CHIRALITY AND SPIN VECTORS IN ECE THEORY

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ABSTRACT

The fundamental chirality and spin vectors of ECE theory are identified using the basic definition of the tetrad field as the rank two mixed index tensor that links two column vectors. The chirality vector defines the direction of spin (left or right handedness or chirality) and the spin vector indicates the existence of spin through a phase factor. The tetrad tensor is therefore made up of both handedness and spin, for example the components of the electromagnetic potential field are components of the tetrad tensor within a scalar factor $A^{(0)}$ where $cA^{(0)}$ is the primordial voltage of ECE theory. Similarly the fermion field is defined by a chirality two-spinor and a spin two-spinor. For the fermion, the tetrad field is a 2 x 2 mixed index tensor. The weak and strong fields can be developed similarly in terms of fundamental chirality and spin column vectors. Each field can be represented using inter-convertible representation spaces, for example the space part of the electromagnetic field can be represented by the O(3) or SU(n) groups, were n = 2, .., n. The SU(2) representation of the electromagnetic field is the Majorana representation. This allows for field unification in any representation space.

Keywords: Einstein Cartan Evans (ECE) field theory, handedness, chirality, spin.

70th Paper of ECE Theory.

1.INTRODUCTION

In Einstein Cartan Evans (ECE) field theory {1- 8} the fundamental field is the tetrad, which is a rank two mixed index tensor {9} that transforms as such under the general coordinate transformation, and is thus generally covariant. Therefore the fundamental fields of physics are tetrads of various kinds: the gravitational, electromagnetic, weak , strong and matter fields. The tetrad is defined as follows:

$$V^a = q^a_\mu V^\mu \qquad - (1)$$

where V^a and V^μ are column vectors which are also generally covariant. The tetrad field is therefore defined by the way in which V^a and V^μ are related geometrically, and the tetrad in turn defines the torsion tensor $T^a_{\mu\nu}$. In ECE theory the electromagnetic field for example is defined by the ansatz:

$$A^a_\mu = A^{(0)} q^a_\mu , \qquad - (2)$$

$$F^a_{\mu\nu} = A^{(0)} T^a_{\mu\nu} , \qquad - (3)$$

where $cA^{(0)}$ is the primordial voltage, c being the speed of light in vacuo and $A^{(0)}$ the potential magnitude of the electromagnetic field. The gravitational field is also defined by the tetrad, the symmetric metric being:

$$g_{\mu\nu} = q^a_\mu q^b_\nu \eta_{ab} \qquad - (4)$$

where η_{ab} is the metric in the tangent spacetime of Cartan geometry {1-9} at point P in the base manifold.

In Section 2, V^a is defined as the chirality vector, and V^μ as the spin vector for the electromagnetic and fermion fields. The electromagnetic tetrad A^a_μ is therefore made up both of chirality (handedness) and spin - it can be left or right circularly polarized for example. Components of the tetrad tensor A^a_μ are denoted {1-9} $A^{(1)}_X$, and so on, and are components of the electromagnetic potential field. The electromagnetic field tensor is then defined by the first Cartan structure equation:

$$F^{a}_{\mu\nu} = (d \wedge A^{a})_{\mu\nu} + (\omega^{a}_{\ b} \wedge A^{b})_{\mu\nu} \quad -(5)$$

where $\omega^{a}_{\mu b}$ is the spin connection. For free rotation {1 - 8}, the spin connection is dual to the tetrad:

$$\omega^{a}_{\mu b} = -\frac{\kappa}{2} \epsilon^{a}_{\ bc} q^{c}_{\mu} \quad -(6)$$

