Double Folding Analysis of ^{6}Li Elastic and Inelastic Scattering on ^{116}Sn

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Giant resonances (GR) in ^{116}Sn excited by ^{6}Li inelastic scattering were studied by the deformed potential model and reported last year [1]. Multipole decomposition analysis [2] showed that the isoscalar giant dipole resonance (ISGDR) strength obtained in this analysis considerably exceeded the energy weighted sum rule(EWSR), indicating that the deformed potential model may not be adequate to study giant resonances excited by ^{6}Li scattering.

The folding model [3] has been widely used to generate the real part of the optical potential (OP) for alpha and heavy ion scattering. The folded potential is obtained by folding the nucleon-nucleon (N-N) effective interaction over target and projectile densities. One of the most widely used N-N effective interactions is the M3Y N-N interaction. In this report, a CD type density dependent N-N interaction, Paris version CDM3Y [4], was used to obtain the real part of optical potential for elastic scattering and real part of transition potential for inelastic scattering. The CD type density dependence function, which is a flexible hybrid of the original DDM3Y and BDM3Y form and which parameters are adjusted to get the correct saturation density and bind energy value, can be expressed as [4]

$$F(\rho) = C\left[1 + \alpha \exp(-\beta\rho) - \gamma\rho\right], \qquad (1)$$

where C=0.2658, α=3.8033, β=1.4099fm^3, and γ=4.0fm^3. The folding model calculations for optical potential and transition potential were carried out with code DFPD4 [5]. Phenomenological Woods-Saxon (W-S) potential was used to construct the imaginary part of OP and transition potential.

The elastic scattering data were fitted with the code ECIS [6]. The parameters obtained are shown in the Table I and the calculated angular distribution of the cross-section is plotted with data in Fig.1. A substantial renormalization factor N_R for real part of potential is needed here to fit ^{6}Li elastic scattering (Please see the Ref.[7] for more detail about the renormalization factor N_R.). Using the folded potential with W-S imaginary term, the cross section for inelastic scattering to low-lying 2^+ and 3^- states were calculated and shown with data in Fig.2 and Fig.3. The parameters used for double folding calculation are listed in Table II. Deformation parameters were obtained from electromagnetic B(EL) values by assuming the mass and coulomb deformation lengths are the same.

Table I. Optical model parameters obtained from the fits of the ^{6}Li+^{116}Sn elastic scattering. The M3Y(R) calculation used a W-S shape for the imaginary potential. N_R is the real renormalization factor for the folded potential.

E_{Li} (MeV)	Potential type	N_R	V (MeV)	r_0 (fm)	A (fm)	W (fm)	r_{I0} (fm)	a_I (fm)
240	Woods-Saxon		188.0	0.837	0.905	28.4	1.17	0.816
240	M3Y(R)	0.5631				23.935	1.19	0.9686

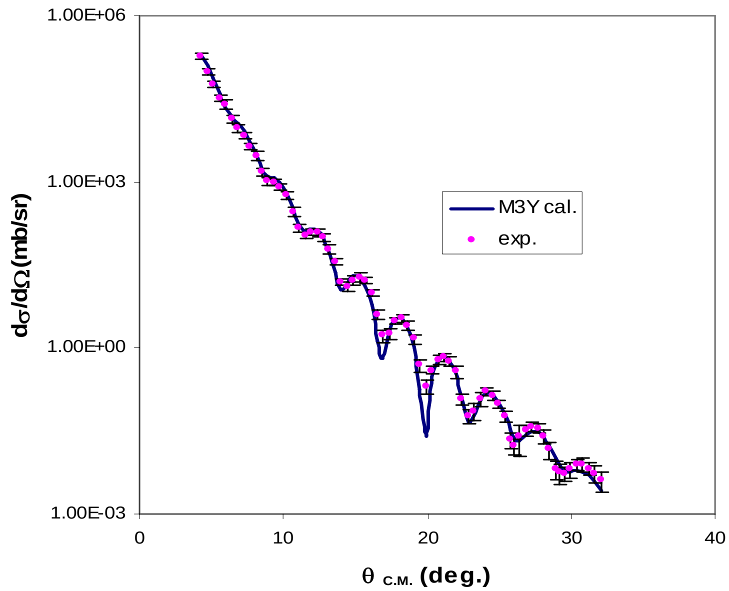

Figure 1. Angular distribution for $^{6}Li+^{116}Sn$ elastic scattering cross-section. The line shows the calculation using the M3Y(R) folded potential with a W-S imaginary term.

