Total reaction cross section for *p-Sm* at E_p=65 MeV

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Introduction

The total reaction cross sections are integral properties of nuclei participating in the reaction. They play an important role in optical and statistical model calculations. Proton differential elastic scattering measurements are available for several stable isotopes and they provide an experimental basis for constraining optical model potentials (OMP). But, up to now, there are not enough experimental data on reaction cross sections to test the statistical model calculations even for stable isotopes, therefore predictions for unstable isotopes are uncertain. It is well known that there is a correlation between nuclear charge radii and reaction cross sections (σ_R). We can make use of this correlation to make a prediction of σ_R for unstable isotopes with the knowledge of nuclear charge distributions and OMPs. In this abstract, we present the prediction of total reaction cross sections using the folding model approach. The calculation proceeds in two steps [1, 2]: firstly, the nuclear ground state properties are calculated in the framework of relativistic Hartree-Bogoliubov (RHB) model based on density-dependent meson-exchange (DD-ME2) relativistic energy density functional [3] for even $^{134-164}$Sm isotopes. The ground state properties are compared with the corresponding available data [4]. In second step, the target radial matter densities calculated in RHB framework have been used in the semimicroscopic optical model to obtain the proton optical potentials for even Sm isotopes. The Jeukenne-Lejeune-Mahaux-Bruyeŕes (JLMB) energy- and density-dependent nucleon-nucleon interaction [5] are folded with the target radial matter densities. The resulting real and imaginary parts of the folded optical potential are used to compute the differential and reaction cross sections for 65 MeV-proton elastic scattering from even $^{134-164}$Sm isotopes.

Ground state properties

The calculated ground state nuclear properties such as binding energy and charge radii for even Sm nuclei are compared and found to be in good accord with the available data [4]. The calculated difference in the mean-squared charge radii, $\delta < r_c^2 >^{N,82}$ as a function of neutron number is plotted in Fig. 1. For comparison, spherical droplet model predicted values for $\delta< r_c^2 >$ are plotted in the same figure. As expected, the values of $\delta< r_c^2 >$ from DIRHB calculations are found to increase on either side of N=82 in agreement with the experimental data. A marked change in slope is observed at N=94, for which experimental data is unavailable, which may arise from shell effects. A smaller kink is observed at N=102. Local magic numbers may exist for unstable nuclei due to varying shell effects at these points which are not as prominent as the robust magic numbers such as $viz.$, $20, 28, 50, 82$ and they need to be studied further in detail.

The droplet model [1] predicts decrease in $\delta< r_c^2 >$ below N=82 but both the experimental and DIRHB calculated values show otherwise. This is due the fact that deformation is not accounted for in the droplet model. Even for $N \geqslant 82$, the droplet model predictions differ from the experimental and the calculated ones, suggesting that the nucleus is deformed, and the deformation is maximum for mid-shell nuclei.

The normalised target density is then folded with JLMB interaction to obtain the OMP parameters. The real and imaginary parts of

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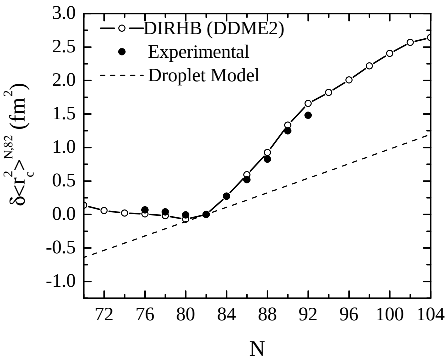

FIG. 1: The calculated $\delta< r_c^2 >^{N,82}$ as a function of neutron number compared with available data [4]. The dashed line represents spherical Droplet model [1].

the central potential are obtained. The real and imaginary parts of the spin orbit interaction are added phenomenologically. These potentials are used to calculate the differential cross-section (dσ/dΩ) and σ_R of the stable nuclei. Fig. 2. shows the plot of dσ/dΩ for the stable isotopes of Sm. It is evident that the calculated and experimental values agree reasonably well with one another.

An overall normalization was needed in the calculated optical model potential such that dσ/dΩ shows good agreement with data. Searches on normalization constants for real and imaginary parts of the central and spin-orbit potentials were performed to obtain minimum χ^2 values in fitting $d\sigma/d\Omega$ data [6] for stable isotopes. It is seen that the normalization constants obtained for all even stable isotopes have a small N dependence.

To make predictions of $d\sigma/d\Omega$ and σ_R for unstable isotopes, a least-squares fit needs to be carried out as a function of N for stable isotopes. The variation of normalization constants obtained from best fit for stable isotopes exhibit a dependence on N. These normalization constants are then extrapolated and are used for calculation of $d\sigma/d\Omega$ and σ_R for neutron-deficient and neutron-rich isotopes.

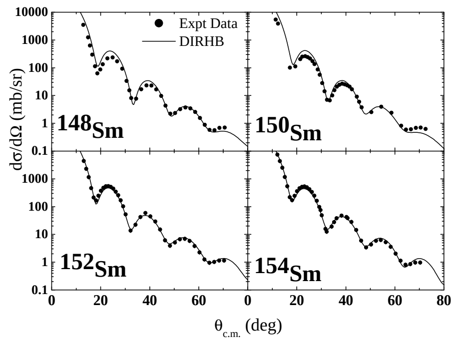

FIG. 2: The calculated elastic scattering differential cross-section (dσ/dΩ) compared with corresponding experimental [6] values for stable Sm isotopes.

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