1)

Paper 54 Notes 8

Quantum Entanglement in ECE Field Theory

Consider two non-interacting systems described by the eigenfunctions q^a_μ and q^b_ν. The latter are described by the ECE Lemmas:

$$\square q^a_\mu = R_1 q^a_\mu \quad -(1)$$

and

$$\square q^b_\nu = R_2 q^b_\nu \quad -(2)$$

The *entangled* eigenfunction is part of $q^a_\mu q^b_\nu$ and the ECE Lemma:

$$\square \left(q^a_\mu q^b_\nu \right) = R q^a_\mu q^b_\nu \quad -(3)$$

where the tensor valued metric is:

$$g^{ab}_{\mu\nu} = q^a_\mu q^b_\nu . \quad -(4)$$

Therefore:

$$\boxed{\square g^{ab}_{\mu\nu} = R g^{ab}_{\mu\nu}} \quad -(5)$$

The eigenvalues R of the entangled state are those of the tensor valued metric acting as eigenfunction. An entangled state is therefore a property of spacetime. The eigenfunction $g^{ab}_{\mu\nu}$ is the sum of a symmetric and anti-symmetric component.

2)

The symmetric component is the Einstein Hilbert metric:

$$g_{\mu\nu} = q_\mu^a q_\nu^b \eta_{ab} \quad - (6)$$

and obeys the eigen-equation:

$$\square g_{\mu\nu} = R_S \, g_{\mu\nu} . \quad - (7)$$

The antisymmetric component is:

$$g_{\mu\nu}^c = q_\mu^a \wedge q_\nu^b \quad - (8)$$

and obeys the eigen-equation:

$$\square g_{\mu\nu}^c = R_A \, g_{\mu\nu}^c . \quad - (9)$$

For rotational motion:

$$\omega^a{}_b = - \frac{\kappa}{2} \epsilon^a{}_{bc} q^c \quad - (10)$$

and so $g_{\mu\nu}^c$ is proportional to the spin connection term in the Cartan structure equation:

$$T^a = d \wedge q^a + \omega^a{}_b \wedge q^b . \quad - (11)$$

The spin connection term is the second term in eqn. (11). This suggests that the most general form of the eigen-equation describing entanglement is:

$$\boxed{\Box T^a = V T^a} \quad -(12)$$

where V is a quantity with the units of volume.
In electrodynamics and optics eq. (11) becomes:

$$F^a = d \wedge A^a + \omega^a{}_b \wedge A^b \quad -(13)$$

using the ECE Ansatz:

$$\left.\begin{aligned} A^a &= A^{(0)} q^a, \\ F^a &= A^{(0)} T^a. \end{aligned}\right\} \quad -(14)$$

or

So there exists an entanglement equation:

$$\boxed{\Box \left(\omega^a{}_b \wedge A^b \right) = R_{AB} \left(\omega^a{}_b \wedge A^b \right)}. \quad -(15)$$

The term $\omega^a{}_b \wedge A^b$ is the one responsible for the Aharonov Bohm (AB) effects. So in electrodynamics and optics there are wave phenomena due to $\omega^a{}_b \wedge A^b$. The particulate nature of light or e/m radiation is contained within R_{AB} in eqn. (15).

So when a photon travels through one of the two apertures of a Young screen

4) in a Young interferometer it is accompanied by a wave / particle described by eq. (15). In exact analogy with the Aharonov Bohm effects the effect described by eq. (15) exists in regions not occupied by the photon at the first aperture of the Young screen. So what we are seeing as a photon appearing to interact with itself is a <u>quantum</u> <u>AB effect</u> in the sense described by eq. (15).

Similarly the entanglement described by eq. (15) occurs in regions where the individual wave function q^a_μ is separated from q^b_ν. So a particle seems to have an effect on a second particle at a long distance from the first.

This is a short synopsis of how ECE theory describes entanglement without the use of indeterminacy. In the EPR arguments the spin connection term $\omega^a{}_b \wedge q^b$ and the Cartan torsion were missing completely.