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Two-Component Spacetime as a Mixture of Non-Locality and Locality: A Conceptual Error about Gravitational Waves, the Different Theories of Gravitation and the Matter-Antimatter Asymmetry

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Abstract: Theories of gravity are incomplete when we neglect quantum phenomena and the internal structure of spacetime described within the Scale-Symmetric Theory (SST). SST shows that the grainy two-component spacetime is a mix of non-locality and locality that leads to a conceptual error about gravitational waves, to different theories of gravitation and to the matter-antimatter asymmetry. Within the General Theory of Relativity (GR) we can not justify whether the metric is local or non-local. Here we described a conceptual error in obtaining the local (speed = c = 299,792,458 m/s) wave-like solutions by solving the non-local/superluminal vacuum field equations of general relativity - we express the opinion that non-locality cannot lead directly to locality. SST, which is the lacking fundamental part of Theory of Everything, shows that spacetime is a mixture of two fields i.e. of the Higgs field (it is non-gravitating, imaginary, non-local and geodesic/metric) and of the Einstein spacetime (it is gravitating, real, local, dynamical and practically-flat/non-geodesic i.e. the total energy-momentum crossing the hypersurface vanishes). Such structure of spacetime causes that there are different theories of gravitation, for example, the GR, which binds the curvature of the non-local Higgs field with the local energy-momentum tensor, the YARK theory, which binds the local Einstein spacetime (ES) with the energy-momentum tensor or the SST which shows the origin of gravitation. Within GR it is easier to describe the non-local phenomena in spacetime (for example, the Kasner solutions describe such phenomena) whereas within YARK theory it is easier to describe the local phenomena in spacetime such as dark energy or "gravitational waves" discovered by LIGO-Virgo Collaborations (which, in reality, are the flows in ES) or the observed energy dependence of gravitational bending which is incomprehensible within the framework of GR. SST shows that we should observe the same speed of propagation of both the "gravitational waves" and electromagnetic waves - there should be high correlation between their intensity for active binary systems of neutron stars or neutron "black holes". The matter-antimatter asymmetry follows from infinitesimal imaginary spin of the Higgs-field components so we must use SST to solve the problem.

1. The definitions

In this paper we assume equivalence of the following terms:

Local ≡ moving with the speed c = 299,792,458 m/s in relation to the source or the stable boundary of spacetime (the stable boundary of spacetime does not exclude the expansion of the Universe and causes that only then the fundamental physical constants are practically constant [1], [2], [3])

Non-local ≡ superluminal

Real ≡ gravitating and not violating the principle of equivalence (PoE)

Imaginary ≡ non-gravitating and violating PoE i.e. carrying inertial mass only i.e. having a finite physical volume which does not create a field

Interpretation of the Michelson-Morley (MM) experiment: photons move with the speed c in relation to their source or a last-interaction object with which the photons are entangled in a quantum way so it may be a MM interferometer also.

Here we express the opinion that curvature of spacetime in the General Theory of Relativity (GR) [4] and the Landau-Lifshitz pseudotensor, which is based on the metric tensor, are non-local and imaginary and that "curvature" of spacetime in YARK theory [5] and the energy-momentum tensor are local and real.

The quantum entanglement is non-local and creates an infinitesimal disorder in the Higgs field in comparison with neutrinos [2]. Quantum entanglement is due to exchanged spin-1 binary system of closed strings which have internal helicity (the entanglon [1], [2]). Due to the dynamic viscosity, the entanglons interact with the Higgs-field components so there appears an infinitesimal gravitation-like disorder in the Higgs field – it is a partially real phenomenon. It means that quantum entanglement is the gate between the imaginary and the real world.

