Study of Spin Rotation Function for Polarized Proton Incident on Zr and Sn Isotopes

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Introduction

The spin-orbit interaction is important to understand the nuclear structure. Experiments with radioactive nuclear beam provide the opportunity to study nuclei with large neutron excess even close to the drip line. For drip line isotopes, nuclear shell effects become very important and the spin-orbit part of the nuclear potential plays an essential role. Further, the spin-orbit term plays an important role in the calculation of the spin observables such as analyzing power and spin rotation function in the polarized proton-nucleus scattering. Recently, we have demonstrated the weakening of the spin-orbit interaction with the addition of neutrons both for Zr and Sn isotopes [1]. As a step further, we investigate the spin rotation function [2]. This is useful in analyzing spin-orbit interaction and also neutron and proton densities in the nucleus. In the present work, we report the calculation of spin rotation function for polarized protons incident on neutron-deficient, stable and neutron-rich Zr and Sn isotopes at 50 MeV.

The fully microscopic proton-nucleus optical potentials are generated in the framework of first-order Brueckner theory employing Urbana V14, soft-core internucleon interaction along with the relativistic mean field (RMF) [3] densities both for protons and neutrons. The calculation [4] of the microscopic proton - nucleus optical potential mainly involves two steps. First one evaluates the complex effective $N - N$ interaction in the first order Brueckner theory of infinite nuclear matter using realistic inter - nucleon interaction. In the second step, this effective interaction is folded with the ground - state target nuclear densities to obtain the nucleon - nucleus optical potential. It is important to note that in these calculations the medium modification and Pauli's correction have been fully taken into account. Since the effective interaction is complex, this approach consistently yields both the real and imaginary parts of the nucleon - nucleus optical potential. The effective interaction (g-matrices) in this approach is energy - and density - dependent.

Here, we follow the approach of Haider *et al.* [4], to calculate the optical potentials for 50 MeV protons incident on Zr and Sn isotopes within the framework of first order Brueckner theory using Urbana V14 soft core inter - nucleon interaction, as illustrative examples. The required nucleon (both for protons and neutrons) density distributions for the targets, obtained in the relativistic mean field approach, are employed.

Results

The calculated angular distribution of spin rotation function R (θ) protons incident on neutron-deficient, stable and neutron-rich isotopes of Zr and Sn are shown in Fig. 1 and Fig. 2 respectively. Figures reveal a rich structure. In general both for Zr and Sn isotopes, it is observed from the figures that the peaks are shifted to lower angles with increase in neutron number, more so at larger angles. One can note the appearance of new peaks for ^{96}Zr and ^{98}Zr for centre of mass angles greater than 140 degrees. In the case of Sn isotopes, the first minimum in the calculated angular distribution of spin rotation function R (θ) diminishes in magnitude as we go towards neutron-rich nuclei.

Experimental data of angular distribution of spin rotation function R (θ) for protons incident on Zr and Sn isotopes at these energies are not available.

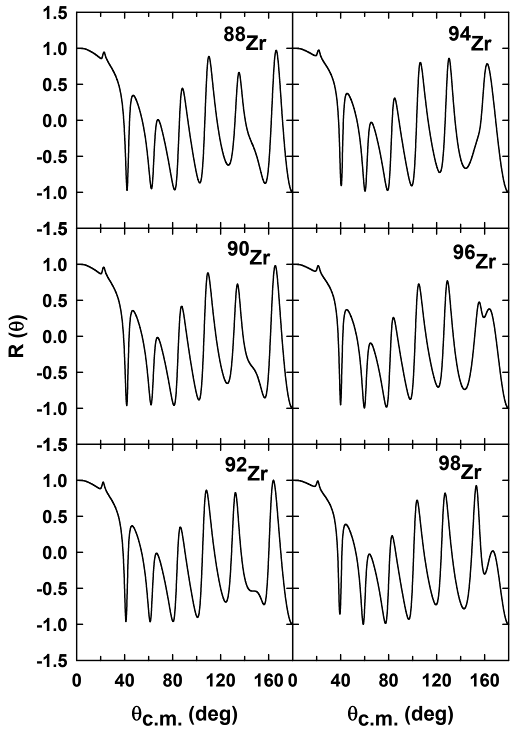

Fig. 1 Calculated angular distribution of spin rotation function *R* (θ) for 50 MeV protons incident on neutron-deficient, stable and neutron -rich isotopes of Zr.

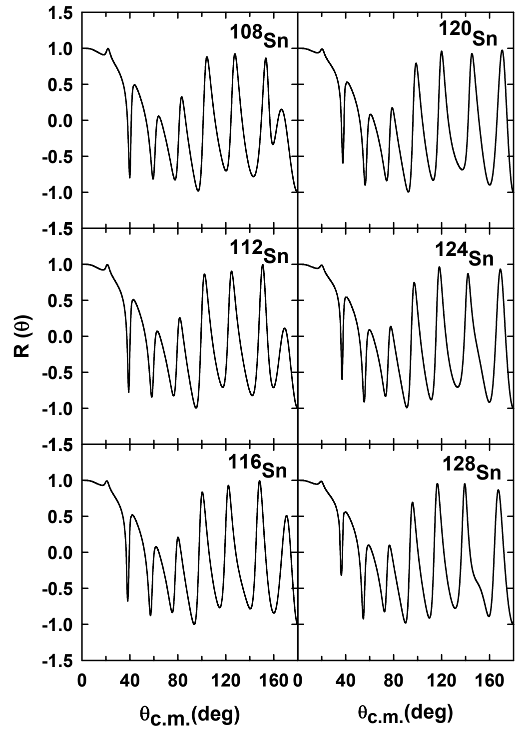

Fig. 2 Calculated angular distribution of spin rotation function *R* (θ) for 50 MeV protons incident on neutron-deficient, stable and neutron -rich isotopes of Sn.

Spin rotation function merits experimental study for exotic nuclei. Further understanding of the variation of *R* (θ) for exotic nuclei is underway. It would be interesting to investigate the variation of spin rotation function with the addition of neutrons.

References

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