinung, daß die von mir bisher vertretenen Feldgleichungen der Gravitation noch einer kleinen Modifikation bedürfen …" **[15]**

By the time, it became clear that the universe was expanding instead of being static and Einstein abandoned the cosmological constant Λ. "Historically the term containing the 'cosmological constant' λ was introduced into the field equations in order to enable us to account theoretically for the existence of a finite mean density in a static universe. It now appears that in the dynamical case this end can be reached without the introduction of λ" **[16]** But lately, Einstein's cosmological constant is revived by scientists to explain a mysterious force counteracting gravity called dark energy. In this context it is important to note that neither Newton's gravitational "constant" big G **[17], [18]** nor Einstein's cosmological constant Λ **[19]** is a constant.

Definition: General tensors

Independently of the tensors of the theory of general relativity, we introduce by definition the following covariant second rank tensors of preliminary unknown structure whose properties we leave undetermined as well. We define the following covariant second rank tensors of yet unknown structure as

$$A_{\mu\nu},\ B_{\mu\nu},\ C_{\mu\nu},\ D_{\mu\nu},\ {}_{R}U_{\mu\nu},\ {}_{R}\underline{U}_{\mu\nu},\ {}_{0}W_{\mu\nu},\ {}_{0}\underline{W}_{\mu\nu},\ {}_{R}W_{\mu\nu} \tag{2}$$

while the tensors $A_{\mu\nu}$, $B_{\mu\nu}$, $C_{\mu\nu}$, $D_{\mu\nu}$ may equally denote something like *the four basic fields of nature*. Especially, the Ricci tensor $R_{\mu\nu}$ itself can be decomposed in many different ways. In the following of this publication we define the following relationships. We decompose the Ricci tensor $R_{\mu\nu}$ by definition as

$$R_{\mu\nu} \equiv A_{\mu\nu} + B_{\mu\nu} + C_{\mu\nu} + D_{\mu\nu} \equiv {}_{R}U_{\mu\nu} + {}_{R}\underline{U}_{\mu\nu} \equiv {}_{0}W_{\mu\nu} + {}_{0}\underline{W}_{\mu\nu} \equiv {}_{R}W_{\mu\nu} \tag{3}$$

to assure that both gravitation and electromagnetism is geometrized simultaneously. Since everything is expressed in terms of curvature tensor, the electromagnetic field itself is completely geometrized from the beginning. By the following definition, the electromagnetic stress energy tensor, denoted as $B_{\mu\nu}$, appears as part of Einstein's stress-energy tensor $(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$, while the tensor $A_{\mu\nu}$, also part of curvature, denotes the stress energy tensor of 'ordinary' matter. Thus far, we obtain

$$A_{\mu\nu} + B_{\mu\nu} \equiv {}_{R}U_{\mu\nu} \equiv \frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c}\times T_{\mu\nu} \tag{4}$$

Scholium.

By this definition, we are following *Vranceanu* in his claim that the energy tensor T_{kl} can be treated as the sum of two tensors one of which is due to the electromagnetic field.

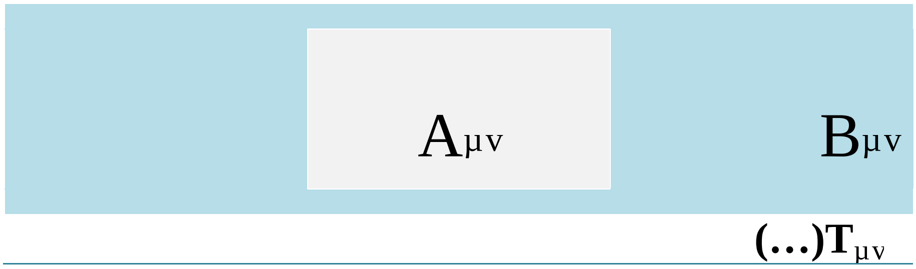
"On peut aussi supposer que le tenseur d'énergie T_{kl} soit la somme de deux tenseurs dont un dû au champ électromagnétique …" [20]

In English:

"One can also assume that the energy tensor T_{kl} be the sum of two tensors one of which is due to the electromagnetic field"

In other words, the stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ is equivalent to the portion of the stress-energy tensor of energy $(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$ which is determined by the stress energy tensor of the electromagnetic field $B_{\mu\nu}$ itself. The stress-energy tensor $T_{\mu\nu}$ has the unit of *energy density* [J/m^3] or *pressure* [N/m^2] which are actually the same unit. In the International System of Units the joule is a derived unit of energy and is defined as 1 [J] = 1 [kg×m²/s²] = [N×m] while 1 [N] = 1 [kg×m/s²] = 1 [J/m] denotes the unit of force. The *table 1* (**Table 1**) may illustrate the relationship above in some more detail.

Table 1. The relationship between ordinary matter $A_{\mu\nu}$ and the electromagnetic field $B_{\mu\nu}$.



Einstein himself was demanding something similar.

"Wir unterscheiden im folgenden zwischen 'Gravitationsfeld' und 'Materie' in dem Sinne, daß alles außer dem Gravitationsfeld als 'Materie' bezeichnet wird, also nicht nur *die 'Materie' im üblichen Sinne,* sondern auch *das elektromagnetische Feld*." [14]

We define an *anti tensor* [2] of Einstein's stress energy tensor $T_{\mu\nu}$, as

$$C_{\mu\nu} + D_{\mu\nu} \equiv {}_{R}U_{\mu\nu} \equiv \frac{R}{2}\times g_{\mu\nu} - \Lambda\times g_{\mu\nu} \tag{5}$$

while Einstein's tensor $G_{\mu\nu}$ is defined by

$$G_{\mu\nu} \equiv A_{\mu\nu} + C_{\mu\nu} \equiv {}_{0}W_{\mu\nu} = R_{\mu\nu} - \frac{R}{2}\times g_{\mu\nu} \tag{6}$$

where $A_{\mu\nu}$ is the known the stress energy tensor of '*ordinary*' matter.

Scholium.
One consequence of the definition before is that the tensor of ordinary matter $A_{\mu\nu}$ becomes *a joint tensor* since the same tensor is a determining part of the Einstein's stress energy tensor $(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$ and equally a determining part of Einsteinian tensor $G_{\mu\nu}$. In probability theory, such a tensor would represent a joint distribution function. The Ricci scalar curvature R $[1/m^2]$ is a contraction of the Ricci tensor $R_{\mu\nu}$ $[1/m^2]$. The Ricci tensor itself is a contraction of the Riemann tensor while a contraction as such doesn't change the units.

Finally, we define an *anti-tensor* $\underline{G}_{\mu\nu}$ of Einsteinian tensor $G_{\mu\nu}$, as

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} \equiv {}_{0}\underline{W}_{\mu\nu} \equiv \frac{R}{2} \times g_{\mu\nu} \tag{7}$$

Scholium.
The following 2x2 table (**Table 2**) may illustrate the basic relationships above

Table 2. The decomposition of the Ricci tensor $\mathbf{R_{\mu\nu}}$ in general.

		Curvature		
		yes	**no**	
Energy / momentum	**yes**	$A_{\mu\nu}$	$B_{\mu\nu}$	${}_{R}U_{\mu\nu}$
	no	$C_{\mu\nu}$	$D_{\mu\nu}$	${}_{R}\underline{U}_{\mu\nu}$
		${}_{0}W_{\mu\nu}$	${}_{0}\underline{W}_{\mu\nu}$	${}_{R}W_{\mu\nu} \equiv R_{\mu\nu}$

The four basic fields under conditions of general theory of relativity.

The tensors $A_{\mu\nu}$, $B_{\mu\nu}$, $C_{\mu\nu}$, $D_{\mu\nu}$ may have different meanings depending upon circumstances. In our attempt to reach a common representation of all four fundamental interactions, the unified field ${}_{R}W_{\mu\nu}$ or the Ricci tensor $R_{\mu\nu}$ is decomposed into several (sub-) fields $A_{\mu\nu}$, $B_{\mu\nu}$, $C_{\mu\nu}$, $D_{\mu\nu}$ in order to achieve unification between general relativity theory and quantum (field) theory from the beginning. The unification of the fundamental interactions is assured by the (sub-) fields $A_{\mu\nu}$, $B_{\mu\nu}$, $C_{\mu\nu}$, $D_{\mu\nu}$ which denote *the four basic fields of nature*. Quantum field theory itself is describing particles as a manifestation of an (abstract) field. In this context a particle a_i can be associated with the field $A_{\mu\nu}$, the particle b_i can be associated with the field $B_{\mu\nu}$, the particle c_i can be associated with the field $C_{\mu\nu}$, the particle d_i can be associated with the field $D_{\mu\nu}$. In the following, we can define something like $A_{\mu\nu} = a_i \times {}_{P}A_{\mu\nu}$ and $B_{\mu\nu} = b_i \times {}_{P}B_{\mu\nu}$ and $C_{\mu\nu} = c_i \times {}_{P}C_{\mu\nu}$ and $D_{\mu\nu} = d_i \times {}_{P}D_{\mu\nu}$ where the subscript $_P$ can denote an individual *particle field*. Maxwell's theory unified the electrical and the magnetic field into an *electromagnetic* field. Meanwhile, the electromagnetic and *weak nuclear forces* have been bound together as an *electroweak* force. The electroweak force and the *strong interaction* have been unified into the standard model of particle physics. Such an approach has not enabled a coherent theoretical framework of physics which fully explains and links together the today known physical aspects of objective reality. In contrast to quantum field theory, in this paper, we will not link the electromagnetic and weak nuclear forces together into the *electroweak* force. On the contrary, we link the *strong interaction* and the *weak nuclear force* into an *ordinary force*. In this sense, all but the electromagnetic force is treated or defined as ordinary force. The ordinary force and the electromagnetic force are or can be linked together into the standard model of particle physics. In our above setting, the ordinary force is determined by the tensor $A_{\mu\nu}$ while the electromagnetic force is determined by the tensor $B_{\mu\nu}$. Quantum field theory itself focuses on the three known non-gravitational forces and has been experimentally confirmed with tremendous accuracy under some appropriate domains of applicability while general relativity itself focuses on gravity. Still, quantum field theory and general relativity, as they are currently formulated, are mutually incompatible. Lastly, only one of these two theories can be correct or both are incorrect.

Definition: The stress energy tensor of the electro-magnetic field $B_{\mu\nu}$

We define the second rank covariant stress-energy tensor of the electromagnetic field $B_{\mu\nu}$, an *anti tensor* [2] of the tensor $A_{\mu\nu}$, as

$$B_{\mu\nu} \tag{8}$$

Under conditions of general relativity, where $A_{\mu\nu}$ denotes the stress energy tensor of ordinary energy/matter, the stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ is an *anti tensor* [2] of ordinary energy/matter $A_{\mu\nu}$. Under conditions of general relativity, the second rank covariant stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ is determined by an anti-symmetric second-order tensor known as the electromagnetic field (Faraday) tensor F. In general, under conditions of general relativity, the second rank covariant stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ in the absence of 'ordinary' matter, which itself is different from the electromagnetic field tensor F, can be derived many different ways. One form of this tensor is

$$B_{\mu\nu} \equiv \left(\left(\frac{1}{4\times\pi} \right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c} \right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu} \right) \right) \right) \tag{9}$$

where F is the electromagnetic field tensor and $g_{\mu\nu}$ is the metric tensor of general relativity.

Scholium.
The probability tensor [2] of the second rank covariant stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ is defined as

$$p\left(B_{\mu\nu}\right) \equiv \frac{\left(\left(\frac{1}{4\times\pi} \right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c} \right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu} \right) \right) \right)}{R_{\mu\mu}} \tag{10}$$

One possible theoretical geometric formulation of the stress-energy tensor of the electromagnetic field [2] follows as

$$\left(\left(\frac{1}{4\times\pi} \right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c} \right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu} \right) \right) \right) \equiv p\left(B_{\mu\nu}\right) \cap R_{\mu\mu} \tag{11}$$

Tensors with relation to the Ricci scalar R

In general, we define the second rank covariant metric tensor ${}_{X}g_{\mu\nu}$ of the tensor $X_{\mu\nu}$ under conditions of a Ricci scalar as

$${}_{X}g_{\mu\nu} \equiv \frac{2\times X_{\mu\nu}}{R} \tag{12}$$

where R denotes the Ricci scalar and $X_{\mu\nu}$ denotes a second rank (even a metric) tensor. Thus far, even a metric tensor can possess a metric. Further, we define $n(X_{\mu\nu})$ as

$$n\left(X_{\mu\nu}\right) \equiv \frac{X_{\mu\nu}}{R} \tag{13}$$

where R denotes the Ricci scalar and $X_{\mu\nu}$ denotes a second rank (even a metric) tensor. Further, we define ${}^{1/n}{}_{k}n(X_{\mu\nu})$ as

$$ {}^{1/n}_{k}\mathrm{n}\left(\mathrm{X}_{\mu\nu}\right) \equiv \frac{\mathrm{X}_{\mu\nu}}{\sqrt[n]{\mathrm{R}^{k}}} \tag{14} $$

where R denotes the Ricci scalar and $X_{\mu\nu}$ denotes a covariant second rank (even a metric) tensor.

