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Electromagnetic interactions in the volume of nuclei

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Structuring the volumes of nuclei and the complex topology of their surfaces, along with attractive nuclear forces, in certain conditions, electromagnetic forces manifest themselves more significantly. At the line of the stability path of exotic nuclides, these forces begin to prevail.

In this paper, we describe the mechanism of interaction of nucleons in the nucleus volume as the interaction of dipole-dipole intranuclear clusters. Such an interaction and its sign, first of all, will depend on the spatial orientation of nucleons or clusters in the nucleus and, therefore, the interaction potential of electromagnetic forces should include not only the Coulomb repulsion of charged nucleons (clusters) but also the magnetic component, which includes the spin-orbit the interaction of nuclear clusters V = Vc + Vm (sl), where Vc is the Coulomb potential; Vm (sl) is the potential of the dipole-dipole interaction. The magnetic component of the electromagnetic potential depends both on the total spin of the nuclear clusters and on their spatial position (orbital). This paper considers nucleons and nuclear clusters that form in dipoles. Based on experimental data on the elastic scattering of alpha particles by 24-Mg from the found cluster widths for mass numbers from 1 to 4 [2], it was possible to construct the corresponding dipole – dipole interaction in s, p, and d states. In the field of heavy nuclei, neutron-deficient and neutron-rich isotopes, the density of nuclear matter fluctuates with respect to the constant 0.15 1 / fm ^ 3 [1]. This fluctuation is associated not only with the deformation of nuclei, but also with the spatial distribution of nucleons within the volume of the nucleus. With an increase in the mass number, the Coulomb repulsive forces cause protons and isolated nuclear clusters to move to the periphery of the nucleus, thereby abnormally increasing the average radius of the nucleus and its deformation, which should affect the density of nuclear matter. From the constructed isotonic dependences of the binding energy of nucleons in the nucleus on the proton excess and deficit, it can be seen that the binding energy per one nucleon decreases quadratically with a decrease and addition of each subsequent proton, which leads to inflation of the nucleus volume and, possibly, the formation of “bubble” nuclei that were still unsuccessfully tried to find in the experiment. Such an idea about inflating the volumes of nuclei was expressed to the authors by Oganessian Yu.T., who drew attention to a particularly significant effect in the field of “Island of stability”.

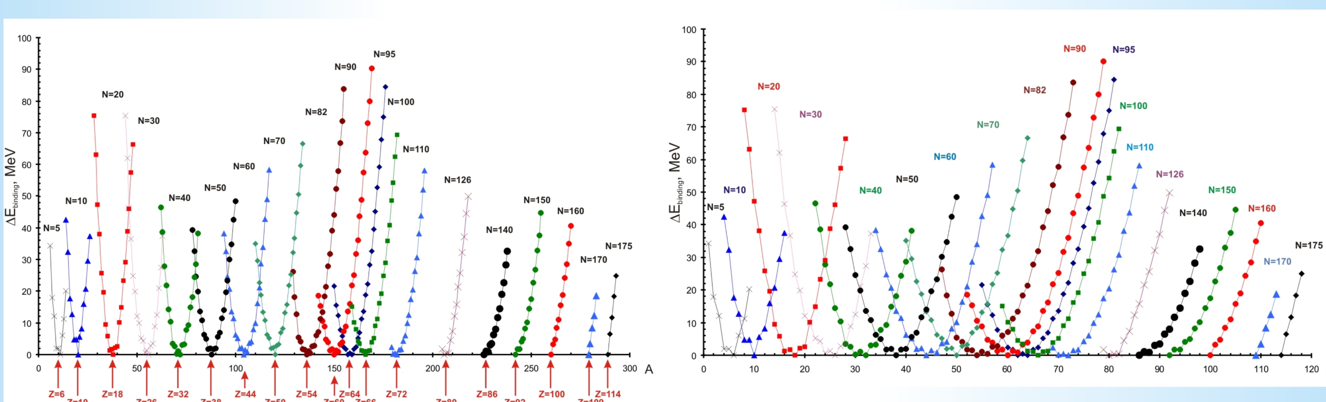
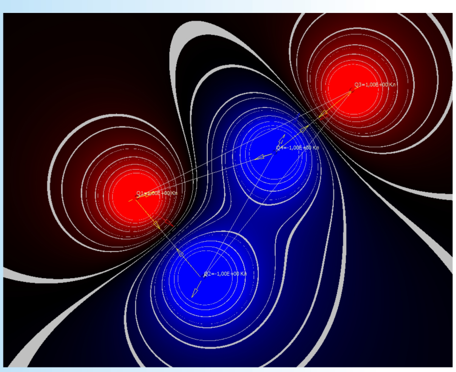
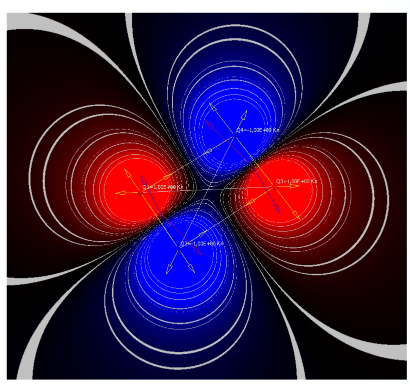
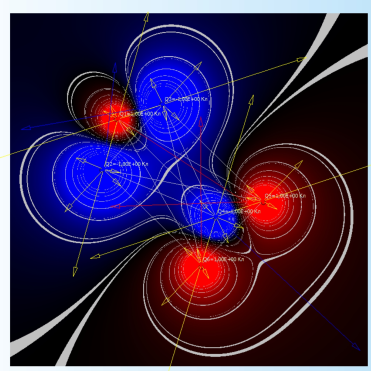


Fig. 1. Isotonic dependences of the binding energy of nucleons in the nucleus on the proton excess and deficiency







In the program developed by the authors, the spatial distribution of point charges and the resulting dipole moments was simulated. It is seen that the formation of the average Coulomb field depends on the relative position and orientation of intranuclear clusters in the core. The figures show examples of electric field configurations for unlike point electric charges, taking into account their spatial location relative to each other.

1. O. Bohr, B. Mottelson. The structure of the atomic nucleus // M .: Mir, 1971.– T.1. 456 p.
2. N.Burtebayev, V.V.Dyachkov, Y.A.Zaripova, A.V.Yushkov, T.K.Zholdybayev, M.Nassurlla. Investigation of cluster configurations of nuclei from 11B to 209Bi on α-particles beams // Book of abstracts. 68 International Conference “Fundamental problems of nuclear physics, atomic power engineering and nuclear technologies” NUCLEUS-2018, Voronezh, 2-6 July 2018, p. 67

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