GENERALLY COVARIANT HEISENBERG EQUATION FROM THE EVANS UNIFIED FIELD THEORY.

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ABSTRACT

A generally covariant form of the Heisenberg equation is derived from the Cartan structure equation of differential geometry. This equation is used to suggest why the conventional Heisenberg uncertainty principle has been observed to fail qualitatively in three independent experiments, the reason is that the conventional Heisenberg equation is not generally covariant, and does not contain the correctly covariant densities of general relativity. This derivation is an illustration of the fact that general relativity and quantum mechanics are unified in the Evans field theory.

Keywords: Evans field theory; Heisenberg equation; Heisenberg uncertainty principle.

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1. INTRODUCTION

Recently the Heisenberg uncertainty principle has been shown experimentally to fail completely. Three independent experiments have demonstrated this in the past few years and all three types of experiment are rigorously reproducible and repeatable. The advanced microscopy work of Croca {1} has shown that even at moderate resolution the principle fails by nine orders of magnitude. As the resolution is increased the principle becomes more and more incorrect. Afshar {2} has carried out a series of reproducible and repeatable experiments which show that the photon and the associated electromagnetic wave can be observed simultaneously. This result implies that the commutator of conjugate variables in the uncertainty principle is zero, a more complete violation of the principles of complementarity and uncertainty is not possible. Yet this is what is observed. Thirdly a series of reproducible and repeatable experiments {3} have shown that two dimensional materials when cooled to within a millikelvin of absolute zero become conductors, whereas the uncertainty principle predicts that they become insulators. Therefore the uncertainty principle has been shown to fail completely in three entirely independent sets of experiments, all of which are rigorously reproducible and repeatable.

Theoretical advances in unified field theory have resulted in the development of a generally covariant unified field theory {4-12} based on differential geometry and the well known Palatini variation of general relativity in which the tetrad is the fundamental field {13-15}. In supersymmetry theory for example the tetrad becomes the gravitino. The tetrad postulate {13-15} of the Palatini variation is the metric compatibility condition of the Einstein Hilbert variation of general relativity and gravitational general relativity has recently been verified to one part in a hundred thousand by long baseline interferometric experiments at NASA {16}. This is therefore the experimental precision of the tetrad postulate in the gravitational theory. In the Evans unified field theory {4-12} the tetrad postulate is developed into the Evans Lemma and wave equation, from which the Dirac equation may be derived in the special relativistic limit. The Schrödinger equation is the non-relativistic limit of the Dirac equation, and the Heisenberg equation is the commutator variation of the Schrödinger equation. Therefore the conventional Heisenberg equation is a non-relativistic equation. It turns out that this is the root cause of the qualitative failure of the Heisenberg uncertainty principle described already.

In Section 2 a generally covariant Heisenberg equation is developed from the Cartan structure equation of differential geometry {4-15} by defining an angular momentum form from the torsion form defined by the structure equation. The angular momentum form is then used to construct a generally covariant commutator equation between angular momenta or rotation generators. This is the type of commutator equation which the basis of conventional quantum mechanics in the non-relativistic limit {17}. However, in the non-relativistic limit the concept of angular momentum density is missing entirely, whereas in general relativity the basic Einstein equation is a proportionality between the Einstein field tensor $G_{\mu\nu}$ and the canonical energy-momentum density $T_{\mu\nu}$. The latter is a density, so is defined with respect to volume. By introducing appropriate angular momentum densities a commutator relation is obtained which is qualitatively in accord with the experiments cited already.

Finally a discussion is given of the need to overhaul the Heisenberg uncertainty principle (the principle of indeterminacy) in the light of new experimental data.

2. ANGULAR MOMENTUM FORMS AND DENSITIES.

The starting point for the derivation of the generally covariant Heisenberg equation is the Cartan structure equation:

$$T^a = D \wedge q^a = d \wedge q^a + \omega^a{}_b \wedge q^b \quad -(1)$$

where T^a is the torsion form, D^ is the covariant exterior derivative, q^a is the tetrad form, $\omega^a{}_b$ is the spin connection and d ^ is the ordinary exterior derivative. The torsion form is related to the Riemannn form $R^a{}_b$ through the Bianchi identity:

$$D \wedge T^a = R^a{}_b \wedge q^b. \quad -(2)$$

Reinstating the indices of the base manifold {4-15}:

$$T^a{}_{\mu\nu} = -T^a{}_{\nu\mu} = (D \wedge q^a)_{\mu\nu}. \quad -(3)$$

Similarly the Riemann form is defined by the second Cartan structure equation:

$$R^a{}_{b\mu\nu} = -R^a{}_{b\nu\mu} = (D \wedge \omega^a{}_b)_{\mu\nu}. \quad -(4)$$

Both the torsion and Riemann forms are antisymmetric in the indices of the base manifold. The torsion form is a vector-valued two-form and the Riemann form is a tensor valued two form.