Definition: The tensor n($A_{\mu\nu}$)

We define the second rank tensor n($A_{\mu\nu}$) as

$$ \mathrm{n}\left(\mathrm{A}_{\mu\nu}\right) \equiv \frac{\left(\frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c}\times T_{\mu\nu}\right)-\left(\left(\frac{1}{4\times\pi}\right)\times\left(\left(F_{\mu c}\times F_{\nu}{}^{c}\right)-\left(\frac{1}{4}\times g_{\mu\nu}\times F_{d\nu}\times F^{d\nu}\right)\right)\right)}{\mathrm{R}} \tag{15} $$

where R denotes the Ricci scalar.

Definition: The metric tensor ${}_{A}g_{\mu\nu}$

We define the second rank metric tensor ${}_{A}g_{\mu\nu}$ as

$$ {}_{A}g_{\mu\nu} \equiv \frac{2\times\left(\left(\frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c}\times T_{\mu\nu}\right)-\left(\left(\frac{1}{4\times\pi}\right)\times\left(\left(F_{\mu c}\times F_{\nu}{}^{c}\right)-\left(\frac{1}{4}\times g_{\mu\nu}\times F_{d\nu}\times F^{d\nu}\right)\right)\right)\right)}{\mathrm{R}} = 2\times\mathrm{n}\left(\mathrm{A}_{\mu\nu}\right) \tag{16} $$

where R denotes the Ricci scalar.

Definition: The tensor n($B_{\mu\nu}$)

We define the second rank tensor n($B_{\mu\nu}$) as

$$ \mathrm{n}\left(\mathrm{B}_{\mu\nu}\right) \equiv \frac{\left(\left(\frac{1}{4\times\pi}\right)\times\left(\left(F_{\mu c}\times F_{\nu}{}^{c}\right)-\left(\frac{1}{4}\times g_{\mu\nu}\times F_{d\nu}\times F^{d\nu}\right)\right)\right)}{\mathrm{R}} \tag{17} $$

where R denotes the Ricci scalar.

Definition: The metric tensor ${}_{B}g_{\mu\nu}$

We define the second rank metric tensor ${}_{B}g_{\mu\nu}$ as

$$ {}_{B}g_{\mu\nu} \equiv \frac{2\times\left(\left(\frac{1}{4\times\pi}\right)\times\left(\left(F_{\mu c}\times F_{\nu}{}^{c}\right)-\left(\frac{1}{4}\times g_{\mu\nu}\times F_{d\nu}\times F^{d\nu}\right)\right)\right)}{\mathrm{R}} \equiv \frac{2\times\mathrm{B}_{\mu\nu}}{\mathrm{R}} \equiv 2\times\mathrm{n}\left(\mathrm{B}_{\mu\nu}\right) \tag{18} $$

where R denotes the Ricci scalar.

Definition: The Tensor n(((8×π×γ)/c⁴)×T$_{\mu\nu}$)

We define the second rank tensor $n(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$ as

$$n(A_{\mu\nu})+n(B_{\mu\nu}) \equiv n\left(\left((4\times 2\times\pi\times\gamma)/c^4\right)\times T_{\mu\nu}\right) \equiv \frac{A_{\mu\nu}+B_{\mu\nu}}{R} \equiv \frac{\left(\frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c}\times T_{\mu\nu}\right)}{R} \tag{19}$$

where R denotes the Ricci scalar.

Definition: The metric tensor $_{E}g_{\mu\nu}$

We define the second rank metric tensor $_{E}g_{\mu\nu}$ as

$$_{E}g_{\mu\nu} \equiv 2\times n(A_{\mu\nu})+2\times n(B_{\mu\nu}) \equiv \frac{2\times(A_{\mu\nu}+B_{\mu\nu})}{R} \equiv \frac{2\times\left(\frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c}\times T_{\mu\nu}\right)}{R} \tag{20}$$

where R denotes the Ricci scalar.

Definition: The tensor n(C$_{\mu\nu}$)

We define the second rank tensor $n(C_{\mu\nu})$ as

$$n(C_{\mu\nu}) \equiv \frac{C_{\mu\nu}}{R} \equiv \frac{\left(\left(\frac{1}{4\times\pi}\right)\times\left(\left(F_{\mu c}\times F_{\nu}{}^{c}\right)-\left(\frac{1}{4}\times g_{\mu\nu}\times F_{d\nu}\times F^{d\nu}\right)\right)\right)-\left(\Lambda\times g_{\mu\nu}\right)}{R} \tag{21}$$

where R denotes the Ricci scalar.

Definition: The metric tensor $_{C}g_{\mu\nu}$

We define the second rank metric tensor $_{C}g_{\mu\nu}$ as

$$_{C}g_{\mu\nu} \equiv 2\times n(C_{\mu\nu}) \equiv \frac{2\times C_{\mu\nu}}{R} \equiv \frac{2\times\left(\left(\left(\frac{1}{4\times\pi}\right)\times\left(\left(F_{\mu c}\times F_{\nu}{}^{c}\right)-\left(\frac{1}{4}\times g_{\mu\nu}\times F_{d\nu}\times F^{d\nu}\right)\right)\right)-\left(\Lambda\times g_{\mu\nu}\right)\right)}{R} \tag{22}$$

where R denotes the Ricci scalar.

Definition: The tensor $n(D_{\mu\nu})$

We define the second rank tensor $n(D_{\mu\nu})$ as

$$n\left(D_{\mu\nu}\right) \equiv \frac{D_{\mu\nu}}{R} \equiv \frac{\left(\frac{R}{2} \times g_{\mu\nu}\right) - \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right)}{R} \tag{23}$$

where R denotes the Ricci scalar.

Definition: The metric tensor ${}_{D}g_{\mu\nu}$

We define the second rank metric tensor ${}_{D}g_{\mu\nu}$ as

$${}_{D}g_{\mu\nu} \equiv 2\times n\left(D_{\mu\nu}\right) \equiv \frac{2\times D_{\mu\nu}}{R} \equiv \frac{2\times\left(\left(\frac{R}{2} \times g_{\mu\nu}\right) - \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right)\right)}{R} \tag{24}$$

where R denotes the Ricci scalar.

Definition: The tensor $n((R/2)\times g_{\mu\nu} - \Lambda\times g_{\mu\nu})$

We define the second rank tensor $n((R/2)\times g_{\mu\nu} - \Lambda\times g_{\mu\nu})$ as

$$n\left(C_{\mu\nu}\right) + n\left(D_{\mu\nu}\right) \equiv n\left(\left(R/2\right)\times g_{\mu\nu} - \Lambda\times g_{\mu\nu}\right) \equiv \frac{C_{\mu\nu} + D_{\mu\nu}}{R} \equiv \frac{R_{\mu\nu} - \left(\frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c} \times T_{\mu\nu}\right)}{R} \equiv \frac{\left(\frac{R}{2} \times g_{\mu\nu}\right) - \left(\Lambda\times g_{\mu\nu}\right)}{R} \tag{25}$$

where R denotes the Ricci scalar.

Definition: The tensor ${}_{\neg E}g_{\mu\nu}$

We define the second rank metric tensor ${}_{\neg E}g_{\mu\nu}$ as

$${}_{\neg E}g_{\mu\nu} \equiv 2\times n\left(C_{\mu\nu}\right) + 2\times n\left(D_{\mu\nu}\right) \equiv 2\times n\left(\left(R/2\right)\times g_{\mu\nu} - \Lambda\times g_{\mu\nu}\right) \equiv \frac{2\times\left(C_{\mu\nu} + D_{\mu\nu}\right)}{R} \equiv \frac{2\times\left(R_{\mu\nu} - \left(\frac{4\times 2\times\pi\times\gamma}{c\times c\times c\times c} \times T_{\mu\nu}\right)\right)}{R} \equiv \frac{2\times\left(\left(\frac{R}{2} \times g_{\mu\nu}\right) - \left(\Lambda\times g_{\mu\nu}\right)\right)}{R} \tag{26}$$

where R denotes the Ricci scalar.

Definition: The tensor n($G_{\mu\nu}$)

We define the second rank tensor n($G_{\mu\nu}$) as

$$n\left(A_{\mu\nu}\right)+n\left(C_{\mu\nu}\right)\equiv n\left(G_{\mu\nu}\right)\equiv\frac{A_{\mu\nu}+C_{\mu\nu}}{R}\equiv\frac{R_{\mu\nu}-\left(\frac{R}{2}\times g_{\mu\nu}\right)}{R} \tag{27}$$

where R denotes the Ricci scalar and $G_{\mu\nu}$ is the Einsteinian tensor.

Definition: The metric tensor ${}_{G}g_{\mu\nu}$

We define the second rank metric tensor ${}_{G}g_{\mu\nu}$ as

$${}_{G}g_{\mu\nu}\equiv 2\times n\left(A_{\mu\nu}\right)+2\times n\left(C_{\mu\nu}\right)\equiv 2\times n\left(G_{\mu\nu}\right)\equiv\frac{2\times\left(A_{\mu\nu}+C_{\mu\nu}\right)}{R}\equiv\frac{2\times\left(R_{\mu\nu}-\left(\frac{R}{2}\times g_{\mu\nu}\right)\right)}{R} \tag{28}$$

where R denotes the Ricci scalar and $G_{\mu\nu}$ is the Einsteinian tensor.

Definition: The tensor n($\underline{G}_{\mu\nu}$)

We define the second rank tensor n($\underline{G}_{\mu\nu}$) as

$$n\left(B_{\mu\nu}\right)+n\left(D_{\mu\nu}\right)\equiv n\left(\underline{G}_{\mu\nu}\right)\equiv\frac{B_{\mu\nu}+D_{\mu\nu}}{R}\equiv\frac{\left(\frac{R}{2}\times g_{\mu\nu}\right)}{R} \tag{29}$$

where R denotes the Ricci scalar and $\underline{G}_{\mu\nu}$ is the anti Einsteinian tensor.

Definition: The metric tensor ${}_{\neg G}g_{\mu\nu}$

We define the second rank metric tensor ${}_{\neg G}g_{\mu\nu}$ as

$${}_{\neg G}g_{\mu\nu}\equiv 2\times n\left(B_{\mu\nu}\right)+2\times n\left(D_{\mu\nu}\right)\equiv 2\times n\left(\underline{G}_{\mu\nu}\right)\equiv\frac{2\times\left(B_{\mu\nu}+D_{\mu\nu}\right)}{R}\equiv\frac{2\times\left(\frac{R}{2}\times g_{\mu\nu}\right)}{R}\equiv g_{\mu\nu} \tag{30}$$

where R denotes the Ricci scalar and $\underline{G}_{\mu\nu}$ is the anti Einsteinian tensor.

Definition: The of the metric tensor ${}_{gr}g_{\mu\nu}$ of the metric tensor $g_{\mu\nu}$

We define the second rank metric tensor ${}_{gr}g_{\mu\nu}$ as

$${}_{gr}g_{\mu\nu}\equiv\frac{2\times g_{\mu\nu}}{R}=2\times n\left(g_{\mu\nu}\right) \tag{31}$$

where R denotes the Ricci scalar.

Definition: The tensor $n(R_{\mu\nu})$

We define the second rank tensor $n(R_{\mu\nu})$ as

$$n(R_{\mu\nu}) \equiv n(A_{\mu\nu}) + n(B_{\mu\nu}) + n(C_{\mu\nu}) + n(D_{\mu\nu}) \equiv \frac{R_{\mu\nu}}{R} \equiv \frac{1}{R} \times R_{\mu\nu} \tag{32}$$

where R denotes the Ricci scalar and $R_{\mu\nu}$ denotes the Ricci tensor.

Definition: The metric tensor ${}_{Ric}g_{\mu\nu}$

We define the second rank metric tensor ${}_{Ric}g_{\mu\nu}$ as

$${}_{Ric}g_{\mu\nu} \equiv 2 \times n(R_{\mu\nu}) \equiv 2 \times \left(n(A_{\mu\nu}) + n(B_{\mu\nu}) + n(C_{\mu\nu}) + n(D_{\mu\nu})\right) \equiv \frac{2 \times R_{\mu\nu}}{R} \equiv \frac{2}{R} \times R_{\mu\nu} \tag{33}$$

where R denotes the Ricci scalar and $R_{\mu\nu}$ denotes the Ricci tensor.

