CRYSTALLINE ELECTROMAGNETIC MODEL OF NUCLEI AND HADRONS

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Currently, there are many models of nuclei and elementary particles that successfully describe their individual properties. But until now there is no single model that would immediately consistently explain all the properties of nuclei, nuclear forces, predict the values of the masses of particles and their other characteristics [1, 2]. This already century-old incapacity of artificial theories of the nucleus is due to the desire to find only an external description of properties in the formal language of quantum mechanics. The fruitlessness of this approach forces us to seek a solution to the mysteries of the nucleus along the way of classical pre-quantum models, in which such scientists as F. Lenard, J. Thomson and W. Ritz tried to establish the internal structure of the nucleus, particles and thereby find not a formal mathematical, but a physical explanation their properties [3].

According to Thomson, the stability of a nucleus consisting of positively charged protons can be explained if the Coulomb force ceases to follow the inverse square law at distances of the order of nuclear distances and may even change sign: repulsion turns into attraction [4]. From the standpoint of modern physics, this assumption is fully justified if we take into account the finite sizes of protons and the discovery of many charged centers (partons) inside them. That is, at distances of the order of the size of a proton, its field behaves not like the field of a point charge, but like the field of a dipole or multipole, which has a complex dependence on distance, direction and even changes its sign. By the way, it was precisely this structure of nuclei in the form of a set of dipoles that F. Lenard assumed back in 1904, having correctly estimated their size at the level of 10^{-14} m [5]. That is, protons at nuclear distances can be attracted without the participation of specific nuclear forces, sticking together like the dipoles of water molecules. The first droplet model of the nucleus was built on this property of water particles. Therefore, it would be natural to assume that the coalescence of protons occurs under the influence of electrostatic forces. Indeed, Thomson back in 1903 showed that the energy released during nuclear decay is of the same order as the energy of electrostatic interaction of parts of the nucleus [6].

What is the specific structure of the proton and the nature of the charges that form it? According to Thomson, a proton consists of many hundreds of electrons and the same positive charges (positrons), which are one more. This explains the unit positive charge of the proton, its mass, which is the sum of the masses of its constituent particles, as well as its size, which is about 10^{-15} m, that is, the same order as the classical electron radius r_0. Such a structure of the proton is more natural than the assumption that the proton consists of hypothetical quarks with fractional charge and other incredible properties, but have never been discovered. A neutron devoid of charge should already consist of an equal number of electrons and positrons. The presence of electrons and positrons inside nucleons is confirmed by the emission of these particles from neutrons or nuclei during β^- and β^+ -decay, as well as by the formation of electron-positron pairs during gamma irradiation of nuclei. All previous objections [1] against the presence of electrons and positrons in the neutron and in the nucleus are eliminated if the nucleons have a complex structure. Thus, the negligible magnetic moment of nucleons in comparison with electrons and positrons is explained by the mutual compensation of their magnetic moments, as in the phenomenon of antiferromagnetism.

If we represent electrons (and positrons), like Thomson and Lorentz, in the form of charged balls of a standard size of the order of the classical electron radius r_0, then they should, under the action of attraction, combine into regular crystalline complexes, like cubic salt crystals from periodically alternating Na^+ and Cl^- ions [7, 8]. Such an idea of the structure of a proton, neutron and other elementary particles makes it possible to explain many of their properties: mass, density, size, charge, magnetic moment and the nature of their interaction. Thus, the nuclear interaction of two protons, exceeding their Coulomb repulsion, is obtained as a direct consequence of their electro-multipole interaction. If two protons, having the shape of cubic crystals, are connected by faces, so that positrons will be opposite the electrons and vice versa, then their mutual attraction may well exceed the Coulomb repulsion of the total charge of protons. As the calculation shows, the force H of attraction exponentially decreases with an increase in the distance z between the faces according to the law $H \approx F_0 N \exp(-z/r_0)$, where F_0 is the elementary force of attraction between an electron and a positron at a distance of about r_0, and N is the number of particles that form each the edge and component for nucleons is of the order of a hundred. That is, the emerging force, like the nuclear force, turns out to be 100 times more intense than the Coulomb interaction [9], and, like the nuclear force, decreases very rapidly with distance. The same force of attraction, obviously, will arise between two neutrons, and between a proton p and a neutron n, which have similar masses, sizes and shapes.

