

# SUPER HEAVY ELEMENTS

*Academician Professor Yuri Oganessian*

*JINR, Dubna, Russian Federation/Cyclotron Institute, TAMU*

## *Summary*

A series of 5 lectures is devoted to one of the most fundamental problems of modern physics, nuclear chemistry and astrophysics – the problem of existence of hypothetical super heavy elements. Experimental studies of the past 15 years led to a discovery of so-called "Island of stability" of neutron-rich nuclei, previously unknown super heavy elements with atomic numbers from 112 to 118. With respect to the synthesized nuclei with  $Z = 108-112$ , new nuclides have a relatively high stability. The existence of SHE, with their atomic and nuclear properties, significantly widens the mass limits of the nuclear map.

**03/09/2015 at 2:30 pm: In the first lecture** we will discuss how atoms and nuclei occurred, will demonstrate their properties and types of decay within the framework of classical (macroscopic) nuclear theory. Nuclear fission, discovered in 1939 and described within the framework of this theoretical model, in further experimental studies led to conflict with the theory. The new microscopic theory revolutionized ideas about the spontaneous fission of heavy nuclei. One of the fundamental consequences of this theory was the prediction of the possible existence of "an island of stability of SHE".

**03/23/2015 at 2:30 pm: In the second lecture** we will present different approaches for artificial synthesis of trans-uranium elements. The mechanism of synthesis of heavy nuclei both in stationary and pulsed neutron flux, as well as the fusion of complex nuclei will be discussed. Of this entire set of experimental data, we will choose the reaction leading to the formation of SHE.

**04/13/2015 at 2:30 pm: In the third lecture** we will describe the experimental conditions for the synthesis of SHE. We will discuss the production of target material with high flux nuclear reactor, acceleration of Ca-48 ions in order to obtain intense beam, construction of the recoil separator and the detector array for registering very rare events of formation and decay of super heavy nuclei, etc.

**04/20/2015 at 2:30 pm: In the fourth lecture** we will present results obtained in the experiments on the synthesis of SHE. We will discuss the properties of new nuclides and their decay products in the light of the theoretical predictions. The results of the first experiments emphasize chemical properties of new elements, in particular their likeness to their light homologs in view of the "relativistic effect" in the structure of the super heavy atom.

**04/27/2015 at 2:30 pm: In the fifth lecture** we will discuss the prospects of studies of super heavy nuclei in connection with creation of large accelerator facilities, such as "SHE-Factory" for more profound studies of the properties of artificially synthesized nuclei and for producing even heavier elements. We will examine potentials of SHE production in nucleosynthesis, as well as searching for

SHE in the natural objects and cosmic rays. The results of the first experiments in that direction will be discussed as well.

*PS. Between the second and third lectures scheduled for 23 March and 13 April 2015 respectively, TAMU will hold the International Symposium SUPER HEAVY NUCLEI (March 31 - April 2). The symposium will feature presentations from many laboratories in the world where the studies of SHE are conducted. For students and researchers who do not work directly in the field and intend to visit the symposium, the first two lectures will be a good introduction to the topics under discussion.*