2. The gravitational waves: a conceptual error in GR

Within GR we can not justify whether the metric is local or non-local. There are many approaches to non-local gravitation (see [6] and the references cited therein). On the other hand, it is generally believed that, according to GR, local wave-like solutions can be obtained by solving the vacuum field equations of GR [4]. When we neglect dark energy, these equations are given by

$$R_{\mu\nu} - (R / 2)\, g_{\mu\nu} = 0 , \tag{1}$$

where $R_{\mu\nu}$ is the Ricci tensor, R is Ricci scalar (it is trace of $R_{\mu\nu}$), and $g_{\mu\nu}$ is metric. The Ricci tensor measures the curvature of the metric which defines distances in the curved by masses Higgs field.

Next, we assume that the metric is a sum of flat metric, $\eta_{\mu\nu}$, and small perturbation $h_{\mu\nu}$. It leads to a wave equation for the small perturbation $h_{\mu\nu}$

$$\Box\, h_{\mu\nu} = 0 , \tag{2}$$

where $\Box$ is the d'Alembert operator $\eta^{\mu\nu}\partial_\mu\partial_\nu$ which contains the speed c – there in an arbitrary way it is assumed that the small perturbation propagates with the speed of light in "vacuum" c. It means that we in an arbitrary way assume that gravitational waves, i.e. waves emitted directly by gravitational fields, are local. The Scale-Symmetric Theory (SST) shows that it is untrue [2] – the components of the pure gravitational fields (i.e. the components of the gradients in the Higgs field) are non-local and imaginary. Moreover, SST shows that the Landau-Lifshitz pseudotensor, which is based on the metric tensor (it means that it is purely geometrical or gravitational in origin), is imaginary and non-local also.

3. The two-component spacetime in the Scale-Symmetric Theory

SST shows that the initial inflation field transformed into the residual inflation field, which we call the Higgs field (it is non-gravitating, imaginary, non-local and geodesic/metric), and into the Einstein spacetime (it is gravitating, real, local, dynamical and practically-flat/non-geodesic i.e. the total energy-momentum crossing the hypersurface vanishes) [1], [2], [3].

The two-component spacetime gives us the opportunity to describe different gravitational phenomena by applying different mathematical methods i.e. by applying different theories of gravitation.

SST shows that the pure gravitational fields are the gradients in the Higgs field – such gradients are created by the gravitating Einstein-spacetime (ES) components [1], [2].

Particles are created because of the quantum entanglement and confinement which are characteristic for the gravitating ES components – such phenomena do not concern the non-gravitating Higgs-field components.

The components of pure gravitational fields are non-local but the gradients in the Higgs field cannot move with speed higher than their carriers i.e. than the local ES components – it leads to conclusion that the pure gravitational fields considered as single objects are local.

There cannot be created pure gravitational waves (such waves would be non-local) – just gravitational fields are inseparably "attached" to the ES components and are "carried" by them.

The "gravitational waves" discovered by LIGO-Virgo Collaborations, in reality, are the local flows in ES that carry the pure gravitational fields.

As the gravitational masses approach each other then the gravitational potential energy of the system must decrease. But it cannot be done via emission of pure gravitational waves by the gradients in the Higgs field. An increase in gravitational mass density of a system forces an ordered outflow of the ES components from the system – such outflow is associated with the gravitational potential/binding energy. But SST shows that in parallel, there is inflow of the ES components (it is due to their chaotic motions) into the system in such a way that the total stress-energy-momentum crossing the hypersurface vanishes (see paragraph **5.2**) – emphasize that we still can say about gravitational potential energy.

4. Non-locality vs. locality: different theories of gravitation

SST shows [2] that the GR binds the curvature of the non-local Higgs field with the local stress-energy-momentum tensor. Within GR it is easier to describe the non-local phenomena in spacetime – for example, the Kasner solutions [7] describe such phenomena.

Notice that the metric $g_{\mu\nu}$ in GR does not concern directly the local ES so within it we cannot describe correctly objects composed of ES components. Moreover, the quantum effects are associated with the excited states of ES so unification of GR and Quantum Mechanics within the same methods is impossible.

