CLUSTERIZATION AND CRYSTALLIZATION OF NUCLEI

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The review gives the main aspects of the fundamentally new emerging nuclear physics.

Section 1 discusses theoretical and experimental facts about the clustering of nuclei and examines experimental evidence of their actual existence. A method for measuring and identifying each type of cluster in one experiment and in one mass spectrum is described.

Section 2 generalizes the sum of the experimental facts in favor of the solid model of the nucleus and the ordering of its structure into a quasicrystalline lattice. Systematics of the geometric parameters of the nuclei - radii, surface diffusion and shape deformation is given throughout the «Valley of Stability». It is shown that superdense nuclei whose density significantly exceed the mean (normal) density $n_0 = 0.147$ fm exist. These are nuclei from ^{4}He to ^{32}S, while the maximum density (superdensity) is demonstrated by the ^{4}He nucleus (α-particle). This suggests two "bricks" of nuclear composition – nucleons and α-particles, and the densest spherical packings in a binary nuclear system: in fact, the ratio of their radii is theoretically equal to 0.4142. And the ratio of the radii of nucleons and α-particles is exactly equal to

$$\frac{r_p}{r_\alpha} = \frac{0.7 \text{ fm}}{1.68 \text{ fm}} = 0.417 .$$

And if we follow this theory, then the «Island of stability», we propose to search not at Z = 114, but at $Z = 128$.

Section 3 gives facts and generalizations in favor of constructing a new nuclear theory in the basis of the topology of a curvilinear non-Euclidean space. Inside the nucleus volume and in the near-nuclear space, this is a Riemannian space with a geodesic in the form of an ellipse with positive curvature $\kappa > 0$. The closed Riemannian space in the microworld of nuclei is the area inside the «Valley of Stability». On the edges of this valley the Riemannian space opens into a flat Euclidean space with zero curvature $\kappa = 0$. Outside the nucleus, the Riemannian space at the Fermi boundary is rectified. Then the zero curvature undergoes a discontinuity and goes over into the Lobachevsky space with negative curvature $\kappa < 0$, and the corresponding instability of the nuclear structure, which serves as the fundamental cause of radioactivity.