Scholium.
The following 2x2 table 3 (**Table 3**) may illustrate the basic relationships above

Table 3. The decomposition of the Ricci tensor $\mathbf{R_{\mu\nu}}$.

		Curvature		
		yes	**no**	
Energy / momentum	**yes**	$n(A_{\mu\nu})$	$n(B_{\mu\nu})$	$n(A_{\mu\nu}) + n(B_{\mu\nu})$
	no	$n(C_{\mu\nu})$	$n(D_{\mu\nu})$	$n(C_{\mu\nu}) + n(D_{\mu\nu})$
		$n(A_{\mu\nu}) + n(C_{\mu\nu})$	$n(B_{\mu\nu}) + n(D_{\mu\nu})$	$n(R_{\mu\nu})$

The unified field under conditions of the general theory of relativity.

The 2x2 table 4 (**Table 4**) illustrates the basic relationships between the metric tensors.

Table 4. The decomposition of the Ricci tensor $\mathbf{R_{\mu\nu}}$ in terms of metric tensors.

		Curvature		
		yes	**no**	
Energy / momentum	**yes**	${}_{A}g_{\mu\nu}$	${}_{B}g_{\mu\nu}$	${}_{E}g_{\mu\nu}$
	no	${}_{C}g_{\mu\nu}$	${}_{D}g_{\mu\nu}$	${}_{\neg E}g_{\mu\nu}$
		${}_{G}g_{\mu\nu}$	${}_{\neg G}g_{\mu\nu} \equiv g_{\mu\nu}$	${}_{Ric}g_{\mu\nu}$

The unified field under conditions of the general theory of relativity.

Definition: The tensor $g_{\mu\nu}$

The mathematics of general relativity are more or less complex. As a result, the curvature of space (represented by the Einstein tensor $G_{\mu\nu}$) is caused by the presence of matter and energy (represented by the stress–energy tensor $T_{\mu\nu}$) and vice versa. The curvature of space is the cause or determines how matter/energy has to move. The Riemannian metric tensor for a curved space-time of general relativity theory, a kind of generalization of the gravitational potential of Newtonian gravitation, is denoted as

$$g_{\mu\nu} \tag{34}$$

In the following, let us define the following. Let

$$a^2 \equiv dy^2 \times dy^2 + \ldots + dy^n \times dy^n \tag{35}$$

and

$$b^2 \equiv dy^1 \times dy^1 \equiv c^2 \times t_0^2 \tag{36}$$

The (unitless) metric tensor $g_{\mu\nu}$ is a central object in general relativity and describes more or less the local geometry of space-time while representing the gravitational potential. The metric tensor determines the invariant square of an infinitesimal line element, denoted as *ds* and often referred to as an interval. In general, the generalization of the standard measure of distance *ds* between two points in Euclidian space due to the Pythagorean theorem is defined as

$$ds^2 \equiv \left(dy^1 \times dy^1\right) + \left(dy^2 \times dy^2 + \ldots + dy^n \times dy^n\right) \tag{37}$$

or

$$ds^2 \equiv \sum_{i=1}^{n} \left(dy^i\right)^2 \tag{38}$$

In general, a coordinate system can be changed from the Euclidean Y's to some coordinate system of X's then

$$dy^m \equiv \frac{\partial y^m}{\partial x^\mu} \times \partial x^\mu \tag{39}$$

and

$$dy^n \equiv \frac{\partial y^n}{\partial x^v} \times \partial x^v \tag{40}$$

The Pythagorean theorem is defined as

$$ds^2 \equiv \sum_m \sum_n \partial y^m \times \partial y^n \times \delta_{mn} \equiv \sum_m \sum_n \frac{\partial y^m}{\partial x^\mu} \times \partial x^\mu \times \frac{\partial y^n}{\partial x^v} \times \partial x^v \times \delta_{mn} \equiv \sum_m \sum_n \frac{\partial y^m}{\partial x^\mu} \times \frac{\partial y^n}{\partial x^v} \times \delta_{mn} \times \partial x^\mu \times \partial x^v \tag{41}$$

While using *Einstein's summation convention*, the metric tensor $g_{\mu v}$ is defined as

$$g_{\mu v} \equiv \delta_{mn} \times \frac{\partial y^m}{\partial x^\mu} \times \frac{\partial y^n}{\partial x^v} \tag{42}$$

and *a curved space compatible formulation of the Pythagorean theorem* follows as

$$ds^2 \equiv \delta_{mn} \times \frac{\partial y^m}{\partial x^\mu} \times \frac{\partial y^n}{\partial x^\nu} \times \partial x^\mu \times \partial x^\nu = g_{\mu\nu} \times dx^\mu \times dx^\nu \tag{43}$$

In other words, it is

$$ds^2 \equiv \left(dy^1 \times dy^1\right) + \left(dy^2 \times dy^2 + \ldots + dy^n \times dy^n\right) \equiv g_{\mu\nu} dx^\mu dx^\nu \tag{44}$$

Under conditions, where

$$c^2 \times_0 t^2 \equiv \left(dy^1 \times dy^1\right) \tag{45}$$

it is

$$ds^2 \equiv \left(c^2 \times {}_0 t^2\right) + \left(dy^2 \times dy^2 + \ldots + dy^n \times dy^n\right) \equiv g_{\mu\nu} dx^\mu dx^\nu \tag{46}$$

Dividing the equation before by the speed of the light squared, c^2, it is

$$\frac{ds^2}{c^2} \equiv \frac{\left(c^2 \times_0 t^2\right)}{c^2} + \frac{\left(dy^2 \times dy^2\right)}{c^2} + \ldots + \frac{\left(dy^n \times dy^n\right)}{c^2} \equiv \left(\frac{1}{c^2}\right) \times g_{\mu\nu} dx^\mu dx^\nu \equiv {}_t\, g_{\mu\nu} dx^\mu dx^\nu \tag{47}$$

where ${}_t g_{\mu\nu} = (1/c^2) \times g_{\mu\nu}$. The term ds^2/c^2 yields the time squared or $ds^2/c^2 = d_R t^2$ as do the other terms. The equation before can be rearranged as

$$d_R t^2 \equiv \left({}_0 t^2\right) + \left(dt^2 \times dt^2\right) + \ldots + \left(dt^n \times dt^n\right) \equiv \left(\frac{1}{c^2}\right) \times g_{\mu\nu} dx^\mu dx^\nu \tag{48}$$

Rearranging equation, we obtain

$$d_R t^2 \equiv \left({}_0 t^2\right) + \left(dt^2 \times dt^2\right) + \ldots + \left(dt^n \times dt^n\right) \equiv \left(\frac{1}{c^2}\right) \times g_{\mu\nu} dx^\mu dx^\nu \equiv g_{\mu\nu} d\frac{x^\mu}{c} d\frac{x^\nu}{c} \equiv g_{\mu\nu} dt^\mu dt^\nu \tag{49}$$

or while using *Einstein's summation convention*,

$$d_R t^2 \equiv \delta_{mn} \times \frac{\partial t^m}{\partial t^\mu} \times \frac{\partial t^n}{\partial t^\nu} \times dt^\mu \times dt^\nu = g_{\mu\nu} \times dt^\mu \times dt^\nu \tag{50}$$

or

$$\frac{d_R t^2}{dt^\mu dt^\nu} = \frac{\left(\left({}_0 t^2\right) + \left(d_2 t \times d_2 t\right) + \ldots + \left(d_n t \times d_n t\right)\right)}{dt^\mu dt^\nu} \equiv g_{\mu\nu} \tag{51}$$

Multiplying by ((R/2)-Λ), it is

$$\left(\frac{R}{2} - \Lambda\right) \times \frac{d_R t^2}{dt^\mu dt^\nu} = \left(\frac{R}{2} - \Lambda\right) \times \frac{\left(\left({}_0 t^2\right) + \left(d_2 t \times d_2 t\right) + \ldots + \left(d_n t \times d_n t\right)\right)}{dt^\mu dt^\nu} \equiv \left(\frac{R}{2} - \Lambda\right) \times g_{\mu\nu} \tag{52}$$

Definition: The metric tensor of the electromagnetic field $_{EM}g_{\mu\nu}$

We define the second rank *metric tensor* of the electro-magnetic field $_{EM}g_{\mu\nu}$ of preliminary unknown structure as

$$_{EM}g_{\mu\nu} \equiv \frac{B_{\mu\nu}}{Y} \tag{53}$$

where Y denotes an unknown (i.e. scalar) parameter. Due to this definition, it is $B_{\mu\nu} = Y \times {}_{EM}g_{\mu\nu}$.

Definition: The anti metric tensor of the electromagnetic field $_{0}g_{\mu\nu}$ or $_{GW}g_{\mu\nu}$

We define the second rank *anti metric tensor* of the electro-magnetic field $_{W}g_{\mu\nu}$ of preliminary unknown structure as

$$_{W}g_{\mu\nu} \equiv {}_{EM}\underline{g}_{\mu\nu} \equiv \frac{D_{\mu\nu}}{Y} \tag{54}$$

where Y denotes an unknown (i.e. scalar) parameter. Due to this definition, it is $D_{\mu\nu} = Y \times {}_{W}g_{\mu\nu}$.

Definition: The relationships between the metric tensors

In general, the metric tensor for a curved space-time of general relativity theory is equally determined as

$$g_{\mu\nu} \equiv g_{\mu\nu} + 0 \equiv g_{\mu\nu} - {}_{W}g_{\mu\nu} + {}_{W}g_{\mu\nu} \equiv {}_{EM}g_{\mu\nu} + {}_{EM}\underline{g}_{\mu\nu} \equiv {}_{EM}g_{\mu\nu} + {}_{W}g_{\mu\nu} \tag{55}$$

where $_{EM}g_{\mu\nu} = g_{\mu\nu} - {}_{W}g_{\mu\nu}$ and $_{EM}g_{\mu\nu}$ denotes the second rank metric tensor of the electro-magnetic field while $_{W}g_{\mu\nu}$ is the second rank *anti metric* tensor of the electro-magnetic field. Both tensors are of still unknown structure. From this definition, it follows that

$$\frac{R}{2} \times g_{\mu\nu} \equiv \frac{R}{2} \times \left({}_{EM}g_{\mu\nu} + {}_{W}g_{\mu\nu} \right) \equiv \frac{R}{2} \times {}_{EM}g_{\mu\nu} + \frac{R}{2} \times {}_{W}g_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} \tag{56}$$

Scholium.
The true meaning of the metric tensor $_{W}g_{\mu\nu}$ is not clear at this moment. One is for sure, the same tensor is an *anti-tensor* of the metric tensor of the electromagnetic field $_{EM}g_{\mu\nu}$. There is some theoretical possibility that the tensor $_{W}g_{\mu\nu}$ is related to something like the metric tensor of the *gravitational waves*, therefore the abbreviation $_{W}g_{\mu\nu}$.

Definition: The tensor of energy of the unified field theory $_{R}E_{\mu\nu}$

In order to assure compatibility between general theory of relativity and the unified field theory, we define the following relationship between the stress energy tensor $(((8 \times \pi \times \gamma)/(c^4)) \times T_{\mu\nu})$ of general relativity and the tensor of energy [2] of unified field theory $_{R}E_{\mu\nu}$ as

$$_{R}E_{\mu\nu} \equiv X \times \left(\frac{8 \times \pi \times \gamma}{c^4} \right) \times T_{\mu\nu} \tag{57}$$

while the value of X is undermined at this moment. The value of X can be X = 1.

Definition: The tensor of time of the unified field theory $_{R}t_{\mu\nu}$

In order to assure compatibility between the second rank tensor $((R/2)\times g_{\mu\nu}-\Lambda\times g_{\mu\nu})$ of general theory of relativity and tensor of time [2] $_{R}t_{\mu\nu}$ of the unified field theory, we define the following relationship.

$$ _{R}t_{\mu\nu} \equiv X \times \left(\frac{R}{2} - \Lambda \right) \times g_{\mu\nu} \tag{58} $$

while the value of X is undermined at this moment. The value of X can be X = 1.

Definition: The tensor of space of the unified field theory $_{R}S_{\mu\nu}$

In order to assure compatibility between the second rank Ricci tensor $R_{\mu\nu}$ of general theory of relativity and tensor of space [2] $_{R}S_{\mu\nu}$ of the unified field theory, we define the following relationship.

$$ _{R}S_{\mu\nu} \equiv X \times R_{\mu\nu} \tag{59} $$

while the value of X is undermined at this moment. The definition before does not exclude the case that X=1.