Within GR scientists try to describe the "gravitational waves" discovered by LIGO-Virgo Collaborations but we can see that there is a conceptual error because the non-local vacuum field equations of general relativity cannot lead directly to the local "gravitational waves".

Within GR it is easier to decipher the internal structure of the pure gravitational fields – we can do it via simultaneous transition to superluminal and imaginary motions (i.e. to non-gravitating motions) in the Einstein energy-momentum relation [2].

The GR describes gravity not as a force, but as a consequence of the curvature of the non-local Higgs field.

On the other hand, SST shows that YARK theory [5] binds the local ES with the local stress-energy-momentum tensor. In YARK theory, geometry of ES is described via the gravitational potential energy associated with the phenomena in ES. Within YARK theory it

is easier to describe the local phenomena in spacetime such as dark energy or the "gravitational waves" [8].

SST shows that the "gravitational waves" discovered by LIGO-Virgo Collaborations are the flows in ES which carry the pure gravitational fields [9].

Within YARK theory or SST it is easier to describe the observed energy dependence of gravitational bending – it is incomprehensible within the framework of GR (the gamma-rays are not deflected according to GR) [10].

SST shows that ordered motions in ES decrease pressure in ES in planes perpendicular to directions of the ordered motions so density of the gravitating ES increases in such planes. It means that gamma-rays (they are the rotational energies of the ES components) create discs in ES with higher mass density. On the other hand, the gravitational potential energy between a massive body and the massive discs near the gamma-rays decreases density of ES. When total mass of the massive discs (it is positive) and the gravitational potential energy (it is negative) is equal to zero then we should not observe a deflection of gamma-rays. There can be negative deflection or repulsion on the high-energy photons also [10].

5. Selected problems

5.1 Equivalence of energy and mass?

Emission of pure rotational energy E by a system (i.e. intensity of ordered motions decreases) increases pressure in ES inside the system – it forces divergent flow of the gravitating ES components that carries gravitational mass M. There is valid the Einstein formula $E = Mc^2$ but it is untrue that the pure energy E can directly transform into the mass M.

Emphasize that emission or absorption of pure energy force radial flows in ES.

5.2 The gravitational potential energy and the total stress-energy-momentum

The Ricci tensor measures the curvature of the metric $g_{\mu\nu}$ associated with the gradients in the non-gravitating Higgs field. The changing distribution of pure gravitational gradients (because of motions of bodies and flows in ES) forces a change in the gravitational potential energy. It can be done only via radial motions of the ES components.

In regions with higher and higher gravitational-mass density (it concerns bodies and ES) there appears more and more virtual pairs of loops built of rotating ES components. Annihilation of such virtual pair transforms it into two pulses moving in opposite directions. The ES components in the divergently moving pulses rotate (their frequencies depend on quantized radii of gravitational orbits around the neutron stars or neutron "black holes" so frequencies are very low in comparison with the visible spectrum [9]) and are entangled and/or confined – this counteracts the damping of such motions. In the places of annihilation of the pairs there are created "holes" in ES which have negative mass whereas the divergently moving pulses carry positive mass. The gravitational potential energy is defined by the dynamics of the "holes" and pulses in ES. We can see that positive mass leaves the system (it is due to the ordered motions), while the ES tries to fill the "holes" (it is due to the chaotic motions; the rate of filling the "holes" depends on mass density of a system). Notice that in a dynamic system, relativistic mass, which is real [2], is changing and follows from flows in ES also.

The very high dynamic pressure in ES (about 10^{45} Pa [3]) causes that total gravitating current via hypersurface is equal to zero – it means that the dynamical ES is practically flat i.e. is non-geodesic. We can say that the total stress-energy-momentum crossing the hypersurface vanishes.

5.3 Symbiosis of YARK theory and quantum mechanics

SST shows that YARK theory starts from ES. On the other hand, ES is the medium for quantum effects so the natural symbiosis of YARK theory with quantum mechanics is possible [11].

