Reactions induced by 18 MeV \( ^6\)He beam on \( ^6\)Li, \( ^7\)Li and \( ^{12}\)C

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The \( ^6\)He nucleus with its exotic structure [1] has been studied extensively in last years with \( ^6\)He radioactive beams, yielding different interesting results. We have studied the \( ^6\)He scattering and reactions on \( ^6\)Li, \( ^7\)Li and \( ^{12}\)C using a 18 MeV \( ^6\)He beam. The measurements were performed at the radioactive beam facility in Louvain-la-Neuve, Belgium. Outgoing charged particles were detected in three large silicon strip detector arrays covering polar angles 4°-12°, 20°-65° and 115°-160° (the total solid angle was \( \Delta \Omega \approx 4 \) sr). Elastic and inelastic scatterings, transfer and compound nucleus reactions, quasi-free scattering and sequential decay processes in three and many-body reactions were observed and results concerning both nuclear structure and reaction mechanism were obtained.

Present results [2] for the \( ^6\)He elastic scattering on all three targets used are in fair agreement with the optical model predictions using the potentials found in the analyses of \( ^6\)Li scattering on the same nuclei and at similar energies. However, non-negligible differences are visible and the \( ^6\)He scattering is better described with more sophisticated models, like the four-body continuum-discretised coupled-channel calculation given in Ref. [6] where influence of the \( ^6\)He Borromean structure is taken into account.

A variety of transfer reactions was also measured; partial angular distributions were obtained and analysed within the DWBA framework. An example is the \( ^6\)He\(^{+}\)\( ^6\)Li\(\rightarrow\alpha\)\( ^9\)Li reaction in which both direct transfers, of \( 2n \) and \( d \), may contribute. The \( \alpha \)-particle pick-up from \( ^6\)Li, \( ^7\)Li and \( ^{12}\)C nuclei forming different states in \( ^{10}\)Be has been observed. Large values of \( \alpha \)-spectroscopic factors for some of the states indicate their well developed \( \alpha\)\( ^6\)He cluster structure.

Several states of \( ^{10}\)Be and their \( \alpha\)\( ^6\)He decay were strongly observed [3] in the sequential reactions, \( ^6\)He\(^{+}\)\( ^6\)Li\(\rightarrow\alpha\)\( ^9\)Li and \( ^6\)He\(^{+}\)\( ^{12}\)C\(\rightarrow\alpha\)\( ^9\)He and \( \alpha\)\( ^{10}\)Be. These findings support the existence of molecule-like structures in \( ^{10}\)Be and of a rotational band with a very large moment of inertia [4]. Similar structures were found for \( ^{14}\)C from the \( ^6\)He\(^{+}\)\( ^{12}\)C\(\rightarrow\alpha\)\( ^9\)Be and \( ^{12}\)C reaction [5].

The two-proton pick-up reaction (\( ^6\)He, \( ^8\)Be), observed here for the first time, was found to be a potentially very useful spectroscopic tool [7]. The first experimental results are obtained for this reaction on \( ^{12}\)C, \( ^{16}\)O and \( ^{19}\)F nuclei (present in the LiF targets used). The measured angular distributions for the \( ^{12}\)C(\( ^6\)He, \( ^8\)Be) reaction show clear signature of a direct process.

Quasi-free scattering of fragile \( ^6\)He nucleus on deuteron and \( \alpha \)-particle clusters in \( ^6\)Li was also observed, as well as population of boron isotopes through the \( ^6\)He\(^{+}\)\( ^6\)Li compound nucleus reactions.

Obtained results indicate that the \( ^6\)He beam is an excellent choice for the study of light exotic nuclei. Final results of all observed phenomena will be summarised. Planned measurements of the \( ^6\)He\(^{+}\)\( ^{14}\)C reactions (beam energy 35 MeV) will also be discussed.

References