Nature of Nuclear Binding Force

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Abstract

The study proves that the force of attraction between nucleons in the nucleus is caused by the interaction between electrons and protons, which is about 100 times stronger than the repulsive Coulomb forces between protons.

Conceptions of Strong and Weak interaction forces are not necessary because all properties of the nucleus can be explained by electric forces. There are only two fundamental interactions: Electromagnetic and Gravitational.

Keywords: physics, chemistry, octet rule, space, atom, nucleus, Periodic table of elements, electron, proton, neutron, shell model of nucleus

PACS Classification codes:

01.55.+b General physics; 31.10.+z Theory of electronic structure, electronic transitions, and chemical binding; 21.60.-n Nuclear structure models and methods; 12.10.-g Unified field theories and models

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Introduction

It has been established [1] that the attraction forces in the nucleus between nucleons are about 100 times stronger than the Coulomb repulsion forces between protons. Therefore, they were called the Strong interaction or Nuclear force. According to theory the Nuclear forces are produced by the action of mesons. Experiments with collisions of fast particles, in which mesons are ejected out of nuclei, are considered as proof that mesons operate in the nucleus. This theory ignores research [2] that proves that mesons are not independent particles but only excited states of electrons (Fig. 1).

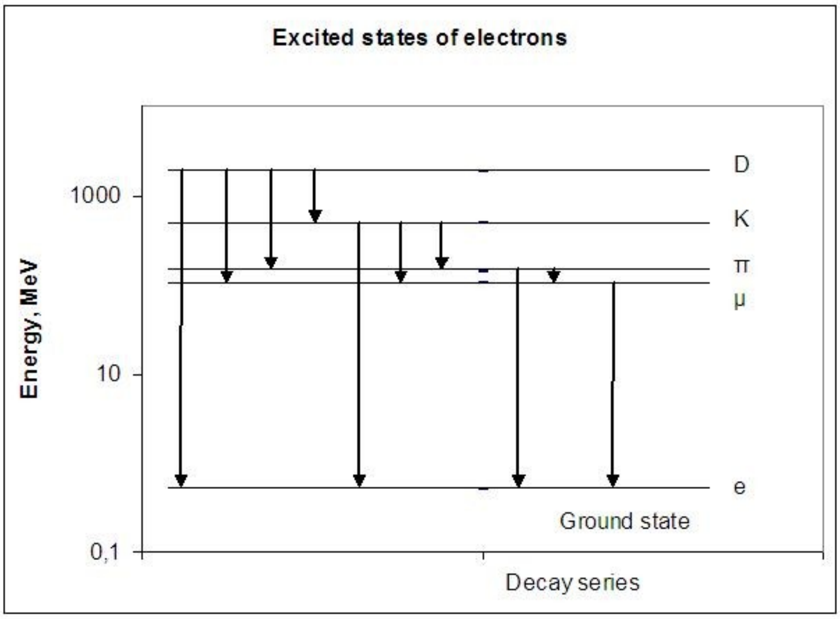

Fig. 1. Excited states of electrons and decay modes of mesons.

Studies of the structure [3] of nuclei show that nuclei, in which the number of protons and neutrons are equal, are stable. There are only few exceptions. On the other hand, nuclei with a predominance of protons or neutrons decay. This suggests that the basis of nuclear stability is the proton-neutron pair.

It is well known that a neutron exists in free space for about 15 minutes, after which it decays into a proton and an electron. Therefore, the neutron can be considered as a composite particle consisting of a proton and an electron. The electron forms a cloud that surrounds the proton from all sides (Fig. 2).

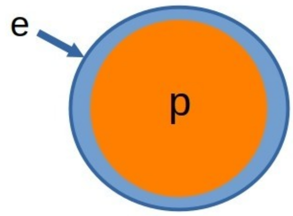

Fig. 2. Structure of the neutron
e – electron (blue), p – proton (orange)

Proton – neutron pair

If there is a proton near the neutron, then there is no reason for the electron to prefer one of the protons, so the electron is between them. It is impossible to determine which of the pair of protons with an electron forms a neutron, so a proton-neutron pair is actually a pair of 2 protons with a bonding electron between them (Fig. 3.).

