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The Equivalence of Time and Gravitational Field

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Abstract

The relationship between energy, time and space is still not solved in an appropriate manner. According to Newton's concept of time and space, both have to be taken as absolute. If we follow Leibniz and his arguments, space and time are relative. Since Einstein's theory of relativity we know at least that energy, time and space are deeply related. Albert Einstein originally predicted that time is nothing absolute but something relative, time changes and can change. Especially, time and gravitational field are related somehow even in detail if we still don't know how. According to the gravitational time dilation, the lower the gravitational potential, the more slowly time passes and vice versa. Somehow, it appears to be that the behaviour of time is directly linked to the behaviour of the gravitational field. The aim of this publication is to work out the interior logic between time and gravitational field and to make the proof that **time is equivalent to the gravitational field and vice versa**.

Keywords: Quantum mechanics; Special relativity; Classical general relativity; Unified field theory; Causality;

1. Introduction

In spite of our attempts to explain natural phenomena in terms of matter and gravitational field these notions are still a point of great dispute to some extent. What is matter, what is the tensor of matter, what is the gravitational field? What is energy, what is time, what is the tensor of time, what is space?

There are a lot of conceptions concerning energy, time and space, Newton's conception was one of them. Gottfried Wilhelm Leibniz (1646-1716), a German philosopher and mathematician, opposed [1] Newton's conception of absolute time and absolute space as published 1687 in Newton's *Philosophiae*

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Naturalis Principia Mathematica. Leibniz claimed that Newton's (1643 – 1727) understanding of time and space is deeply misleading. According to Leibniz, space and time are relative. The disagreement between Newton and Leibniz over the nature of time and space had influence on Immanuel Kant's (1724-1804) theory of space and time and thus far on Einstein too. Einstein's (1879–1955) own understanding of the philosophy of space and time was influenced by Kant's philosophical point of view and culminated in Einstein's publication about the foundation of the theory of general relativity. Notice that, in general, time has been claimed to possess only one dimension in contrast to space. How can we distinguish between curvature and straightness in one dimension, under which circumstances is time (regarded as a one dimensional continuum) curved or straight? One might assume, that time (because of the claimed one dimensionality) is free of all those problems related with (the multi-dimensional) space. Consequently, time and space are not the same and have to be treated separately. In contrast to this, relativity theory added time to space and combined space and time into space-time. The conception of time and space as a four-dimensional manifold according to relativity theory has not reduced time only to a special property of space. Even through the combination of time and space into a four-dimensional manifold, time has not lost its own and peculiar character and meaning. But what is time? Whatever time may be, time can and must be distinguished from space, both are not the same and are not identical. If we follow Reichenbach, "Time is logically prior to space" [2] . To see this problem clearly, even if we may not know exactly what time is, some "things" about time are already known, some properties of time (time is not absolute and can change, simultaneity of events et cetera) as discovered by the theory of relativity are already secured. Time as such, whatever time at the end may be, cannot be reduced only to a fourth dimension. Before we proceed from this position to further progress, we shall mention that even if time and space are different and not the same, both are deeply related. In this article I will provide a solution of the interior logic between a gravitational field and time as such. Such a solution of the problem of time and gravitational field provides a good contribution to unify relativity and quantum theory in a new and unified field theory.

2. Material and methods

2.1. The relationship between matter and gravitational field according to Albert Einstein

The basic relationship between energy, time and space is related to Einstein's theory of relativity [3]. Einstein himself defined matter *ex negativo*, Einstein himself denoted *everything but the gravitational field* as *matter*. In so far, according to Einstein, 'matter' (what ever matter as such may denote, however matter as such may be organised by nature) includes therefore not only matter in the ordinary sense, but the electromagnetic field as well. Einstein wrote:

"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 elektro-magnetische Feld. "[4]

Einstein's writing translated into English:

>> We make a distinction hereafter between 'gravitational field' and 'matter' in this way, that we denote **everything but the gravitational field as 'matter'**, the word matter therefore includes not only matter in the ordinary sense, but the electromagnetic field as well. <<

Everything (whatever this *everything* may denote, a quantum mechanical object, the whole world as such) is constituted and determined by ***either*** matter ***or*** gravitational field. There is nothing else which is constituting a whole or everything as such but matter and gravitational field. In last consequence, there is no third between matter and gravitational field, a third is not given, *tertium non datur*. Matter and gravitational field can thus far be treated as being complementary. The very important principle of complementarity has been formulated by Albert Einstein much earlier then by Niels Bohr although Einstein himself did not use a special term like *principle of complementarity* for the basic relationship between matter and gravitational field.

