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EXOTISM OF NUCLEI

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Exotic states of the nuclear matter i.e., of the nuclei in extreme states (with high spin, large deformation, high density and temperature, the neutron- or proton- rich nuclei on the boundary of nucleon stability) play an important role in studies of fundamental nuclear properties, which bring us closer to deducing the equation of state of the nuclear matter. This is undoubtedly of great significance for extrapolating microcosm characteristics to the macroworld that presents our Universe. Synthesis and study of neutron-rich isotopes have two main goals: finding the position of neutron stability boundaries and obtaining data on properties of exotic nuclei near these boundaries. The development of accelerator technology has made it possible to obtain the accelerated beams of secondary radioactive nuclei. In this connection, new vast opportunities have opened up for studying both the structure of light exotic nuclei themselves and the peculiarities of nuclear reactions induced by these nuclei. It is extremely important to obtain new information regarding nuclei near the nucleon stability boundary because considerable deviations of properties of such nuclei from the widely known regularities may be expected (and are already observed). Here the nuclei in a range of small Z serve as convenient objects for investigation. However, the question of how general the corollaries made for this small number of nuclei is crucial. The experiment alone can give an answer to this question. At present the most sophisticated physics experiments, which are carried out at large-scale accelerator facilities and require enormous financial investments, can be realized only through the combined efforts and cooperation of the leading scientific centers. As an example, we can mention the creation of the Large Hadron Collider at CERN and of the heavy ion accelerators at the Joint Institute for Nuclear Research (Dubna) which count about 20 member-states. Thus, the research is being done in collaboration of the research centers of several countries. Each country makes its financial and intellectual contribution to the creation of the large-scale facilities, allowing to penetrate deeply into the mysteries of matter and to obtain new information not only for nuclear physics, but also for other scientific fields such as astronomy, condensed matter physics and up-to-date technologies. The present work reviews the properties of the super neutron-rich isotopes. The changes in nuclear structure appearing as one goes away from the β-stability line are discussed in detail. Information is presented on the mass (hence, on the separation energy of nucleons and on nuclear stability), the radii of nucleon distributions, the momentum distributions of fragments from the break-up of neutron-rich nuclei, on the possibility of halo formation as well as on the deformation and quantum characteristics of the ground states of different isotopes. The location of the neutron drip line and questions about the stability of nuclides are considered in connection with the weakening or even vanishing of the shell effects at the magic numbers 20 and 28, and the discovery of the new neutron magic number.

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