Search for chiral bands in ^{133}Ce

H.C. Jain, R. Palit, P.K. Joshi, S. Lakshmi and I. Mazumdar

T.I.F.R., Mumbai-400005, India.

Frauendorf [1] suggested an angular momentum coupling scheme for nuclei with triaxial deformation according to which the energy of the valence particles and holes is minimised if their angular momenta are aligned along the short or long axis while the collective (core) angular momentum is aligned along the intermediate axis which is a preferred axis of rotation for irrotational flow-like moment of inertia. The three mutually perpendicular angular momenta couple to a total angular momentum tilted out of the three principal axes planes. This angular momentum coupling can be placed into a right handed or left handed system. The reversal of the direction of the collective angular momentum along the intermediate axis changes the chirality. The consequence of the two possible couplings is the appearance of two bands - called the 'chiral doublet' - with nearly degenerate energy levels having same spins and parity. Recently, a chiral doublet based on three quasi-particle configuration [$\nu(h11/2)^{-1}\Theta$ $\pi(h11/2)^2$] was reported in ^{135}Nd [2]. This prompted us to search for a chiral doublet in ^{133}Ce which is an isotone of ^{135}Nd. The level structure of ^{133}Ce has been studied through the ^{16}O + ^{122}Sn reaction using 80 and 85 MeV ^{16}O beam from the 14-UD pelletron accelerator in T.I.F.R. Mumbai. The target was prepared by rolling a 1.3 mg/cm^2 thick enriched ^{122}Sn target foil onto a 15 mg/cm2 thick Au backing. The gamma decay following the reaction was studied using an array consisting of 8 Compton suppressed clover detectors with 14 NaI(Tl) multiplicity filter. The data were collected when three or more clovers fired along with two or more firings in NaI(Tl) multiplicity filter. The decay scheme was studied from the analysis of gamma - gamma coincidence data. The spins of levels and multipolarity of the gamma transitions were obtained from the directional correlation orientation (DCO) ratios, angular distribution and integrated polarization directional correlation (IPDCO) measurements. The partial level scheme of ^{133}Ce obtained from the present work shows transitions in bands B1, B2 and B3 are in agreement with those reported in refs. [3,4]. Spins and parity of levels in band 2 have been established in the present work. The important feature of our work is the observation of M1 transitions connecting levels in Band 2 to levels in Band 1 and also the E2 transitions from levels in band 1 to band 2. A comparison of gamma energies with increasing spins in bands B1 and B2 shows that there is crossover between spins 27/2 and 29/2. The presence of interband transitions and crossover in gamma energies with increasing spin strongly suggest that bands B1 and B2 form a 'chiral doublet'.

References:

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