2.2. Axioms.

2.2.1. Axiom I. (Lex identitatis. Principium identitatis. The identity law)

The foundation of all what may follow is the following axiom:

$$ +1 \equiv +1. \tag{60} $$

2.2.2. Axiom II.

$$ \frac{+1}{+0} \equiv +\infty. \tag{61} $$

2.2.3. Axiom III.

$$ \frac{+0}{+0} \equiv +1. \tag{62} $$

3. Results

3.1. Theorem. The unification of gravity and electromagnetism

Claim. (Theorem. Proposition. Statement.)
In general, the gravitational and the electromagnetic field can be joined into *one single hyperfield* which itself is completely determined by the geometrical structure of the space-time. We obtain

$$2 \times C_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) = +B_{\mu\nu} + C_{\mu\nu} \tag{63}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{64}$$

Multiplying this equation by the stress-energy tensor of general relativity $((4\times 2\times\pi\times\gamma)/(c^4))\times T_{\mu\nu}$, it is

$$+1 \times \left(\frac{4\times 2\times\pi\times\gamma}{c^4} \times T_{\mu\nu}\right) = +1 \times \left(\frac{4\times 2\times\pi\times\gamma}{c^4} \times T_{\mu\nu}\right) \tag{65}$$

where γ is Newton's gravitational 'constant' [17], [18] , c is the speed of light in vacuum and π , sometimes referred to as 'Archimedes' constant', is the ratio of a circle's circumference to its diameter. Due to Einstein's general relativity, the equation before is equivalent with

$$R_{\mu\nu} - \left(\frac{R}{2} \times g_{\mu\nu}\right) + \left(\Lambda \times g_{\mu\nu}\right) = \left(\frac{4\times 2\times\pi\times\gamma}{c^4} \times T_{\mu\nu}\right) \tag{66}$$

where $R_{\mu\nu}$ is the Ricci curvature tensor (the trace of Rimanian curvature tensor), R is the scalar curvature, $g_{\mu\nu}$ is the metric tensor, Λ is the cosmological constant and $T_{\mu\nu}$ is the stress–energy tensor. By defining the Einstein tensor as $G_{\mu\nu} = R_{\mu\nu} - (R/2)\times g_{\mu\nu}$, it is possible to write the Einstein field equations in a more compact as

$$G_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) = \left(\frac{4\times 2\times\pi\times\gamma}{c^4} \times T_{\mu\nu}\right) \tag{67}$$

Due to our definition above it is $G_{\mu\nu} = A_{\mu\nu} + C_{\mu\nu}$. Substituting this relationship into the equation before, we obtain

$$A_{\mu\nu} + C_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) = \left(\frac{4\times 2\times\pi\times\gamma}{c^4} \times T_{\mu\nu}\right) \tag{68}$$

Under these conditions, we recall our definition before where $((8\times\pi\times\gamma)/(c^4)) \times T_{\mu\nu} = A_{\mu\nu} + B_{\mu\nu}$. Substituting this relationship into the equation before, we obtain

$$A_{\mu\nu} + C_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) = A_{\mu\nu} + B_{\mu\nu} \tag{69}$$

where $A_{\mu\nu}$ denotes the stress energy tensor of ordinary matter and $B_{\mu\nu}$ denotes the stress energy tensor of the electromagnetic field. Simplifying equation, it is

$$+C_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) = +B_{\mu\nu} \tag{70}$$

where $C_{\mu\nu}$ denotes the gravitational field due to the stress energy tensor of ordinary matter $A_{\mu\nu}$. We add the tensor $C_{\mu\nu}$ on both sides of the equation before. The unification of gravity and electromagnetisms under conditions of general relativity theory follows as

$$+C_{\mu\nu}+C_{\mu\nu}+\left(\Lambda\times g_{\mu\nu}\right)=+B_{\mu\nu}+C_{\mu\nu} \tag{71}$$

or in general as

$$2\times C_{\mu\nu}+\left(\Lambda\times g_{\mu\nu}\right)=+B_{\mu\nu}+C_{\mu\nu} \tag{72}$$

Quod erat demonstrandum.

Scholium.

The theorem of the unification of gravity and electromagnetism does not contain any additional fields and is formulated in four dimensional space-time. Thus far, within the sum of the tensors $B_{\mu\nu}$ + $C_{\mu\nu}$, both electromagnetism and gravity are successfully unified and linked to each other. Up to now, there is neither theoretical nor experimental evidence that there might be unobserved additional fields or extra dimensions necessary for the unification of gravity and electromagnetism. Therefore, for geometry underlying the theorem of the unification of gravity and electromagnetism we choose Riemannian geometry which is known to be suitable for gravitational interaction. Accordingly, until today all attempts known to geometrize electromagnetism or unify electromagnetism with gravitation in the framework of Riemannian geometry were in vain. Still, the theorem of the unification of gravity and electromagnetism demonstrates equally that Riemannian geometry is appropriate for unification of gravitation and electromagnetism. The most important and interesting thing is a prediction of the theorem of the unification of gravity and electromagnetism that the stress energy tensor of the electromagnetic field $B_{\mu\nu}$ is a source for ordinary gravitational field $C_{\mu\nu}$. From physical point of view, this prediction can be confirmed by experiments in strong electromagnetic field very precisely.

Lastly, the electromagnetic field $B_{\mu\nu}$ is a source for the ordinary gravitational field $C_{\mu\nu}$ since both fields are related by the equation $C_{\mu\nu} + \Lambda\times g_{\mu\nu} = B_{\mu\nu}$ and the ordinary gravitational field $C_{\mu\nu}$ is itself is a determining part of Einstein's tensor $G_{\mu\nu}$. Furthermore, the ordinary gravitational field $C_{\mu\nu}$ when the stress energy tensor of the electromagnetic field $B_{\mu\nu}$ is equal to zero ($B_{\mu\nu} = 0$) is still determined by the equation $C_{\mu\nu} + \Lambda\times g_{\mu\nu} = B_{\mu\nu}$. Thus far, under these circumstances it is $C_{\mu\nu} + \Lambda\times g_{\mu\nu} =(B_{\mu\nu} =0)=0$ and the ordinary gravitational field $C_{\mu\nu}$ is given exactly by the equation $C_{\mu\nu} = -\Lambda\times g_{\mu\nu}$.

In conclusion, we note that when the ordinary gravitational field $C_{\mu\nu}$ is equal to zero or $C_{\mu\nu} = 0$ the stress energy tensor of the electromagnetic field $B_{\mu\nu}$ derived from the equation $C_{\mu\nu} + \Lambda\times g_{\mu\nu} = B_{\mu\nu}$ is determined in this context by the equation $(C_{\mu\nu} =0) + \Lambda\times g_{\mu\nu} = B_{\mu\nu}$. In other words, we obtain $\Lambda\times g_{\mu\nu} = B_{\mu\nu}$. Under these conditions, the metric tensor ${}_{EM}g_{\mu\nu}$ of the stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ follows in general from the equation $\Lambda\times g_{\mu\nu} = B_{\mu\nu} = (R/2) \times {}_{EM}g_{\mu\nu}$ as ${}_{EM}g_{\mu\nu} = (2\times\Lambda/R)\times g_{\mu\nu} =(2\times\Lambda)\times n(g_{\mu\nu})$.

3.2. Theorem. The anti Einsteinian tensor $\underline{G}_{\mu\nu}$

Claim. (Theorem. Proposition. Statement.)
The anti Einsteinian tensor $\underline{G}_{\mu\nu}$ is determined as

$$\underline{G}_{\mu\nu} = B_{\mu\nu} + D_{\mu\nu} = +\left(\frac{R}{2}\right) \times g_{\mu\nu} \tag{73}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{74}$$

Multiplying this equation by the Ricci Tensor $R_{\mu\nu}$, it is

$$+1 \times \left(R_{\mu\nu}\right) = +1 \times \left(R_{\mu\nu}\right) \tag{75}$$

Due to our definition above, it is $A_{\mu\nu} + B_{\mu\nu} + C_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu}$. Substituting this relationship into the equation before, we obtain

$$A_{\mu\nu} + B_{\mu\nu} + C_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} \tag{76}$$

The sum of the tensor $\underline{G}_{\mu\nu} = B_{\mu\nu} + D_{\mu\nu}$ can be obtained as

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} - A_{\mu\nu} - C_{\mu\nu} \tag{77}$$

which can be simplified as

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} - \left(A_{\mu\nu} + C_{\mu\nu}\right) \tag{78}$$

Due to our definition, Einsteinian tensor $G_{\mu\nu}$ is defined as $G_{\mu\nu} = A_{\mu\nu} + C_{\mu\nu}$. Rearranging equation above, it is

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} - \left(G_{\mu\nu}\right) \tag{79}$$

Einstein's tensor $G_{\mu\nu}$ is defined as $G_{\mu\nu} = R_{\mu\nu} - ((R/2) \times g_{\mu\nu})$. Substituting this relationship into the equation before, we obtain

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} - \left(R_{\mu\nu} - \left(\left(\frac{R}{2}\right) \times g_{\mu\nu}\right)\right) \tag{80}$$

Rearranging equation, we obtain

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} - R_{\mu\nu} + \left(\frac{R}{2}\right) \times g_{\mu\nu} \tag{81}$$

At the end, we obtain

$$\underline{G}_{\mu\nu} \equiv B_{\mu\nu} + D_{\mu\nu} = +\left(\frac{R}{2}\right) \times g_{\mu\nu} \tag{82}$$

Quod erat demonstrandum.

3.3. Theorem. The determination of the unknown parameter Y

Claim. (Theorem. Proposition. Statement.)
The unknown parameter Y is determined as

$$Y = \left(\frac{R}{2}\right) \tag{83}$$

where R denotes the Ricci scalar.

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{84}$$

Multiplying this equation by the *anti Einsteinian tensor* $\underline{G}_{\mu\nu}$, it is

$$+1 \times \left(\underline{G}_{\mu\nu}\right) = +1 \times \left(\underline{G}_{\mu\nu}\right) \tag{85}$$

The same tensor was determined by the theorem before as $B_{\mu\nu} + D_{\mu\nu} = \underline{G}_{\mu\nu}$. Substituting this relationship into the equation before, we obtain

$$B_{\mu\nu} + D_{\mu\nu} \equiv \underline{G}_{\mu\nu} = \left(\frac{R}{2}\right) \times g_{\mu\nu} \tag{86}$$

Due to our definition above, it is as $B_{\mu\nu} = Y \times {}_{EM}g_{\mu\nu}$ and $D_{\mu\nu} = Y \times {}_{W}g_{\mu\nu}$. Substituting this relationship into the equation before, we obtain

$$B_{\mu\nu} + D_{\mu\nu} \equiv \left(Y \times {}_{EM}g_{\mu\nu}\right) + \left(Y \times {}_{W}g_{\mu\nu}\right) = \left(\frac{R}{2}\right) \times g_{\mu\nu} \tag{87}$$

Due to our definition $g_{\mu\nu} = {}_{EM}g_{\mu\nu} + {}_{W}g_{\mu\nu}$, the equation before can be rearranged as

$$B_{\mu\nu} + D_{\mu\nu} \equiv Y \times \left({}_{EM}g_{\mu\nu} + {}_{W}g_{\mu\nu} \right) \equiv Y \times \left(g_{\mu\nu} \right) = \left(\frac{R}{2} \right) \times g_{\mu\nu} \tag{88}$$

In other words, it is

$$Y \times \left(g_{\mu\nu} \right) = \left(\frac{R}{2} \right) \times g_{\mu\nu} \tag{89}$$

A further manipulation of the equation before yields the result that

$$Y = \left(\frac{R}{2} \right) \tag{90}$$

Quod erat demonstrandum.

Scholium.

Such a result is logical too. Due to our definition it is

$$g_{\mu\nu} \equiv {}_{EM}g_{\mu\nu} + {}_{W}g_{\mu\nu} \tag{91}$$

where ${}_{EM}g_{\mu\nu} = g_{\mu\nu} - {}_{W}g_{\mu\nu}$ and ${}_{EM}g_{\mu\nu}$ denotes the second rank *metric tensor of the electro-magnetic field* while ${}_{W}g_{\mu\nu}$ is the second rank *anti metric tensor of the electro-magnetic field*. Multiplying equation above by the term (R/2), we obtain

$$\left(\frac{R}{2} \right) \times g_{\mu\nu} \equiv \left(\left(\frac{R}{2} \right) \times {}_{EM}g_{\mu\nu} \right) + \left(\left(\frac{R}{2} \right) \times {}_{W}g_{\mu\nu} \right) \tag{92}$$

which is exactly the result as obtained above.

3.4. Theorem. The geometrization of the stress-energy tensor of the electromagnetic field

Claim. (Theorem. Proposition. Statement.)
The geometrization of the stress-energy tensor of the electromagnetic field under conditions of general relativity follows as

$$B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{93}$$

where R denotes the Ricci scalar and ${}_{EM}g_{\mu\nu}$ denotes the *metric tensor* of the electromagnetic field.

