INTERACTION BETWEEN THE NUCLEONS IN THE

ATOMIC NUCLEUS

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It is known that between the nucleons in the atomic nucleus there are forces with a far greater magnitude in comparison to the electrostatic and gravitational interactions between them. These nuclear forces, also called strong interaction, determine the strong connection between the nuclear particles – the nucleons. The empiric equations, which are employed in calculating the nuclear forces, don't give us any information about the character and nature of the physical processes associated with the interaction between the nucleons in the atomic nucleus.

The purpose of this work is to make an attempt at clarifying the reasons behind and the character of the interactions between the nucleons in the atomic nucleus, while speculations about the structure of the nucleons and the atomic nucleus are being considered. The author considers that such clarifications will greatly contribute to the enhancement of our knowledge of the atomic nucleus on one hand, and will serve as a basis for the future development of the nuclear physics and its practical applications, on the other hand.

1. Basic assumptions

1.1. We assume that the strong interaction is taking place between every two neighbor nucleons in the atomic nucleus and is a quantum of energy,

$$E = -h \cdot \nu$$

that is being emitted from the first and absorbed by the second nucleon. If we succeed in finding ν, we will determine the value of the nuclear forces.

1.2. Further we use the Huygens-Fresnel principle about diffraction of the waves, which applied in this case at certain boundary conditions, leads us to the equation

$$2 \cdot r^2 \cdot \nu = c \cdot x \quad (1)$$

where: r - radial size (radius) of the nucleons at the moment of interaction.
x - distance between the two nucleons at the moment of interaction.

The boundary conditions for the mentioned case are:

- because of the indivisibility of a quantum of energy, the number of the zones of Fresnel equals 1.
- a quantum of energy with frequency ν is considered a flat wave, diffracted by the emitting nucleon onto the absorbing nucleon.

From this time forth we will be looking at the basic state of the atomic nucleus, not at its excited state, i.e. quantum number $n = 1$.

1.3. Using data from experiments for the energy E, we determine ν and from (1) we ascertain that at the moment of interaction $r \gg x$. This conclusion leads to very important assumptions, namely:

1.4. In the moment of interaction we can look at the nucleons as flat particles, and if we go into detail, as composed from a positively charged nucleus (further referred to as micronucleus) and the particles revolving around it. K^{-}-meson in case of the neutron and K^{o}

-meson in case of the proton. The revolving motion of the charged particles will be used as a circular current. After such assumption we immediately find out the following about the magnetic momentum of the neutron:

$$\mu_n = \frac{e.\hbar}{2.c.m_{K^-}} = -1,905\mu$$

The stable levels of the K^- -meson regarding the micronucleus are

$$r_n = \frac{n^2.\hbar^2}{e^2.m_{K^-}} \qquad (2)$$

In which n is the quantum number. As we already pointed out, n = 1. For the free neutron we get $r = 5,\ 44 \cdot 10^{-12}\,\text{cm}$.

1.5. The strong interaction is being caused by resonance phenomena between the interacting nucleons – circular currents.

2. Atomic resonance equations

2.1. The emitting of a quantum of energy takes place, when the natural frequency of the emitting nucleon becomes equal to the natural frequency of the whole system of two nucleons, while the two nucleons move towards one another or away from each other. The frequency of the quantum of energy is equal to this frequency, which we call “resonance”. Similarly, we call the distance between the two nucleons at the moment of interaction – “resonance distance”.
Under the influence of the emitted quantum of energy, the nucleons come closer to each other, until this is stopped by the force of electrostatic repulsion, after which begins the separation of the nucleons from each other. They go through the resonance distance again, where a quantum of energy is being emitted once more, et cetera. We have an infinitely pulsing nucleus.

2.2. Let us go back to determining the natural frequency of the nucleon and the system of two nucleons, in this case neutron and proton (D_1^2). From the theoretical electrical engineering is known, that the natural frequency of the system of two circular currents is

$$\omega = \frac{1}{\sqrt{C_c.M}}$$

where: M – mutual inductance of the system.
C_c – capacity of the system.

$$M = \mu_0.r.f(k)$$

$$f(k) = \left(\frac{2}{k} - k\right).\bar{K} - \frac{2}{k}.\bar{E}$$

$$k^2 = \frac{4r^2}{x^2 + 4r^2}$$

$$\bar{K} = \int_0^{\frac{\pi}{2}} \frac{d\beta}{\sqrt{1 - k^2 \sin^2(\beta)}} \ ; \quad \bar{E} = \int_0^{\frac{\pi}{2}} \sqrt{1 - k^2 \sin^2(\beta)}.d\beta$$

$$C_c = \frac{4\pi^2 \varepsilon_0 r}{k_a \bar{K}_a - k\bar{K}}$$

$$k_a \cong 1 \text{ for } a^2 \ll 4r^2$$
$$\bar{K}_a \cong ln\frac{8r}{a}$$

After transformations we get:

$$2\pi^2.\nu.r\sqrt{\varepsilon_0\mu_0}.\sqrt{\frac{\ln\frac{8r}{x}-2}{\ln\frac{x}{a}}}=1 \qquad (3)$$

where: ε_0 - electric permittivity of the vacuum.

