Differential Cross-Section Calculations for Pre-Equilibrium Emission and Analysis of Experimental Data for ^{208}Pb

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Abstract. In this study, neutron-emission spectra produced by (n,xn) reactions on nuclei ^{208}Pb have been calculated. Angle–integrated cross sections in neutron induced reactions on targets ^{208}Pb have been calculated at the bombarding energies from 3 MeV to 20 MeV. We have investigated multiple pre-equilibrium matrix element constant from internal transition for ^{208}Pb(n,xn) neutron emission spectra. In the calculations, the Hybrid and the Geometry Dependent Hybrid models have been used. Pre-equilibrium direct effects have been examined by using full exciton model. By analyzing (n,xn) reaction on ^{208}Pb, with the incident energy from 3 MeV to 20 MeV, the importance of multiple pre-equilibrium emission can be seen clearly. All calculated results have been compared with experimental data. The obtained results have been discussed and compared with the available experimental data and found agreement with each other.

Keywords: Nuclear reaction models and methods, Emission spectra, Mean free path
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INTRODUCTION

It has been established that pre-equilibrium processes play an important role in nuclear reactions induced by light projectiles with incident energies above about 10 MeV. Recently, researchers have formulated several quantum–mechanical reaction theories [1] that are based on multi-step concepts and in which statistical evaporation at lower energies is connected to direct reactions at higher energies. The double differential neutron emission cross section at 14 MeV incident energy from lead is rather important with applied and basic points of views. The particular feature of this nucleus is that the (n,2n) reaction has a dominant contribution (90%) in total nonelastic cross section.

RESULT AND DISCUSSION

In this study, neutron-emission spectra produced by (*n,xn*) reactions on nucleus ^{208}Pb have been calculated. The calculations have been made in the framework of the GDH model using ALICE-91 computer code [2] and the Full-exciton model using PCROSS computer code[3]. There is strong dependence of the calculated emission spectra on the parameter of matrix element K if the parameterizations proposed by Kalbach are used in the calculations of internal transitions rates λ^i (i=+,)and it is sought to achieve a good adjustment of the theoretical calculations to the experimental spectra. Blann's parameterization for internal transition rate calculation involves the introduction of the parameter of mean free path k_{mfp} so called because its value determines the mean free path of the nucleon in the nuclear matter. This parameter allows an increase in mean free path. We have investigated multiple pre-equilibrium matrix element constant from internal transition for ^{208}Pb (n,xn) neutron emission spectra. Mean free path constants correspond to the experimental values for 14.1 MeV neutrons, (Fig.1). In study the standard Weiskopf-Ewing theory was used for equilibrium calculations. Particle-hole state density expression reported by Williams was used in the pre-equilibrium model calculation.

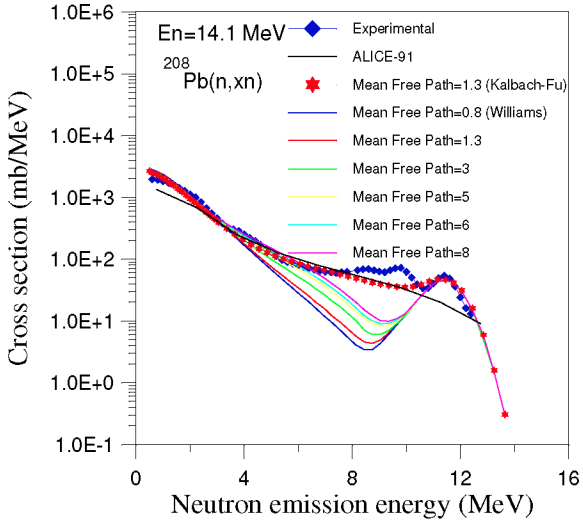

FIGURE 1. Comparison between the calculated and measured neutron spectra from the reaction ^{208}Pb+n at 14.1 MeV and investigation of mean free path constant. Data were taken from Ref. [4].

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