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{94}$$

Multiplying this equation by the stress-energy tensor of the electromagnetic field, denoted as $B_{\mu\nu}$, it is

$$+1 \times \left(B_{\mu\nu}\right) = +1 \times \left(B_{\mu\nu}\right) \tag{95}$$

Due to our definition above, the stress-energy tensor of the electromagnetic field was determined by the relationship $B_{\mu\nu} = Y \times {}_{EM}g_{\mu\nu}$. Rearranging the equation before we obtain

$$B_{\mu\nu} = Y \times {}_{EM}g_{\mu\nu} \tag{96}$$

According to the theorem before, the unknown parameter Y is determined as Y = R/2. The geometrization of the electromagnetic field under conditions of general relativity follows as

$$B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{97}$$

Quod erat demonstrandum.

Scholium.
In a more far reaching development, at least since general relativity theory brought the geometry to the scenario of physics, many attempts were made to extend general relativity's geometrization of gravitation to non-gravitational fields. In particular, *the geometrization of the electromagnetic field* became a principal focus and a cornerstone of physical interest and inquiry. The many geometric theories of electromagnetism as published meanwhile are still not consistent with the framework of the quantum theory or self-contradictory, despite the fact that the electromagnetic theory was consolidated in the 19th century. The present theorem before describes the stress-energy tensor of the electro-magnetic field as directly related or determined by the space-time geometry or the metric tensor ${}_{EM}g_{\mu\nu}$. A unified field theory, in the sense of a completely geometrical field theory of all fundamental interactions, is no longer only a theoretical desire.

3.5. Theorem. The determination of the metric tensor of the electromagnetic field $_{EM}g_{\mu\nu}$

Claim. (Theorem. Proposition. Statement.)

The metric tensor of the electromagnetic field $_{EM}g_{\mu\nu}$ under conditions of general relativity is determined as

$$_{EM}g_{\mu\nu} = \left(\frac{2}{R}\right) \times \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) = \left(\frac{2}{R}\right) \times B_{\mu\nu} \equiv 2 \times n\left(B_{\mu\nu}\right) \quad (98)$$

where R denotes the Ricci scalar and $_{EM}g_{\mu\nu}$ denotes the metric tensor of the electromagnetic field.

Direct proof.

In general, using axiom I is it

$$+1 = +1 \quad (99)$$

Multiplying this equation by the stress-energy tensor of the electromagnetic field, abbreviated as $B_{\mu\nu}$, it is

$$+1 \times \left(B_{\mu\nu}\right) = +1 \times \left(B_{\mu\nu}\right) \quad (100)$$

Due to our theorem before, the geometrization of the electromagnetic field under conditions of general relativity is determined as

$$\left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} = B_{\mu\nu} \quad (101)$$

The stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ is determined in detail i. e. by the relationship

$$B_{\mu\nu} \equiv \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) \quad (102)$$

where F is the electromagnetic field tensor and $g_{\mu\nu}$ is the metric tensor. The equation before changes to

$$\left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} = \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) = B_{\mu\nu} \quad (103)$$

The metric tensor of the electromagnetic field $_{EM}g_{\mu\nu}$ under conditions of general relativity is determined as

$$_{EM}g_{\mu\nu} = \left(\frac{2}{R}\right) \times \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) = \left(\frac{2}{R}\right) \times B_{\mu\nu} \equiv 2 \times n\left(B_{\mu\nu}\right) \quad (104)$$

Quod erat demonstrandum.

3.6. Theorem. The tensor $C_{\mu\nu}$

Claim. (Theorem. Proposition. Statement.)
The tensor $C_{\mu\nu}$ is determined as

$$C_{\mu\nu} = B_{\mu\nu} - \left(\Lambda \times g_{\mu\nu}\right) = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - \left(\Lambda \times g_{\mu\nu}\right) \tag{105}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{106}$$

Multiplying this equation by the stress-energy tensor of the electromagnetic field, denoted as $B_{\mu\nu}$, it is

$$+1 \times \left(B_{\mu\nu}\right) = +1 \times \left(B_{\mu\nu}\right) \tag{107}$$

Due to our theorem before, the metric tensor of the electromagnetic field under conditions of general relativity is determined as

$$B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{108}$$

where R denotes the Ricci scalar and ${}_{EM}g_{\mu\nu}$ denotes the metric tensor of the electromagnetic field. Due to the another theorem above, it is

$$+C_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) = +B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{109}$$

The tensor $C_{\mu\nu}$ is determined by the stress energy tensor of the electromagnetic field $B_{\mu\nu}$ as

$$C_{\mu\nu} = B_{\mu\nu} - \left(\Lambda \times g_{\mu\nu}\right) = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - \left(\Lambda \times g_{\mu\nu}\right) \tag{110}$$

Quod erat demonstrandum.

Scholium.
Lastly, the stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ is a source or a determining part for the ordinary gravitational field $C_{\mu\nu}$. From physical point of view, this theorem can be confirmed by experiments in strong electromagnetic fields.

3.7. Theorem. The determination of tensor of the hyperfield of gravitation and electromagnetism

Claim. (Theorem. Proposition. Statement.)
The geometrized form of the hyper-tensor of unification of gravitation and electromagnetism is determined as

$$C_{\mu\nu} + B_{\mu\nu} = R \times {}_{EM}g_{\mu\nu} - (\Lambda \times g_{\mu\nu})$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{111}$$

Multiplying this equation by the stress-energy tensor of the electromagnetic field, denoted as $B_{\mu\nu}$, it is

$$+1 \times (B_{\mu\nu}) = +1 \times (B_{\mu\nu}) \tag{112}$$

Due to our theorem before, the stress energy tensor of the electromagnetic field under conditions of general relativity is determined as

$$B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{113}$$

where R denotes the Ricci scalar and ${}_{EM}g_{\mu\nu}$ denotes the metric tensor of the electromagnetic field. Due to a theorem before, it is

$$+C_{\mu\nu} + (\Lambda \times g_{\mu\nu}) = +B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{114}$$

The tensor $C_{\mu\nu}$ is determined by the stress energy tensor of the electromagnetic field $B_{\mu\nu}$ as

$$C_{\mu\nu} = B_{\mu\nu} - (\Lambda \times g_{\mu\nu}) = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - (\Lambda \times g_{\mu\nu}) \tag{115}$$

Adding the stress-energy tensor of the electromagnetic field $B_{\mu\nu} = (R/2) \times {}_{EM}g_{\mu\nu}$ to the equation before, we obtain the geometrized form of the hyper-tensor of $C_{\mu\nu}$ puls $B_{\mu\nu}$ (i. e. the unity of gravitation and electromagnetism) as

$$C_{\mu\nu} + B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} + \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - (\Lambda \times g_{\mu\nu}) = R \times {}_{EM}g_{\mu\nu} - (\Lambda \times g_{\mu\nu}) \tag{116}$$

Quod erat demonstrandum.

3.8. Theorem. The tensor $D_{\mu\nu}$

Claim. (Theorem. Proposition. Statement.)
The tensor $D_{\mu\nu}$ is determined as

$$D_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{W}g_{\mu\nu} \tag{117}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{118}$$

Multiplying this equation by the stress-energy tensor of the electromagnetic field, denoted as $B_{\mu\nu}$, it is

$$+1 \times \left(B_{\mu\nu}\right) = +1 \times \left(B_{\mu\nu}\right) \tag{119}$$

Due to our theorem before, the stress energy tensor of the electromagnetic field under conditions of general relativity is determined as

$$B_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} \tag{120}$$

where R denotes the Ricci scalar and ${}_{EM}g_{\mu\nu}$ denotes the metric tensor of the electromagnetic field. Adding the tensor $D_{\mu\nu}$, we obtain

$$B_{\mu\nu} + D_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} + D_{\mu\nu} \tag{121}$$

According to a theorem before, this relationship is equivalent with

$$B_{\mu\nu} + D_{\mu\nu} = \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} + D_{\mu\nu} = \left(\frac{R}{2}\right) \times g_{\mu\nu} \tag{122}$$

Rearranging the equation before, the tensor $D_{\mu\nu}$ is determined as

$$D_{\mu\nu} = \left(\frac{R}{2}\right) \times g_{\mu\nu} - B_{\mu\nu} = \left(\frac{R}{2}\right) \times g_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} = \left(\frac{R}{2}\right) \times \left(g_{\mu\nu} - {}_{EM}g_{\mu\nu}\right) = \left(\frac{R}{2}\right) \times {}_{W}g_{\mu\nu} \tag{123}$$

Quod erat demonstrandum.

3.9. Theorem. The geometrization of the stress energy tensor of 'ordinary' matter $A_{\mu\nu}$

Claim. (Theorem. Proposition. Statement.)

The geometrization of the stress-energy tensor of 'ordinary' matter $A_{\mu\nu}$ can be obtained as

$$A_{\mu\nu} = R_{\mu\nu} - R \times {}_{EM}g_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{W}g_{\mu\nu} + (\Lambda \times g_{\mu\nu}) \tag{124}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{125}$$

Multiplying this equation by the Ricci Tensor $R_{\mu\nu}$, it is

$$+1 \times (R_{\mu\nu}) = +1 \times (R_{\mu\nu}) \tag{126}$$

Due to our definition above, it is $A_{\mu\nu} + B_{\mu\nu} + C_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu}$. Substituting this relationship into the equation before, we obtain

$$A_{\mu\nu} + B_{\mu\nu} + C_{\mu\nu} + D_{\mu\nu} = R_{\mu\nu} \tag{127}$$

The tensor of ordinary matter $A_{\mu\nu}$ follows as

$$A_{\mu\nu} = R_{\mu\nu} - B_{\mu\nu} - (C_{\mu\nu} + D_{\mu\nu}) \tag{128}$$

The tensor $B_{\mu\nu}$ itself was determined as $B_{\mu\nu} = (R/2)\times_{EM}g_{\mu\nu}$. The addition of the tensors $D_{\mu\nu}$ plus $C_{\mu\nu}$ is determined as $D_{\mu\nu} + C_{\mu\nu} = (R/2)\times g_{\mu\nu} - \Lambda\times g_{\mu\nu}$ .The equation before changes to

$$A_{\mu\nu} = R_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - \left(\left(\frac{R}{2}\right) \times g_{\mu\nu} - (\Lambda \times g_{\mu\nu})\right) \tag{129}$$

Rearranging equation before, we obtain

$$A_{\mu\nu} = R_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - \left(\frac{R}{2}\right) \times g_{\mu\nu} + (\Lambda \times g_{\mu\nu}) \tag{130}$$

The tensor $(R/2)\times g_{\mu\nu}$ is determined as $(R/2)\times g_{\mu\nu} = (R/2)\times_{EM}g_{\mu\nu} + (R/2)\times_{W}g_{\mu\nu}$. The equation can be simplified as

$$A_{\mu\nu} = R_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{W}g_{\mu\nu} + (\Lambda \times g_{\mu\nu}) \tag{131}$$

The geometrization of 'ordinary' matter follows in general as

$$A_{\mu\nu} = R_{\mu\nu} - R \times {}_{EM}g_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{W}g_{\mu\nu} + \left(\Lambda \times g_{\mu\nu}\right) \tag{132}$$

Quod erat demonstrandum.

