Comparative Statistical Model Calculations for Radiative Neutron Capture

Though all of the Hauser-Feshbach codes in the literature solve the same mathematical picture, even when exactly the same nuclear physics inputs have been selected there can still be a wide range of results between individual code packages. These variations come from two primary sources: 1) the implementation of details regarding various nuclear physics input models; 2) numerical effects arising from non-model dependent aspects.

Recently two new codes, named CIGAR and SAPPHIRE, have been developed. The codes have been designed to contain an identical, overlapping set of nuclear physics input models for a user to select between. As a result, the impact on the calculations arising from non-model aspects can be investigated. Using these two codes Maxwellian averaged cross sections have been computed for approximately 345 isotopes. Results from CIGAR and SAPPHIRE have been compared to data contained in the KADoNiS database, as well as to calculations performed with the codes NON-SMOKER and TALYS.

Figs. 1 & 2 - Percentage differences of $kT = 30$ keV MACS calculated with CIGAR, SAPPHIRE, NON-SMOKER and TALYS, compared to the KADoNiS database. Since CIGAR and SAPPHIRE use the same nuclear input models, differences between the calculations can be attributed to non-model effects, such as the truncation of experimental $J\pi$ data used in a calculation, as well as energy binning for the transmission coefficients.

Fig. 3 - Impact of $J\pi$ truncation on $kT = 30$ keV MACS. Calculated with SAPPHIRE.

Fig. 4 - Percentage differences of $kT = 30$ keV MACS, calculated with CIGAR and compared to the KADoNiS database, for various nuclear input model combinations. The considered models represent, respectively, $\gamma$-strength function, level density and optical models. Calculations are somewhat insensitive the optical model used, but are highly dependent on the level density and $\gamma$-strength function model. Consequently, details which are implemented differently in different code packages ostensibly using the same models (i.e. level density, back shift, or giant dipole resonance parameters) can have a significant effect.

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