BE(3) transition strength from inelastic scattering in ^{6}Li+^{112}Sn reaction

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Introduction

The electric octupole transition strengths, i.e., BE(3) values, have been measured for ^{112}Sn target using different methods like Coulomb excitation of the target [1], inelastic scattering of electron (e,e′) [2], proton (p,p′) [3] and heavy ions [4]. However, they have a wide range of BE(3) values with large uncertainties. The BE(3) value obtained by Coulomb excitation method with a better accuracy [5] is smaller than the one obtained in Ref. [1] by the same method. The values obtained from (α, α') scattering lie even below the ones obtained by Coulomb excitation [5] and much lower than the (p,p′) values. It was suggested that the B(E3) value extracted from the inelastic data of a reaction involving heavier projectile could be smaller compared to proton [5]. With such large uncertainties on the BE(3) values it is very difficult to choose a particular set using which one can predict the inelastic cross sections for the 3^- state of the ^{112}Sn target to understand the experimental data, specially for heavy ions. So, it is proposed to determine the above value for ^{112}Sn isotope by measuring the inelastic scattering of another heavy ion, ^{6}Li, and compare with literature values.

Experimental details

The angular distributions for elastic and inelastic cross sections for ^{6}Li+^{112}Sn system have been measured at a bombarding energy of 30 MeV using BARC-TIFR Pelletron facility at Mumbai. Four telescopes of single Si surface barrier detectors, placed at 10^o apart, on a rotatable arm inside a 1.5 m diameter scattering chamber were used to detect the light charged particles in the angular range of $\theta_{\rm lab} = 40^o - 140^o$. Each telescope consists of a ΔE detector of thickness $\sim 50\mu m$ and a E-detector of $\sim 1500 - 2000\mu m$. A typical 2-dimensional (ΔE-E) spectrum acquired using a single telescope at θ_{lab}=100^o is shown in Fig. 1(a). The one dimensional projection spectrum for ^{6}Li particles is shown in Fig. 1(b). Along with the elastic peak, the yields of two inelastic states corresponding to first two excited states of target i.e., 2^+ (1.256 MeV) and 3^- (2.355 MeV) states are found to be dominant.

Data analysis and results

Differential cross sections for the elastic scattering angular distributions normalized to the Rutherford cross sections are shown in Fig. 2(a). The inelastic cross sections corresponding to ^{112}Sn(2^+,1.256 MeV) and ^{112}Sn(3^-,2.355 MeV) are shown in Fig. 2(b) and (c) respectively. Optical model (OM) analysis using SNOOPY code has been made to fit the elastic scattering data. The OM potential parameters are of Woods-Saxon volume form with values V_R=27.53 MeV, a_R=0.682 fm, V_I=29.14 MeV, a_I=0.518 fm and $r_R = r_I$=1.2 fm. These potentials have been used later in the coupled-channels calculations using FRESCO that included elastic as well as two inelastic states. The coupling parameters (B(E2)=0.240 e^2b^2 [6]

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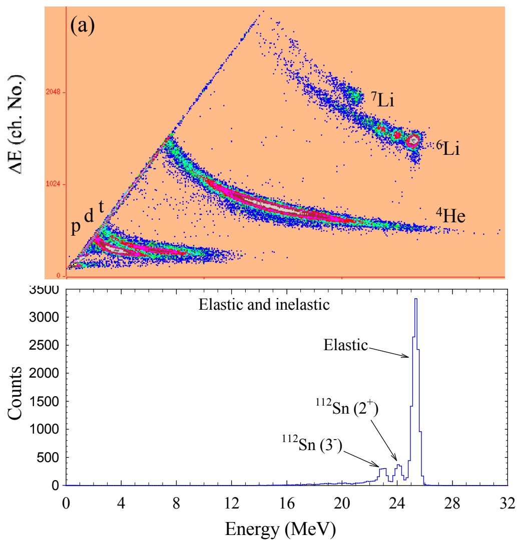

FIG. 1: Typical 2-dimensional (ΔE-E) spectrum acquired using a single telescope at θ_{lab}=100^{o} for ^{6}Li+^{112}Sn reaction at E_{lab}=30 MeV is shown in upper panel (a). One dimensional projection of ^{6}Li particle band is shown in panel (b).

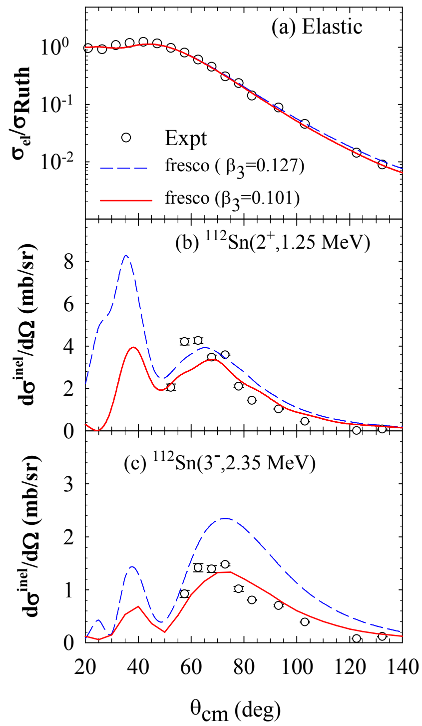

FIG. 2: Experimental differential cross sections for (a) elastic scattering and (b,c) inelastic scattering corresponding to (2+, 1.256 MeV) and (3-, 2.35 MeV) excited states of ^{112}Sn respectively. Dashed and solid lines correspond to the results of coupled-channels calculations using FRESCO with β_3=0.127 and 0.101 respectively.

and BE(3)=0.087 e^2b^3 [5]) available in the literature have been used for the two inelastic states. The results of the FRESCO calculations along with the measured data are shown in Fig. 2 as dotted lines. The theoretical cross sections predicted for 2^+ state were found to reproduce the experimental cross sections reasonably well. However, the data for 3^- state are much lower compared to the FRESCO prediction. Results with a new but reduced B(E3) value (=0.055 e^2b^3), shown as a solid line, reproduces the experimental cross section for 3^- state. It implies that B(E3) values quoted in Refs. [1–3] are not suitable for present case. The new BE(3) value for ^{112}Sn nucleus obtained from present data is close to the one obtained by (α,α') method [5] and it is consistent with the observation that the value reduces for reactions involving heavier projectiles. A systematic measurement of BE(3) and BE(2) values for all the Sn isotopes by inelastic scattering of different heavy ions along with theoretical calculations is also planned for the future.

References

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