3.10. Theorem. The probability tensor of the electromagnetic field $p(B_{\mu\nu})$

Claim. (Theorem. Proposition. Statement.)
The probability tensor $p(B_{\mu\nu})$ of the stress-energy tensor of the electromagnetic field is determined as

$$p\left(B_{\mu\nu}\right) \equiv \left(\frac{1}{2}\right) \times g^{\mu\nu} \times {}_{EM}g_{\mu\nu} = \frac{\left(\left(\frac{1}{4 \times \pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right)}{R_{\mu\nu}} = \frac{B_{\mu\nu}}{R_{\mu\nu}} \tag{133}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{134}$$

Multiplying this equation by the stress-energy tensor of the electromagnetic field, denoted as $B_{\mu\nu}$, it is

$$+1 \times \left(B_{\mu\nu}\right) = +1 \times \left(B_{\mu\nu}\right) \tag{135}$$

Due to our theorem before, the geometrization of the electromagnetic field under conditions of general relativity is determined as

$$\left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} = B_{\mu\nu} \tag{136}$$

The stress-energy tensor of the electromagnetic field $B_{\mu\nu}$ was determined i.e. by the relationship

$$B_{\mu\nu} \equiv \left(\left(\frac{1}{4 \times \pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) \tag{137}$$

where F is the electromagnetic field tensor and $g_{\mu\nu}$ is the metric tensor. The equation before changes to

$$\left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} = \left(\left(\frac{1}{4 \times \pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}{}^{c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) = B_{\mu\nu} \tag{138}$$

The Ricci scalar R is defined as the contraction of the Ricci tensor $R_{\mu\nu}$ or it is $R = g^{\mu\nu}R_{\mu\nu}$. The equation before changes to

$$\left(\frac{1}{2}\right) \times g^{\mu\nu} \times R_{\mu\nu} \times {}_{EM}g_{\mu\nu} = \left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}^{\ c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right) = B_{\mu\nu} \tag{139}$$

A *commutative division* [2] by the Ricci tensor $R_{\mu\nu}$ leads to the relationship

$$\left(\frac{1}{2}\right) \times g^{\mu\nu} \times {}_{EM}g_{\mu\nu} = \frac{\left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}^{\ c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right)}{R_{\mu\nu}} = \frac{B_{\mu\nu}}{R_{\mu\nu}} \tag{140}$$

This equation is identical with the probability tensor $p(B_{\mu\nu})$ of the stress-energy tensor of the electromagnetic field. In general it is

$$p\left(B_{\mu\nu}\right) \equiv \left(\frac{1}{2}\right) \times g^{\mu\nu} \times {}_{EM}g_{\mu\nu} = \frac{\left(\left(\frac{1}{4\times\pi}\right) \times \left(\left(F_{\mu c} \times F_{\nu}^{\ c}\right) - \left(\frac{1}{4} \times g_{\mu\nu} \times F_{d\nu} \times F^{d\nu}\right)\right)\right)}{R_{\mu\nu}} = \frac{B_{\mu\nu}}{R_{\mu\nu}} \tag{141}$$

Quod erat demonstrandum.

3.11. Theorem. The probability tensor is determined by the metric tensor

Claim. (Theorem. Proposition. Statement.)
In general let $n(X_{\mu\nu})=X_{\mu\nu}/R$ where $X_{\mu\nu}$ denotes a second rank co-variant tensor and R denotes the Ricci scalar, the contraction of the Ricci tensor as $R=g^{\mu\nu}R_{\mu\nu}$. Further, $p(X_{\mu\nu})=X_{\mu\nu}/R_{\mu\nu}$ denotes the probability tensor [2] of the tensor $X_{\mu\nu}$. The probability tensor $p(X_{\mu\nu})$ of a tensor $X_{\mu\nu}$ is determined by the metric tensor as

$$p\left(X_{\mu\nu}\right) \equiv g^{\mu\nu} \times n\left(X_{\mu\nu}\right) \tag{142}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{143}$$

Multiplying this equation by the tensor $X_{\mu\nu}$, it is

$$+1 \times \left(X_{\mu\nu}\right) = +1 \times \left(X_{\mu\nu}\right) \tag{144}$$

A commutative [2] division of the tensor $X_{\mu\nu}$ by the Ricci tensor $R_{\mu\nu}$ yields

$$\frac{X_{\mu\nu}}{R_{\mu\nu}} = \frac{X_{\mu\nu}}{R_{\mu\nu}} \tag{145}$$

which is equivalent with

$$p\left(X_{\mu\nu}\right) \equiv \frac{X_{\mu\nu}}{R_{\mu\nu}} = \frac{X_{\mu\nu}}{R_{\mu\nu}} \tag{146}$$

or with

$$p\left(X_{\mu\nu}\right) \equiv \frac{X_{\mu\nu}}{R_{\mu\nu}} \tag{147}$$

Rearranging equation it is

$$p\left(X_{\mu\nu}\right) \times R_{\mu\nu} \equiv X_{\mu\nu} \tag{148}$$

Changing equation, we obtain

$$p\left(X_{\mu\nu}\right) \times g^{\mu\nu} \times R_{\mu\nu} \equiv g^{\mu\nu} \times X_{\mu\nu} \tag{149}$$

Due to the relationship $R=g^{\mu\nu}R_{\mu\nu}$, the equation before simplify as

$$p\left(X_{\mu\nu}\right) \times R \equiv g^{\mu\nu} \times X_{\mu\nu} \tag{150}$$

or as

$$p\left(X_{\mu\nu}\right) \equiv g^{\mu\nu} \times \frac{X_{\mu\nu}}{R} \tag{151}$$

(152)

In general, it is $n(X_{\mu\nu})=X_{\mu\nu}/R$. The probability tensor of a tensor $X_{\mu\nu}$ is determined by the (*inverse or) conjugate* metric tensor as

$$p\left(X_{\mu\nu}\right) \equiv g^{\mu\nu} \times n\left(X_{\mu\nu}\right) \tag{153}$$

Quod erat demonstrandum.

Scholium.
Quantum physics (quantization) focuses on the probability (amplitudes) while general relativity theory relies on geometry (tempo-spatial points). The definition of a probability tensor $p(X_{\mu\nu})$ of a tensor $X_{\mu\nu}$ marks a remarkable degree of interaction between probability theory and the highly dimensional theory of general relativity and is a key step to the unification of quantum physics and general relativity by probabilitizing general relativity's geometric background. In principle, a contradiction free transformation of a geometrical mathematical framework into a probabilistic mathematical framework and vice versa is possible. A geometrization of probability theory appears to be necessary too.

3.12. Theorem. The normalization of the relationship between the tensors of general theory of relativity.

Claim. (Theorem. Proposition. Statement.)
The relationship between the tensors of general theory of relativity can be normalized as

$$\frac{\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)}{R_{\mu\nu}}+\frac{\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)}{R_{\mu\nu}}\equiv 1_{\mu\nu} \tag{154}$$

Direct proof.
In general, using axiom I is it

$$+1=+1 \tag{155}$$

Multiplying this equation by the stress-energy tensor of general relativity $((4\times 2\times \pi\times \gamma)/(c^4))\times T_{\mu\nu}$, it is

$$+1\times\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)=+1\times\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right) \tag{156}$$

where γ is Newton's gravitational 'constant' [17], [18] , c is the speed of light in vacuum and π , sometimes referred to as 'Archimedes' constant', is the ratio of a circle's circumference to its diameter. Due to Einstein's general relativity, Einstein's field equations are determined as

$$\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)=R_{\mu\nu}-\left(\frac{R}{2}\times g_{\mu\nu}\right)+\left(\Lambda\times g_{\mu\nu}\right) \tag{157}$$

where $R_{\mu\nu}$ is the Ricci curvature tensor (the trace of Rimanian curvature tensor), R is the scalar curvature, $g_{\mu\nu}$ is the metric tensor, Λ is the cosmological constant and $T_{\mu\nu}$ is the stress–energy tensor. Rearranging equation we obtain

$$\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)=R_{\mu\nu} \tag{158}$$

A *commutative* [2] division of tensors simplifies the equation as

$$\frac{\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)}{R_{\mu\nu}}+\frac{\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)}{R_{\mu\nu}}=\frac{R_{\mu\nu}}{R_{\mu\nu}}\equiv 1_{\mu\nu} \tag{159}$$

where $1_{\mu\nu}$ denotes the tensor of unified field [2]. In general, a normalization of some tensors of general relativity follows as

$$\frac{\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)}{R_{\mu\nu}}+\frac{\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)}{R_{\mu\nu}}\equiv 1_{\mu\nu} \tag{160}$$

Quod erat demonstrandum.

3.13. Theorem. The normalization of the relationship between the tensors of the unified field theory.

Claim. (Theorem. Proposition. Statement.)
The relationship between the tensors of the unified field theory normalized as

$$\frac{\left(\frac{4\times 2\times \pi\times \gamma}{c^{4}}\times T_{\mu\nu}\right)}{R_{\mu\nu}}+\frac{\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)}{R_{\mu\nu}}\equiv 1_{\mu\nu} \tag{161}$$

Direct proof.
In general, using axiom I is it

$$+1=+1 \tag{162}$$

Multiplying this equation by the energy tensor of general relativity ${}_{R}T_{\mu\nu}$, it is

$$+1\times\left({}_{R}E_{\mu\nu}\right)=+1\times\left({}_{R}E_{\mu\nu}\right) \tag{163}$$

The field equations of the unified field theory [2] are determined as

$${}_{R}E_{\mu\nu}={}_{R}S_{\mu\nu}-{}_{R}t_{\mu\nu} \tag{164}$$

where ${}_{R}S_{\mu\nu}$ is the tensor of space [2] of the unified field theory and ${}_{R}t_{\mu\nu}$ is the tensor of time [2] of the unified field theory. Rearranging equation it is

$${}_{R}E_{\mu\nu}+{}_{R}t_{\mu\nu}={}_{R}S_{\mu\nu} \tag{165}$$

A *commutative* [2] division of tensors simplifies the equation as

$$\frac{{}_{R}E_{\mu\nu}}{{}_{R}S_{\mu\nu}}+\frac{{}_{R}t_{\mu\nu}}{{}_{R}S_{\mu\nu}}=\frac{{}_{R}S_{\mu\nu}}{{}_{R}S_{\mu\nu}}\equiv 1_{\mu\nu} \tag{166}$$

where $1_{\mu\nu}$ denotes the tensor of unified field [2]. In general, a normalization of some tensors of the unified field theory follows as

$$\frac{{}_{R}E_{\mu\nu}}{{}_{R}S_{\mu\nu}}+\frac{{}_{R}t_{\mu\nu}}{{}_{R}S_{\mu\nu}}=1_{\mu\nu} \tag{167}$$

Quod erat demonstrandum.

3.14. Theorem. The determination of X

Claim. (Theorem. Proposition. Statement.)
The unknown parameter X, which can be equal to 1, can be determined as

$$X = \left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right) \tag{168}$$

Direct proof.
In general, using axiom I is it

$$+1 = +1 \tag{169}$$

Multiplying this equation by the tensor of the unified field $1_{\mu\nu}$, of the unified field, it is

$$+1 \times \left(1_{\mu\nu}\right) = +1 \times \left(1_{\mu\nu}\right) \tag{170}$$

or

$$1_{\mu\nu} = 1_{\mu\nu} \tag{171}$$

Due to the theorem about the normalization of some tensors of the unified field theory, this equation rearranges to

$$1_{\mu\nu} = \frac{{}_{R}E_{\mu\nu}}{{}_{R}S_{\mu\nu}} + \frac{{}_{R}t_{\mu\nu}}{{}_{R}S_{\mu\nu}} \tag{172}$$

According to the theorem about the normalization of some tensors of the general theory relativity, the equation before rearranges to

$$\frac{\left(\frac{4 \times 2 \times \pi \times \gamma}{c^4} \times T_{\mu\nu}\right)}{R_{\mu\nu}} + \frac{\left(\frac{R}{2} \times g_{\mu\nu}\right) - \left(\Lambda \times g_{\mu\nu}\right)}{R_{\mu\nu}} = \frac{{}_{R}E_{\mu\nu}}{{}_{R}S_{\mu\nu}} + \frac{{}_{R}t_{\mu\nu}}{{}_{R}S_{\mu\nu}} \tag{173}$$

A *commutative multiplication and division* [2] of tensors changes the equation before to

$$\left(\frac{4 \times 2 \times \pi \times \gamma}{c^4} \times T_{\mu\nu}\right) + \left(\frac{R}{2} \times g_{\mu\nu}\right) - \left(\Lambda \times g_{\mu\nu}\right) = \frac{R_{\mu\nu} \cap {}_{R}E_{\mu\nu}}{{}_{R}S_{\mu\nu}} + \frac{R_{\mu\nu} \cap {}_{R}t_{\mu\nu}}{{}_{R}S_{\mu\nu}} = R_{\mu\nu} \tag{174}$$

Due to our definition, it is ${}_{R}E_{\mu\nu} = X \times (((8 \times \pi \times \gamma)/(c^4)) \times T_{\mu\nu})$ and equally ${}_{R}t_{\mu\nu} = X \times ((((R/2) \times g_{\mu\nu})) - (\Lambda \times g_{\mu\nu}))$. Substituting these relationships into the equation before we obtain

$$\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)=\frac{R_{\mu\nu}\cap X\cap\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)}{{}_{R}S_{\mu\nu}}+\frac{R_{\mu\nu}\cap X\cap\left(\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)\right)}{{}_{R}S_{\mu\nu}}=R_{\mu\nu} \tag{175}$$

Due to *commutative operations* [2], this equation can be simplified as

$$\left(\frac{R_{\mu\nu}\cap X}{{}_{R}S_{\mu\nu}}\right)\cap\left(\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)\right)\right)=R_{\mu\nu} \tag{176}$$

which itself can be simplified as

$$\left(\frac{R_{\mu\nu}\cap X}{{}_{R}S_{\mu\nu}}\right)\cap\left(R_{\mu\nu}\right)=R_{\mu\nu} \tag{177}$$

or as

$$\left(\frac{R_{\mu\nu}\cap X}{{}_{R}S_{\mu\nu}}\right)\cap\frac{R_{\mu\nu}}{R_{\mu\nu}}=\frac{R_{\mu\nu}}{R_{\mu\nu}}=1_{\mu\nu} \tag{178}$$

or as

$$\left(\frac{R_{\mu\nu}\cap X}{{}_{R}S_{\mu\nu}}\right)=1_{\mu\nu} \tag{179}$$

The determination of the value of X follows as

$$X=1_{\mu\nu}\cap\left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right)=\left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right) \tag{180}$$

Quod erat demonstrandum.

