Original Research Article

The Electromagnetic Field Representation of the Quantum Mechanics

Abstract: In this work a new representation of quantum mechanics, that is, the electromagnetic field representation, is proposed, which is different from the Schroedinger`s equation and Heisenberg`s Matrix. It is pointed out that even though the results from Schroedinger`s equation, Heisenberg`s Matrix and electromagnetic field representation in describing the quantum system are the same, the principles and procedures in describing the quantum system are totally different. The meaning of the electromagnetic field representation of quantum mechanics to our scientific work is still under exploring and the result will be presented in following work.

Keywords:quantum mechanics, Schroedinger`s equation, Heisenberg`s Matrix, Electromagnetic field

I.Introduction

At the beginning of last century, Max Planck [1] proposed the quantum concept based on the black body radiation experiment. The Niels Bohr [2-6] applied the quantized atomic model to the hydrogen atom and succeeded in explanation about the spectra from the hydrogen atom. Then the quantum storm appeared and a lot of new concepts explosively showed up, such as the uncertainty principle [7] and Pauli principle [8]. These new concepts claimed the new branch of science born, called ``quantum mechanics``. After more than one hundred years developing, the quantum mechanics already became the essential tool for scientist to explore the secret of the nature.

Conventionally, the quantum mechanics can be described quite well by Schroedinger equation [9] and Heisenberg`s matrix mechanics [10]. It has been proved that both descriptions are equivalent but Heisenberg`s matrix description is more strict. Both methods, Schroedinger`s equation and Heisenberg`s matrix mechanics, are found widely application in scientific fields. Here we would like to propose a new representation of the quantum mechanics, that is, the electromagnetic field representation and offer an alternative method for scientist in doing research work.

II. Theoretical Consideration

Theoretically, we can take the simplest system, hydrogen atom, to start our discussion

$$\int_0^\infty \varphi_{1s} H \varphi_{1s}^* d\tau = E_{1sg} \qquad (1)$$

where φ_{1s} is the wave function of hydrogen atom at ground state, H is the Hamilton operator, E_{1sg} is the energy of the hydrogen atom at ground state.

This equation tells us that the hydrogen atom at ground state, its energy for keeping the hydrogen atom in stability can be obtained by applying the Hamilton operator onto the system and integrating over whole space. Our previous work demonstrated that the main role in keeping the hydrogen atom in stability comes from the electromagnetic energy of system [11-13], therefore, we can get,

$$\int_0^\infty \varphi_{1s} H \varphi_{1s}^* d\tau = N \int_0^\infty \left(\frac{\varepsilon}{2}|E|^2 + \frac{1}{2\mu}|B|^2\right) d\tau \qquad (2)$$

where N is the conversion factor to change the joule unit to atomic unit; ε and μ are the permittivity and permeability of vacuum, respectively; H is the Hamilton operator for hydrogen atom; E and B are the electric field and magnetic field of hydrogen atom, respectively. From the principle of mathematic integration [14], we get,

$$\varphi_{1s} H \varphi_{1s}^* = N \left(\frac{\varepsilon}{2}|E|^2 + \frac{1}{2\mu}|B|^2\right) \qquad (3)$$

Based on the electromagnetic theory, we know there is the relation between electric and magnetic fields [15] as,

$$E=cB, \qquad (4)$$

where c is the speed of light in vacuum, therefore, the last two terms in bracket (see equation (3) above) can be combined as one term as,

$$\varphi_{1s} H \varphi_{1s}^* = N \left(\frac{\varepsilon}{2}|E|^2 + \frac{1}{2\mu c^2}|E|^2\right) \qquad (5)$$

$$\varphi_{1s} H \varphi_{1s}^* = N \left(\frac{\varepsilon}{2} + \frac{1}{2\mu c^2}\right)|E|^2 \qquad (6)$$

$$\varphi_{1s} H \varphi_{1s}^* = K|E|^2 \qquad (7)$$

where $K = N\left(\frac{\varepsilon}{2} + \frac{1}{2\mu c^2}\right)$

$$|E|^2 = \frac{1}{K}\varphi_{1s} H \varphi_{1s}^*$$

$$= \frac{1}{K}\left(\frac{1}{2\pi} - \frac{1}{\pi r}\right)e^{-2r}$$

$$= F_{1s}(r)\frac{1}{K} \qquad (8)$$

where $F_{1s}(r) = \left(\frac{1}{2\pi} - \frac{1}{\pi r}\right)e^{-2r}$

$$E \cdot E^* = \frac{1}{K}F_{1s}(r)exp(-E_{1sg}ti)exp(E_{1sg}ti) \qquad (9)$$

therefore,

$$E = \pm\left(\frac{F_{1s}(r)}{K}\right)^{1/2} exp(-E_{1sg}t_i) \qquad (10)$$

$$B = \pm \frac{1}{c}\left(\frac{F_{1s}(r)}{K}\right)^{1/2} exp(-E_{1sg}ti) \qquad (11)$$

