RIPL Starter File Parameter Validation for Actinide Nuclei

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Nuclear reaction theory calculations are of particular importance for actinide nuclei data evaluation. Pending and future requests on actinide nuclear data hardly ever would be meet with measured data base. Current measured cross section data base for actinide nuclei in most cases is restricted to fission data, in some cases they are supplemented with inelastic scattering or capture data. Our evaluation approach is based on nuclear reaction theory application for data analyses. Recently it was employed for evaluation of nuclear data files for 243-Cm, 245-Cm, 246-Cm, 241-Am, 242m-Am, 242g-Am, 243-Am, 238-Pu, 242-Pu, 238-Np, fission data fit within Hauser-Feshbach-Moldauer theory serves as a major constraint for capture, (n,n') and (n,xn) data prediction. Available neutron-induced fission cross section data could be described with a statistical theory approach from 1 keV up to 40 MeV incident neutron energy [1,2]. On this basis fission level density and fission barrier parameters were obtained for 49 Th - Cf nuclei.

Measured data base for 238-U nuclide provides a unique possibility to compare calculated data with measured total, elastic, inelastic, fission, capture, (n,2n), (n,3n) and (n,4n) data up to 40 MeV [2,3]. A coupled channels optical model is adopted for n+238-U interaction data analysis. A consistent description of total and inelastic scattering data below 1 MeV incident neutron energy might be used to refine the recommended in Starter File optical potential parameter set. The direct excitation of ground state rotational band levels 0+-2+-4+-6+-8+ was estimated within rigid rotator model, as compared with 0+-2+-4+ coupling basis recommended either by Haouat et al. (1982) and Young (1995). Present potential parameters were obtained by fitting neutron total cross section data, angular distribution data up to 30 MeV incident neutron energy and neutron strength functions. In the optical potential, proposed by Young (1995) there is a relatively small volume absorption term. It influences total cross section data fit, but changes drastically the reaction cross section shape above 10 MeV. We argue that adding volume absorption term one faces severe problems with consistent description of fission and (n,xn) reaction cross section data in 10-40 MeV incident neutron energy range [2]. To follow the fission data trend above 20 MeV, we should introduce instead additional decrease of imaginary potential term W_D. Proton- induced reaction data for 238-U also were described [2].

Constant temperature level density parameters U_c, U_0 and T, another important ingredient of statistical theory calculation, are defined by fitting cumulative number of low-lying levels. Current values of constant temperature model parameters U_c, U_0 and T [4] generally are discrepant with Starter File estimates made based solely on cumulative plot fits. Producing fits of cumulative plots, latter parameters might lead to incorrect estimates of the cut-off energy, above which appreciable missing of levels starts. Another obvious consequence is incorrect extrapolation of level density shape even in a few-MeV excitation energy range. In present approach constant temperature model parameter T has a meaning of nuclear temperature, in other words it is correlated with level density shape, extrapolated from the excitation energy equal to the binding energy of the neutron to the matching point U_c. Another constant temperature model parameter U_0 is not much different from the odd-even correction to the excitation energy, used in the level density model. Smooth trends revealed in this parameter values make them particularly suitable for extrapolations to lower and higher mass actinide nuclei.

The statistical Hauser-Feshbach-Moldauer theory calculation of neutron-induced reactions for 238-U shows fair description of available data base. Our experience of using nuclear reaction theory with relevant input parameters, which are consistent or coincide with RIPL Starter File recommendations provides a clear evidence of rather high potential of RIPL Starter File for data prediction.

References:

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