Scholium.

The straightforward question is, must we accept that $({}_{R}S_{\mu\nu}/R_{\mu\nu}) = 1_{\mu\nu}$ or $({}_{R}S_{\mu\nu}/R_{\mu\nu}) = c^2$ or $({}_{R}S_{\mu\nu}/R_{\mu\nu}) = 1/c^2$? The probability tensor of the stress-energy tensor of the theory of general relativity is defined as $p((((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})) = ((((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu}))/R_{\mu\nu}$. The energy tensor of the unified field theory is defined as ${}_{R}E_{\mu\nu}=X\times(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$. The value of X is determined as $({}_{R}S_{\mu\nu}/R_{\mu\nu})$. The equation before changes to as ${}_{R}E_{\mu\nu} = ({}_{R}S_{\mu\nu}/R_{\mu\nu})\times(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$. In general, the probability tensor is of use to express the energy tensor as ${}_{R}E_{\mu\nu} = ({}_{R}S_{\mu\nu})\times((((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu}) /R_{\mu\nu})$. The probability tensor simplifies this equation simplifies in other word to ${}_{R}E_{\mu\nu}={}_{R}S_{\mu\nu}\times p((((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu}))$.

The probability tensor of the tensor $((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu}))$ is defined in general something as $p(((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu}))) = (((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu})))/R_{\mu\nu}$. The value of X is determined equally as $({}_{R}S_{\mu\nu}/R_{\mu\nu})$. The tensor of time ${}_{R}t_{\mu\nu} = X\times((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu}))$ follows as ${}_{R}t_{\mu\nu}=({}_{R}S_{\mu\nu}/R_{\mu\nu})\times((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu}))$ or as ${}_{R}t_{\mu\nu}=({}_{R}S_{\mu\nu})\times(((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu})) /R_{\mu\nu})$ or as ${}_{R}t_{\mu\nu} = {}_{R}S_{\mu\nu}\times p(((((R/2)\times g_{\mu\nu}))-(\Lambda\times g_{\mu\nu})))$. In last consequence, the relationship between the field equations of unified field theory and Einstein's theory of general relativity is determined by the equation

$${}_{R}E_{\mu\nu}+{}_{R}t_{\mu\nu}=\left(\left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right)\cap\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right)\cap\left(\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)\right)\right)={}_{R}S_{\mu\nu} \tag{181}$$

or by the equation

$$\left({}_{R}S_{\mu\nu} \cap p\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)\right) + {}_{R}S_{\mu\nu} \cap p\left(\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)\right) = \left(\left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right)\cap\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\frac{{}_{R}S_{\mu\nu}}{R_{\mu\nu}}\right)\cap\left(\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)\right)\right) = {}_{R}S_{\mu\nu} \tag{182}$$

Einstein's field equation yield the result

$$\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right) = R_{\mu\nu} \tag{183}$$

What is the physical meaning of Einstein's field equation, if we multiply the same by the term ($1/c^2$). In this case we obtain

$$\left(\frac{1}{c^2}\right)\times\left(\frac{4\times 2\times \pi\times \gamma}{c^4}\times T_{\mu\nu}\right)+\left(\frac{1}{c^2}\right)\times\left(\left(\frac{R}{2}\times g_{\mu\nu}\right)-\left(\Lambda\times g_{\mu\nu}\right)\right) = \left(\frac{1}{c^2}\right)\times R_{\mu\nu} \tag{184}$$

In the International System of Units the *joule*, the unit of energy, is defined as 1 [J] = 1 [kg×m²/s²] = 1 [N×m] while 1 [N] = 1 [kg×m/s²] = 1 [J/m] denotes the unit of force. The stress-energy tensor $T_{\mu\nu}$ without the mathematical term $((8\times\pi\times\gamma)/(c^4))$ has the unit of *energy density* [J/m³], it is 1 [J/m³] = 1 [(kg×m²)/(s²×m³)]. Let us multiply the stress-energy tensor $T_{\mu\nu}$ by ($1/c^2$), we obtain 1 [J/m³] ×($1/c^2$) = 1 [(kg×m²)/(s²×m³)] × [1/[m²/s²]] which is equivalent with 1 [J/m³] ×($1/c^2$) = 1 [(*s*²×kg×m²)/(s²×m³×*m*²)]. Consequently, the term s² and m² cancels out and we obtain the unit 1 [J/m³] ×($1/c^2$) = 1 [(kg)/(m³)]. In other word, the stress-energy tensor $T_{\mu\nu}$ changes to the stress tensor of matter. Thus far, under these conditions there is some evidence that it makes sense to assume that $R_{\mu\nu} = {}_{R}S_{\mu\nu} = c^2 \times {}_{R}U_{\mu\nu}$ [2]. This assumed as correct, the tensor ${}_{R}g_{\mu\nu}$ [2] is determined as ${}_{R}g_{\mu\nu}=((((R/2) \times(1/c^2) \times g_{\mu\nu}))-(\Lambda \times(1/c^2) \times g_{\mu\nu}))$ where the term $(1/c^2) \times g_{\mu\nu}$ can denote something like the metric tensor of time ${}_{t}g_{\mu\nu}= (1/c^2) \times g_{\mu\nu}$.

3.15. Theorem. The geometrization of the stress-energy-tensor $T_{\mu\nu}$

In general theory of relativity the gravitational field is completely geometrized. Still, Einstein failed to geometrize the stress-energy-momentum tensor $T_{\mu\nu}$ too. Einstein was convinced that the main problem in the unified field theory was the geometrization of the stress-energy-momentum tensor of matter on the right-hand side of his field equations known to be determined as $R_{\mu\nu} - (R/2)\times g_{\mu\nu} + \Lambda\times g_{\mu\nu} = (((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$. The geometrization of the stress-energy-momentum tensor of the matter $T_{\mu\nu}$ should result in the geometrization of the quantum i. e. matter fields.

Claim. (Theorem. Proposition. Statement.)
The total geometrization of all fields or Einstein's field equations with geometrized energy-momentum tensor of the matter ($T_{\mu\nu}$) are determined as

$$\frac{R}{2}\times{}_{Ric}\,g_{\mu\nu}-\frac{R}{2}\times g_{\mu\nu}+\frac{R}{2}\times\Lambda\times{}_{gr}g_{\mu\nu}=\frac{R}{2}\times{}_{E}\,g_{\mu\nu} \tag{185}$$

Direct proof.
In general, using axiom I is it

$$+1=+1 \tag{186}$$

Multiplying this equation by the tensor of the stress-energy tensor $(((8\times\pi\times\gamma)/(c^4))\times T_{\mu\nu})$, we do obtain

$$\left(\frac{4\times 2\times\pi\times\gamma}{c^4}\times T_{\mu\nu}\right)=\left(\frac{4\times 2\times\pi\times\gamma}{c^4}\times T_{\mu\nu}\right) \tag{187}$$

Due to Einstein’s general theory relativity, this equation can be rearranged as

$$R_{\mu\nu}-\left(\frac{R}{2}\times g_{\mu\nu}\right)+\left(\Lambda\times g_{\mu\nu}\right)=\left(\frac{4\times 2\times\pi\times\gamma}{c^4}\times T_{\mu\nu}\right) \tag{188}$$

Multiplying Einstein’s field equation by the term (2/R), we obtain

$$\left(\frac{2}{R}\right)\times R_{\mu\nu}-\left(\frac{2}{R}\right)\times\left(\frac{R}{2}\times g_{\mu\nu}\right)+\left(\frac{2}{R}\right)\times\left(\Lambda\times g_{\mu\nu}\right)=\left(\frac{2}{R}\right)\times\left(\frac{4\times 2\times\pi\times\gamma}{c^4}\times T_{\mu\nu}\right) \tag{189}$$

Due to our definition, this equation is equivalent with

$${}_{Ric}\,g_{\mu\nu}-g_{\mu\nu}+\Lambda\times{}_{gr}g_{\mu\nu}={}_{E}\,g_{\mu\nu} \tag{190}$$

Multiplying the equation before by the term (R/2), Einstein’s field equation completely geometrized follows as

$$\frac{R}{2}\times{}_{Ric}\,g_{\mu\nu}-\frac{R}{2}\times g_{\mu\nu}+\frac{R}{2}\times\Lambda\times{}_{gr}g_{\mu\nu}=\frac{R}{2}\times{}_{E}\,g_{\mu\nu} \tag{191}$$

Quod erat demonstrandum.

Scholium.
In view of Einstein's geometrization of gravity, the stress-energy tensor $T_{\mu\nu}$ is the source-term of Einstein's field equations. From the geometrical point of view, the stress-energy tensor $T_{\mu\nu}$ is still a field without any geometrical significance. In particular, the main goal of the very transparent and also highly general theorem above is to describe matter as an inherent geometrical structure and to incorporate both, the principles of general relativity and quantum theory, in one mathematical formula. Such a theorem is expected to be able to provide a satisfactory (geometrical) description of the microstructure of spacetime. We rearrange the equation before as

$$\frac{R}{2} \times {}_{G}g_{\mu\nu} + \frac{R}{2} \times \Lambda \times {}_{gr}g_{\mu\nu} = \frac{R}{2}\left({}_{Ric}g_{\mu\nu} - g_{\mu\nu}\right) + \left(\frac{R}{2} \times \Lambda \times {}_{gr}g_{\mu\nu}\right) = \frac{R}{2} \times \left({}_{G}g_{\mu\nu} + \Lambda \times {}_{gr}g_{\mu\nu}\right) = \frac{R}{2} \times {}_{E}g_{\mu\nu} \tag{192}$$

or as

$$\frac{R}{2} \times \left({}_{G}g_{\mu\nu} + \Lambda \times {}_{gr}g_{\mu\nu}\right) = \frac{R}{2} \times {}_{E}g_{\mu\nu} \tag{193}$$

Einstein's vacuum field equations can be obtained when the known the stress-energy-momentum tensor is to be determined as $(R/2) \times {}_{E}g_{\mu\nu} = 0$. Under these conditions ($T_{\mu\nu}=0$), the Einstein vacuum equations are determined by the fact that

$$\frac{R}{2} \times {}_{G}g_{\mu\nu} = -\frac{R}{2} \times \Lambda \times {}_{gr}g_{\mu\nu} \tag{194}$$

One focus of this paper is the attempt to build a bridge between quantum theory and classical geometry. The equation before can be changed as

$$i \times \hbar \times \left(\frac{R}{i \times \hbar \times 2} \times \left({}_{G}g_{\mu\nu} + \Lambda \times {}_{gr}g_{\mu\nu}\right)\right) = \left(\frac{R}{2} \times {}_{E}g_{\mu\nu}\right) \tag{195}$$

In this context we multiply the equation before by the wave-function Ψ. We obtain the Schrödinger's equation as

$$i \times \hbar \times \left(\left(\frac{R}{2 \times i \times \hbar} \times {}_{G}g_{\mu\nu}\right) + \left(\frac{R}{2 \times i \times \hbar} \times \Lambda \times {}_{gr}g_{\mu\nu}\right)\right) \times \Psi = \left(\frac{R}{2} \times {}_{E}g_{\mu\nu}\right) \times \Psi \tag{196}$$

or a kind of *a 'normalized' Schrödinger's* equation where $R = (2 \times i \times \hbar) \sim h/\pi$ as

$$i \times \hbar \times \left({}_{G}g_{\mu\nu} + \Lambda \times {}_{gr}g_{\mu\nu}\right) \times \Psi = {}_{E}g_{\mu\nu} \times \Psi \tag{197}$$

an equation where quantum meets geometry and vice versa, where the metric (i. e. *geometry*) is a determining part of this equation, but the wave-function (i.e. *quantum*) too. In last consequence, the gravitational field itself can be quantized. A profound methodological challenge for the physicist was the geometrization of the stress-energy tensor $T_{\mu\nu}$. This problem is solved. The mathematical term $(R/2) \times {}_{E}g_{\mu\nu}$ denotes the geometrical description of the stress-energy tensor $T_{\mu\nu}$ of general relativity, it is $(((8 \times \pi \times \gamma)/(c^4)) \times T_{\mu\nu}) = (R/2) \times {}_{E}g_{\mu\nu}$.

