A Study of Nuclei in the Mass 137 Region of the Light Rare Earths

P. J. Bishop, A. N. James, A. J. Kirwan, P. J. Nolan, D. J. Thornley, and K. L. Ying
Department of Physics, University of Liverpool, Liverpool L69 3BX, U.K.

and

R. Wadsworth and S. Mullins
Department of Physics, University of York, Heslington, York YO1 5DD, U.K.

and

D. J. G. Love
Daresbury Laboratory, Daresbury, Warrington WA4 4AD, U.K.

Early work[1] in the mass ~ 136 region of the light rare earths has identified yrast sequences in even-even nuclei which suggest deformations consistent with recent calculations[2]. Measurements of the deformation, deduced from lifetime experiments[3], also agree well with the theoretical calculations.

To further the study of the deformation systematics and also to elucidate the nature of the bandcrossings in ^{136}Sm an experiment was performed to identify the gamma-rays in the neighbouring odd nuclei. This was executed using the POLYTESSA escape suppressed germanium array on the recoil separator. The attainment of sufficient resolution to remove the Z ambiguity in the different mass spectra demanded a highly inverse reaction, for which the beam and target combination of ^{74}Se + ^{66}Zn at an energy of 290 MeV provided a recoil velocity of 0.047c. Doppler broadening of the gamma-ray peaks due to this high velocity was alleviated by collimation of the hyper-pure germanium detectors at angles of 37° and 63°.

Velocity dipersion of the recoils provided unequivocal identification of the concomitant gamma-rays within the mass regions 136 to 138. Information provided by the ion chamber permitted the individual isotopes, from which the gamma-rays originated, to be identified.

Of the eight nuclei observed, gamma-rays were identified for the first time in ^{137}Sm, ^{137}Eu and in the odd-odd nuclei ^{136}Pm and ^{138}Eu. The establishment of the high intensity gamma-rays originating from these nuclei permitted the execution of a second experiment to collect gamma-gamma data, from which it was proposed to establish their decay schemes. This subsequent experiment, performed in February 1987, also used the reaction ^{74}Se + ^{66}Zn at 290 MeV and was performed utalising the POLYTESSA array, with 20 hyper-pure germanium detectors.

Analysis of the odd nuclei, currently still in progress, has revealed, for ^{137}Eu, a yrast sequence constructed of stretched E2's as shown in Fig.1. The data has been assigned a ground state spin of 11/2, based on systematics, and only shows evidence of a gradual upbend upto the 39/2 level as shown in the alignment plot, Fig.3, where it is plotted togther with the longer yrast sequence of ^{136}Sm. The plot shows evidence that the alignment in ^{136}Sm, attributed to the $h_{11/2}$ proton is blocked as was expected.

A preliminary decay scheme for ^{137}Sm is presented in Fig.2. The main negative parity bands show considerable signature splitting, 95 keV at $\hbar\omega = 0.28$ MeV, which is not seen in the side band. With further analysis it is hope to extend the shorter of the

bands past the bandcrossing and thus establish the nature of the second backbend seen in ^{136}Sm.

1) C. J. Lister et al, *Phys. Rev. Lett.* **55** (1985), 810
2) G. A. Leander and P. Möller, *Phys. Lett.* **110B** (1982), 17
3) R. Wadsworth et al, *J. Phys. G.* **13** (1987), 205

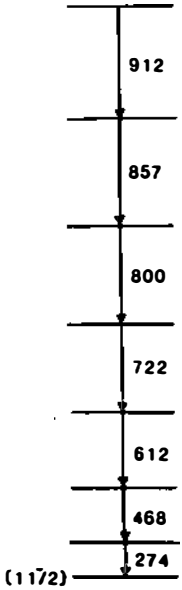

Fig.1 Decay sceme of ^{137}Eu.

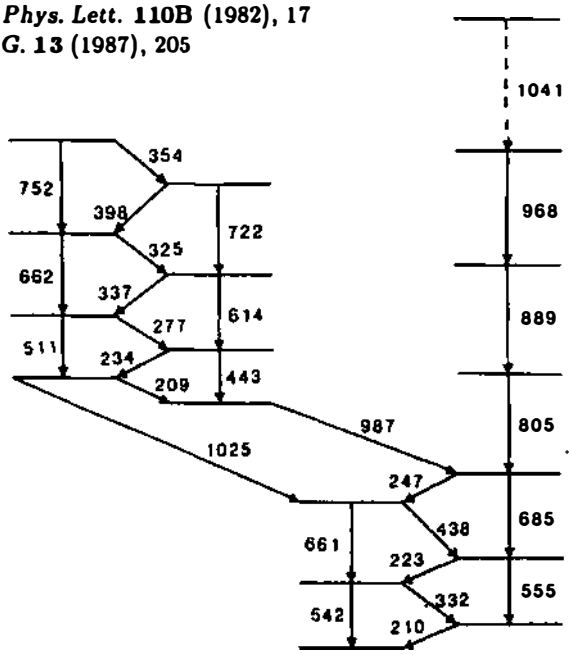

Fig.2 Preliminary decay scheme of ^{137}Sm.

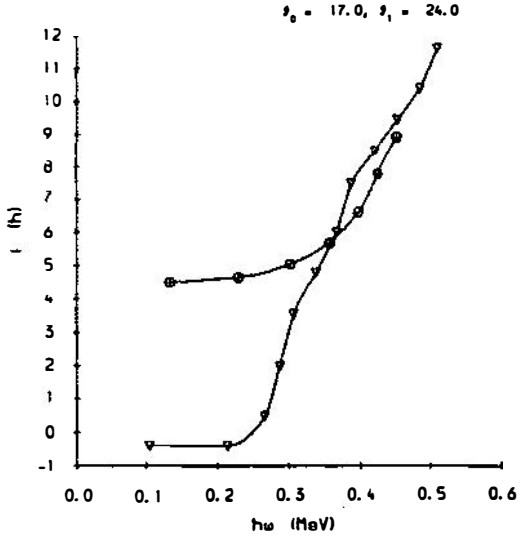

Fig.3 Alignment plot of ^{137}Eu and the longer yrast band of ^{136}Sm.