Pseudo-forces within non-local geometrodynamic model?

Shushi T.

August 5, 2017

Abstract

In this letter we describe a new concept of "pseudo-forces" that is obtained from a non-local geometrodynamic model. We argue that while the gravity force is described by the curvature of spacetime, the other three forces are, in fact, pseudo-forces that evolve from such geometrodynamic model.

Introduction.—Suppose that our universe has exactly $(3 + 1)$ spacetime dimensions. What general relativity teaches us is that there is no place for other forces, except the gravity force, that are described as a curvature of the $(3+1)$ spacetime manifold. Experiments have shown that besides the gravity force there are other three forces in the universe. The attempts to describe the four fundamental forces by curved spacetime led researchers to develop string theory in which there are $n > 3$ space-like dimensions [2, 3, 4, 5, 6, 8, 9]. Therefore, it seems that the **only** way that such forces will be created by the curvature of the $(3 + 1)$ spacetime manifold is by assuming that these forces are, in fact, pseudo-forces.

Suppose we have $(3+1)$ spacetime manifold with the non-local geometrodynamic model [10]. Then, any object in the universe is described by the metric

$$\mathcal{Z}_{\mu\nu},$$

and there is only a single force in the universe, the gravitational force. The three quantum forces are obtained using particle interactions, these particles are the force carrier particles (Gauge Bosons).

*Department of Physics, Ben-Gurion University of the Negev

Such interactions are not interactions that goes behind the theory of the non-local geometrodynamic model, since, in fact, the forces that are described by such interactions are caused by the transmission of particles which can be also obtained for macroscopic objects. The calculation of the scattering process between the interacted particles relies on the conserved quantities (e.g. conservation of angular momentum, energy, and charge).

For gravitational object with small mass (and density), general relativity teaches us that the energy E_ε of a small volume V_ε is very small, even negligible. The non-local geometrodynamic model [10] assumes that every particle in the universe is a curvature of (3+1) spacetime. Therefore, there must be a mechanism that "amplifies" the energy of the particles such that $E_{\text{Particle}} >> E_\varepsilon$. We can derive such amplification using the concept of superoscillations of the spacetime curvature. Superoscillation is a phenomenon of waves, where a wave that is globally band-limited may consists local segments which oscillate faster than its fastest Fourier components [1]. We postulate that every particle is a curvature of the spacetime that creates a wave in spacetime. Unlike the curvature of macroscopic objects, we assume that, in general, the particles consist inherent superoscillations.

We define the metric of each particle in the following form

$$\mathcal{Z}_{\mu\nu} = g_{\mu\nu} + H\left(T^P_{\mu\nu}\right) r_{\mu\nu}, \tag{1}$$

where $g_{\mu\nu}$ is the pseudo-Riemannian metric, $T^P_{\mu\nu}$ is the stress-energy tensor of the particle that is described by the metric $g_{\mu\nu}$, H is a measure of $T^P_{\mu\nu}$ in the same units of the Planck constant, and $r_{\mu\nu}$ is the non-local metric.

Taking the rotation $t \to it$, we now have a new tensor $\mathcal{Z}_{\mu\nu} = \alpha_{\mu\nu} + i\beta_{\mu\nu}$, where $\alpha_{\mu\nu}$ and $\beta_{\mu\nu}$ are real metrics. In a special case with real metric $\lambda_{\mu\nu}$, the particle's metric $\mathcal{Z}_{\mu\nu}$ takes the following form

$$\mathcal{Z}_{\mu\nu} = \alpha_{\mu\nu} + i\beta_{\mu\nu} = \lambda_{\mu\nu} f_a(t, \mathbf{x}),$$

where $\mathbf{x} = (x_1, x_2, x_3)$ are the spatial dimensions, and $f_a(t, \mathbf{x})$ is some complex superoscillatory function. Under certain conditions the smallest wavelength in the expansion is 1. The form the superoscillatory function f_a implies on a superposition of the particle with large wavelengths, and thus small energy values (since the energy is proportional to the inverse of the wavelength). Around $|x| < \sqrt{n}$, the function can be approximated as an exponential function

$$f_a(x) \approx e^{iax},$$

with much larger wavenumber, $a > 1$. Assuming the wave-particle duality and de-Broglie wavelength for the superoscillatory function, $f_a(x)$ describes a single wave with large energy value, that is much larger than the energy of each of the superposition states. Thus, we see that $f_a(x)$ is a superoscillatory function.

