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# Whole and Part in Helium

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**Abstract:** *The thesis that the whole and the part must be aligned has been tested on the example of the Helium atom.*

**Keywords:** *Part and whole, Helium isotopes, double surface geometry*

## 1. Introduction

The purpose of this article is on the example of Helium isotopes to examine the validity of the thesis that the whole and the part must be aligned [1].

## 2. The Bohr-Like Obit

On Bohr orbit [2] the electron circulates around a nucleus consisted of only one proton. On Bohr-like orbit [3] the electron circulates around a nucleus consisted of more than one proton. Consequently the orbit length $s$ shortens and the kinetic energy $Wk$ of the electron on it enlarges. The ratio of both orbit lengths (as well as the inverse ratio of corresponding kinetic energies of the electron) equals the effective nuclear charge $Z_{effective}$ which covers the shielding effect committed by neighbouring electrons, too. The above statement is written as follows:

$$Z_{effective} = \frac{s_{Bohr} = \alpha^{-1}}{s_{Bohr-like}} = \frac{Wk_{Bohr-like}}{Wk_{Bohr} = Ry}. \tag{1}$$

Knowing the effective nuclear charge $Z_{effective}$ [3] and with the help of the equation (1) any Bohr-like orbit length expressed in Compton wavelengths of the electron and the corresponding kinetic energy of the electron on it can be given with the help of the inverse fine structure constant $\alpha^{-1} = 137.035\,999\,084$ and Rydberg constant $Ry = 13.605\,693\,122\,994\ eV$, respectively.

The Bohr-like orbit length:

$$s_{Bohr-like} = \frac{\alpha^{-1}}{Z_{effective}}. \tag{2}$$

The Bohr-like orbit kinetic energy of the electron:

$$Wk_{Bohr-like} = Z_{effective}\ x\ Ry. \tag{3}$$

## 3. The Bohr-Like Orbit in the Helium

The effective nuclear charge of Helium is the next [3]:

$$Z_{effective}^{Helium} = \frac{27}{16} = 1{,}6875. \tag{4}$$

So (2), the Bohr-like orbit length in Helium yields:

$$s_{Bohr-like}^{Helium} = \frac{\alpha^{-1}}{Z_{effective}^{Helium}} = \frac{16}{27}\alpha^{-1} = 81{,}206\,517\,976\,\lambda_e. \tag{5}$$

And the circulating electron (3) on the Bohr-like orbit in the Helium possesses the next kinetic energy:

$$Wk_{Bohr-like}^{Helium} = Z_{effective}^{Helium}\ x\ Ry = \frac{27}{16}\ Ry = 22{,}959\ 607\ 145\ \ eV. \tag{6}$$

## 4. THE BOHR-LIKE ORBIT DISTRIBUTION IN THE HELIUM

Analogous to the Bohr orbit distribution[1] the Bohr-like orbit can be distributed, too. So the electron in the ground state of any atom circulates around the nucleus on one of the distributed orbits according to the restrictions of the double surface geometry [2]:

$$s(n) = n\left(2 - \frac{1}{\sqrt{1 + \frac{\pi^2}{n^2}}}\right), \qquad n \in \mathbb{N}. \tag{7}$$

Where a natural number $n$ is the elliptic length and an irrational number $s(n)$ is the average elliptic-hyperbolic length of some distributed orbit expressed in Compton wavelengths of the electron. Respecting this concept - and allowing the diversity of kinetic and potential energy at the untouched total energy - the kinetic energy $W_k$ of the electron in the ground state of an atom is of the distributed orbit $n$ dependent. In the Helium atom the distribution takes place in the interval $1 \le n \le 162$ as follows [1]:

$$Wk(n) = \frac{27}{16}Ry\left(2\frac{s(81)}{s(n)} - 1\right) = \frac{27}{16}Ry\left(2\frac{81(2 - \frac{1}{\sqrt{1 + \frac{\pi^2}{(81)^2}}})}{n(2 - \frac{1}{\sqrt{1 + \frac{\pi^2}{n^2}}})} - 1\right), \quad 1 \le n \in \mathbb{N} \le 162. \tag{8}$$

Where $Ry$ denotes Rydberg constant.

On the 81th orbit with the length $s(81) = 81.206\ 517\ 976\ \lambda_e$ the kinetic energy of the electron equals $\frac{27}{16}$ Rydberg constant:

$$W_k(81) = \frac{27}{16}Ry = 22{,}959\ 607\ 145\ eV. \tag{9}$$

And on the longer orbit the kinetic energy is smaller, for instance on the 90th orbit it possesses the next value:

$$W_k(90) = \ 18{,}447\ 850\ 138\ \text{eV}. \tag{10}$$

And on the 120th orbit has the next value:

$$W_k(120) = \ 6{,}862\ 494\ 685\ \text{eV}. \tag{11}$$

Orbits with $n > 162$ are out of range. Belonging to the negative kinetic energy of the electron they are impossible.