The angular momentum two-form is introduced in this paper as:

$$J^a{}_{\mu\nu} = -J^a{}_{\nu\mu} = \frac{\hbar}{\kappa} T^a{}_{\mu\nu} \quad -(5)$$

where $\hbar$ is the reduced Planck constant, the least angular momentum or action in the universe, and κ is a wavenumber. Therefore:

$$E^a = c\kappa J^a = \omega J^a = c\hbar T^a \quad -(6)$$

is a two form with the units of energy, where c is the speed of light in vacuo. Eq. (6) can be interpreted as a generally covariant version of the fundamental Planck quantization:

$$E = \hbar \omega \qquad - (7)$$

where ω is the angular frequency in radians per second. Thus:

$$E^a_{\mu\nu} = - E^a_{\nu\mu} \qquad - (8)$$

is a vector valued energy two form with time-like and space-like components. More precisely it is an angular-energy / angular-momentum two form. In order to make the antisymmetric E^a generally covariant it has to be converted into a density, denoted ϵ^a, in analogy with the symmetric canonical energy momentum density appearing in the Einstein equation. The densities ϵ^a are vector valued two forms with the units of J m^{-3}, energy divided by volume. Due to the antisymmetric structure of ϵ^a, there exist cyclic relations of the type:

$$\epsilon^a \wedge \epsilon^b = \epsilon_0 \epsilon^c \qquad - (9)$$

et cyclicum

where ϵ_0 is the least energy density magnitude of a given elementary particle.

The conventional Heisenberg equation can be expressed { 17 } in the non-relativistic limit as a cyclic relation between angular momenta:

$$[J_X, J_Y] = i\hbar J_Z \qquad - (10)$$

et cyclicum

an equation which is independent of the choice of operator representation. Within the factor $\hbar$ Eq. (10) is the fundamental commutator relation between rotation generators { 18 }. In special relativity these are generators of the Poincaré group and in general relativity of the Einstein group. They are torsion forms within the factor h / κ defined in Eq. (5).

Therefore the generally covariant Heisenberg equation is a cyclic relation between torsion forms defined by the Cartan structure equation.

It is seen that volume does not enter into Eq. (10) in the non-relativistic limit in which this equation is written. Reinstating the wavefunction, ψ, the Heisenberg equation is usually written as:

$$[J_X, J_Y]\psi = i\hbar J_Z \psi \quad -(11)$$

and is equivalent to the Schrödinger equation. However Eq. (11) is not a correctly objective or generally covariant equation of physics because it is not correctly derived from differential geometry. The wavefunction ψ is not recognized to be the correctly covariant wavefunction of the Palatini variation of general relativity, the tetrad q^a_μ {4-15}. In all situations of interest to physics the latter obeys the tetrad postulate:

$$D_\nu q^a_\mu = 0 \quad -(12)$$

which is fundamental to differential geometry and can be proven rigorously in several ways. From Eq. (12) we obtain the identity:

$$D^\nu (D_\nu q^a_\mu) := 0 \quad -(13)$$

or

$$\Box q^a_\mu = R q^a_\mu \quad -(14)$$

where R is a well defined {4-12} scalar curvature. Eq. (14) is the Evans Lemma, the subsidiary proposition leading to the Evans wave equation:

$$(\Box + kT) q^a_\mu = 0 \quad -(15)$$

where:

$$R = -kT \quad -(16)$$

Here k is Einstein's constant and T is an index contracted canonical energy-momentum density. The Lemma and wave equation are valid for all radiated and matter fields because the tetrad postulate is valid for any connection. Thus the Evans wave equation is the fundamental wave equation of generally covariant unified field theory {4-12} from which all the major equations of physics are derived in well defined limits. This procedure should therefore also be used to derive the Heisenberg equation in its generally covariant or rigorously objective form. In so doing the Heisenberg uncertainty principle is abandoned, because the principle is acausal and diametrically at odds with causal and objective general relativity. The Heisenberg uncertainty principle is not objective because it asserts unknowability {17}. This is a subjective assertion introduced by Bohr and Heisenberg on the grounds of then incomplete or restricted experimental data.