Thus, the crystal model of nucleons explains all the properties of nuclear forces: their identical action in bonds of the *n-n, p-p, n-p, p-n* type; high intensity (due to the large number of interacting charges); short-range character and rapid decay with distance (from multipole interaction), saturation effect (only nucleons that are in contact with faces interact). Moreover, this model immediately leads to the exact value of the force intensity, its dependence on distance and the value of the radius of action of nuclear forces, which coincides in order of magnitude with the classical radius of an electron r_0, which quantum physics has not yet been able to explain. The higher strength, the binding energy of two protons or two neutrons (pairing energy, which increases the stability of even-even nuclei), can also be explained. Although protons and neutrons have similar structures and sizes, they can still have a slight difference in the shape and size of the faces, which is why the number of bonds N, and hence the strength, bond energy is maximized when homogeneous particles join, the faces of which correspond to each other in shape (Democritus's scheme), or by size (Lomonosov's scheme [10]). Such a combination by electrostatic forces on the principle of similarity (complementarity) has long been known in chemistry, for example, in proteins, or in nucleotides in a DNA molecule. Likewise, nucleons in the nucleus combine more readily according to the principle of similarity. Thus, there is every reason to believe that the nuclear interaction has an electrostatic nature and is due to the complex structure of protons, neutrons and other hadrons.

Then the energy released in nuclear reactions is ordinary electrostatic energy. If the energy of the multipole interaction is higher than the energy of the Coulomb repulsion, then their difference is released during the fusion of nuclei, and if less, then the energy is released during the decay of nuclei. The connection of this energy $W = mc^2$ with the mass defect m, which disappeared during the reaction, also receives a simple explanation. This formula, deduced by Thomson back in 1881, shows the connection between the electromagnetic energy W and the so-called electromagnetic mass: when accelerating, two charges of the same name are affected by a braking force proportional to the acceleration, as if the charges have an additional inert mass m - it was called electromagnetic. If two opposite charges approach each other, then an accelerating force arises during acceleration, which subjectively reduces the mass of charges by an amount m. That is why, when, for example, deuterium nuclei merge, the mass of the resulting helium nucleus decreases by the value m from the interaction of opposite charges forming nucleons. Moreover, this mass is exactly proportional to the released energy $W = mc^2$. And, say, in the α-decay of the uranium nucleus, the mass decreases due to the disappearance of the extra electromagnetic mass m associated with the repulsion of the like-charged nucleus and the alpha-particle and proportional to the energy $W = mc^2$ acquired by the helium nucleus under the action of this repulsion. Likewise, during the "annihilation" of an electron and a positron, they do not really disappear: the particles only combine into a neutral pair separated by a distance of the order of r_0, and the released energy of gamma radiation is the potential energy $W = mc^2$ of their electrostatic interaction, released when approaching to such a distance [7].

The model of protons and neutrons in the form of regular crystalline bodies, cubes, leads to the crystal structure of the atomic nucleus. Connecting flat faces, nucleons to maximize the binding energy and minimum potential energy should form layers and bodies of regular geometric shapes, as in the case of atoms that form crystals. Such a layered formation of the nucleus makes it possible to explain the existence of the magic numbers of nucleons, which remains a problem for quantum mechanics [1, 11]. It was noticed long ago that magic numbers are made up of numbers of the form n (n + 1) - the so-called doubled triangular numbers. This confirms that protons and nucleons are located in the nucleus in successive ever increasing regular geometric layers that form bodies in the form of pyramids. In this case, the most stable nuclei are precisely those with the magic number of neutrons and protons, that is, with completely filled layers, in which the binding energy is maximum. It also explains why the heavy nuclei split in half at an average ratio of 3: 2. A simple explanation is obtained for isomers of nuclei, that is, nuclei in which the nucleon composition is the same, but the spatial arrangement of nucleons in the nucleus is different, and therefore the bond energies, half-lives and other properties differ [3].