μ_0 - Magnetic permeability of the vacuum.

a - radius of the section of the circular current (K^- -meson)

The natural frequency of the circular current is calculated analogically. We get:

$$2\pi^2.\nu.r\sqrt{\varepsilon_0\mu_0}.\sqrt{1-\frac{2}{\ln\frac{8r}{a}}}=1 \qquad (4)$$

In case of the two nucleons

$$r=\frac{n^2.\hbar^2}{2e^2.m_{K^-}} \qquad (2')$$

After the appropriate calculations from equations 1, 2', 3 and 4, we get for D_1^2:

r = 2, 75 $\cdot 10^{-12}$ cm; ν = 0, 65 $\cdot 10^{21}$ Hz

x = 3, 28 $\cdot 10^{-13}$ cm; E = 2, 69 MeV – energy of the strong (resonance) interaction

a = 1,36 $\cdot 10^{-14}$ cm;

In the nucleus, as known, there are electrostatic forces between the charged particles at work, therefore the full interaction energy between the proton and the neutron in D_1^2 is

$$P = E + U$$

where: U - energy of the electrostatic interaction. As we use our knowledge of the theoretical electrical engineering, we find "U" and after calculation we get:

$$P = 2,26 \text{ MeV}$$

2.3. The equations 2', 3 and 4 assume the corresponding appearance for the bigger nuclei:

$$r=\frac{n^2.\hbar^2}{S_N e^2.m_{K^-}} \qquad (2'')$$

where S_N gives an account about the influence of the positively charged micronuclei. In this case we have accepted that the micronuclei (respectively the nucleons) are "arranged" in a line. "N" is the number of nucleons in the given nucleus.

$$\nu.A.r.\sqrt{\frac{\ln\frac{8r}{x}-2}{\ln\frac{x}{a}}}=1 \qquad (3')$$

$$\nu .A.r.\sqrt{1-\frac{2}{\ln\frac{8r}{a}}}=1 \qquad (4')$$

where: $A=4\pi^2\frac{N_0}{N}\sqrt{\varepsilon_0\mu_0}$

N_0 - number of neutrons in the nucleus

As we already mentioned, besides the resonance interaction, in the nucleus there are constant electrostatic forces at work, which can be easily determined. Then the full energy of the interaction between every two neighbor nucleons in the nucleus is

$$P=-h\nu+\frac{e^2S_{1N}}{x}-\frac{e^2S_{2N}.x}{r^2} \qquad (5)$$

where S_{1N} and S_{2N} are sums, depending upon the position of the two nucleons in the nucleus.

2.3.Examples

- For the nucleus of Be_4^9

r = 8, 06 · 10^{-13} cm; x = 8, 64 · 10^{-14} cm

ν = 1, 99 · 10^{21} Hz; E = 1, 67 MeV

a = 5, 24 · 10^{-15} cm;

- For the nucleons in the nucleus of U_{92}^{235}

r = 2, 67 · 10^{-13} cm; x = 2, 6 · 10^{-14} cm

ν = 0, 545 · 10^{22} Hz; E = 22, 53 MeV

2.4. So far we have accepted, that the quantum of energy emitting nucleon is the neutron, as in the atomic nucleus occurs a continuous conversion of neutrons into protons and a constant cycle of coming nearer and separating of the neutrons; it appears that the nucleus is pulsing. Moreover the number of protons and neutrons at every moment is constant.

3. Possible applications

The here presented ideas give us less answers than they pose questions, pointing us in the direction of deeper study of the atomic nucleus and the elementary particles. Along with the theoretical significance, I'd like to point out some more concrete applications:

3.1. Explanation of the formation of the atomic nucleus after the Big Bang: at a definite stage of the expanding matter the nucleons are formed. As the nucleons continue to expand, they go through the resonance distance and form the atomic nuclei.

3.2. An alternative method to achieve a nuclear fusion: for this purpose we need to ensure the reaching of resonance distance between the nucleons. In other words we use protons and neutrons to start the reaction, for example by reaching the required high pressure (other external influences can be applied), thereafter light nuclei are being "inserted" to increase the power.

3.3. It sounds quite alchemical, nevertheless it can be expected, that we can destroy a given nucleus in preliminarily chosen point by externally influencing it with certain frequency, in which case we will get the desired new nucleus.

3.4. It can be shown, that there is such a maximal number of nucleons and such proportion between protons and neutrons, after which the nucleus, in natural conditions, cannot exist.

3.5. Explanation of the natural radioactivity and many other phenomena related to the atomic nucleus.

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