General Relativity and Gravity from Heisenberg's Potentia in Quantum Mechanics

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Abstract

Recently we have provided a physically consistent and a mathematically justified ontological model of Heisenberg's suggested "potentia" in quantum mechanics. What arises is that parallel to the real three dimensional $SO(3)_l$ space there is a coexisting dual space called potentia space $SO(3)_p$, wherein velocity $c \rightarrow \infty$. How does this affect gravity? We show here that gravity actually sits in the space of potentia. The space of potentia does not allow gauging. Thus gravity is not quantized.

Keywords : general relativity, gravity, space-time, potentia, quantum mechanics

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Heisenberg had hypothesized the abstract concept of "potentia" to provide a philosophically consistent description of the puzzles of quantum mechanics. In a recent paper [1], the author has proposed a physically consistent and a mathematically justified framework to obtain an ontologically real space for this potentia. This requires a fundamental use of the discrete subgroups of the relevant Lie groups. The details are given in [1]. For the sake of completeness we have summarized the arguments in Appendix here.

The point is that in addition to the real x-, y- and z-three dimensional space specified by the group structure $SO(3)_l$, there exists simultaneously, in the background, another equally real "potentia" space with the group structure $SO(3)_p$. This potentia space, as shown in [1], is an absolute space with infinite velocity $c \to \infty$. Similar situation holds for the two-dimensional subspace with group $SO(2)_l$ and its corresponding potentia space of $SO(2)_p$.

Hence there are four quantities as a measure of length. These are: (1). r ; (2). r^2 ; (3). $\vec{r}$; (4). $\vec{r}^2$. The first two arise only in the potentia space and the latter two in the standard $SO(3)_l$ space. Thus these dual and simultaneously coexisting spaces sit piggyback on each other. To distinguish the two spaces we label them as "THIS" space for the space $SO(2)_l$ and "THAT" space for the potentia space $SO(2)_p$.

Let us propose a consistent model of this reality for a single particle travelling in that potentia space $SO(2)_p$ from some initial point "0" to another point point "1". Let this be specified by distance "r". This automatically induces a vector "$\vec{r}$" in this space $SO(2)_l$. Also instantaneously is created a circular surface area πr^2 in that space (potentia). This in turn indices a surface with area $\pi \vec{r}^2$ in this space. Note that "that" space is specified by (1). r ; and (2). r^2 and "this" space by (3). $\vec{r}$ and (4). $\vec{r}^2$.

What is the significance of the above for our observed space, gravity and the general theory of relativity?

One notices that in general relativity and cosmology [2,3] at a fundamental level (black hole area, metric for spherically symmetric spaces etc) one needs measures of size as r and r^2 only. Thus right away one notes that the space-time structure that manifests itself is that of "that" space (potentia) of $SO(3)_p$ *and* $SO(2)_p$.

Thus the most significant conclusion that we draw here is that gravity, as defined by the theory of general relativity, sits in the space of "potentia".

One immediate implication - we know that the strong, weak and elctromagnetic forces are gauge forces as these reside in "this" space of $SO(3)_l$. Hence gravity residing in "that" space of potentia, cannot be a gauge force.

Thus gravity is not quantized and should be a classical force. This conclusion is consistent with such a result obtained by the author some time ago [4].

Long ago Rosenfeld had said that empirical evidence and not logic forces us to quantize fields [5]. In the absence of such evidences one should resist temptations to quantize gravity. "Even the legendary Chicago machine cannot deliver the sausages if it is not supplied with hogs" [5]. The wisdom of these statements has been confirmed here by the fact that we find that gravity exists is the space of potentia.

Next we see that in the classical equation,

$$F = (\frac{GM}{r^2})m \tag{1}$$

The field of mass M given in the bracket and the test-particle, both sit in the space of potentia. This is gravitational interaction. How is this different from the corresponding Coulombic interaction?

$$F = (\frac{kQ}{\vec{r}^2})q \tag{2}$$

Note that the difference with respect to the gravitational force above is that in the Coulombic case we have used vector-r squared, as this happens in "this" space of $SO(3)_l$.

