The Influence of the Precompound Mechanism on Neutron-Induced Reactions

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Neutron-induced reactions of an incident energy of up to 15 MeV are predominantly governed by the compound-nucleus mechanism. As the neutron energy increases, the precompound emission becomes more and more important, decreasing the influence of the compound-nucleus emission. The precompound mechanism governs the emission of particles from the composite system prior to the attainment of statistical equilibrium, i.e. it precedes the compound-nucleus emission.

Using the precompound and the compound-nucleus mechanism, the neutron-induced reaction cross sections are calculated for outcoming neutrons, protons, α-particles and γ-rays, at incident neutron energies ranging from 4 MeV to 24 MeV, for 12 nuclei with A=45 to 209. The compound-nucleus model is based on the Weisskopf-Ewing evaporation formalism, while the precompound mechanism is based on the exciton model. The reaction cross sections are determined by closed-form expressions. Besides the input parameters common to the exciton and to the compound-nucleus models there are two additional input parameters in the exciton model. The initial exciton number n_o is commonly taken to be $n_o=3$ for all nucleon-induced reactions, thus leaving the parameter K (absolute value of the two-body mean square matrix element $|M|^2=K\,A^{-3}E^{-1}$) as the only free parameter of the model. The calculated data for the primary-neutron spectra and for (n,p), (n,2n) and (n,3n) excitation functions are compared with experiment. Good agreement with experimental data is obtained using K=600 MeV^3 for most of the nuclei studied. For some of them, the parameter K exhibits deviations from the above value, which are due to structural effects.