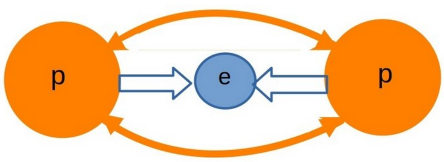

Fig. 3. Proton-neutron pair
e – electron, p- proton
Repelling forces p-p orange, attracting forces p-e white

The nucleus has 4D hyperspace inside [4, 5, 6, 7] so the solid angle is $2\pi^2$ and the Coulomb force equation is

$$F = q_1q_2/2\pi^2\varepsilon_0r^3 \qquad (1)$$

where: q – charge, r – distance between charges, ε_0 – permittivity of space.

In this case: $|q_1| = |q_2| = e$.

The path (effective distance) of the repulsive forces is longer than the distance between the protons because they have to bend around the electrons. If the distance between the electron and the proton is *r*, then the effective distance between the protons is approximately *4r*.

The force of attraction between a proton and an electron:

$$F_{pe} = e^2/2\pi^2\varepsilon_0 r^3$$

The repulsive force between protons:

$$F_{pp} = e^2/2\pi^2\varepsilon_0 (4r)^3$$

The attraction forces act between the electron and the two protons, so the resulting force between the protons is 2 times greater and the ratio of forces is:

$$2F_{pe}/F_{pp} = 2(4)^3 = 128$$

The obtained approximate result agrees well with the observations.

Nucleus

Atomic nuclei are made up of proton-neutron pairs. Since it is impossible to distinguish a proton created by the decay of a neutron from other protons, it would be more correct to say that the nucleus is made up of protons that are “glued” together by electrons. The most stable nuclei are those in which the number of protons and neutrons is the same, or in other words, there are twice as many protons as electrons. If there are too many electrons, then the nucleus eject them out and we can observe beta-decay. If there are not enough electrons, the nucleus capture the outer electrons.

As an example, let's look at the helium nucleus, which contains 4 nucleons: 2 protons and 2 neutrons (Fig. 4). In the He nucleus, neutrons split into protons and a cloud of electrons. Other nuclei have a similar structure but are difficult to represent on paper.

Protons are arranged evenly in the nucleus. It follows the principle of densest packing and provides minimum potential energy.

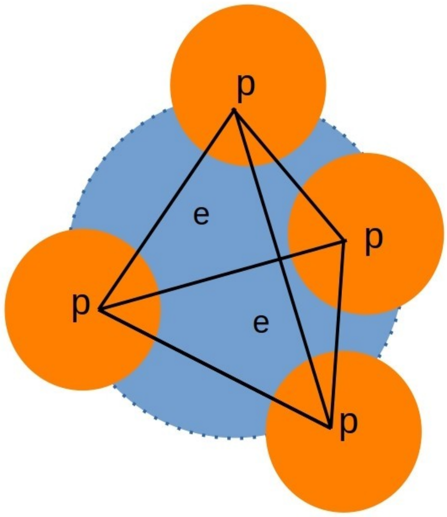

Fig. 4. Helium nucleus
The four protons are bound together by a cloud of 2 electrons

A possibly compact proton packing forms a tetrahedron. Since the positive charge of two protons is compensated by the negative charges of two electrons, the total charge of the He nucleus is equal to the charge of 2 protons.

Conclusions

The nucleus contains only protons and electrons. A neutron is a proton ejected from the nucleus together with an electron. After a short while, an electron is separated from it and begins to orbit the proton, i.e. hydrogen is produced.

The nucleus is made up of a lattice of protons, held together by a cloud of electrons. The nucleus is stable if there are twice as many protons as electrons.

The Strong interaction, or Nuclear force, is essentially the same as the Coulomb force, which is caused by the interaction of protons with electrons. Therefore, the conception of Strong and Weak interactions as separate types of forces are not needed. There are only two fundamental interactions: Electromagnetic and Gravitational.

The Electromagnetic interaction between nucleons can be described by Maxwell's equations adapted to 4D space.

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Acknowledgements: We are very grateful to Ieva Mazere for valuable discussions and assistance.

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