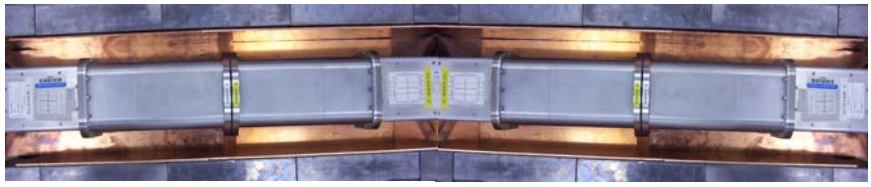
α-capture measurements on p-nuclei



Abundance calculations for the p-nuclei involve an extended network of about 20,000 nuclear reactions of almost 2000 nuclei with masses ranging from 12 to 210 [1]. These associated photo-dissociation and capture rates are typically calculated with the statistical Hauser Feshbach Model (HF-Model. The (γ,α) flow is critical for the processing of heavier elements towards lower masses in the p-process flow [1]. However these rates carry a substantial uncertainty which is believed to be associated with the alpha optical potential used for the HF calculations. Particularly critical reactions are (γ,α) photo-dissociation processes near the N,Z=50 closed shell since they feed the ^{92,94}Mo, ^{94,96}Ru p-nuclei, whose high observed natural abundance is in severe discrepancy with all theoretical predictions (e.g. [1,2]).

A critical test for the reliability of HF predictions is the measurement of ^{106}Cd(α,γ)^{110}Sn and ^{112}Sn(α,γ)^{116}Te along the p-process path at the Z=50 closed shell. This experiment was performed using the activation method; a stable sample ^{106}Cd and ^{112}Sn is bombarded with a charged particle beam producing a radioactive species whose characteristic γ- rays are then measured to determine the production cross section. The experiment was carried out using the Notre Dame Tandem Pelletron accelerator. The highly enriched ^{110}Cd and ^{112}Sn targets were activated in the energy range of 7 to 12 MeV in 0.5 MeV increments. The Gamow window for the ^{106}Cd(α,γ)^{110}Sn reaction at a typical p-process temperature of T=3 GK ranges between 6.7 and 10 MeV while that of ^{112}Sn(α,γ)^{116}Te between 6.8 and 10.2 MeV. After irradiation, the γ–rays of the activated samples were measured using two Clover detectors in close geometry (9 mm between detector and target) surrounded by 5 cm lead bricks for reducing the natural background radiation.

The experimental results for α capture are consistently lower than the HF predictions, while the for parallel (α,α), (α,p), and (α,n) cross sections excellent agreement can be observed.

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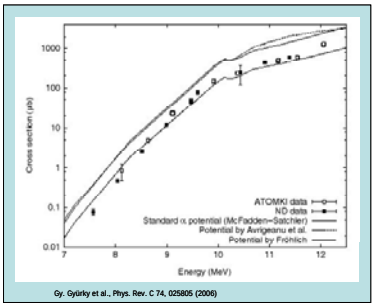
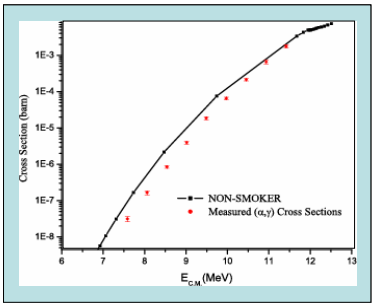
[1] W. Rapp, M. Wiescher, J. Görres, H. Schatz, F. Käppeler, Astrophys. J. 653, 474 (2006)
[2] M. Arnould, S. Goriely, Phys. Rep. 384, 1 (2003)



Experimental cross section results for the ^{106}Cd(α,γ)^{110}Sn reaction obtained at Notre Dame and Atomki facilities, in comparison with theoretical Hauser Feshbach model predictions for three different alpha potentials..



Experimental cross sections of the ^{112}Sn(α,γ)^{116}Te reaction obtained at Notre Dame in comparison with Hauser Feshbach predictions.

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