The Geometro-Hydrodynamical Formalism of Quantum Spinning Particle

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Abstract. We construct the geometro-hydrodynamical formalism for a spinning particle based on the six-dimensional manifold of autoparallelism geometry, which is represented as a vector bundle with a base formed by the manifold of the translational coordinates and a fiber specified at each point by the field of an orthogonal coordinate frame underlying the classical spin. We show that the geometry of oriented points leads to the existence of the field of torsion with the source – the classical spin. We expand the geometro-hydrodynamical representation of Pauli field developed by Takabayasi and Vigier and represent the spinor field in the geometrical way.

The geometro-hydrodynamical theory implements the new formalism of spinor field keeping to the realistic geometro-hydrodynamical representation. We developed the idea of Takabayasi, Holland and Vigier, that the spinor wave must represent a new physical field propagating in space and influencing the corpuscle of mass moving within it and this field has the geometrical nature. We, at first step, went in the direction of geometrical description and introduced the manifold which is represented as a vector bundle with a base formed by the manifold of the translational coordinates and a fiber specified at each point by the field of an orthogonal coordinate frame or triad. In this non-relativistic interpretation, the triad becomes the element of space and we can identify the triad field as a fluid, and each element of this fluid has rotational degrees of freedom.

The first hypothesis underlying the geometro-hydrodynamical model of the quantum mechanics is that rotation of an object in the physical space affects its geometry, which takes the form of a three-dimensional bundle defined by internal rotational coordinates, or the Euler's angles. A rotational metric should therefore exist, in addition to translational metric, and be determined with infinitely small rotation around the instantaneous axis of the triad. Rotation of the triad, which makes impossible any description of an object movement that doesn't involve rotational coordinates, has its physical manifestation in the torsion field characterized by Ricci's torsion tensor.

The second concept is that the spinor wave characterizing the state of the spinning particle, represents a new type of physical field, the torsion field, which is caused by internal motion of an assembly of the triads. The field of triads is defined in the hydrodynamical representation as a fluid of a continuous distribution of very small rotating bodies. This spatial distribution is specified by the hydrodynamical density. The torsion field influences on the corpuscle moving via it through the coordinates of the fiber or set of Euler angles varying from point to point. The dynamical evolution of the torsion field reduces itself to the movement of the center of mass of the ensemble of the rotating bodies. In the other words, the non-observable wave function assumes the geometrical representation and is characterized by real physical field which has the geometrical nature. The new formalism of the spinor wave field developed in this article keeps to the realistic geometro-hydrodynamical representation based on the ideas of Takabayasi, Vigier and Holland, but is the natural extension of this hydrodynamical formalism of a spinning particle. We try to interpret the wave function in terms of real geometrical form.

Because the spin vector of the particle is collinear with one of the triad axis, torsion field must directly influence the polarization vector or spin of a particle. The method is unified with the

hydrodynamical representation, in which the torsion field affects the neutral particle via the spin - vorticity which exists as a result of inhomogeneity of the triad field. In the regions of electromagnetic fields absence, the torsion field can influence the spinning particle evolution via the phase of wave function. The “canonical” momentum contains the torsion term that leads to the effect of torsion on the neutral particle wave function. To distinguish effects due to spin-vorticity vector from effects due to torsion, a region of space should be experimentally arranged, where vorticity is equals to zero, because the phase of a particle wave function is affected as it passes through the region with a nonzero potential of the torsion field. We use complex wave function and measurements tell us about the magnitude, as a result, the information encoded by phase is lost.

The external torsion field dynamically evolved through the field of triads, which rotate in the corresponding fashion and the spinning particle is feeling the torsion field, which affects the center of mass and the spin vector. On the other hand, the spin of particle must create its own torsion field. We know that the mass determines the affine connection of Riemannian space and creates the gravitation field, the charge creates the electromagnetic field. In the new paradigm developed in this article the fundamental property of matter is that intrinsic angular momentum or spin, characterized by the triad, must create the new torsion field and appears the source of torsion which is given by the third rank Ricci tensor.

The main distinction is that the torsion field has different physical nature, which was discussed above. The first experimental possibility of the torsion field influence detection is the observation of Aharonov–Bohm-like effects for the spinning neutral matter. Our theory predicts that when a beam of neutral spinning particles passes through a region of space in which there is no electromagnetic field, but there is torsion field, an interference pattern can change. The torsion field must be generated by systems of spinning particles and it appears that the torsion field inside the system must have some kind of non-local effect on the particles. On the other hand, in fact, the torsion influence is a purely local interaction with the torsion vector potential. The torsion potential is defined by connectivity on a principal bundle of the autoparallelism geometry. The changes in the fiber bundle space can lead to the phase shift on wave-function of the particles. The second way of torsion registration is the spectral analysis experiments. As we can see from the equation of motion [1] the influence of torsion field can lead to splitting and shifting of known spectral lines. The spin evolution equation contains the new term that characterizes the torsion-torque generated by spin-vorticity coupling. Torsion torque can lead to the precession of spin in the external torsion field. The equation of motion [1] predicts the existence of spiral or circular trajectories of neutral particles in external torsion fields.

References.

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