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V–20 Electric Quadrupole and Hexadecapole Transition Moments in Rare Earth Nuclei by Coulomb Excitation Experiments

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Higher order effects in Coulomb excitation provide an interesting tool for the investigation of finer details of the electromagnetic properties of nuclei. Here we would like to report on a systematic investigation of E4 and E2 transition moments in the rare earth region.

Relative elastic and inelastic cross sections for scattering of alpha particles from $Sm^{152,154}$, $Gd^{158,160}$, $Dy^{162,164}$, and $Er^{166,168,170}$ were measured at beam energies between 11 and 13 MeV. The alpha particles were detected near a scattering angle of 180° in a cooled annular surface barrier detector.

From the measured excitation probabilities values for $B(E2, 0^+ \rightarrow 2^+)$ and $B(E4, 0^+ \rightarrow 4^+)$ were obtained by means of the Winther de Boer Coulomb excitation computer program. Quantum mechanical corrections were applied to the calculated 2^+ and 4^+ cross sections using the results of Alder *et al.*[1] and part of the analysis was carried out using a new Quantum mechanical coupled channels code AROSA, by Alder *et al.* All possible E2 and E4 moments between the 0^+, 2^+, 4^+ and 6^+ members of the ground state rotational band were included in the calculations.

In order to compare the results with theoretical predictions, the extracted transition moments were converted into the model dependent deformation parameters β_2 and β_{4}, using both a uniform as well as a Fermi charge distribution. The results for the β_4 deformations are compared with the calculations of Gotz *et al.*[3] and Nilsson *et al.*[4] in Fig. 1. The general trend predicted by these calculations is very well reproduced by the experimental results. The data may support a preference for the calculation of Gotz *et al.* but this is not conclusive because of the experimental uncertainties shown, as well as the uncertainties associated with the model used in deriving the deformation parameters from the transition matrix elements. The results can also be compared with (α, α′) experiments above the Coulomb barrier by Henderie *et al.*[5] and Aponick *et al.*[6] Within the quoted experimental errors the β_4 values obtained in the various experiments are in agreement. The data on Sm^{152} are in good agreement with recent electron-scattering experiments of Bertozzi *et al.*[7] but the present results on Sm^{152} and Sm^{154} are somewhat smaller than those of a previous Coulomb excitation experiment by Stephens *et al.*[8] A large part of this difference is attributable to the use of slightly different $B(E2\ 0^+ \rightarrow 2^+)$ and $B(E2\ 2^+ \rightarrow 4^+)$ values.

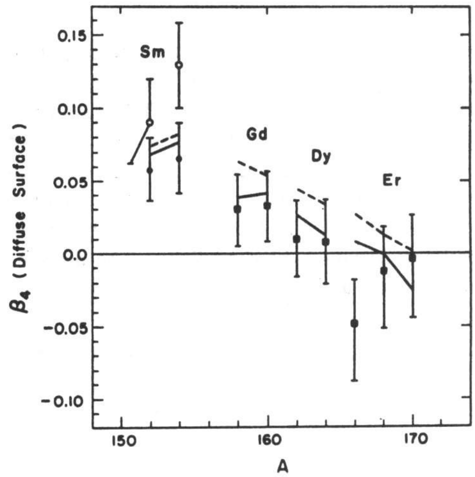

Fig. 1

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