

## Deep sub-barrier fusion and transfer reactions with ${}^6\text{He}$ and ${}^6\text{Li}$ beams

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The availability of Radioactive Ion Beams (RIBs) has opened many new perspectives for nuclear physics studies. One example is the influence of light weakly bound nuclei with halo and cluster structure, such as  ${}^6\text{He}$  and  ${}^6\text{Li}$ , on the fusion and transfer processes. The reaction mechanism involved and the relevant theoretical description of the processes have been the subject of intense discussion in a few recent review articles [1,2]. Therefore, it is of great interest to study the interaction of loosely bound nuclei, including nuclei with cluster structure, especially at energies close to the Coulomb barrier.

In connection with this we have measured excitation functions for fusion and nucleon transfer taking place in the interaction of  ${}^6\text{He}$  and  ${}^6\text{Li}$  ions with the heavy Pb, Au and Pt targets at energies up to about 60 MeV [3]. The experiments were carried out at the accelerator complex for radioactive beams DRIBs of the Flerov Laboratory of Nuclear Reactions (JINR). The stacked-foil activation technique in combination with the magnetic spectrometer MSP-144 for improving the beam energy resolution ( $\text{FWHM} \leq 600 \text{ keV}$ ) was used. The identification of the observed reaction products was done by their radioactive  $\gamma$ - or  $\alpha$ -decay.

It was found that the data on fusion reactions, followed by the evaporation of two neutrons ( ${}^{206}\text{Pb}({}^6\text{He}, 2n){}^{212}\text{Po}$ ) at deep sub-barrier energies significantly higher than the one, calculated using the framework of the statistical model for compound-nuclei decay. The observed enhancement in the  ${}^{206}\text{Pb} + {}^6\text{He}$  reaction is consistent with calculation within the model of "sequential fusion" [4].

It was also shown that the reaction of one neutron transfer from  ${}^6\text{He}$  to the  ${}^{197}\text{Au}$  target nucleus at deep sub-barrier energies ( $B_{\text{cm}} - E_{\text{cm}} \leq 15 \text{ MeV}$ ) takes place with relatively high probability. In the case of the  ${}^6\text{Li}$ -induced reactions on  ${}^{198}\text{Pt}$  we observed enhanced cross section for deuteron transfer also at sub-barrier energies. These results provide evidence that, contrary to the case of strongly bound nuclei, at sub-barrier energies the main contribution to the cross section comes from transfer reactions: neutrons from  ${}^6\text{He}$  and deuterons from  ${}^6\text{Li}$  ( ${}^6\text{Li}$  is known to have a  $(d+{}^4\text{He})$ -cluster structure).

1. N. Keely et al., Prog. Part. and Nucl. Phys. 59 (2007) 579.
2. L.F. Canto et al., Phys. Rep. 424 (2006) 1.
3. Yu.E. Penionzhkevich et al., Eur. Phys. J A31 (2007) 185.
4. V.I. Zagrebaev, Phys. Rev. C67 (2003) 061601(R).