231(6): Potential Energy as a Result of Spacetime Dynamics

The Einstein energy equation can be written as:

$$\frac{E^2}{c^2} + \underline{p}^{(3)} \cdot \underline{p}_3 + \sqrt{2}\left(\underline{p}^{(1)} \cdot \underline{p}_1 - i\underline{p}^{(2)} \cdot \underline{p}_2\right) \quad -(1)$$

$$= \frac{E^2}{c^2} - p_X^2 - p_Y^2 - p_Z^2 = m^2 c^2.$$

The fundamental tetrad definition is:

$$q^a_\mu = \underline{e}^a \cdot \underline{e}_\mu \quad -(2)$$

where:

$$\underline{e}^a = \left(\underline{e}^{(0)}, \underline{e}^{(1)}, \underline{e}^{(2)}, \underline{e}^{(3)}\right) \quad -(3)$$

$$\underline{e}_\mu = \left(\underline{e}_0, \underline{e}_1, \underline{e}_2, \underline{e}_3\right) \quad -(4)$$

A special case of eq. (2) is

$$q^\mu_\mu = \underline{e}^\mu \cdot \underline{e}_\mu, \quad -(5)$$

so $q^0_0 = 1, \; q^i_i = -1, \; i = 1, 2, 3 \quad -(6)$

Therefore:

$$\frac{E^2}{c^2} q^0_0 + p_X^2 q^1_1 + p_Y^2 q^2_2 + p_Z^2 q^3_3 \quad -(7)$$

$$= \frac{E^2}{c^2} q^{(0)}_0 + \sqrt{2}\left(p_X^2 q^{(1)}_1 - i p_Y^2 q^{(2)}_2\right) + p_Z^2 q^{(3)}_3$$

$$= m^2 c^2$$

2) Considering the circular polar basis and Cartesian basis then:

$$\begin{bmatrix} \underline{e}^{(1)} \\ \underline{e}^{(2)} \end{bmatrix} = \begin{bmatrix} q_1^{(1)} & q_2^{(1)} \\ q_1^{(2)} & q_2^{(2)} \end{bmatrix} \begin{bmatrix} \underline{e}^1 \\ \underline{e}^2 \end{bmatrix} \quad -(8)$$

where

$$\underline{e}^{(1)} = \frac{1}{\sqrt{2}}(\underline{i} - i\underline{j}), \quad -(9)$$

$$\underline{e}^{(2)} = \frac{1}{\sqrt{2}}(\underline{i} + i\underline{j}), \quad -(10)$$

$$\underline{e}^1 = \underline{i}, \quad \underline{e}^2 = \underline{j}, \quad -(11)$$

so

$$\underline{e}^{(1)} = q_1^{(1)}\underline{i} + q_2^{(1)}\underline{j} \quad -(12)$$

$$\underline{e}^{(2)} = q_1^{(2)}\underline{i} + q_2^{(2)}\underline{j}. \quad -(13)$$

Consider now the transformation:

$$\underline{e}^{(1)} \rightarrow e^{i\phi}\underline{e}^{(1)} \quad -(14)$$

where

$$\phi = \omega t - kZ. \quad -(15)$$

The effect of this transformation is to introduce rotation and translation of $\underline{e}^{(1)}$. The complex conjugate transform is:

$$\underline{e}^{(2)} \rightarrow e^{-i\phi}\underline{e}^{(2)} \quad -(16)$$

Eqs. (14) and (16) are equivalent to transforming the tetrads as follows:

3)

$$q_1^{(1)} \rightarrow q_1^{(1)} e^{i\phi}, \quad -(17)$$

$$q_2^{(1)} \rightarrow q_2^{(1)} e^{i\phi}, \quad -(18)$$

$$q_1^{(2)} \rightarrow q_1^{(2)} e^{-i\phi} \quad -(19)$$

$$q_2^{(2)} \rightarrow q_2^{(2)} e^{-i\phi}. \quad -(20)$$

Eqs. (17) to (20) introduce the Cartan torsion and curvature through the structure equations, so the spacetime is now that of general relativity.

The effect of eqs. (17) to (20) is:

$$p^2 \rightarrow p_x^2 e^{i\phi} + p_y^2 e^{-i\phi} + p_Z^2 \quad -(21)$$

$$:= \pi^2$$

It is now assumed that m^2c^2 is an invariant under the transformations (17) to (20). So:

$$\frac{\epsilon^2}{c^2} - \pi^2 = \frac{E^2}{c^2} - p^2 = m^2c^2, \quad -(22)$$

or

$$\boxed{\epsilon^2 - c^2\pi^2 = E^2 - c^2p^2 = m^2c^4} \quad -(23)$$

Furthermore, it is assumed that:

$$\mathcal{E} = E - V, \quad \underline{\pi} = \underline{p} - \underline{p}_1 \quad -(24)$$

where V is a potential energy of spacetime, and $\underline{p}_1$ is a linear momentum of spacetime. The quantities V and $\underline{p}_1$ are introduced by making the frame of reference a dynamic quantity as in eqs. (17) to (20). Therefore we obtain the relativistic and generally covariant Hamilton Jacobi equation:

$$\boxed{\pi^{\mu}\pi_{\mu} = m^2c^2} \quad -(25)$$

where

$$\pi^{\mu} = \left(\frac{\mathcal{E}}{c}, \underline{\pi}\right). \quad -(26)$$

From eqs. (23) and (24):

$$\boxed{(E - V)^2 = c^2(\underline{p} - \underline{p}_1)\cdot(\underline{p} - \underline{p}_1) + m^2c^4} \quad -(27)$$

This can now be reduced to a Schrodinger equation and used to study the effect of spacetime energy-momentum on LENR.