## 5. THE WHOLE-PART ALIGNMENT

The whole-part alignment assumes the next relation [1]:

$$\frac{\lambda_{part}}{\lambda_{whole}}\frac{s(1)}{s(n)} = \frac{m_{whole}}{m_{part}}\frac{s(1)}{s(n)} = 1. \qquad n \in \mathbb{N}. \tag{12}$$

Here $\lambda$ and $m$ denotes the wavelength and the mass of a physical body as a whole or as its part, respectively, and $R = s(n)$ is the modified whole-part ratio:

$$R = s(n) = \frac{m_{whole}}{m_{part}}\ s(1) = \frac{m_{whole}}{m_{part}}\ x\ 1{,}696\ 685\ 529. \tag{13}$$

The whole-part alignment is achieved by the appropriate kinetic energy of the part:

$$m_{part} = m_{rest} + \frac{W_k}{c^2}. \tag{14}$$

So it holds

$$R_{aligned} = s(n) = \frac{m_{whole}}{m_{rest} + \frac{W_k}{c^2}} s(1) = \frac{m_{whole}}{m_{rest} + \frac{W_k}{c^2}} x\ 1{,}696\ 685\ 529, \quad (15)$$

And

$$R_{unaligned} = s(n \notin \mathbb{N}) = \frac{m_{whole}}{m_{rest}} s(1) = \frac{m_{whole}}{m_{rest}} x\ 1{,}696\ 685\ 529. \quad (16)$$

Then

$$W_k = \left(\frac{R_{unaligned}}{R_{aligned}} - 1\right) m_{rest} c^2. \quad (17)$$

In a Helium atom the rest mass of the part $m_{part}$ is the rest mass of the electron $m_e$:

$$m_{rest} = m_e = 0.000\ 548\ 583\ 3\ Da = 510\ 998{,}950 \frac{eV}{c^2}. \quad (18)$$

And the mass of the whole $m_{whole}$ is the mass of some Helium isotope $m_{He}$.

## 6. THE WHOLE-PART ALIGNMENT IN THE HELIUM

Nine Helium isotopes are known[4]. They are presented in Table1. All of them possess two protons and two electrons but have different number of neutrons and consequently nucleons as their sum. Those with the number of atomic nucleons 3 and 4 are stable; those with the number of atomic nucleons 2, 5, 6, 7, 8, 9 and 10 are unstable. Stable isotopes are denoted in bold print.

**Table1.** *Basic characteristics of Helium isotopes*

| $^A{}_Z$ He (isotope) | A(number of nucleons) | Z (number of protons) | A-Z (number of neutrons) |
|---|---|---|---|
| $^2{}_2$He or He-2 | 2 | 2 | 0 |
| **$^3{}_2$He or He-3** | **3** | **2** | **1** |
| **$^4{}_2$He or He-4** | **4** | **2** | **2** |
| $^5{}_2$He or He-5 | 5 | 2 | 3 |
| $^6{}_2$He or He-6 | 6 | 2 | 4 |
| $^7{}_2$He or He-7 | 7 | 2 | 5 |
| $^8{}_2$He or He-8 | 8 | 2 | 6 |
| $^9{}_2$He or He-9 | 9 | 2 | 7 |
| $^{10}{}_2$He or He-10 | 10 | 2 | 8 |

With the help of the equations (12), (13), (14) and the known data for the mass of isotopes and electron [4] the ratios of the whole-part alignment $R$ - as well as the kinetic energies $W_k$ of the electrons enabling the alignment - in the Helium isotopes are given. The alignment is carried out on the nearest available aligned whole-part ratio $R_{aligned}$. The data and results are collected in Table2.

**Table2.** *The whole-part alignment in the Helium isotopes*

| | $m_{He}$ (in Daltons) | $R_{unaligned}$ | $R_{aligned}$ | $Wk_{aligned}$ | $Wk_{distributed}$ |
|---|---|---|---|---|---|
| He-2 | 2,015 894 | 6.234,856 543 752 | 6234,000 791 595 | -11,82 eV | Out of range |
| **He-3** | **3,016 029 322 65** | **9.328,124 474 041** | **9328,000 529 031** | **6,79 eV** | **6,86 eV** |
| **He-4** | **4,002 603 254 13** | **12.379,449 064** | **12379,000 398 643** | **18,52 eV** | **18,45 eV** |
| He-5 | 5,012 057 | 15.501,537 473 749 | 15502,000 318 333 | -15,26 eV | Out of range |
| He-6 | 6,018 885 89 | 18.615,507 599 785 | 18616,000 265 084 | -13,52 eV | Out of range |
| He-7 | 7,027 991 | 21.736,517 731 477 | 21737,000 227 023 | -11,34 eV | Out of range |
| He-8 | 8,033 934 39 | 24.847,749 139 371 | 24848,000 198 600 | -5,16 eV | Out of range |
| He-9 | 9,043 95 | 27.971,575 310 440 | 27972,000 176 419 | -7,76 eV | Out of range |
| He-10 | 10,052 82 | 31.091,858 282 310 | 31092,000 158 716 | -2,34 eV | Out of range |