4. Discussion

A new approach to quantum gravity and the unified field theory developed by the author is already published [2]. Besides of the misprint in this paper [2] in Eq. (76)

$$ {}_{0}\omega_{\mu\nu} \equiv 2_{\mu\nu} \cap_{R} \pi_{\mu\nu} \cap {}_{R}f_{\mu\nu} \equiv \frac{1_{\mu\nu}}{{}_{R}\hbar_{\mu\nu}} \cap \left(G_{\mu\nu} - \Lambda \times g_{\mu\nu}\right) \tag{76} $$

which should be changed to

$$ {}_{0}\omega_{\mu\nu} \equiv 2_{\mu\nu} \cap_{R} \pi_{\mu\nu} \cap {}_{R}f_{\mu\nu} \equiv \frac{1_{\mu\nu}}{{}_{R}\hbar_{\mu\nu}} \cap \left(G_{\mu\nu} + \Lambda \times g_{\mu\nu}\right) \tag{76} $$

one way how to geometrize the electromagnetic field is already provided. In this paper the geometrization of the electromagnetic field under conditions of general relativity theory is developed in more (technical) detail. This paper has answered the question about the geometrization of the electromagnetic field under conditions of general theory of relativity.

Thus far, this publication has not answered the question whether does *geometrization* excludes *quantization* and vice versa. In other words, is there a dualism between geometrization and quantization in the sense *either* geometrization *or* quantization. This *geometry-quantum dilemma* leads straight forward to the question *which came first, the geometry or the quantum*? In general, are the rules of quantization more fundamental than the rules of (classical) geometry or vice versa? The question about *the very first geometry* or *the very first quantum* also evokes the question of how the development of this universe in general began. Thus far, *quantizing geometry* is not only a major undertaking but a theoretical necessity and vice versa. *Geometrizing the quantum* should be provided by a self-consistent deterministic formulation of a unified field theory of nature. In this context, the geometric entity ’*line*’ (in the framework of string-theory: the string) is determined by points. But what is a *point*, how does geometry defines a point? A point appears to be something quantized. In other words, within geometry (a line, a string), the quantum (a point) can be found and surely vice versa. Within the quantum (a point) the geometry (a line) can be found. The one cannot without its own other and vice versa. Today, a unified description of all physical phenomena is endangered especially by the incompatibility between the deterministic geometrical formulation of general relativity and the claimed indeterministic nature of quantum mechanics. Thus far, the problems of *quantizing geometry* or *geometrizing the quantum* are not solved. *The answer to such and similar questions may be considered for future work.* In this paper, the tensor $D_{\mu\nu}$ was derived in Eq. (78) as

$$ D_{\mu\nu} = \left(\frac{R}{2}\right) \times g_{\mu\nu} - B_{\mu\nu} = \left(\frac{R}{2}\right) \times g_{\mu\nu} - \left(\frac{R}{2}\right) \times {}_{EM}g_{\mu\nu} = \left(\frac{R}{2}\right) \times \left(g_{\mu\nu} - {}_{EM}g_{\mu\nu}\right) = \left(\frac{R}{2}\right) \times {}_{W}g_{\mu\nu} \tag{78} $$

In particular, the physical content of the tensor $D_{\mu\nu}$ is not clear at this moment. Still, a further lack of clarity may not stem from this fact. In order to express the physical content of the tensor $D_{\mu\nu}$ it is necessary to distinguish clearly between the tensor $D_{\mu\nu}$ and the tensor $B_{\mu\nu}$. To within acceptable margin of error, the information carried by the tensor $D_{\mu\nu}$ is very different from the information as carried by the stress-energy tensor of the electro-magnetic field $B_{\mu\nu}$. In this context, the tensor $D_{\mu\nu}$ is *an anti-tensor* of the stress-energy tensor of the electro-magnetic field $B_{\mu\nu}$. But, as noted above, there are some aspects connected with the tensor $D_{\mu\nu}$. In fact, the tensor $D_{\mu\nu}$ is a sub-tensor of the metric tensor $g_{\mu\nu}$ of Einstein's gravitational theory of curved spacetime. Thus far, *the metric tensor* ${}_{W}g_{\mu\nu}$ has to do something with the gravitational field. Moreover, it is possible and highly desirable that the metric tensor ${}_{W}g_{\mu\nu}$ is determined by fuctuations of gravitational fields and that the same tensor represents something like ”ripples” in spacetime. The interaction between electromagnetic and gravitational waves and the transformation of one wave into another became already a principal focus of theoretical interest and inquiry and has been discussed [21] in literature. Under these assumptions, the tensor $D_{\mu\nu}$ could be determined by the metric tensor of the gravitational waves. More precisely stated, it may be rather difficult to understand the significance that has to be accorded the tensor $D_{\mu\nu}$ but the assumption that the tensor $D_{\mu\nu}$ represents a fourth and until today unknown ‘force’ does not make any sense so far. Despite Einstein's intent to realize something like a unified field theory, there is considerable disagreement about the extent to which, if at all, such a theory is possible. And yet, from the epistemological standpoint, despite the long history of trials about a completely geometrical field theory of all fundamental interactions under conditions of Einstein's gravitational theory of curved spacetime, it is possible to go beyond general relativities ‘*definite*’ advance in physical knowledge. Furthermore, besides of the influence of Einstein's reduction of physics to geometry, *geometry is nothing absolute but something relative*. In fact, striving towards an extension of Einstein's gravitational theory, we may append an unknown tensor $X_{\mu\nu}$ to Einstein’s filed equations for this purpose. To be sure, the Einstein field equations (EFE) with the extra term $X_{\mu\nu}$ may be written in the form

$$R_{\mu\nu} = \left(\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times c}\times T_{\mu\nu}\right) + \left(\frac{R}{2}\times g_{\mu\nu} - \Lambda\times g_{\mu\nu}\right) + \left(X_{\mu\nu} - X_{\mu\nu}\right) = G_{\mu\nu} + \Lambda\times g_{\mu\nu} + \frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times c}\times T_{\mu\nu} \tag{198}$$

and it follows that

$$R_{\mu\nu} + X_{\mu\nu} = \left(\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times c}\times T_{\mu\nu}\right) + \left(\frac{R}{2}\times g_{\mu\nu} - \Lambda\times g_{\mu\nu}\right) + X_{\mu\nu} = G_{\mu\nu} + \Lambda\times g_{\mu\nu} + X_{\mu\nu} + \frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times c}\times T_{\mu\nu} \tag{199}$$

More precisely, one possible extension of general relativity is viewed within the table 5 (**Table 5**).

Table 5. A possible extention of the theory of general realtivity.

		Curvature		
		Yes	**No**	
Energy / momentum	**yes**	$\mathrm{R}_{\mu\nu} - \frac{\mathrm{R}}{2} \cap g_{\mu\nu} + \Lambda \cap g_{\mu\nu} - \frac{\mathrm{R}}{2} \cap {}_{\mathrm{EM}}\, g_{\mu\nu}$	$\left(\frac{\mathrm{R}}{2}\right) \cap {}_{\mathrm{EM}}\, g_{\mu\nu}$	$\left(\frac{4_{\mu\nu} \cap 2_{\mu\nu} \cap \pi_{\mu\nu} \cap \gamma_{\mu\nu}}{c_{\mu\nu} \cap c_{\mu\nu} \cap c_{\mu\nu} \cap c_{\mu\nu}}\right) \cap \mathrm{T}_{\mu\nu}$
	no	$\left(\frac{\mathrm{R}}{2}\right) \cap {}_{\mathrm{EM}}\, g_{\mu\nu} - \Lambda \cap g_{\mu\nu}$	$\left(\frac{\mathrm{R}}{2}\right) \cap {}_{\mathrm{W}}\, g_{\mu\nu} + X_{\mu\nu}$	$\left(\frac{\mathrm{R}}{2}\right) \cap g_{\mu\nu} - \Lambda \cap g_{\mu\nu} + X_{\mu\nu}$
		$\mathrm{G}_{\mu\nu}$	$\left(\frac{\mathrm{R}}{2}\right) \cap g_{\mu\nu} + X_{\mu\nu}$	$\mathrm{R}_{\mu\nu} + X_{\mu\nu}$

5. Conclusions

In the 1940s, the theoretical framework of quantum electrodynamics consolidated electromagnetism with quantum physics. It has also to be noted that the trial to geometrize the electromagnetic field within the theoretical framework of general relativity has still not met with much success. In this publication, the electromagnetic field has been geometrized under conditions of general relativity.

Acknowledgements

None.

Appendix

None.

References

[1] Goenner, H. F. M. (2004) On the History of Unified Field Theories. *Living Reviews in Relativity*, **7**, 1-153. http://dx.doi.org/10.12942/lrr-2004-2

[2] Barukčić, I. (2016) Unified Field Theory. *Journal of Applied Mathematics and Physics*, **4**, 1379-1438. http://dx.doi.org/10.4236/jamp.2016.48147

[3] Nordström, G. (1914) Über die Möglichkeit, das elektromagnetische Feld und das Gravitationsfeld zu vereinigen. *Physikalische Zeitschrift*, **15**, 504–506.

[4] Kaluza, T. (1921) Zum Unitätsproblem in der Physik. *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften*, 966–972.

[5] Weyl, H. (1918) Reine Infinitesimalgeometrie. *Mathematische Zeitschrift*, **2**, 384–411. http://dx.doi.org/10.1007/BF01199420

[6] Eddington, A. S. (1921) A Generalisation of Weyl's Theory of the Electromagnetic and Gravitational Fields. *Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character*, **99**, 104-122. http://www.jstor.org/stable/93978

[7] Bach, R. (alias Förster) (1921). Zur Weylschen Relativitätstheorie und der Weylschen Erweiterung des Krümmungstensorbegriffs. *Mathematische Zeitschrift*, **9**, 110–135. http://dx.doi.org/10.1007/BF01378338

[8] Einstein, A. (1925) Einheitliche Feldtheorie von Gravitation und Elektrizität, *Sitzungsberichte der Preußischen Akademie der Wissenschaften*, **22**, 414–419.

[9] Finsler, P. (1918) Über Kurven und Flächen in Allgemeinen Räumen, *PhD Thesis -University of Göttingen*.

[10] Randers, G. (1941). On an Asymmetrical Metric in the Four-Space of General Relativity. *Phys. Rev.*, **59**, 195–199. https://doi.org/10.1103/PhysRev.59.195

[11] Einstein, A. (1950) On the Generalized Theory of Gravitation. *Scientific American*, **182**, 13-17. http://dx.doi.org/10.1038/scientificamerican0450-2

[12] Tonnelat, M. A. (1955) *La théorie du champ unifié d'Einstein et quelques-uns de ses développements*. Gauthier-Villars. Paris, p. 5.

[13] Einstein, Albert. (1915) Die Feldgleichungen der Gravitation. *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften*, **48**, 844-847.

[14] Einstein, A. (1916) Die Grundlage der allgemeinen Relativitätstheorie. *Annalen der Physik*, **354**, 769-822. http://dx.doi.org/10.1002/andp.19163540702

[15] Einstein, A. (1917) Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie. *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften*, **6**, 142-152.

[16] Einstein, A. and de Sitter, W. (1932) On the relation between the expansion and the mean density of the universe. *Proceedings Of The National Academy Of Science*, **18**, 213-214. http://dx.doi.org/10.1073/pnas.18.3.213

[17] Barukčić, I. (2015) Anti Newton - Refutation of the Constancy of Newton's Gravitational Constant Big G. *International Journal of Applied Physics and Mathematics*, **5**, 126-136. http://dx.doi.org/10.17706/ijapm.2015.5.2.126-136

[18] Barukčić, I. (2016). Newton's gravitational constant Big G is not a constant. *Journal of Modern Physics*, **7**, 510-522. http://dx.doi.org/10.4236/jmp.2016.76053

[19] Barukčić, I. (2015) Anti Einstein - Refutation of Einstein's General Theory of Relativity. *International Journal of Applied Physics and Mathematics*, **5**, 18-28. http://dx.doi.org/10.17706/ijapm.2015.5.1.18-28

[20] Vranceanu, G. (1936) Sur une théorie unitaire non holonome des champs physiques. *Journal de Physique Radium*, **7**, 514-526. http://dx.doi.org/10.1051/jphysrad:01936007012051400

[21] Zel'dovich, Ya. B. (1973) Electromagnetic and gravitational waves in a stationary magnetic field. *Zh. Eksp. Teor. Fiz.*, **65**, 1311-1315.

The changes in this version with respect to the first version are signified by red colour as much as possible.

Jever, 19.10.2017 Ilija Barukcic