# A New Semiempirical Approach of Excitation Functions for (n, p) and (n,$\alpha$) Reactions Based on Evaporation and Exciton Models

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The precise (n, p) and (n,$\alpha$) reaction cross sections are of prime importance from the viewpoint of nuclear applications and fundamental problems of nuclear physics, such as the nuclear transmutation rate, nuclear heating, and radiation damage due to the hydrogen and alpha gas production in the potential first wall structural materials of the fusion-reactor, fast neutron reactor and the sub-critical reactor of an accelerator driven system. However, the available measured data of excitation functions for (n, p) and (n,$\alpha$) reactions are scare and the existing data are scattered about. Thus it is necessary to develop formulae to evaluate the (n, p) cross section of nuclides for which the absence measured data are available. Many parameters such as the binding energy, level density, giant dipole resonance parameters, gamma-branching, the neutron optical potential etc., of the target and residual nuclei, should be input and adjusted in the theory model codes to fit all the measured data. Several systematic studies were proposed to describe the cross section for (n, p) and (n,$\alpha$) reactions. However, those work are not only around the neutron energy of about 14 MeV, but also they are almost based only on the evaporation model, and almost all these work show deviation between the calculation results and measured data. Under the assumptions that the main competing process with proton emission is neutron emission, and the second particle emission is neglected; the preequilibrium emission in the first step in the equilibrium process, which is characterized by exciton n = 3 is only considered , and "never come back", a semiempirical approach to study the excitation functions for the (n, p) and (n,$\alpha$) reactions on the basis of evaporation and exciton models is obtained, and the "pick-up" mechanism of alpha in pre-equilibrium emission is adopted for studying (n,$\alpha$) reaction. In the incident neutron energy range up to 20 MeV and the mass region of 23 A 209, the adjustable parameter of the semiempirical method was investigated. Its strong dependence on (N-Z+1)/A and the incident neutron energy is observed. The for (n, p) reaction resulting from the fit to the 161 experimental data and = 3.222 for (n,$\alpha$) reaction fitting to the 120 experimental data points with four parameters is the lowest of all the existing formulas at En = 14.5 MeV. The predictions of the excitation functions for the (n, p) and (n,$\alpha$) reactions are good agreement with the experimental data. The ratios of the experimental cross sections to systematics calculations are in the region of 0.7 1.3 for (n, p) reaction and 0.6$\sim$1.5 for (n,$\alpha$) reaction in the present work at neutron energy of 14.5 MeV, and the ratios of M Belgaid's systematic results are during the region of 0.5$\sim$2.0 for (n, p) reaction and 0.5$\sim$1.7 for (n,$\alpha$) reaction 0.5$\sim$2.0 for (n,$\alpha$) reaction These systematic results demonstrate that the contribution of preequilibrium emission must be taken into account in the formulas. Our calculation shows that for medium weight nuclei the fraction of preequilibrium is $\sim$30 to 50% at En = 20 MeV.

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