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1.22 GENERALIZED OPTICAL MODEL FOR ^{152}Sm(P,P') POLARIZED DATA *

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This investigation is a part of our program to get the most accurate information possible on the shape and the collective properties of the Sm isotopes, e.g. for further comparison of nuclear and electromagnetic transition densities. We have therefore chosen for a new treatment of the experimental data.

A first analysis of our 20.4 MeV polarized data of the well known rotator nucleus ^{152}Sm was performed in a "classical" way including compensation of the optical model (OM) parameters for its deformation and the multi-channel reality by fitting explicitly to the strong excited inelastic channels in a CC scheme[1,2]. A conventional OM one-channel analysis with the code OPTIMO[3] provided starting values for the Woods-Saxon parametrization (see Table I, C1). To account explicitly in a 0^+-2^+-4^+ CC scheme for the loss of flux out of the elastic channel a further adaptation of the imaginary (surface) depth (W_s) and the geometry parameters (r_i,a_i) was performed in the strong coupling approach by the code ECIS[4]. Keeping the β_4 strength fixed at a reasonable value of 0.07[5] the parameters of the imaginary potential were fitted together with the deformation strength parameter β_2 on the data for both the 0_1^+ and 2_1^+ levels (see Fig. 1.a) as these two levels are both very sensitive to these parameters. A further adjustment of the β_2 and β_4 to the 2_1^+ and 4_1^+ data provided us with the final deformation strengths where the β_2 did not change significantly (<0.5%). The final results are given in Table I (C2). This resulted in a good description of the g.s. cross section and the 2_1^+ strength, while we noticed a worsening in the analyzing power of the elastic data (see Fig. 3).

This work pointed out the difficulty to determine potential parameters and deformation strengths in a simultaneous fit to the 0_1^+ and 2_1^+ data, as these two levels show a different sensitivity to the imaginary potential. Not only the influential back-couplings are specific for each of the two levels, but also the different sensitivity to OM-dependent form factors. Whereas it is still expected that the OM potential reproduces the elastic data as accurately as possible, the choice of a multipole of order 2 to reproduce the 2_1^+ data derived from the same OM potential is less obvious. The first excited level should therefore be of second importance. As the ground state itself is also very sensitive to the coupling strengths, we investigated if the minimization of χ^2 for the g.s. by a set β_2, β_4, W_s, r_i, a_i corresponds with a physical value of β_2. Working therefore in the same coupling scheme 0_1^+-2_1^+-4_1^+, we restricted for selected β_2, β_4 values the fit to the elastic data only, considering the coupling to higher levels as perturbation (see Fig. 1.b). The imaginary potential was fitted in a first run (Table I. C3a) before adjusting the other potentials (Table I, C3b). It can be seen from Fig. 3 that the adjustment of the imaginary potential parameters already substantially improve the quality of the fit. The minimum in χ^2 (Fig. 2) resulting from the fit of the total OM parameter set corresponds with the β_2 needed to describe the 2_1^+ data. Still a description of the backward region of the 2_1^+ level deteriores accounting for an incorrect λ=2 form factor and/or incomplete coupling schemes. This method gives less reliable values for the β_4 strength. This can be associated to smaller backcoupling effects to the g.s. and hence more sensitivity to inaccurate measurements of the g.s. in the backward angular region.

Similar results has been found for the vibrator (^{148}Sm) in a 0_1^+-2_1^+-3_1^- CC scheme. The χ^2 minimum is less pronounced as expected from the smaller back-coupling to the g.s. It furnishes us with a good estimate of β_2 but does not reproduce the β_3.

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Table I. Optical-model parameters obtained in the analysis of ^{152}Sm polarized data at 20.4 MeV

	V_o	r_o	a_o	W_s	r_i	a_i	V_{so}	r_{so}	a_{so}
C1	50.70	1.225	0.677	12.43	1.119	0.863	5.066	1.131	0.335
C2				11.73	1.213	0.707			
C3a				12.90	1.208	0.647			
C3b	52.57	1.212	0.704				6.109	1.120	0.496

Table II. Deformation strength and chi-squared values obtained for the g.s.

