Activation masurement of α-induced cross sections for ^{197}Au

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A reliable α-nucleus potential is the essential prerequisite for the calculation of (γ,α) reaction rates for heavy neutron-deficient nuclei. This defines the γ-process path which is responsible for the nucleosynthesis of rare neutron-deficient nuclei, the so-called p-nuclei. The α-nucleus potential can be derived from the analysis of α-elastic scattering and from the cross sections of α-induced reactions.

The present experiment on ^{197}Au extends previous studies towards heavier nuclei where the increasing Coulomb barrier leads to very small cross sections. The new results cover the energy range from about 13.5 to 20 MeV and thus reach the upper end of the Gamow window for stellar temperatures of $T_9 \approx 3$, whereas literature data for ^{197}Au are available only at higher energies.

A combination of γ-ray and X-ray spectroscopy was used to identify the decays of the residual ^{201}Tl, ^{200}Tl, and ^{199}Tl nuclei from the (α,γ), (α,n), and (α,2n) reactions which are the dominating reaction channels. At some energies, the X-ray activity had to be followed over more than one month to disentangle the contributions of ^{199}Tl, ^{200}Tl, and ^{201}Tl from their different half-lives.

Statistical model calculations were made using the TALYS code. From a strict χ^2-based assessment of the cross sections in the different reaction channels, a set of parameters (α-nucleus potential, nucleon-nucleus potential, γ-ray strength function, and level density) could be identified which provides the best description of the experimental data. The choice of these parameters allows to extrapolate the measured cross sections towards lower energies with significantly reduced uncertainties. A careful discussion of the remaining uncertainties will be provided.

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