and the spin connection can therefore be identified as being itself a potential field component. In this special case of pure rotation the spin connection becomes a generally covariant mixed index tensor (a tetrad tensor). In general however the spin connection is not a tensor {9}. Similarly the Christoffel connection of Riemann geometry is not a tensor in general because it does not transform covariantly under the general coordinate transformation. The tetrad in contrast always transforms covariantly because it is a rank two mixed-index tensor {9}. In general relativity any quantity with this property of general covariance may be a physical quantity (for example the Riemann tensor and the metric). In the standard model in contrast the electromagnetic potential field is a vector (i.e rank one tensor) A_{μ} and is developed with gauge theory in which it is not gauge invariant. A great deal of confusion results in the standard model for this reason, because it is held that a quantity that is not gauge invariant is not a physical quantity, a view that predates quantum theory and relativity and goes back to Heaviside. Faraday and Maxwell in contrast regarded A_{μ} as physical. At the same time in the standard model, A_{μ} is considered physical in the minimal prescription. The standard model is therefore self-inconsistent, in that A_{μ} is at once non-physical and physical, and is also incomplete, because it is special relativity, i.e. Lorentz covariant but not generally covariant as required by Einsteinian general relativity. ECE theory clears up this confusion by regarding

A^a_μ as a generally covariant tetrad field, which is always a physical field. In ECE theory the tetrad is also the gravitational field, and in the latter, a is the index that defines the Minkowski or flat tangent spacetime of Cartan geometry {1-9} and μ is the index of a curving base manifold. As seen in Eq. (4), the symmetric metric of gravitational theory is made up of two tetrads multiplied together. The tetrad is therefore the fundamental gravitational field, and not the symmetric metric. The gravitational tetrad is therefore defined as the rank two tensor that links the flat spacetime column four-vector V^a with the curved spacetime column four-vector V^μ. These are four-vectors because there are four dimensions, time and three space dimensions. The gravitational tetrad therefore has 16 components. In the well known Einstein Hilbert (EH) theory there is no consideration given to torsion, only to curvature. For this reason EH is not a unified field theory as is well known. ECE is a unified field theory in the well defined sense that it is governed not by Riemann geometry without torsion, but by Cartan geometry with inclusion of both the Riemann or curvature form $R^a_{\ b}$ and the Cartan torsion form T^a. These are governed by the two well known Cartan structure equations:

$$T^a = D \wedge q^a := d \wedge q^a + \omega^a_{\ b} \wedge q^b \quad -(7)$$

$$R^a_{\ b} = D \wedge \omega^a_{\ b} := d \wedge \omega^a_{\ b} + \omega^a_{\ c} \wedge \omega^c_{\ b} \quad -(8)$$

and the two Bianchi identities of Cartan (i.e. differential) geometry:

$$D \wedge T^a := R^a_{\ b} \wedge q^b \quad -(9)$$

$$D \wedge R^a_{\ b} := 0. \quad -(10)$$

It is seen that the curvature and torsion are inter-related ineluctably by the basic geometry. The EH theory is the limit:

$$T^a = 0. \quad -(11)$$

In Section 2 therefore the electromagnetic and fermion fields are developed as tetrad fields governed by Eqs. (7) to (10), and thus linked to the gravitational field by these equations of Cartan geometry, thus synthesizing a generally covariant unified field theory as required by the basic philosophy of objectivity (Bacon) and relativity (Einstein and others). In so doing, Section 2 defines the index a of the electromagnetic and fermion fields as that of chirality and the index μ of these fields as that of spin. Therefore the same overall method is used for the gravitational, electromagnetic and fermion fields, in that the tetrad definition links one column vector to another. For the fermion field, the SU(2) representation space is used as is well known, and so the column vectors have two entries, i.e. are two-spinors. The spinor field is therefore a 2 x 2 tetrad with four components. The tetrad is therefore one two-component row vector superimposed on another. If each row vector is transposed to a column two-vector, the result is a column four-vector, the Dirac spinor {1-8} made up of two Pauli spinors. It is shown in Section 2 that the a index of the tetrad in this case represents handedness (right or left fermion) and the μ index represents spin. The Dirac spinor contains chirality (referred to in this case as helicity). The effect of any other field on the fermion field is then governed by the geometry of Eqs. (7) to (10) and by the minimal prescription.

Finally Section 3 is a discussion of how these concepts can be extended to the weak and strong fields using the appropriate representation spaces, and how fields can be inter-related using ECE theory using any representation space such as O(3) or SU(n).