According to SST, the ground state of the ES is a superfluid "vacuum" (in such state, the ES components interact gravitationally only) but due to the quantum entanglement and confinement, which are characteristic for the ES components, in ES can appear quantum effects [2]. The Standard Model concerns phenomena that take place in the ES.

5.4 Polarization of the "gravitational waves"

In paper [8] we can read as follows

> *"…the impossibility to arrive at any conclusions about the polarization of the detected LIGO signals, so that these signals do not provide a convincing in favour of GR amongst its alternatives"*.

Here, applying the SST, we showed that the above conclusion is correct. SST shows that dynamic pressure in ES decreases in directions perpendicular to the direction of a flow in ES. This means that the arm of the interferometer in the direction perpendicular to the direction of flow in ES has the smallest length.

5.5 Sudden disappearance of the Sun

Assume that the Sun suddenly disappeared. Then the gradient in the Higgs field (i.e. the pure gravitational field) created by Sun disappears in a superluminal way. But there is still the local gravitational potential energy. It means that the Earth would keep orbiting for about 500 seconds, which is the time dark energy (according to SST, dark energy consists of additional ES components [3]) takes to travel the distance a little longer than the radius of the Earth orbit.

5.6 The lacking energy

SST shows that the non-gravitating energy frozen inside the ES components is about $0.6 \bullet 10^{119}$ times higher than their gravitational energy in the ground state (i.e. their unitary spin does not rotate) [2]. The frozen non-gravitating energy is the lacking energy that appears in quantum description.

5.7 Degrees of freedom and the matter-antimatter asymmetry

According to SST, we need 6 degrees of freedom to describe the Higgs-field components associated with the Ricci tensor and metric in GR. Neglecting the size and rotation of the Higgs-field components we reduce the number of degrees of freedom from 6 to 4 (i.e. to x, y, z, t) as it is in GR. But the matter-antimatter asymmetry follows from the size and, especially, from the initial left-handed rotation of the Higgs-field components [12] so within GR we cannot solve the matter-antimatter-asymmetry problem. The same concerns the quantum physics because, in reality, it says nothing about properties of the components of the Higgs field.

5.8 Speed of the "gravitational waves"

According to SST, the detected "gravitational waves" are the flows in the Einstein spacetime i.e. they are the ordered motions of the ES components. On the other hand, the ES components are the carriers of photons (photons are their rotational energies). It leads to

conclusion that speeds of propagation of the “gravitational waves” and electromagnetic waves are the same.

We should observe the high correlation between the intensity of “gravitational” and electromagnetic waves for gravitationally active systems such as binary systems of neutron stars or neutron “black holes” [3].

6. Summary

The Scale-Symmetric Theory is the lacking fundamental part of the Theory of Everything so it defines initial conditions and boundaries for all other correct theories.

SST leads to the two-component spacetime. In turn, it leads to different descriptions of gravity. Different theories of gravity are fruitful in descriptions of selected phenomena in spacetime. This diversity in the descriptions of gravity allows for a more complete description of phenomena in spacetime and suggests its internal structure.

SST takes into consideration both vacua (i.e. the Higgs field and ES) simultaneously. It causes that we can decipher internal structure of the ES components and we can describe the origin of the Quantum Mechanics.

Generally, we can say that the excited states of the local ES concern the Standard Model (SM) interactions and the YARK-type gravitational potential energy so a natural symbiosis of both theories is possible. On the other hand, the gradients in the non-local Higgs field, which are produced by the local stress-energy-momentum tensor, define directly geometry of the non-local pure gravitational fields in the General Theory of Relativity – it is the reason that unification of SM and GR within the same methods is impossible. It is because the properties of the Higgs field and Einstein spacetime are very different.

The Scale-Symmetric Theory shows that theories of gravity are incomplete when we neglect quantum phenomena and the internal structure of spacetime described within SST.

SST shows that speed of the electromagnetic waves and of the discovered by LIGO-Virgo Collaborations “gravitational waves” (i.e. of the successively following flows in the Einstein spacetime) are the same.

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