LaTeX Determination of excitation function of (n,2n) reaction on ^{87}Rb from threshold to 20MeV

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Introduction

The evaluation of cross section data for neutron induced reaction is required for several application in nuclear energy field. The nuclear model parameter plays an essential role in determining the excitation function for a particular reaction. Also, the nuclear level density parameter is effectively involved in the prediction of nuclear reaction data. In the present work the theoretical excitation function of $^{87}Rb(n,2n)^{86m}Rb$ reaction for the incident neutron energy ranges from 10MeV to 20MeV are determined by using TALYS1.8 nuclear reaction code.

TALYS1.8 is a computer code system which is developed for the simulation of various nuclear reaction data in the field like conventional and innovative nuclear power reactors (GEN-IV), transmutation of radioactive waste, fusion reactors, accelerator applications, medical isotope production. The input parameters in TALYS are adjusted with in the acceptable limit to determine the theoretical cross-section which agreed suitably with experimental cross section, and to understand the nuclear reaction theory of the particular reaction. In this work semi-microscopic optical model potential and microscopic level density model have been used to calculate the cross section for $^{87}Rb(n,2n)^{86m}Rb$ reaction. The calculated cross sections are compared with the EXFOR experimental data and with the other evaluated data files ENDF, TENDL-2017,CENDL 3.1,BROND 3.1, ROSFOND 2010.

Nuclear model calculation

TALYS1.8 calculation with semi-microscopic optical model potential is as described in Jeukenne-Lejeune-Mahaux(JLM) optical model potential calculation. The Mod'ele Optique Microscopique module reads the radial matter densities from the nuclear structure database and performs the folding of the Nuclear Matter (NM) optical model potential described in the literature[1] with the densities to obtain a local Optical model potential.The final NM potential for a given nuclear matter density $\rho = \rho_n - \rho_p$ and asymmetry $= (\rho_n + \rho_p)/\rho$ reads

$$U_{NM}(E)_{\rho,\alpha} = \lambda_V(E)\left[V_0(\tilde{E} \pm \lambda_{V_1}\alpha V_1(\tilde{E})\right] + i\lambda_{W1}(E)\left[W_0(\tilde{E} \pm (E)\alpha W_1 \tilde{E}\right] \quad (1)$$

Where E is the incident neutron energy, $\tilde{E} = E - V_c$, V_c is the coulomb field, $V_0, V_1 W_0, W_1, \lambda_V \lambda_{V_1} \lambda_W$ and $\lambda W1$ are the real isoscalar, real isovector,imaginary isoscalar and imaginary isovector,real (isoscalar+isovector), real isovector, imaginary, and imaginary isovector normalization factors respectively. The phenomenological Optical model potential for nucleon-nucleus scattering U is defined as

$$U(r,E) = -\nu_V(r,E) - iW_V(r,E) - iW_D(r,E) + \nu_{SO}(r,E).1.\sigma + iW_{SO}(r,E).1.\sigma + \nu_c(r) \quad (2)$$

where $\nu_{V,SO}, W_{V,D,SO}$ represent the real and imaginary componants of the volume(V), Central (C), spin-orbit (SO) potentials. The real part of the volume potential is

$$V_V(r,E) = V_V(E)f(r,R_V,a_V) \quad (3)$$

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In the present calculation the parameter R_V for neutron is adjusted to 1.5

Level density

There are 6 models for level density calculations that where included in TALYS1.8. The 3 phenomenological level densities which are constant temperature Fermi gas model, Backshifted Fermi gas model, Generalised superfluid model.The 3 microscopic level density models[2] which are the Microscopic level densities from Gorielys tables, Microscopic level densities from Hilaires combinatorial tables, Microscopic level densities from Hilaires combinatorial tables that includes temperature-dependent Hartree-Fock-Bogolyubov calculations using the Gogny Force[3]. The microscopic level densityρ_{Hfm} can be adjusted through a constant c and paring shift δ

$$\rho(E_x, J, \Pi) = exp\left(c, \sqrt{E_x - \delta}\right) \times \rho_{HFM}(E_x - \delta, J, \Pi) \tag{4}$$

The constant c plays a role similar to that of the level density parameter 'a' of phenomenological models. Adjusting c and δ together gives adjustment flexibility at both low and higher energies. In the present work the microscopic level density calculations using temperature-dependent Hartree-Fock-Bogolyubov calculations using the Gogny interaction are performed to produce the theoretical calculation.

Result and Discussion

The excitation function of $^{87}Rb(n,2n)^{86m}Rb$ reaction for the incident neutron energy ranges from 10 MeV to 20 MeV are determined by using TALYS1.8 nuclear reaction codes which is illustrated in FIG.1. The present calculation is performed by invoking Jeukenne-Lejeune-Mahaux Optical model potential, microscopic level densities temperature dependent Hartree-Fock-Bogolyubov Gogny force from Hilares combinational tables. The calculated cross-section is plotted along with the available experimental data taken from EXFOR data library and the other evaluated data files ENDF, TENDL-2017,CENDL 3.1,BROND 3.1, ROSFOND 2010. The comparison of the calculated cross-section shows good agreement with EXFOR experimental data than evaluated data files .

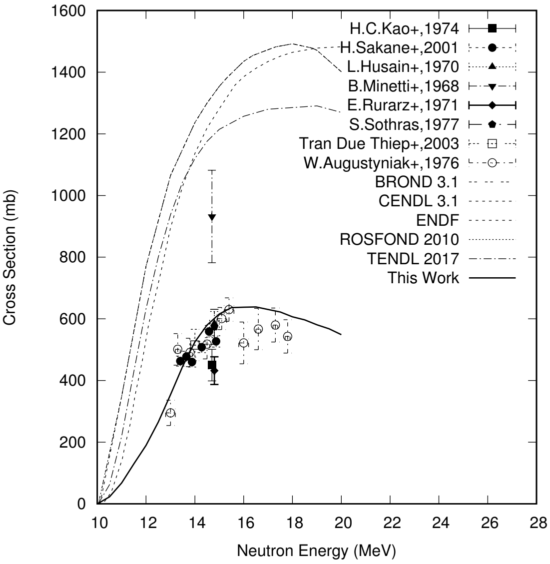

FIG. 1: Excitation function of $^{87}Rb(n,2n)^{86m}Rb$. along with experimental EXFOR data and other evaluated data file

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