Therefore, we conclude that even if the small mass and density in space-time implies on very small energy, for a particle following a superoscillatory function the superposition of energies implies on a much larger energy. But, what about strong measurements? in the case of strong measurements the superposition state of the energy collapse and even though we detect a larger energy value. Therefore, it seems that the non-local geometroynamic model teaches us that the strong measurement is, in fact, a weak measurement of the internal structure of the particle which consists of superoscillations. In this way, the strong measurement do not interfere this superposition state which is a superposition of the superposition state. Thus, for a sequence of superoscillatory functions $f_a^1, f_a^2, ..., f_a^m$, the superposition of a particle with m different states can be described by the weighted-sum

$$\sum_{i=1}^{m} w_i f_a^i(x),$$

with weights $w_i, i = 1, 2, ..., m$. In the case of a strong measurement the superposition state collapse to one of the states $f_a^1, f_a^2, ..., f_a^m$.

Postulating the symmetric groups of quantum field theory for the electromagnetic, weak and strong forces, we hypothesize that the symmetric group of these forces is approximated to a sub-symmetric group of the curved space-time manifold, $\mathcal{M}_{3+1}$, in the Planck scale

$$SU(3) \times SU(2) \times U(1) \tilde{\subset} \mathcal{M}_{3+1},$$

where $A \tilde{\subset} B$ means that the symmetric group A is approximation of another symmetric group that is contained in B.

One of the fundamental properties of the proposed model [10] is that there can be infinite number of symmetry groups $K_1, K_2, ..., K_\infty$ such that

$$K_i \tilde{\subset} \mathcal{M}_{3+1}, i = 1, 2, ...$$

The main conclusion of such argument is that there are additional pseudo-forces rather than the three known ones. We note that the non-local geometrodynamic model argued that there are no elementary particles in nature.

A natural question should then be asked: Why we can observe only 3 pseudo-forces with a specific group symmetries?. The answer to this question may be addressed by one of the assumptions of the non-local geometrodynamic model. This model assumes that there is no zero-dimensional object in nature, i.e. there is no meaning to a "point" in our universe. This means that before the Big-Bang there was some $(3+1)$ spacetime manifold $\mathcal{O}$ following a small length scale (e.g., the Planck length scale). The structure of such manifold can be revealed by particle physics with the group symmetries $SU(3) \times SU(2) \times U(1)$. Thus, hypothetically, for a different universe with different structure of such primary manifold $\mathcal{O}$ one will have different pseudo-forces in such a universe, while the gravity force will remain in its familiar form, i.e., following the standard general relativity.

References

[1] Aharonov, Y., Colombo, F., Sabadini, I., Struppa, D. C., & Tollaksen, J. (2015). The mathematics of superoscillations. arXiv preprint arXiv:1511.01938.

[2] Englert, F., & Brout, R. (1964). Broken symmetry and the mass of gauge vector mesons. Physical Review Letters, 13(9), 321.

[3] Hagiwara, K., Hikasa, K., Nakamura, K., Tanabashi, M., Aguilar-Benitez, M., Amsler, C., ... & Conforto, G. (2002). Review of particle physics. Physical Review D (Particles and Fields), 66(1).

[4] Herrero, M. (1999). The standard model. In Techniques and Concepts of High Energy Physics X (pp. 1-59). Springer Netherlands.

[5] Nilles, H. P. (1984). Supersymmetry, supergravity and particle physics. Physics Reports, 110(1-2), 1-162.

[6] Peskin, M., & Schroeder, D. (1995). An introduction to quantum field theory.

[7] Povh, B., Rith, K., Scholz, C., Zetsche, F., Rodejohann, W., Povh, B., ... & Rodejohann, W. (2015). Quarks, Gluons, and the Strong Interaction. Particles and Nuclei: An Introduction to the Physical Concepts, 103-122.

[8] Povh, B., Rith, K., Scholz, C., Zetsche, F., & Rodejohann, W. (2015). Exchange Bosons of the Weak Interaction and the Higgs Boson. In Particles and Nuclei (pp. 185-205). Springer Berlin Heidelberg.

[9] Rosner, J. L. (2001). The standard model in 2001. arXiv preprint hep-ph/0108195.

[10] Shushi, T. (2016). A non-local geometrodynamics model based on general relativity and the notion of quantum foam. arXiv preprint arXiv:1606.07210.