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Restoring the Hidden Variables in Quantum Mechanics

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Abstract: *In a paper published in Physics Essays the author had derived the London equations from some basic assumptions. We had found there that there is a curvature of spacetime and a localized surface tension. We continue explaining the free energy expansion in Ginzburg Landau theory and find the rest of the hidden variables,*

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I. Main Part

Associated with a curvature of spacetime is the creation of new volume. This will be described in the following using the equivalence principle and by finding a thermal expansion coefficient. Volume as we know expands on heating.

We had found in the article of reference [1] that :

$$\frac{\hbar^2}{2m}\Delta P = \frac{\hbar^2}{2mN}\Delta|\psi|^2 = \sigma K \quad (1)$$

In that specific paper [1] the author claimed that the curvature of spacetime found in equation (1) was derived from the mass energy equivalence. The next logical thought is that we should have a mass density. We are going to use the following symbol Greek rho defined as following:

$$\rho = \frac{dm}{dV} \quad (2)$$

Now equation (1) may be written as:

$$\frac{\hbar^2}{2m}\Delta P = \sigma K = \rho c^2 \quad (3)$$

From taking a look at Ginzburg-Landau expansion of free energy density [2]we may write equation (1) as

$$\frac{\hbar^2}{2m}\Delta P = P(E-U) - \frac{1}{2}m|\vec{v}|^2 = \frac{dF}{dV} = PQ - \left(\frac{1}{2}m|\vec{v}|^2 - Pm\left(\frac{d\vec{r}}{dt}\right)^2\right) \quad (4)$$

We are going to exploit the following identity:

$$|\nabla\psi|^2 = \left|e^{i\phi}\nabla|\psi| + i|\psi|e^{i\phi}\nabla\phi\right|^2 = \left(\nabla|\psi|\right)^2 + |\psi|^2\left(\nabla\phi\right)^2 \quad (5)$$

Inserting equation (5) into equation (4) we finally have:

$$\frac{dF}{dV} = PQ - \frac{\hbar^2}{2m}\left(\nabla|\psi|\right)^2 = \frac{mc^2}{\mathrm{N}\chi} - \frac{\hbar^2}{2m}\left(\nabla|\psi|\right)^2 \quad (6)$$

Where:

$$\chi = \left(\frac{NK_B dT}{EdV}\right)^{-1} = \frac{\varepsilon}{\varepsilon_0} \quad (7)$$

It is the thermal coefficient of expansion divided by the energyand also the electric susceptibility.

In the paper of reference [1] we had declared that:

$$\frac{d\vec{r}}{dt} = \frac{\hbar}{m}\nabla\phi + \frac{e}{mc}\vec{A} \quad (8)$$

From Schrodinger equation it is easy to find out that

$$\hbar \frac{\partial \phi}{\partial t} = -E \quad (9)$$

Therefore we may transform the quantum potential as follows:

$$Q = E - U - 2\frac{1}{2}m\left(\frac{d\vec{r}}{dt}\right)^2 = -\hbar\frac{\partial \phi}{\partial t} - U - \frac{\hbar}{m}\nabla\phi\cdot\frac{d\vec{r}}{dt} - \frac{e}{mc}\vec{A}\cdot\frac{d\vec{r}}{dt} \quad (10)$$

Analyzing the terms we come across the next equation:

$$Q = -\hbar\frac{d\phi}{dt} - U - \frac{e}{mc}\overleftarrow{A}\cdot\frac{d\vec{r}}{dt} \quad (11)$$

If we take in mind that we had assigned a point flux to the phase phi equation (11) becomes more transparent and Q describes the electrostatic potential U plus the potential arising from Faraday law of induction.

$$ePQ = e\frac{|\psi|^2}{N}Q = \frac{U'dq}{dV} \quad (12)$$

From hereon we will call therefore the quantum potential as the thermodynamic potential for it describes the electromagnetic energy.

Now the expansion of the free energy density becomes easier to understand. First of all we know that free energy has a term proportional to the surface tension to describe surface phenomena. Apart from this and the electromagnetic energy artificially added and described by the quantum potential we have:

$$F = U - TS \Rightarrow dF = TdS - PdV - TdS - SdT = PdV - SdT \quad (13)$$

We have found the term proportional to a temperature density and it looks like the entropy described is fixed. The pressure term is of course the energy density found.

References

[1]. About a possible derivation of the London equations, SpirosKoutandos, Physics essays,vol 33, no2 ,2020

[2]. Introduction to superconductivity, Michael Tinkham, Dover editions

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