The contemporary experiments with vastly improved data cited in the introduction now show that the Heisenberg uncertainty principle must be abandoned in favor of Einsteinian physics, i.e. objective and causal physics.

So in using the correctly covariant Evans wave equation, based directly on the Einsteinian principles of rigorous objectivity and rigorous causality the concept of canonical energy momentum density is introduced through T and R. The wavefunction is also correctly identified as the tetrad, the fundamental field in the Palatini variation {13-15} of general relativity. The correspondence principle shows that Eq. (15) must reduce to the Dirac equation when one particle is considered in the special relativistic limit:

$$\left(\Box + \frac{m^2 c^2}{\hbar^2} \right) q^a_\mu = 0 \quad -(17)$$

where m is the mass of the particle. Therefore in this limit:

$$kT = \frac{m^2 c^2}{\hbar^2} . \qquad -(18)$$

In the rest frame of one particle:

$$T = \frac{m}{V_0} = \frac{E_0}{c^2 V_0} \qquad -(19)$$

where the rest energy is:

$$E_0 = mc^2 \qquad -(20)$$

and where V_0 is a new concept {4-12}, the REST VOLUME:

$$V_0 = \frac{k\hbar^2}{mc^2} = \frac{k\hbar^2}{E_0} . \qquad -(21)$$

For the electron:

$$V_0 = 2.53 \times 10^{-81} \, m^3 . \qquad -(22)$$

Every elementary particle, including the photon and the neutrinos, has a rest volume inversely proportional to its mass. This is a new law of physics derived form the Evans unified field theory.

Using the de Broglie equation for the rest frequency ω_0 :

$$E_0 = mc^2 = \hbar \omega_0 \qquad -(23)$$

we obtain:

$$V_0 = \frac{\hbar k}{\omega_0} \quad -(24)$$

a simple inverse proportionality between V_0 and ω_0 and a new statement of wave particle duality: a particle with rest volume V_0 is also a wave of rest frequency ω_0 .

In the rest frame in the special relativistic limit therefore:

$$\epsilon_0 = \frac{\hbar \omega}{V_0} \quad -(25)$$

which is the quantum of energy density for an elementary particle, including the photon. The energy densities $\epsilon^a, \epsilon^b, \epsilon^c$ appearing in Eq. (9) must in general be defined with respect to a volume V. It is plausible to define V in the special relativistic limit as the sample volume or volume occupied by the apparatus, while V_0 is the particle's rest volume, or minimum volume. Therefore:

$$\epsilon^a = E^a / V \quad -(26)$$

and so on, where:

$$E^a = \omega J^a \quad -(27)$$

and so on. The fundamental rotation generator relation at the root of the Heisenberg equation is therefore expressed as:

$$[V\epsilon^a, V\epsilon^b] = i(V_0 \epsilon_0)(V\epsilon^c) \quad -(28)$$

or

$$[J^a, J^b] = i\hbar \frac{V_0}{V} J^c \quad -(29)$$

Eq. (29) is a plausible development of the Heisenberg equation to include the concept of angular momentum density. Essentially the geometry is proportional to a density in physics through Eq. (16). In general:

$$V \gg V_0 \quad -(30)$$

and so it is possible that:

$$[J^a, J^b] \sim 0 \quad -(31)$$

as observed in the experiments cited already. Eq. (31) means that a particle and wave may be observed simultaneously for all practical purposes, as in the Afshar experiments. If for example V is one cubic meter V_0 for the photon is many orders of magnitude smaller, so V_0 / V is essentially zero as observed experimentally {1-3}. In the Afshar experiments for example the volume used for the photon is V_0 , and V is the effective volume of the apparatus. The wave spreads throughout the apparatus as also observed in the Croca experiments and in the Aspect experiments { 19 }, but the volume associated with the photon as particle is V_0 . The photon therefore appears simultaneously as a particle and also as a wave, as observed experimentally. The Croca and Aspect experiments show that the wave can occupy the whole of the apparatus and spread out indefinitely. In the conventional Copenhagen interpretation a photon is either a particle or a wave, but never a particle and wave simultaneously. This idea leads to all kinds of difficulties as is well known, and so should be abandoned..