In summary we conclude here that gravity as defined by the theory of general relativity sits in the space of "potentia", which is an absolute space with $c \to \infty$. Also as such gravity is not quantized

Appendix :

From a recent paper [1] let the two electrons be residing in space,

$$SU(2)_S \otimes SO(3)_l \tag{3}$$

Here $SO(3)_l$ specifies the three-dimensional x-, y- and z-space. We discussed how the antisymmetric wave function at the position of sequential numbers (12) existing in the wave function, does not exist in the ordianry $SO(3)_l$ space [1]. It actually exists in the space of "potentia" as proposed by Heisenberg. But wherefrom does this potentia pop up?

The group structure $SU(2)$ has a centre of Z_2 (addition modulo 2 with elements [0,1]). Then the factor group,

$$\frac{SU(2)_S}{Z_2} \cong SO(3)_p \tag{4}$$

Here given the group structure space in the above equation, there is no justification in associating the above orthogonal group with the group $SO(3)_l$. We should treat it as another independent SO(3) group and is thus labelled with another subscript "p". Now we identify it with the word "potentia" assuming that this space is defining the space of potentia.

As Z_2 is a discrete subgroup of the group $SU(2)_S$ and hence it should label its fundamental representation with its Z_2 centre elements [0,1] as,

$$\begin{pmatrix} \uparrow (0) \\ \downarrow (1) \end{pmatrix} \tag{5}$$

In the symmetric group S_3 the antisymmmteric state is,

$$\begin{array}{|c|}\hline \\ \hline \\ \hline \\ \hline \end{array} \tag{6}$$

But this is zero for electrons as these are representations of the group $SU(2)_S$. Now invoke the above internal mathematical condition to ensure the vanishing of the above state. We do so by putting the Z_2 labels in the Young diagram for the SU(2) fundamental representation as,

$$\begin{array}{|c|}\hline 0 \\ \hline 1 \\ \hline \end{array} \tag{7}$$

And thus for three particles the relevant non-zero Young diagram is,

$$\begin{array}{|c|c|}\hline 0 & 0 \\ \hline 1 & \multicolumn{1}{c}{} \\ \cline{1-1} \end{array} \tag{8}$$

The labels $[0,1] \cong [1,2]$ are now associated with the sequential labels (12) corresponding to the center Z_2 lables. The subscipt "p" for potentia on the orbital group is justified as the centre being a discrete group, the exchange over this space is a jump between 1 and 2 with infinite speed. This is instantaneous exchange in this space with $c \to \infty$. The points at which the particles are defined in both the spaces is what makes these two spaces to sit piggyback on each other. When measuremt is preformed in our $SO(3)_l$ space then the wave function collapse occurs and nonlocality is manifested.

For a single particle, the phase of the wave function $e^{i\phi}\ \psi$ is relevant. This gives the group $U(1)$. Now given the additive group of the real number $\mathcal{R}$ and the infinite set of integers $\mathcal{Z}$, the factor group is,

$$\frac{\mathcal{R}}{\mathcal{Z}} \cong U(1) \sim SO(2)_p \tag{9}$$

Now $SO(2)_l$ is a subgroup of the orbital space $SO(3)_l$. However we identify the above $SO(2)_p$ as an independent and different orbital space which is labelled by the set $\mathcal{Z}$. We have taken the cue from the above set Z_2 for the two particle system. Hence we suggest that this potentia space of $SO(2)_p$ labels the particle in that space by the discrete set $\mathcal{Z}$. Let us propose that the spaces $SO(2)_l$ and $SO(2)_p$ are simultaneous and dual to each other and sitting piggyback on each other.

When observation is made in the space $SO(2)_l$ then the wave function collapses in such a manner that in the potentia space with jumps in $\mathcal{Z}$ from $1 \to 2 \to 3 \to 4 \to \cdots$ occur, while it travels continuously and with velocity $v \leq c$ in our orbital space. Clearly for a bound state these jumps would correspond to instantaeous quantum jumps in the potentia space. So quantum jumps do not occur in real $SO(2)_l$ space but in the $SO(2)_p$ potentia space with infinite velocity.

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