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Island of Super Heavy Elements

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When D.I. Mendeleev published the first Periodic Table with the 63 chemical elements, the charming Maria Sklodowska was only two years old. 29 years later she, with Pierre Curie, will discover two new elements: radium and polonium. The Curies, with Henri Becquerel got the Nobel Prize in physics (1903) "for outstanding achievements in the joint research of the phenomena of radiation".
Only eight years later Ernest Rutherford (1911) proposes his planetary model of atom, and after two years "Bohr's atom" will puzzle all the educated physicists with his postulates, but explain the emission spectrum of a hydrogen atom. Further on, George Gamow proposes to consider the nucleus as a drop of nuclear liquid (1928). On the basis of this model, Niels Bohr and John Archibald Wheeler will develop the theory of nuclear fission (1939). From this theory it followed that probability of the process of spontaneous fission that is rare for uranium, will grow progressively with increasing number of protons in the nucleus, resulting in complete loss of stability for nuclei with Z≥100.
However, the predictions greatly vary due to the presence of the internal structure of nuclear matter. One of the unexpected and fundamental outcomes of the new microscopic theory (1969) was the existence of a hypothetical "Island of Stability" in the area of very heavy (superheavy) nuclei, where, within the former concepts, the nuclei and elements cannot exist. Verification of these unusual predictions appeared to be complex and difficult.
The talk is devoted to the 30-year long Odyssey that led to this mystical Island. Here are summarized various attempts of search in nature and of artificial synthesis of superheavy elements before these resulted in the discovery of the five new chemical elements (2000-2012). Elements with atomic numbers 114, 115, 116, 117, and 118 with their names and symbols fill today the seventh period in Mendeleev's Periodic Table. Isotopes of the new elements and products of their radioactive decay have added 52-two new neutron-rich nuclides up to the mass A=294 to the nuclear map.
As we move away from the latest stable Pb-208 into the region of heavier nuclei, we observe their amazing survivability. At the verge of their existence, in the domain of large Coulomb forces, there appears an extra bonding of nucleons due to the structural properties of nuclei that enables the existence of islands of stability of very heavy elements. The fundamental predictions of the microscopic nuclear theory have got experimental confirmation in full.
The relatively long lifetimes of the new elements make it possible to investigate their chemical properties. To what extent do the superheavy elements follow their lighter homologues in their chemical behavior? The theoretical expectations, along with the results of the first chemical experiments, are discussed now in terms of determining the boundaries of the Periodic Table of elements.
Experimental studies of production and decay properties of the superheavy elements were carried out in Dubna, in Laboratory of Nuclear Reactions of JINR, in extensive cooperation with the national laboratories and universities of the USA, Germany, France, Switzerland, Japan, and Institutes of the JINR Member States.

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