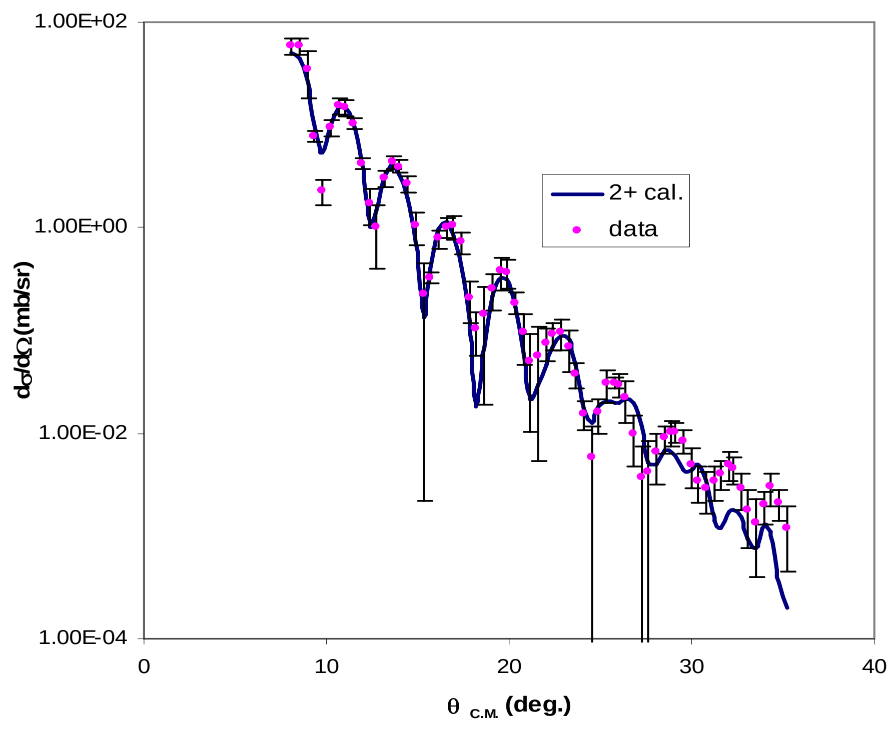

Figure 2. The line shows the calculated differential cross-section calculated using the M3Y(R) potential given in Table 1 for inelastic scattering to the 1.29 MeV 2^{+} state in ^{116}Sn plotted versus average center-of-mass angle. The electromagnetic B(EL) value was used. The data are shown by the circles. The error bars include statistical and systematic errors.