| Other data | |
|---|---|
| $m_e$(Da) | 0,000 548 583 3 |
| $m_e c^2$(eV) | 510 998,950 |
| s(1) | 1,696 685 529 |

For instance, the whole-part characteristics of the most abundant helium isotope He-4 are given as follows:

The unaligned whole-part ratio of He-4 is the next (12):

$$R_{unaligned}^{He-4} = \frac{m_{He-4}}{m_e} s(1) = \frac{4{,}002\ 603\ 254\ 13}{0{,}000\ 548\ 583\ 3} 1{,}696685\ 529 = 12.379{,}449\ 064. \tag{19}$$

The aligned whole-part ratio of He-4 is the next (13):

$$R_{aligned}^{He-4} = s(12379) = \left(2 - \frac{1}{\sqrt{1 + \frac{\pi^2}{12379^2}}}\right) = 12379{,}000\ 398\ 643. \tag{20}$$

And the kinetic energy of the electron enabling the whole-part alignment of He-4 is the next (14):

$$Wk_{aligned}^{He-4} = \left(\frac{12.379{,}449\ 063\ 817}{12379{,}000\ 398\ 643} - 1\right) 510\ 998{,}950\ eV = 18{,}521\ \ eV. \tag{21}$$

The kinetic energy of the electron enabling the whole-part alignment of the Helium isotope He-4 (18) approximately equals the kinetic energy of the electron on the $90^{th}$distributed Bohr-like orbit in the ground state of Helium atom (10):

$$Wk_{aligned}^{He-4} = 18{,}52\ eV\ \approx W_k(90) = \ 18{,}45\ \text{eV}. \tag{22}$$

The same approximate equality is achieved in the case of the other stable Helium isotope He-3, too. Here the kinetic energy of the electron enabling the whole-part alignment (Table2) approximately equals the kinetic energy of the electron on the $120^{th}$distributed Bohr-like orbit in the ground state of Helium atom (11):

$$Wk_{aligned}^{He-3} = 6{,}79\ eV\ \approx W_k(120) = 6{,}86\ \text{eV}. \tag{23}$$

In the Helium isotopes He-2, He-5, He-6, He-7, He-8, He-9 and He-10 the whole-part alignment cannot be achieved at the nearest whole-part ratio $R_{aligned}$ since the needed kinetic energy of the electron belongs to the orbits available outside the range of Bohr-like orbit distribution. This could be the reason of instability of these isotopes. But not necessarily, since the alignment could be carried out at the second nearest whole-part ratio $R_{aligned}$, too.

## 7. CONCLUSION

The validity of the whole-part alignment has been extended from Hydrogen to Helium.

## DEDICATION

This fragment is dedicated to the hills between the rivers Pesnica and Ščavnica, so that this world, with its nobility, would protect the new Šprinaer pharmacy in Cerkvenjak - the heart of Slovenske gorice. **Ta fragment je posvečen gričem med rekama Pesnico in Ščavnico, da bi ta svet s svojo žlahtnostjo zaščitil novo lekarno Šprinaer v Cerkvenjaku - osrčju Slovenskih goric.**

**Figure1.** *Whole and Part in Cerkvenjak*

## REFERENCES

[1] Janez Špringer (2021). Whole and Part in Hydrogen Atom. International Journal of Advanced Research in Physical Science (IJARPS) 8(5), pp.1-3, 2021.

[2] Janez Špringer. How Far Away and Often from Bohr Orbit (Treatise on the Choice). International Journal of Advanced Research in Physical Science (IJARPS). Volume 3, Issue 9, 2016, PP 1-6

[3] Janez Špringer. Conceptual Helium Atom Radius. International Journal of Advanced Research in Physical Science (IJARPS) Volume 4, Issue 2, February 2017, PP 13-16

[4] *Wang, M.; Audi, G.; Kondev, F. G.; Huang, W. J.; Naimi, S.; Xu, X. (2017).* "The AME2016 atomic mass evaluation (II). Tables, graphs, and references" (PDF). *Chinese Physics C.* ***41*** *(3): 030003-1–030003-442*

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