A Criticism to the Quantum Mechanics

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Abstract

There are two supposed equivalent versions of the quantum mechanics: the matrix mechanics and the wave mechanics. We think that only the first is true.

Key words: quantum mechanics, matrix mechanics, wave mechanics.

1. Introduction

The so-called quantum mechanics (QM) was first developed by Heisenberg in 1925 and was called (soon) the matrix mechanics (MM). Next, but in the same year, Schrödinger developed a second version called the wave mechanics (WM). We think that only the first (MM) is true.

2. The matrix mechanics

To see directly an (atomic) electron we send to it a X-photon

$$p = \frac{h}{\lambda} \tag{2.1}$$

where p and λ are the momentum and the wavelength of the photon, respectively, and h the Planck's constant; and then we watch the scattered photon (Compton effect or Compton scattering), $p' = h/\lambda'$. But (2.1) destroys the observation because produce a perturbation on the electron trajectory.

Therefore, to observe really, we watch the photon (that is, the light) emitted by the atom. This corresponds to

$$E_{ij} = E_i - E_j = h f_{ij} \tag{2.2}$$

where E_i and E_j are the energy levels of the electron corresponding to the levels i and j, respectively, and E_{ij} and f_{ij} the energy and the frequency of the light emitted. For emission, it is $i > j$ and $E_i > E_j$. But the quantities E_{ij} and f_{ij} are the components of entities called matrices, which do not commute: if A and B are matrices, then AB is not necessarily the same as BA. From (2.2), it is obtained the (canonical) commutation relation (see the appendix)

$$[x, p] = xp - px = i\hbar \tag{2.3}$$

where x and p are the position and the momentum of the electron, respectively, $i^2 = -1$ and $\hbar = h/2\pi$. From (2.3), it is obtained the Heisenberg's uncertainty principle

$$\Delta x \Delta p \geq \frac{\hbar}{2} \tag{2.4}$$

where Δx and Δp are the uncertainties in the position and in the momentum of the electron, respectively.

(2.1) and (2.2), which represent real facts, are in essence the base for the MM.

3. The wave mechanics

The WM is based in the de Broglie equation

$$mv = \frac{h}{\lambda} \tag{3.1}$$

where m, v and λ are, respectively, the moving mass, the speed and the wavelength of the (atomic) electron (and $p = m\,v$ is its momentum).

Multiplying the Newton's equation of the energy

$$E = T + V = \frac{p^2}{2m_0} + V \tag{3.2}$$

(where E, T, V, p and m_0 are, respectively, the total, kinetic and potential energies, the momentum and the rest mass of the electron) by the so-called wave function Ψ, and substituting E by the operator $i\hbar\partial/\partial t$ and p by $-i\hbar\nabla$ (where $\nabla = (\partial/\partial x, \partial/\partial y, \partial/\partial z)$, and x, y and z are the spatial coordinates), we have the Schrödinger's equation

$$i\hbar \frac{\partial}{\partial t}\Psi(\vec{r},t) = \left[-\frac{\hbar^2}{2m_0}\nabla^2 + V(\vec{r},t)\right]\Psi(\vec{r},t) \tag{3.3}$$

where $\vec{r} = (x, y, z)$ and t is the time.

As a single real wave does not represent correctly a particle, it was introduced the wave packet using the Fourier's transform. Then, Ψ is not already a real wave function representing a single real wave but a complex wave function representing a wave packet. And, proposed by Born, $|\Psi|^2 = \Psi\,\Psi^*$ (where Ψ^* is the complex conjugate of Ψ) represents the probability density ρ of finding the particle at the point (x, y, z) at the instant t, which implies that

$$\Psi = \rho^{1/2}\, e^{i\alpha} \tag{3.4}$$

where α is an argument ($\Psi^* = \rho^{1/2}\, e^{-i\alpha}$).

But (3.1), (3.3) and (3.4) are based on suppositions, not in real facts.

4. Discussion and conclusion

The fact that the two versions seem equivalents is only because the first equation of both versions, (2.1) and (3.1), are equivalents. It is because of this equivalence that the WM seems in accordance with the observations.

However, the wave function does not exist, it is only a supposition. All the equations that use wave functions are incorrect. This invalidates the equations such as: (3.3), Klein-Gordon, Dirac, etc.

In summary, as MM is based on real facts and WM not, we think that only MM is true. We need to develop the QM following only the initial idea of Heisenberg (that is, following only the MM).

Appendix

Considering the atomic electron as a harmonic oscillator, we have:

$x_{ij}(t) = x_{ij}(0)\, exp(i2\pi f_{ij} t)$

$p_{ij}(t) = m\, dx_{ij}(t)/dt = m\, x_{ij}(0)\, exp(i2\pi f_{ij} t)\, i2\pi f_{ij} = m\, x_{ij}(t)\, i2\pi f_{ij} = a\, x_{ij}(t)\, f_{ij}$

with $a = m\, i2\pi$

$x = [x_{ij}]$, $p = [p_{ij}]$, $x_{ji} = x_{ij}^*$, $f_{ji} = (E_j - E_i)/h = -f_{ij}$

$[x, p] = xp - px = [\sum_k x_{ik}\, p_{kj}] - [\sum_k p_{ik}\, x_{kj}] = [\sum_k x_{ik}\, a\, x_{kj}\, f_{kj}] - [\sum_k a\, x_{ik}\, f_{ik}\, x_{kj}]$
$= a\, [\sum_k (f_{kj} - f_{ik})\, x_{ik}\, x_{kj}] = a\, [(\sum_k (f_{kj} - f_{ik})\, x_{ik}\, x_{kj})_{i \neq j} + (\sum_k (f_{kj} - f_{ik})\, x_{ik}\, x_{kj})_{i=j}]$
$= a\, [0 + \sum_k (f_{kj} - f_{jk})\, x_{jk}\, x_{kj}] = a\, [\sum_k 2\, f_{kj}\, x_{kj}^*\, x_{kj}] = a\, [\sum_k 2\, f_{kj}\, |x_{kj}|^2]$
$= i\, [\sum_k 2\, m\, 2\pi f_{kj}\, |x_{kj}|^2] = i\, \hbar\, I$

where I is the unit (or identity) matrix.

For the last relation, note that the stationary orbit condition of Bohr for the atomic electron was: $m\, v\, r = n\hbar$; then, $n\hbar = m\, v\, r = m\, \omega r\, r = m\, 2\pi f\, r^2$, where n is a positive integer, $\omega = 2\pi f$ the angular frequency and r the radius of the orbit.

Note also that it would be:

$(\sum_k (f_{kj} - f_{ik})\, x_{ik}\, x_{kj})_{i \neq j} = 0$.

References

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