	β_2	β_4	χ^2(cross section)	χ^2(analyzing power)
C1			36.2894	4.1527
C2	0.224	0.056	62.0328	11.3539
C3a	0.235	0.023	25.7703	1.2163
C3b	0.235	0.023	23.8111	1.3540

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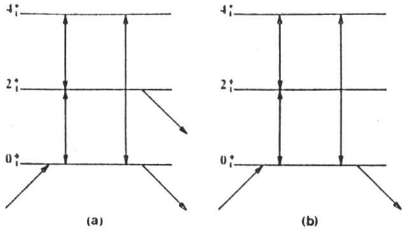

Fig. 1.

Fit scheme of the performed 0^+-2^+-4^+ CC calculations. The fit included two levels (a) or only one (b).

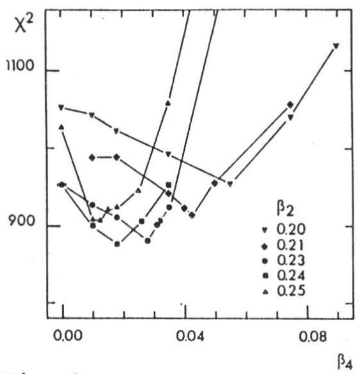

Fig. 2.

χ^2 summed over all experimental points, obtained for the g.s. with method C3. The lines serve only to guide the eye between the points obtained with the same β_2 values (given by the numbers written in the Fig.), but different $\beta_4$values.

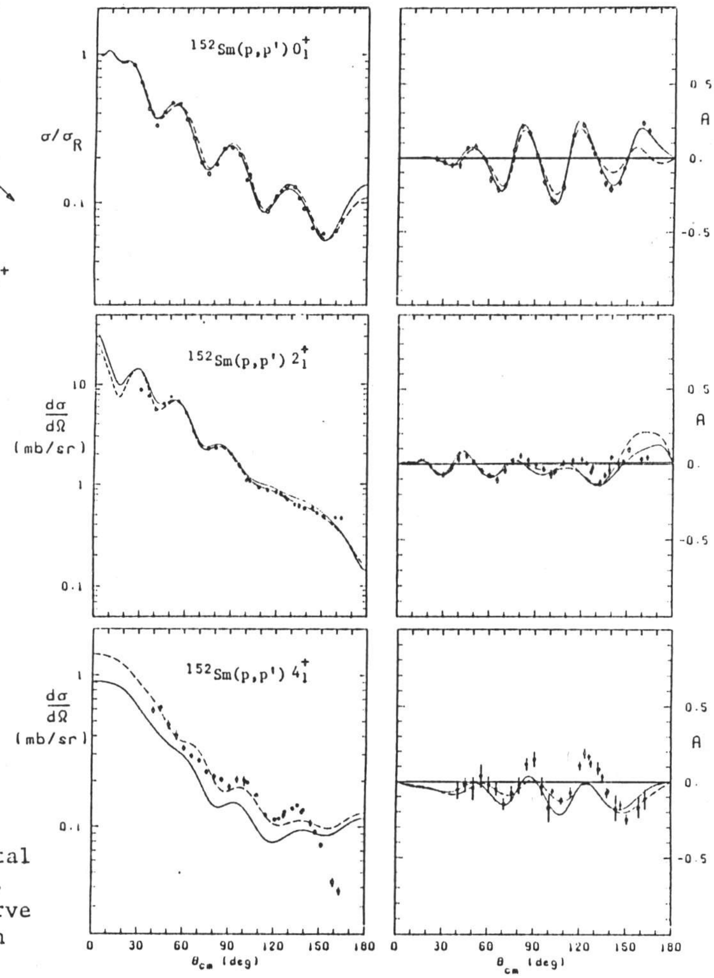

Fig. 3. Resulting cross sections and analyzing powers for the fitting method C3a (full line) and C2 (dashed line).