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WAVE MECHANICS AND ECE THEORY

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ABSTRACT

Generally covariant wave mechanics is developed from Einstein Cartan Evans (ECE) field theory. The ECE lagrangian density is identified and used in the ECE Euler Lagrange equation to identify the origin of the Planck constant as a minimized action of general relativity. It is shown that the Planck constant as used in special relativity (standard model wave mechanics) is a special case in which volume is fortuitously cancelled out. More generally the commutator equation of Heisenberg must include volume. The Cartan structure equation, Cartan torsion, and Bianchi identity are derived from the lagrangian density. The Aspect experiment is explained using ECE wave mechanics, and quantum entanglement is described using the spin connection term of ECE theory. The Bohr Heisenberg indeterminacy is discarded in favor of a causal, objective and unified wave mechanics. Phase velocity, v, in ECE wave mechanics can become much greater than c (which remains the universal constant of relativity theory) and the equations defining the condition v >> c are given.

Keywords: Einstein Cartan Evans (ECE) field theory; generally covariant wave mechanics, origin of the Planck constant; ECE lagrangian density; derivation of the Cartan structure equation, Cartan torsion and Bianchi identity; description of the Aspect experiment and quantum entanglement, greater than c phase velocity.

1. INTRODUCTION

Recently {1-38} it has been shown that the origin of generally covariant wave mechanics is the tetrad postulate of Cartan geometry {39, 40}, the fundamental requirement that a vector field be independent of the coordinate system used to describe it. General covariance in physics means that its equations are covariant under the general coordinate transformation. This means that they retain their form, a tensor in one coordinate system must be a tensor in any other coordinate system. The equations of physics are therefore objective to an observer in one reference frame moving in an arbitrary way with respect to an observer in any other reference frame. The requirement of objectivity in physics manifests itself as this fundamental principle of general relativity and without this principle there is no objective physics, nature would mean different things to different observers. Special relativity is known to be accurate to one part in twenty seven orders of magnitude and general relativity to one part in one hundred thousand for the solar system. So the principle of objectivity is tested to high precision. The other fundamental attribute of relativity theory is that the constant c be universal. This is usually interpreted to mean that no information can travel faster than c and other constants in physics are based on a fixed c in standards laboratories worldwide. The constancy of c is needed to ensure causality, to ensure that nothing happens without a cause.

Throughout the twentieth century, general relativity was thought to be incompatible with the principle of indeterminacy developed mainly by Bohr and Heisenberg. This principle states that pairs of variables such as position x and momentum p behave in such a way that if one is known exactly (for example x), the other (for example p) is unknowable. This assertion is based on a variation inferred by Heisenberg of the Schrödinger equation of non-relativistic wave mechanics. There is nothing, however, in the original Schrodinger equation which implies indeterminacy, the Schrödinger equation is based {41} on the fact that action is minimized in particles by the classical Hamilton principle of least action, and that time interval is minimized in waves by the classical Fermat principle of least time. The Heisenberg commutator equation is a restatement of the Schrödinger equation. It has been shown {1-38} that the Schrödinger equation is a well defined non-relativistic quantum limit of the Einstein Cartan Evans (ECE) wave equation of general relativity. Therefore the Schrödinger equation has been shown to be objective and causal and has been shown to be an equation of relativity theory. It follows that the Heisenberg commutator equation is also objective and causal. It cannot lead to Bohr Heisenberg indeterminacy and cannot lead to anything that is unknowable. Recently {42-45} the Bohr Heisenberg indeterminacy principle has indeed been refuted experimentally in several independent ways, all of which are repeatable and reproducible. Indeterminacy is therefore an intellectual aberration which worked itself uncritically into thousands of textbooks of the twentieth century era.

In Section 2 the lagrangian density of generally covariant unified field theory is deduced and used to derive the fundamental ECE wave equation. Therefore from the outset the concept of volume is introduced into wave mechanics because the lagrangian density has the units of energy divided by volume. It has been shown {1-38} that the experiments of Croca et al. {42}, experiments which refute indeterminacy experimentally, can be explained by ECE theory with the introduction of volume into the Heisenberg commutator equation. The ECE lagrangian density inferred in this Section is the fundamental origin of this volume. Key quantities in wave mechanics must therefore be densities, in common with the rest of general relativity. This deduction is seen at work in the fundamental ECE wave equation {1-38}:

$$(\square + kT)\, q^a_\mu = 0 \quad -(1)$$

Here k is Einstein's constant, T is the index reduced canonical energy momentum, a concept first introduced {46} by Einstein, and q^a_μ is the tetrad of Cartan geometry {39, 40}, the fundamental unified field of ECE theory. In the rest frame:

$$T = \frac{m}{V} \quad -(2)$$

which is mass divided by volume. The lagrangian density in this limit is:

$$\mathcal{L} = c^2 T = \frac{mc^2}{V} \quad -(3)$$

and is the rest energy divided by volume. All other wave equations of physics are limits of the ECE wave equation {1-38}, so volume is inherent in all of them. In this section it is shown that the Cartan structure equation and the Bianchi identity of Cartan geometry can be derived form the same lagrangian density. It is thus inferred that all of physics (both classical and quantum) derives from the tetrad postulate, the fundamental mathematical requirement that a complete vector field is independent of the way it is written, independent of the coordinate system used to define the vector field. This inference leads to an unprecedented degree of simplicity and fundamental understanding.

In Section 3 the fundamental origin of the Planck constant is discussed within ECE field theory using fact that action is:

$$S = \frac{1}{c} \int \mathcal{L} \, d^4 x \quad -(4)$$

an integral of the lagrangian density $\mathcal{L}$ over the four-volume $d^4 x$. Action has the units of energy multiplied by time, and these are also the units of angular momentum. Using these concepts the fundamental Planck Einstein and de Broglie equations of quantum mechanics are derived within the concepts of ECE field theory and thus of general relativity. This derivation is not possible in the standard model because there, wave mechanics is not generally covariant. The evolution of the tetrad in ECE theory is governed by:

$$q^a_\mu(x^\mu) = \exp\left(i\frac{S}{\hbar}\right) q^a_\mu(0) \quad -(5)$$

where S is the action and $\hbar$ a constant of proportionality introduced to make the exponent dimensionless as required. This is the reduced Planck constant. The fundamental origin of Eq. (5) is wave particle duality. In ECE theory there is no distinction between wave and particle, both are manifestations of ECE spacetime. The Dirac electron, for example, is defined by the limit {1-38}:

$$kT = \frac{m^2 c^2}{\hbar^2} \quad -(6)$$

of the ECE wave equation (1). This is not a point particle, because from Eqs. (3) and (6) emerges the rest volume of any particle:

$$V = \frac{k\hbar^2}{mc^2}. \quad -(7)$$

The wave nature of the Dirac electron is governed by the same ECE wave equation through the SU(2) representation of the tetrad {1-38}. In Section 3 it is shown that the Planck constant is a limit of Eq. (4), a limit in which the volume V fortuitously cancels. There is a lot more to the Planck constant in generally covariant unified wave mechanics than the standard model's quantum mechanics.

In Section 4 the Aspect experiment and quantum entanglement are discussed within the context of generally covariant and causal wave mechanics, and finally in Section 5 it is shown that under well defined circumstances, the phase velocity, v, of a generally covariant wave can become much larger than c, and indeed approach infinity. The phase velocity v >> c, combined with the spin connection, lead to many new inferences and possible new technologies.