Path Distribution Energy and Possible Consequences

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Previously (*Progress in Physics, 2013, v. 4, 83–84*) one investigated the geometric distribution of the frequencies of the path of the electron in the ground state of Hydrogen atom. In this paper one shows that the resulting difference detected on the fifth decimal of the inverse fine structure constant is accompanied by the difference in the quantized energy up to 0.04 eV. The difference in charge as well as energy of the distributed and non-distributed electrons could explain the origin of van der Waals intermolecular interactions.

1 Theoretical background

The distribution of the path of the electron changes the inverse fine structure constant [1]. Let us see what is accompanied to that change. The inverse fine structure constant can be expressed as:

$$\alpha^{-1} = \frac{2\varepsilon_0 h c}{e^2}. \tag{1}$$

The energy equivalent of the mass of the electron E_e can be expressed as [2]:

$$E_e = m_e c^2 = \frac{e^2}{4\pi\varepsilon_0 r_e}. \tag{2}$$

The inverse fine structure constant α^{-1} and the energy equivalent of the mass of the electron E_e are in inverse proportion since combining (1) and (2) the next relation is given:

$$\alpha^{-1} = \frac{h c}{2\pi E_e r_e}. \tag{3}$$

Other parameters staying untouched the inverse fine structure constant α^{-1} is changed due to the change of the electron charge e and consequently the energy equivalent of the mass E_e. Energetically more favorable is the greater inverse fine structure constant α^{-1} since it belongs to the smaller charge e and energy equivalent E_e. Therefore the proposed distributed path of the electron in the ground state of Hydrogen atom [1] is more favorable than non-distributed one. Having greater α^{-1} possesses lower E_e. The most favorable is the infinite-sided distribution with the largest α^{-1} and the lowest E_e. Energies of the discrete distributions are quantized. The difference in energy between the non-distributed electron E_0 and on the arbitrary number of the even-sides k distributed electron E_k is given by:

$$\Delta E_k = E_0 - E_k. \tag{4}$$

Because of the inverse proportion of α^{-1} and E_e holds:

$$\frac{\alpha^{-1}_{k-sided}}{\alpha^{-1}_{0-sided}} = \frac{E_0}{E_k}. \tag{5}$$

The difference in energy is then expressed as:

$$\Delta E_k = \left(\frac{\alpha^{-1}_{k-sided}}{\alpha^{-1}_{0-sided}} - 1 \right) E_0. \tag{6}$$

The difference in energy between the energy equivalents of the mass of the electron at the different number of sides of distribution ΔE_k (4) is also the difference of the distribution energies ΔE_d:

$$\Delta E_k = \Delta E_d = \Delta E_{0-distribution} - E_{k-distribution}. \tag{7}$$

The distribution energy of the non-distribution is assumed to be zero:

$$E_{0-distribution} = 0. \tag{8}$$

So the distribution energy of the path of the electron of the arbitrary *k-sided* distribution is given by:

$$E_{k-distribution} = -\Delta E_d = -\Delta E_k. \tag{9}$$

The negative distribution energy means that energy is released in the case when the electron path becomes distributed, and on the contrary, the energy is spent in the case when the electron path becomes non-distributed. The distribution of the path of the electron does not need to be atom-radius dependent (it is distribution-radius dependent) [1] so what applies for Hydrogen atom could hold true also for other atoms.

2 Calculation of the Distribution Energy

The non-distribution energy $E_{0-distribution}$ is zero by definition (8).

On the two decimals rounded energy of the two-sided distribution can be calculated with the help of equations (6) and (9) knowing the CODATA value of the energy equivalent of the mass of the electron $E_e = 510998.91$ eV, and the appropriate distributed inverse fine structure constants $\alpha^{-1}_{0-sided} = 137.036006$ and $\alpha^{-1}_{2-sided} = 137.036014$ [1]:

$$E_{2-distribution} = -0.03 \text{ eV}. \tag{10}$$

On the two decimals rounded energy of the infinite-sided distribution can be calculated in the same way knowing the inverse fine structure constant $\alpha_{\infty-sided}^{-1} = 137.036018$ [1]:

$$E_{\infty-distribution} = -0.04 \text{ eV}. \quad (11)$$

The infinite number of the quantized distribution energies in the range of 0.04 eV can be calculated on all k-sides of the ground state of Hydrogen atom. Of course this paper brings no statement of how many of them are physically true.

3 Instead of conclusion

The proposed quantized distribution energies of the electron seem to have physico-chemical consequences. Ranged up to 0.04 eV (10), (11) are of the same order of magnitude as the typical energies from 0.4 kJ/mol to 4 kJ/mol of the van der Waals interaction between atoms [3]. Indeed:

$$\frac{4 \text{ kJ}}{\text{mol}} \approx \frac{0.04 \text{ eV}}{\text{molecule}}. \quad (12)$$

The different energy and charge of the distributed and non-distributed electrons could explain the origin of the mentioned intermolecular interactions.

Dedication

This fragment is dedicated to my wife Ivka.

References

1. Špringer J. Geometric Distribution of Path and Fine Structure. *Progress in Physics*, 2013, v. 4, 83–84.

2. Haken H., Wolf H.C., Brewer W.D. The Physics of Atoms and Quanta: Introduction to Experiments and Theory. 2005, Springer. p. 70.

3. http://chemwiki.ucdavis.edu/Physical_Chemistry/Quantum_Mechanics/Atomic_Theory/Intermolecular_Forces/Van_Der_Waals_Interactions. Retrieved October 2013.