It is interesting that this idea of atoms and microparticles in the form of pyramids has a very ancient origin and was assumed by Pythagoras, Plato, Kepler, Lomonosov. Moreover, Lomonosov foresaw that the bond intensity of particles is proportional to the area of their contact (the number of bonds N), predicted the existence of isotopes and isomers when he talked about the standard of the shape and weight of particles of this type: "Homogeneous, I call those corpuscles that are equal in size and similar in shape ... they may have some dissimilarity in shape and inequality, but so insignificant that they can be neglected and not taken into account when looking for the cause of a significant difference in cohesion. For example, if the mass is one corpuscle refers to the mass of the other, as 1000 to 999, and in relation to the figure - if two corpuscles have the figure of a pyramid standing on a square base, and one has an angle to the base equal to 52° 31', and the second 52° 30' [10] ".

The formation of a double pyramid in the core, instead of a single one, can be explained by the electrostatic repulsion of the parts of the core, which tend to be located as far away from each other as possible, as well as by the magnetic structure of the core. The nucleus, which has a magnetic moment, as it crystallizes, overgrows with nucleons on both sides, just as a magnet overgrows from two poles with beards of magnetic filings located along the magnetic field lines. The magnetic moment of the nucleus is associated with the magnetic moments of the nucleons forming it, the ordered arrangement of which makes it possible to explain the "quantization" of the magnetic moments of the nuclei, nuclear spectra, and the fine structure of atomic spectra, since charged particles (protons or electrons) vibrate in the magnetic field of the nucleus with fixed frequencies. Moreover, such standard magnetic moments of nuclei and their influence on the spectra were predicted by Thomson and Ritz in the framework of the classical crystal model of atoms and nuclei [3, 4].

Physicists, on the basis of experimental analysis, more and more often come to the idea of a complex spatial crystalline structure of "elementary" particles and nuclei [11], in many ways resembling nanostructures, protein molecules and even DNA. The crystal model of the nucleus is also interesting because it allows direct experimental verification by the Laue method. It is possible to check and study the crystal structure of nuclei and nucleons, as in the case of chemical crystals, by irradiating the crystal at a wavelength smaller or comparable to the size of the crystal cell ($\lambda \sim 10^{-16}$–10^{-15} m - hard gamma rays), and then investigating diffraction pattern on a photographic plate. If the crystal structure of nuclei and hadrons is confirmed, then this will allow not only a deeper study of the structure of matter, understanding the nature of interactions and correctly predicting the properties of all nuclei and particles, but also it is much more effective to experimentally study their structure and it is easier to release nuclear energy. Until now, fission of nuclei at nuclear power plants was carried out in a barbaric way, with blunt random blows at them. If we take into account their crystalline structure, fission can be carried out at lower energies, by means of a sharply directed impact, separation of nucleons and nuclei along crystallographic planes, along cleavage planes, along areas of least strength, defects, etc.

Huge opportunities in this regard are opened by laser radiation, with the help of which it is possible not only to efficiently accelerate particles and nuclei [12], but also to separate them directly, cut them with a 'laser scalpel', since the electric field strength E in the laser beam of the most powerful installations gradually approaches the strength of the Coulomb field $E = 10^{21}$ V / m, which binds together electrons and positrons. Then electrons and positrons, moving in the opposite electric field, can be separated from each other, which will be perceived as the appearance of electron-positron pairs in a vacuum - an effect long assumed in a powerful laser field and called instability, or "boiling" of vacuum. On the one hand, this will allow separating electron-positron pairs floating in a vacuum, and on the other hand, it will make it possible to split nucleons and nuclei into the smallest components, producing a complete disintegration of matter. This will make it possible to generate nuclear energy in an environmentally friendly and economical way, from cheaper and safer nuclear fuel, which is not capable of self-detonation and does not lead to large-scale accidents. Knowing the crystal structure of particles, it will be possible to develop methods for constructing new particles and nuclei, assembling them as if from cubes, carrying out an economically beneficial transmutation, obtaining scarce chemical elements, etc. Thus, the idea of the crystal structure of elementary particles and nuclei will help to significantly advance theoretical and experimental physics and develop fundamentally new ways of transforming matter.

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