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DIRECT REACTIONS AND SYNTHESIS OF COLD HEAVY NUCLEI

Thursday, 14 July 2022 15:00 (20 minutes)

The cross-section of the superheavy element's yields produced in collision of heavy ions is extremely small. One of the main reasons for this smallness comes from the fact that the compound nucleus produced in this collision possesses the excitation energy which substantially exceeds its fission barrier and therefore practically immediately performs fission into the two fragments. Moreover, even the meager amount of the surviving superheavy elements immediately starts neutron evaporation and leaves the region of the most stable superheavy isotopes.

To minimize the influence of these processes one might use direct reactions of alpha-particle knock-on by the incident ion and heavy fragment stripping of this ion. In these reactions a major part of the projectile is transferred to the target and forms a superheavy nucleus while alpha particle might carry away the major part (sometimes practically all) of the system's excitation energy. Very fast alpha-particles created in these processes were first observed by the FNLR experimental group at JINR back in 1980-ies (see refs. in [1]) practically simultaneously with the theoretical explanation of their results in terms of heavy particle stripping or knock-on reactions (see e.g. [2]). It was pointed that registration of alpha-particles with energy close to the kinematical two-body limit $E^{(2)}_{\alpha,lim}$ meant that the new heavy nuclei with Z equal to the sum of the target Z_T and projectile Z_P charges minus 2 was created in the observed reaction.

These experiments are renewed now on the U-400 accelerator at FNLR. The use of the new high resolution magnetic analyzer and detector system allows to measure light particles at the high-energy end of the spectrum whose yield is about $10^{-6} \div 10^{-8}$ of the yield at maximum. The experiments are performed with the different sets of the projectiles and the targets. Practically for all those sets alphas were observed close to the two-body limiting energies $E^{(2)}_{\alpha,lim}$. However, in all the cases of the possible nuclei production with $Z = (Z_T + Z_P)$ 99 alpha-particles with energies exceeding $E^{(2)}_{\alpha,lim}$ were observed. A possibility is considered that this indicates a new type of the direct process which might be named "direct fission". If the binary nuclear system created in the peripherical collision of the projectile and the target closely resembles the excited heavy nucleus in the process of fission into two asymmetric fission projects, then the emitted alpha-particle might also carry a part of the Q-energy produced in fission.

1. V.I. Zagrebaev, Yu.E. Penionzhkevich, PEPAN 24, 295 (1993).
2. V.E. Bunakov, V.I. Zagrebaev, Z. Phys. A 304, 231 (1982).

The speaker is a student or young scientist

No

Section

1. Experimental and theoretical studies of nuclear reactions

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