2.2. Einstein's field equation

Einstein's field equation as a kind of a relativistic wave equation describes the interaction of the gravitational field and matter as such. In so far, if all what is existing can be expressed by Einstein's field equation, it follows straightforward, that the same equation will not contradict the basic relationship between energy, time and space. Thus far, let

T_{ik} denote the stress energy tensor, let
R_{ik} denote the Ricci-tensor, let
R denote the Ricci-scalar, let
γ denote Newton's gravitational constant, let
Λ denote the cosmological constant, let
g_{ik} denote the metric field, let
π denote the mathematical constant, let
c denote the speed of the light in vacuum.

Einstein field equation was derived [5] as

$$(R_{ik}) - (((R / 2) * g_{ik}) + (\Lambda * g_{ik})) = (((4 * 2 * \pi * \gamma) / (c * c * c * c)) * T_{ik}) \quad (1)$$

From this equation follows that

$$(R_{ik}) = (((4 * 2 * \pi * \gamma) / (c * c * c * c)) * T_{ik}) + (((R / 2) * g_{ik}) - (\Lambda * g_{ik})) \quad (2)$$

3. Results

Theoretically, energy, time and space can be expressed as notions, as scalars, as quantum mechanical operators, as tenors et cetera depending upon circumstances. The language or the mathematical framework used to express the basic relationship between energy, time and space should not have any influence on the interior and basic relationship between energy, time and space as such. Thus far, in what follows, let us define the following. Let E denote the *energy*, let T denote the *time*, let S denote *something* (i. e. the space), let M denote the *matter* according to Einstein's understanding of the word matter, let G denote the *gravitational field* according to Einstein's understanding of the word gravitational field, let U denote *everything* according to Einstein's understanding of the word everything.

3.1. Normalisation of the relationship between matter and gravitational field

Claim.
The basic relationship between matter (M) and gravitational field (G) can be normalised as

$$(M / U) + (G / U) = 1. \quad (3)$$

Proof.

Matter (whatever this may be) according to Einstein's understanding of the word matter (M) is equivalent to itself, it is identical with itself. We obtain

$$M = M. \quad (4)$$

Adding some gravitational field to matter will not change the basic relationship above at all. We obtain

$$M + G = M + G. \quad (5)$$

The interaction between gravitational field and matter will lead to something. But in the same way, whatever may be regarded by us, small or big object, they will be determined by matter and gravitational field. If we follow Einstein in his reasoning we will have to accept that

$$M + G = U. \quad (6)$$

whatever U as such may denote (U denotes everything according to Einstein). Dividing Eq. (6) by U we obtain

$$(M / U) + (G / U) = (U / U) = 1. \quad (7)$$

Q. e. d.

Matter and gravitational field are opposites, the more matter, the less the gravitational field and vice versa, the one can pass over into its own opposite and vice versa.

3.2. Normalisation of the relationship between energy and time

Energy and time are related somehow. There is something like energy in our world but there is something like time too. Even if energy and time are related, energy and time are not the same, they are different. Some are claiming, that there is only energy in our world. Thus far, time is nothing special but a certain kind of energy. Our world is built upon energy and time. But what is time? The more properties attributed to time we recognise, the more we will know about time. One of the properties attributed to time is the capability of time to stand in relation to energy and to organise its relationship to energy out of itself.

Claim.

The basic relationship between energy and time can be normalised as

$$(E / S) + (T / S) = 1. \quad (8)$$

Proof.

