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Study of the 85gKr(d,pγ) reaction for astrophysics at ANL

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About 50% of the elements heavier than iron are produced in the so-called s-process, where the lifetime for neutron capture of the nuclei involved is typically longer than their β-decay lifetimes. In the modeling of the s-process, great uncertainty derives from the competition between neutron capture and β-decay, in particular in some isotopes called "branching points". ^{85}Kr is an important branching point of the s-process, that influences both the ^{86}Kr/^{82}Kr ratio in presolar grains and the abundances of heavy Sr isotopes that are produced also by r-process. A better understanding of this branching point can be achieved only if the neutron capture cross section on ^{85}Kr is sufficiently well constrained, but a direct measurement of this cross section is extremely complicated due to the radioactivity of the sample.
The (d,pγ) reaction has been demonstrated to be a reliable indirect probe of the (n,γ)-reaction cross section, and ^{85}Kr can be accelerated as a pure beam. For this reason, the ^{85}Kr(d,pγ)^{86}Kr reaction has been carried out at 10 MeV/u in inverse kinematics at Argonne's ATLAS facility using the HELIOS spectrometer and the Apollo array. Excited state at energies from around 2-14 MeV in ^{86}Kr were populated, where S_n=9.86 MeV, with a Q-value resolution of about 150 keV. The $2^+ \rightarrow 0^+$ and $4^+ \rightarrow 2^+$ γ-rays are clearly observed, from which the γ-ray emission probabilities as a function of excitation energy [$P_p(E_{ex})$] can be determined. P_p shows the characteristic behaviour with a constant value below S_n and a decrease at higher excitation energies. These data are used to extract the cross sections for ^{85}Kr(n,γ) reaction, complementing recent direct, high-precision measurements on the stable Kr isotopes. The technique has significant potential for future indirect (n,γ)-reaction studies.

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