Production and study of new neutron rich heavy nuclei in multinucleon transfer reactions

V.I. Zagrebaev[1] and W. Greiner[2]

[1]*Flerov Laboratory of Nuclear Reactions, JINR, Dubna, Moscow Region, Russia*
[2]*Frankfurt Institute for Advanced Studies,*
J.W. Goethe-Universität, Frankfurt, Germany

30 years ago there had been a great deal of interest in the use of heavy ion multinucleon transfer reactions for the production of new neutron rich isotopes of heavy nuclei. Many experiments of such kind have been performed those time and very interesting information concerning collision dynamics have been derived. The cross sections for the production of above–target elements were found to decrease very rapidly with increasing atomic number of surviving heavy nuclei. Nevertheless, the level of 0.1 μb of the cross sections has been reached those time, and several isotopes of Fm and Md have been synthesized in low–energy collisions of ^{238}U with ^{248}Cm target. It was found that the yields of near– and above–target actinide nuclei depend strongly on a choice of the projectile nucleus. Nuclear structure effects (in particular, the closed neutron shell $N = 126$) were also observed in the distribution of binary reaction products formed in low–energy damped collisions of heavy ions.

Renewed interest in the multinucleon transfer reactions with heavy ions is caused by the limitations of other reaction mechanisms for the production of new heavy and superheavy neutron enriched nuclei. The present limits of the upper part of the nuclear map are very close to the beta–stability line while the unexplored area of heavy neutron–rich nuclides (also those located along the neutron closed shell N = 126 to the right–hand side of the stability line) is extremely important for nuclear astrophysical investigations and, in particular, for the understanding of the r process of astrophysical nucleogenesis. For elements with Z>100 only neutron deficient isotopes (located to the left of the stability line) have been synthesized so far. The "northeast" area of the nuclear map cannot be reached in fusion, fission or fragmentation processes widely used nowadays for the production of new nuclei. Multinucleon transfer processes in near barrier collisions of heavy (and very heavy, U–like) ions seem to be quite promising reaction mechanism allowing us to produce and explore neutron–rich heavy nuclei including those located at the superheavy island of stability.

In my talk I shall discuss briefly our view (and our model [1, 2]) of damped heavy ion collisions. Our predictions for the production of new neutron-rich heavy nuclei in multinucleon transfer reactions will be discussed and new experiments will be proposed. A special attention will be paid to the "inverse" quasi–fission mechanism leading to formation of reaction fragments with masses lighter than projectile and heavier than target masses. A new project (new setup) realized at Flerov laboratory (JINR) and aimed on the production and study of new heavy nuclei produced in the multinucleon transfer reactions will be shortly reviewed.

---

[1] V. Zagrebaev and W. Greiner, J. Phys. G **34**, 1 (2007).
[2] V.I. Zagrebaev and W. Greiner, Phys. Rev. C **83**, 044618 (2011).