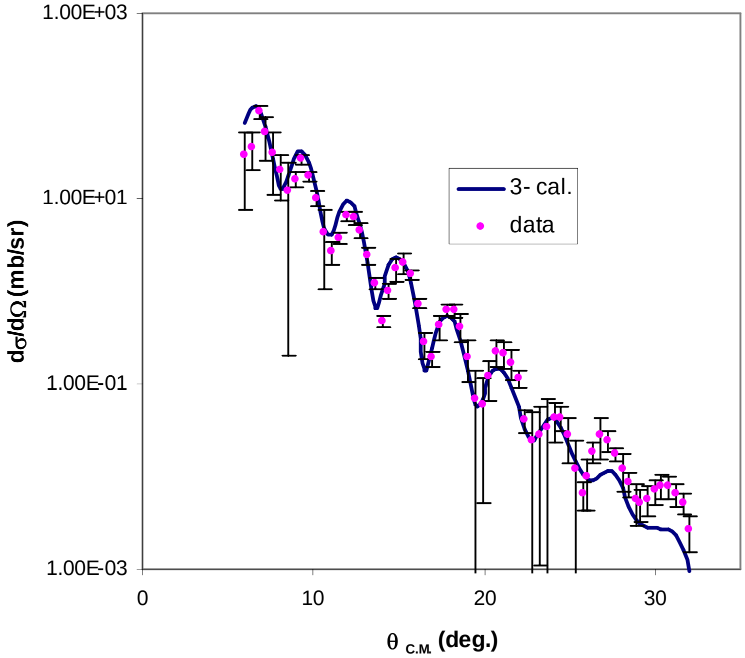

Figure 3. The line shows the differential cross-section calculated using the M3Y(R) potential given in Table 1 for inelastic scattering to the 2.27 MeV 3^- state in ^{116}Sn plotted versus average center-of-mass angle. The electromagnetic B(EL) value was used. The data are shown by the circles. The error bars include statistical and systematic errors.

Table II. Parameters used in double folding calculations for inelastic scattering to low lying 2^+ and 3^- states of ^{116}Sn

E_x(MeV); J^π	δ_m	N_R	W (MeV)	r_{i0} (fm)	a_i (fm)
1.29; 2^+	0.6441	0.5631	23.935	1.19	0.9686
2.27; 3^-	0.8397	0.5631	23.935	1.19	0.9686

Calculations for L=0-4 isoscalar excitations at E_x=16 MeV exhausting 100% of the respective sum rules are shown in Fig. 4. While the cross sections for the other multipoles are similar to those with the deformed potential, the ISGDR cross section is approximately a factor of 6 higher. Preliminary multipole decomposition using the folding model calculations result in strengths for L=0, 1, and 2 in approximate agreement with those obtained from α scattering[8]. The ISGDR cross section was also found to be quite sensitive to the details of the calculation for α scattering [9].

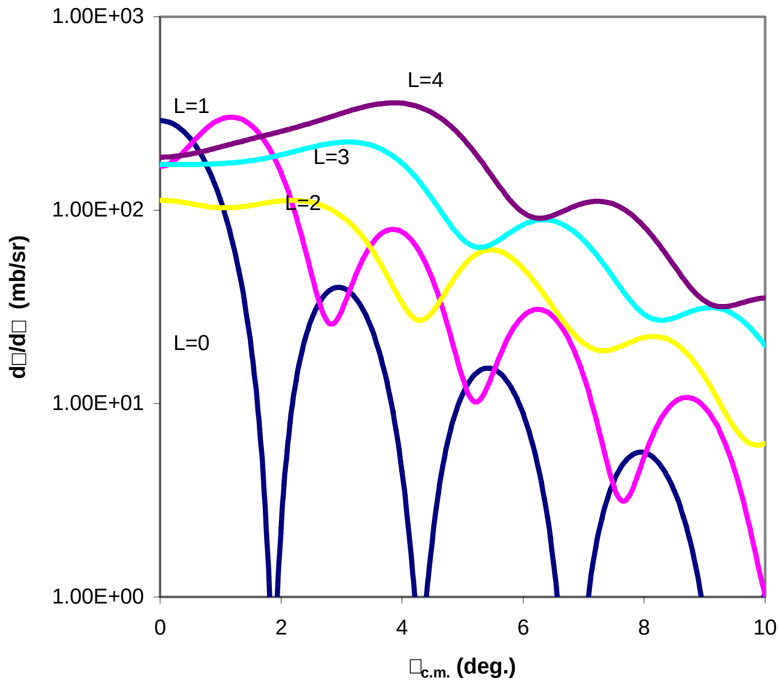

Figure 4. Angular distributions for L=0, 1, 2, 3, 4 excitations at E_x=16 MeV exhausting 100% of the respective EWSR's calculated with the M3Y(R) potential shown in Table 1.

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