If we take the real parts of E and B, they are

$$E = \pm \left(\frac{F_{1s}(r)}{K}\right)^{1/2} cos(E_{1sg}t) \qquad (12)$$

$$B = \pm \frac{1}{c}\left(\frac{F_{1s}(r)}{K}\right)^{1/2} cos(E_{1sg}t) \qquad (13)$$

If we take the imaginary parts of E and B, they are

$$E = \pm \left(\frac{F_{1s}(r)}{K}\right)^{1/2} sin(E_{1sg}t) \qquad (14)$$

$$B = \pm \frac{1}{c}\left(\frac{F_{1s}(r)}{K}\right)^{1/2} sin(E_{1sg}t) \qquad (15)$$

Similarly,

$$|E|^2 = \varphi_{2p0} H \varphi_{2p0}^* \frac{1}{K}$$

$$= \frac{1}{K}\left[\frac{1}{32\pi} r \left(\frac{3}{8}r - \frac{3}{2}\right) e^{-r} cos^2(\theta)\right]$$

$$= \frac{1}{K} F_{2p0}(r,\theta) \qquad (16)$$

where $F_{2p0}(r,\theta) = \frac{1}{32\pi} r \left(\frac{3}{8}r - \frac{3}{2}\right) e^{-r} cos^2(\theta)$

$$E \cdot E^* = F_{2p0}(r,\theta) \frac{1}{K} exp(-E_{2p0}ti) exp(E_{2p0}ti) \qquad (17)$$

therefore,

$$E = \pm \left[\frac{1}{K} F_{2p0}(r,\theta)\right]^{1/2} exp(-E_{2p0}ti) \qquad (18)$$

$$B = \pm \frac{1}{c}\left[\frac{1}{K} F_{2p0}(r,\theta)\right]^{1/2} exp(-E_{2p0}ti) \qquad (19)$$

If we take the real parts of E and B, they are

$$E = \pm \left[\frac{1}{K} F_{2p0}(r,\theta)\right]^{1/2} cos(E_{2p0}ti) \qquad (20)$$

$$B = \pm \frac{1}{c}\left[\frac{1}{K} F_{2p0}(r,\theta)\right]^{1/2} cos(E_{2p0}ti) \qquad (21)$$

If we take the imaginary parts of E and B, they are

$$E = \pm\left[\frac{1}{K}F_{2p0}(r,\theta)\right]^{1/2} sin(E_{2p0}ti) \quad (22)$$

$$B = \pm\frac{1}{c}\left[\frac{1}{K}F_{2p0}(r,\theta)\right]^{1/2} sin(E_{2p0}ti) \quad (23)$$

Based on the same procedure above, we can change all the wave functions of hydrogen atom into the electromagnetic fields spacetime distribution. Originally, we got the property of system by applying the Hamilton operator onto the system and doing the quantum calculation. Now, we can get the property of system from the electromagnetic field spacetime distribution, that is, we can describe the system by its electromagnetic fields spacetime distribution instead of quantum mechanics.

III. Application of electromagnetic field representation of quantum mechanics onto hydrogen atom system

From the Schroedinger' equation, the hydrogen atom at ground state can be calculated as

Energy (hydrogen atom at ground state)= $\int_0^\infty \varphi_{1s} H \varphi_{1s}^* d\tau$

$$= -0.5(a.u.) \quad (24)$$

Now we start with the electromagnetic spacetime distribution of the hydrogen atom obtained above,

Energy (hydrogen atom at ground state)= $\int_0^\infty K|E|^2\, d\tau$

$$= \int_0^\infty K\, F_{1s}(r)\, \frac{1}{K} d\tau$$

$$= \int_0^\infty F_{1s}(r) d\tau$$

$$= \int_0^\infty \left(\frac{1}{2\pi} - \frac{1}{\pi r}\right) e^{-2r} 4\pi r^2 dr$$

$$= -0.5(a.u.) \quad (25)$$

Comparing the results from Schroedinger' equation and the electromagnetic spacetime distribution, it is obvious both methods give the same results, which demonstrate the both representations of quantum mechanics are equivalent. However, we should point out that even though the Schroedinger's equation, Heisenberg's matrix and the electromagnetic field representation are equivalent in describing the quantum system, their principles and procedures in describing the quantum system are totally different, which can be seen from the calculation example of hydrogen atom here.

IV. Conclusion

In this work we develop a new way to express the quantum mechanics, that is, the electromagnetic fields spacetime distribution of system. This new representation of quantum mechanics can find wide application in the future and further result will be presented in the following work.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

V. Reference

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