Title

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Inelastic Alpha Particle Scattering in the Rare Earth Region and Determination of β_4

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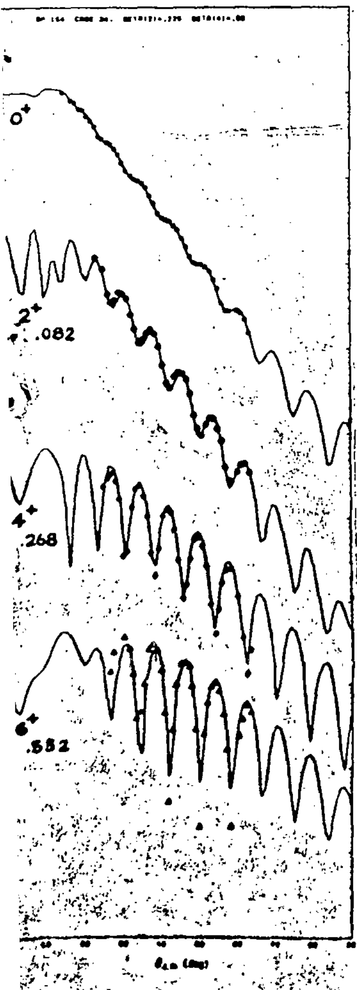
The analysis of the scattering of 50 MeV alpha particles[1] from Sm^{152} and Sm^{154} showed that he multiple nuclear excitation mechanism[2] reasonably explains the angular distributions of xcited states. Extension of the scattering work to other permanently deformed rare earth uclei gives new information about levels belonging to the ground state rotational band. In articular, the interference between direct and multiple excitation modes yields reliable measrements of higher order deformations in these states.

The experiments consisted of detection in 4 cooled lithium drifted silicon detectors of 0 MeV alpha particles provided by the Berkeley 88" cyclotron which were elastically and inelasically scattered by thin metallic foils of the isotopically enriched rare earths. The resoluion was sufficient and backgrounds were low enough to obtain data for states up to 8^+ levels f the ground state band. The data were analysed using a complex coupled rotational model oupled-channels calculation. The inclusion of Coulomb, as well as nuclear, excitation up to th order in the interaction (requiring use of partial waves up to ℓ=90) was necessary for eproduction of details of the angular distributions. The amount of higher order deformations s then sensitively determined by the angular distributions to the higher spin states. The uality of the resulting fits is shown in fig.1 for Sm^{154}, where we find β_4=+0.05±.01. The ualitative difference for Yb^{176} is seen in fig. 2, where preliminary calculations indicate hat a β_4=-0.04 is necessary. Table I lists our results to date, most of which are tentative.

These results may be understood on the basis of a calculation similar to that performed by arada[3] in the actinide region. β_4 is determined by a perturbation calculation using Nilsson rbitals and a r^4Y_{40} interaction; the result is shown in fig. 3. Although there is a rather rbitrary choice of zero, corresponding to a selection of contributing orbitals, the trend owards more negative β_4 deformation is unequivocal and in agreement with the experimental esults. In order to compare the β values from the scattering work with those derived from EM experiments, a scale factor of about 1.5 must be applied. This should be noted in comparing fig. 3 with Table I.

Table I

Nuclide	Sm^{152}	Sm^{154}	Gd^{158}	Yb^{174}	Yb^{176}	Hf^{178}
β_2	0.205	0.225	0.230	0.245	0.240	0.245
β_4	+0.045	+0.050	+0.045	-0.040	-0.040	-0.045



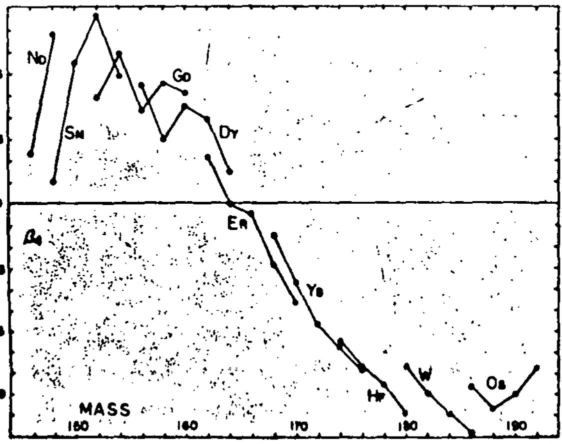
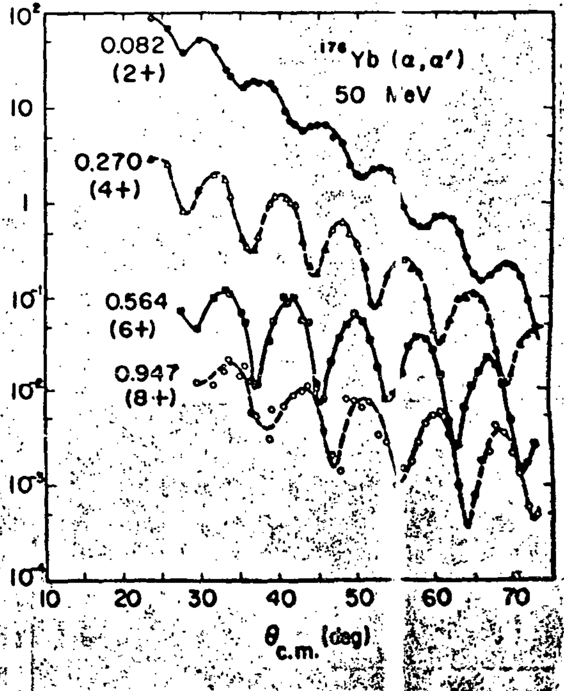


Fig. 3 (above) Calculation of β_4.

Fig. 1 (left) Data and coupled-channels fit for Sm^{154}.

Fig. 2 (right) Data for Yb^{176}.



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