Deterministic Quantum Model of Atom

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Abstract

The deterministic quantum model of atom described in the order of Deterministic Quantum Physics has proved a deterministic and non probabilistic formulation of atom model is possible. The preceding deterministic model presents nevertheless an imprecision regarding the use of spin. In fact in that model the double sign, positive and negative, for spin has been used in improper way. Because in the order of the Non-Standard Model electron spin is related to electron charge that is always by convention negative, it is manifest that electron spin has to assume always a negative value.

1. Introduction

In the article "Basic Principles of Deterministic Quantum Physics"[1], starting from D'Alembert-Schròdinger equation the deterministic quantum model of atom was derived for any atomic number Z. In that model energy levels are given by

$$E_{nks} = -\frac{2Z^2Rhc}{n^2}\left(1 - \frac{k^2}{2n^2}\right)\left(1 - \frac{1}{2}\frac{\alpha^2Z^2(k\pm s)^2}{n^4}\right) \qquad (1)$$

where $n = 1, 2, 3 ......$ principal quantum number or quantum number of level

$k = 1, 2 .....n$ quantum number of sub-level

$s = \frac{k}{2}$ quantum number of spin

$R = \frac{e^4 m_o}{8\varepsilon_o^2 ch^3}$ is Rydberg's constant

$\alpha = \frac{e^2}{2\varepsilon_o ch}$ is the Lamb constant or constant of fine structure

The deterministic quantum model (1) is substantially different from Dirac's indeterministic quantum model[2] that is prevalent in the present physics:

$$E_n = -\frac{Z^2Rhc}{n^2}\left(1 - \frac{Z^2\alpha^2}{n^2}\left(\frac{3}{4} - \frac{n}{j+\frac{1}{2}}\right)\right) \qquad (2)$$

where n=1, 2,3..... is the principal quantum number

$j = \frac{1}{2}, \frac{3}{2} .... n - \frac{1}{2}$ is the magnetic quantum number

Dirac's model is inappropriate to describe the atomic structure because it doesn't make use of appropriate quantum numbers and it doesn't consider Lamb's shifts of spectral lines. Besides it makes use of a relativistic correction based on Lorentz's factor that has been proved to be obsolete in the order of the Theory of Reference Frames[3] .

When the equation (1) of the deterministic quantum model was derived the Non-Standard Model[4][5][6][7][8] (NSM) didn't have been formulated yet. In this model (NSM) the "Theorem of Charge and of Spin" has established a strict relation between the angular momentum (spin) of an elementary particle with rotating mass and its electric charge:

$$Q = \pm \frac{q_s}{S} \qquad (3)$$

in which the double sign indicates electric charge Q can be positive or negative as a consequence of the fact that angular momentum (spin) of particle can have two opposite values because also the direction of rotation of particle round its axis can have two opposite values. S is a constant given by

$$S = \frac{h}{4\pi e} = 0.33 \cdot 10^{-15} \text{ volt} \cdot \text{s} \qquad (4)$$

The relation (3) proves electric charge has bipolar nature (positive and negative) because intrinsic angular momentum (spin) of particle, due to the rotary motion of particle with respect to its axis of symmetry, is bipolar because rotation can happen in two opposite directions.

In the event of electron, because electron has always negative electric charge it is manifest that the two opposite values of spin ($\pm h/4\pi$) cannot regard electron that has always negative spin ($q_s = -h/4\pi$). The positive value of spin characterizes instead in NSM positron that is antiparticle of electron and it has always positive electric charge. Positrons aren't present in matter but in antimatter and hence the double sign for spin, positive and negative, in the relation (1) doesn't have meaning because in atoms of matter there aren't antiparticles[4][8][9]. This consideration proves the deterministic quantum model, given by (1), has to be duly corrected.

