

## Peculiarities of interaction of weakly bound lithium nuclei ( $A=6-11$ ) at low energies: Elastic scattering and Total reaction cross sections

The review presents the latest experimental data on the total reaction cross sections and angular distributions of differential cross sections for elastic scattering of light weakly bound lithium nuclei 6–9,11Li [1].

A review of papers on the interaction of weakly bound (cluster and exotic) 6-9Li and 11Li nuclei published so far and their analysis shows that there are no experimental data on total reaction cross sections (TRC,  $\sigma_R$ ) and it is necessary to measure it for Li-isotopes at energies from the Coulomb barrier  $B_c=(3-4)$  MeV up to (10–40) MeV/nucleon on 28Si, 27Al, 9Be, and 12C nuclei.

For the interacting systems (8,9Li+28Si), there are only two points with a large energy error (about  $\pm 10$  MeV/nucleon) in Ref. [2] (Warner et al.): for (8Li+28Si)- reaction at 34 and 50 MeV/nucleon, and for reaction (9Li+28Si)- at 37 and 50 MeV/nucleon.

The new data on TRC for reactions (8,9Li+28Si) in the energy range (5–30) MeV/nucleon with their analysis are presented in [3]. In the TRC energy dependence of (9Li+28Si) reaction, a “bump”, i.e., a local increase in the cross section in the energy interval (10–30) MeV/nucleon, was first observed. Therefore, this dependence requires further theoretical analysis and experimental study.

In Ref. [2] in the energy range from 25 to 52.5 MeV/nucleon there were only three points for TRC for the system (11Li+28Si) at energies of 29.9, 42.5 and 52.5 MeV/nucleon. The points have large errors both in energy (up to  $\pm 7$  MeV/nucleon) and in the values of the cross section ( $\pm 100$  mb). In the work of Villari [4] one point at an energy of 25.5 with an error in the TRC value of  $\pm 386$  mb was obtained. Li Chen [5] presents six points at energies from 25 to 41 MeV/nucleon, however, he does not give errors in cross sections and energy.

Therefore, the measurements of TRC (8,9,11Li+28Si), presented in [5, 3] and planned for 2018 in the previously unexplored energy interval, will fill the gap in the available literature data.

Large TRC values detected in the  $\sigma_R(E)$  dependence, as well as their rapid increase in a short energy interval in the low-energy region, can lead to a release of a large amount of energy, which is interesting in terms of search for new energy sources of the future.

The obtained new data (the existence of an anomalous increase in the TRC) in a narrow energy range (10-30) MeV/nucleon in the (6He, 9Li)+28Si reactions at barrier energies will enable scientists to explain important questions of nucleosynthesis (nuclear astrophysics).

One of the most important features explaining why light elements are abundant in the universe is the increase in the interaction cross sections in the sub-barrier energy region in nuclear reactions with weakly bound nuclei. This effect is especially strongly manifested for light cluster nuclei 6,9,11Li and nuclei with a neutron halo 6,8He and 11Li. The main channels of interaction of such nuclei are transfer, breakup and complete- fusion reactions.

Such peculiarities of interactions manifested in an increase in the cross section for the transfer of clusters and for complete-fusion reactions near the Coulomb barrier are typical of many weakly bound nuclei.

In the future, this will enable us to predict the trend in the change in the excitation function  $\sigma_R(E)$  in the interaction of a light weakly bound nucleus with the same target nucleus, in order to obtain the TRC energy dependence at barrier energies. In particular, scientists are very interested in the TRC behavior for such reactions as (11Li+2H), (11Li+9Be) and others at energies near (above and below) the Coulomb barrier.

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