The Electromagnetic Field Representation of the Quantum Mechanics

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Author’s contribution
The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT
In this work a new representation of quantum mechanics, that is, the electromagnetic field representation, is proposed, which is different from the Schrödinger’s equation and Heisenberg’s Matrix. It is pointed out that even though the results from Schrödinger’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 further result regarding the application of the electromagnetic field representation of quantum mechanics to different atomic and molecular systems will be presented later.

Keywords: Quantum mechanics; Schrödinger’s equation; Heisenberg’s Matrix; electromagnetic field.

1. 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
2. THEORETICAL CONSIDERATION

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

\[ \int_0^\infty \varphi_{1s} H \varphi_{1s}^* \, dr = E_{1s}\ ]

(1)

where \( \varphi_{1s} \) is the wave function of hydrogen atom at ground state, \( H \) is the Hamilton operator, \( E_{1s} \) is the energy of the hydrogen atom at ground state.

This equation tells us that for 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,

\[ \int_0^\infty \varphi_{1s} H \varphi_{1s}^* \, dr = N \int_0^\infty \left( \frac{\xi}{2} |E|^2 + \frac{1}{2\mu} |B|^2 \right) \, dr \]

(2)

where \( N \) is the conversion factor to change the joule unit to atomic unit; \( \epsilon \) and \( \mu \) 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,

\[ \varphi_{1s} H \varphi_{1s}^* = N \left( \frac{\xi}{2} |E|^2 + \frac{1}{2\mu} |B|^2 \right) \]

(3)

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

\[ E = c B, \]

(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,

\[ \varphi_{1s} H \varphi_{1s}^* = N \left( \frac{\xi}{2} |E|^2 + \frac{1}{2\mu c^2} |E|^2 \right) \]

(5)

\[ \varphi_{1s} H \varphi_{1s}^* = N \left( \frac{\xi}{2} + \frac{1}{2\mu c^2} \right) |E|^2 \]

(6)

\[ \varphi_{1s} H \varphi_{1s}^* = K |E|^2 \]

(7)

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

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

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

(8)

where \( F_{1s}(r) \) is the wave function of hydrogen atom at ground state.

This equation tells us that for 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,

\[ E = \pm \left( \frac{F_{1s}(r)}{K} \right)^{1/2} \exp\left( -E_{1s}g t \right) \exp\left( E_{1s}g t \right) \]

(9)

if we take the real parts of \( E \) and \( B \), they are

\[ E = \pm \left( \frac{F_{1s}(r)}{K} \right)^{1/2} \cos\left( E_{1s}g t \right) \]

(12)

\[ B = \pm \frac{1}{c} \left( \frac{F_{1s}(r)}{K} \right)^{1/2} \cos\left( E_{1s}g t \right) \]

(13)

if we take the imaginary parts of \( E \) and \( B \), they are

\[ E = \pm \left( \frac{F_{1s}(r)}{K} \right)^{1/2} \sin\left( E_{1s}g t \right) \]

(14)
quantum mechanics, such as Schrödinger’s equation and Heisenberg’s matrix.

3. APPLICATION OF ELECTROMAGNETIC FIELD REPRESENTATION OF QUANTUM MECHANICS ONTO HYDROGEN ATOM SYSTEM

From the Schrödinger’s equation, the hydrogen atom at ground state can be calculated as

\[
\text{Energy (hydrogen atom at ground state)} = \int_0^\infty \phi_{1s}^* \frac{1}{\hbar} \frac{\partial \phi_{1s}}{\partial t} dt
\]

\[
= -0.5 \text{ (a.u.)}
\]

Now we start with the electromagnetic field representation of the hydrogen atom obtained above,

\[
\text{Energy (hydrogen atom at ground state)} = \int_0^\infty K |E|^2 d\tau
\]

\[
= \int_0^\infty K F_{2p0}(r, \theta) \frac{1}{\hbar} dt
\]

\[
= \int_0^\infty F_{2p0}(r, \theta) d\tau
\]

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

\[
= -0.5 \text{ (a.u.)}
\]

Comparing the results from Schrödinger’s equation and the electromagnetic field representation, 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 Schrödinger’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.

4. CONCLUSION

In this work we develop a new way to express the quantum mechanics, that is, the electromagnetic field representation of quantum system. From the calculation example, we demonstrate the equivalence of the
Schrödinger’s equation and the electromagnetic field representation in describing the quantum system, that is, hydrogen atom. We believe the new representation of quantum mechanics developed in this work definitively will find wide application in the future and further result will be presented later.

DISCLAIMER

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.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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