Chiral Bands in Even-Even Mo and Ru Nuclei

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Abstract

The conditions for observing chiral symmetry breaking in nuclei are a well-deformed, triaxial nucleus with substantial contributions of angular momentum along all three axis as first noted by Frauendorf and co-workers [1]. Well deformed triaxial odd-odd nuclei with the high j, angular momentum of a proton (or neutron) hole aligned along the long axis and that of the high j angular momentum of a neutron (or proton) particle aligned along the short axis and rotational angular momentum along the intermediate axis, have provided the necessary characteristics to give rise to chiral structures. Chiral symmetry breaking gives rise to two sets of $\Delta I = 1$ bands, where the levels in each have identical spins and parities and are nearly degenerate in energy. Such doublet chiral bands have been reported, for example, in ^{104}Ru [2] and ^{134}Pr [3]. We carried out γ-γ-γ coincidence studies of the prompt γ-rays in neutron-rich nuclei populated in the spontaneous fission of ^{252}Cf. With 102 detection in Gammasphere, a total of 6×10^{11} triple coincidences were collected. This high statistics data set enabled us to search for more weakly populated band structures in neutron-rich nuclei.

We have observed in even-even ^{106}Mo, ^{110}Ru and ^{112}Ru, extended $\Delta I = 1$ doublet band structures which are nearly degenerate in energy. These nuclei are known to have significant quadrupole deformation, $\beta_2 \sim 0.3$. Our studies of the staggering of the energy levels in the γ bands in these nuclei and in bands built on high j orbitals in their odd-Z neighbors, Nb, Tc and Rh show that these nuclei have significant triaxiality, reaching a maximum of $\gamma = 30^o$ in Ru and Rh according to one particle plus triaxial rotor calculations. These doublet bands have all the other properties expected for chiral bands. The experimental evidence for these new bands and their triaxiality and comparison of their properties with those expected for chiral doublets will be presented. Tilted axis cranking calculations give further support for their chiral interpretations. These are a new type of chiral structures which correspond to soft chiral vibrations.

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