The (^{7}Be,^{3}He) and (^{7}Be,α) Reactions: New Tools for ^{3}He- and α-Transfer Studies

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Abstract

Large cross sections for the (^{7}Be,^{3}He) and (^{7}Be,α) reactions on light nuclei at E(^{7}Be)= 34 MeV have been observed for the first time. The (^{7}Be,^{3}He) reaction selectively populates the known α-cluster states in these nuclei. The data suggest that the (^{7}Be,^{3}He) and (^{7}Be,α) reactions can provide new tools for study of ^{3}He- and α-transfer and hence clustering in nuclei throughout the periodic table.

The study of alpha-particle transfer reactions on p-shell and sd-shell nuclei is important for our understanding of the structure of these nuclei and for the analysis of the helium-burning process in nuclear astrophysics. α-particle reduced widths of bound and nearly-bound states can, in principle, be extracted from α-stripping reactions such as (^{7}Li,t) and (^{6}Li,d) [1,2]. The study of such reactions provides complimentary information to that obtained from (α, α) scattering and (α, γ) capture reactions. The pronounced selectivity of such reactions and forward peaking of the angular distributions are indicative of a direct α-transfer reaction mechanism. A new RNB α-transfer reaction, (^{7}Be,^{3}He) which is analogous to the (^{7}Li,t) reaction may prove to be better suited since it has better reaction kinematics and perhaps reduced projectile breakup in the excitation regions of interest.

We have investigated the (^{7}Be,^{3}He) and (^{7}Be,α) reactions at E(^{7}Be)= 34 MeV. The ^{7}Be beam was produced via the ^{6}Li(^{3}He,d)^{7}Be production reaction. The 37 MeV ^{6}Li primary beam was provided by the FN tandem accelerator at the University of Notre Dame (UND). The ^{7}Be beam, 10^5 S^{-1}, at 34 MeV was collected and focused at the scattering chamber using the University of Michigan/UND TwinSol RNB facility [3,4,5]. The reaction products were detected and identified using an array of five ΔE-E Silicon Surface-Barrier (SiSB) detector telescopes covering an angular range of 15°-70°. Thick self supporting targets were used together with a natural gold target for Rutherford scattering. The measured angular distributions of the reaction rates for levels in ^{16}O, for example, will be presented. Likewise the ^{3}He transfer, (^{7}Be,α), reaction also appears to have large cross sections. This reaction can provide valuable nuclear structure information not easly obtainable otherwise.

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