2. The deterministic quantum model (DQM) of atom

Preceding considerations exclude inside atom electrons can have two opposite values of spin, as it was assumed in the (1), but necessarily they must have always a negative value of spin.
Negative electric nature of electron excludes hence the possibility of the double sign for spin. On the contrary the double sign regards instead orbital angular momentum q_k of electron in atom because effectively electron in orbital motion can revolve in both directions and this motion isn't associated with spin and with antimatter.
Orbital momentum of electron in every sub-level k of atom is given by[1]

$$q_k = k \frac{h}{2\pi} \qquad k = 1, 2, \ldots\ldots\ldots n \qquad (5)$$

Because within every sub-level orbital motion can happen in both opposite directions, it is possible to consider, for every value k of the sub-level, two opposite values of orbital momentum

$$q_k = \pm k \frac{h}{2\pi} \qquad k = 1, 2, \ldots\ldots\ldots n \qquad (6)$$

Like this total angular momentum q_t of every electron is given by

$$q_t = q_k + q_s \qquad (7)$$

where q_s is the intrinsic angular momentum (spin) of electrons[1]

$$q_s = - s \frac{h}{2\pi} \qquad (8)$$

in which s is a quantum number given by[1]

$$s = \frac{k}{2} \qquad (9)$$

Electron spin is negative because its electric charge is always negative.
From (6), (7) and (8) we have

$$q_t = q_k + q_s = \pm k \frac{h}{2\pi} - s \frac{h}{2\pi} = (\pm k - s) \frac{h}{2\pi} \qquad (10)$$

Hence it needs to replace in the (1) the term (k±s) with the term (±k-s).
The (1) becomes like this

$$E_{nks} = -\frac{2Z^2Rhc}{n^2}\left(1 - \frac{k^2}{2n^2}\right)\left(1 - \frac{1}{2}\frac{\alpha^2Z^2(\pm k-s)^2}{n^4}\right) \qquad (11)$$

We observe the same quantum number k is used in the (11) in two different terms: in the first term $(1- k^2/2n^2)$, like quantum number for sub-level, and in the second term $(1- \alpha^2Z^2(\pm k+s)^2/2n^4)$. This second term considers Lamb's shift of spectral lines because of the relativistic correction of mass due to the variation of electrodynamic mass with the velocity.

It is manifest that the simultaneous use of the same quantum number produces a mistake in calculation of energy levels of electron. Hence it is convenient to introduce a new quantum number j (called "momentum quantum number") and clearly this quantum number j for every value k of sub-level can assume values

$$j = 1, 2, \ldots k \qquad (12)$$

Consequently the (9) becomes

$$s = \frac{j}{2} \qquad (13)$$

As per these considerations it follows that energy levels of electron in atom, considering all quantum number that have been introduced, are given by

$$E_{nkjs} = -\frac{2Z^2Rhc}{n^2}\left(1 - \frac{k^2}{2n^2}\right)\left(1 - \frac{1}{2}\frac{\alpha^2Z^2(\pm j-s)^2}{n^4}\right) \qquad (13)$$

in which

$n = 1, 2, \ldots$	quantum number of level
$k = 1, 2, \ldots n$	quantum number of sub-level
$j = 1, 2, \ldots k$	quantum number of orbital momentum
$s = \frac{j}{2}$	quantum number of spin

Like this also Pauli's principle of exclusion is valid because every electron inside atom has to occupy necessarily a different quantum state defined by different values of four quantum numbers n, k, j, s.

The (13) can be written also in the following shape

$$E_{nkjs} = -\frac{2Z^2Rhc}{n^2}\left(1 - \frac{k^2}{2n^2}\right)\left(1 - \frac{1}{2}\frac{\alpha^2Z^2(j-s)^2}{n^4}\right) \qquad (14)$$

in which j= ±1, ±2, ... ±k and s=|j|/2

From (13) or from (14) it is possible to derive the number of energy levels that are available for electrons in atom (table 1).

energy level	sub-level	relativistic sub-levels	number of electrons for level
n =1	k =1	j=1	2
n=2	k=1,2	j=1,2	8
n=3	k=1,2,3	j=1,2,3	18
n=4	k=1,2,3,4	j=1,2,3,4	32
n=5	k=1,2,3,4,5	j=1,3,3,4,5	50

Table 1 Number of electrons for every energy level of atom

The table 1 gives the same number of electrons for energy level of the deterministic quantum model described by the (1). What changes instead is the numerical value of energy of single levels and sub-levels.

References

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