Energy (whatever energy may be) is equivalent to itself too, energy is identical with it self. We obtain

$$E = E. \quad (9)$$

Adding some time to energy will lead to something and will not change the basic relationship above at all. We obtain

$$E + T = E + T. \quad (10)$$

The interaction between energy and time will lead to something, whatever this something may be. Space is the unity and the struggle between energy and time, space is from my standpoint of view this

result of the interaction between energy and time. We denote space as S = E + T. Substituting this relationship into Eq. (10), we obtain

$$E + T = S, \tag{11}$$

whatever S at the end may denote. Dividing Eq. (11) by S we obtain

$$(E / S) + (T / S) = (S / S) = 1. \tag{12}$$

Q. e. d.

The more energy, the less time and vice versa, energy is the opposite of time, time itself is the opposite of energy, both are opposed to each other. Such an opposition can destroy itself.

3.3. The equivalence of time and gravitational field

Claim.

Time and gravitational field are equivalent. Both are separated only by a proportionality factor (S / U). We obtain

$$T = (S / U) * G . \tag{13}$$

Proof.

$$\mathbf{1 = 1.} \tag{14}$$

From Eq. (12) we know that (E / S) + (T / S) = 1. Substituting this relationship into Eq. (14) leads to the following relationship.

$$(E / S) + (T / S) = 1. \tag{15}$$

From Eq. (7) we know that (M / U) + (G / U) = 1. Substituting this relationship into equation (15) leads to the next equation.

$$(E / S) + (T / S) = (M / U) + (G / U). \tag{16}$$

Multiplying both sides of Eq. (16) by S we obtain

$$((S * E) / S) + ((S * T) / S) = ((S * M) / U) + ((S * G) / U). \tag{17}$$

This equation can be simplified as

$$E + T = ((S / U) * M) + ((S / U)* G). \tag{18}$$

We should recall that E + T = S (Eq. (11)). From this follows that

$$E + T = ((S / U) * M) + ((S / U)* G) = S. \tag{19}$$

The relationship between energy and time is directly related to the relationship between matter and gravitational field. Since matter is determined by energy and vice versa, Eq. (19) forces us to accept that

$$E = (S / U) * M. \tag{20}$$

Substituting this relationship into Eq. (19) we obtain

$$E + T = E + (S / U)* G. \tag{21}$$

Subtracting both sides of the Eq. (21) by E, we obtain

$$\mathbf{T = (S / U)* G} \tag{22}$$

Q. e. d.

Since (S / U) is only a proportionality factor, we must accept that **time is equivalent to the gravitational field and vice versa**.

4. Discussion

The proof of the equivalence of time and gravitational field is logically consistent. Even if I must leave open the question what S and U may denote at the end, both are related to each other in a certain manner. It is of course possible and highly desirable that

$$(S / U) = c^2, \tag{23}$$

where c denotes the speed of the light in vacuum. Such a profound relationship between S and U would simplify the relationship between time and gravitational field to

$$\mathbf{T = c^2 * G}. \tag{24}$$

The above assumption (Eq. 23) could imply that **Einstein's mass-energy-equivalence** known as

$$E = c^2 * m, \tag{25}$$

can be regarded in general as a **matter – energy – equivalence**

$$E = c^2 * M, \tag{26}$$

since mass is only a special kind of matter, **matter is equivalent to energy and vice versa**. An electro-magnetic field is part of matter, mass itself is part of matter. Under certain circumstances, the electro-magnetic field can be treated as mass too. Theoretically, the whole energy of an electro-magnetic field can change into mass or is equivalent to a certain amount of mass. This leads to the fact, that matter=mass+ mass $_{\text{Electro-magnetic field}}$. In so far, it is allowed to talk about the matter-energy-equivalence in general. But this leads straightforward to the fact that we must accept that that

$$T = (S / U)* G , \tag{27}$$

while (S / U) is not only a proportionality factor but equivalent to (S / U) = c^2. The equivalence of time and gravitational field is derived above in a logically consistent manner, time is equivalent to the gravitational field and vice versa.

5. Conclusion

Under the circumstances above, we obtain **the equivalence of time and gravitational field** as

$$T = (S / U)* G, \tag{28}$$

where T denotes the time, G denotes the gravitational field and (S / U) denotes a proportionality factor only. This new understanding of the basic relationship between time and gravitational field is worked out in a logically consistent manner. This new and basic relationship between time and gravitational field can serve as a foundation for the unification [6] of quantum and relativity theory and will enable the successful development of a unified [7] field theory.

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