Odd-parity doublet bands in $^{108, 110, 112}$Ru

Y.X. Luo[1,2], J.H. Hamilton[1], S.J. Zhu[1,3], J.O. Rasmussen[2], A. V. Ramayya[1], J.K. Hwang[1], S. Frauendorf[4], A. Gelberg[5], I. Stefanescu[5], X-L, Che[3], P.M. Gore[1], D. Fong[1], E.F. Jones[1], S.C. Wu[2], I.Y. Lee[2], W. C. Ma[6], G.M. Ter-Akopian[7], A.V. Daniel[7], M.A. Stoyer[8] and R. Donangelo[9]

[1] *Department of Physics, Vanderbilt University, Nashville, TN 37235, USA*
[2] *Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720*
[3] *Physics Department, Tsinghua University, Beijing 100084, China*
[4] *Physics Department, University of Notre Dame, Notre Dame, IN 46556, USA*
[5] *Universität zu Käln, Koeln, German*
[6] *Mississippi State University, Drawer 5167, Mississippi State, MS 39762, USA*
[7] *Flerov Laboratory for Nuclear Reactions, JINR, Dubna, Rassia*
[8] *Lawrence Livermore National Laboratory, Livermore, CA 94550, USA*
[9] *Universidade Federal do Rio de Janeiro, CP 68528, RG Brazil*

The theory of chiral doubling of rotational bands in triaxial nuclei developed by Frauendorf and others [cf. 1] has led to numbers of searches for such doublet bands, particularly in odd-odd triaxial nuclei. In even-even ^{106}Mo, we observed doublet bands which tilted-axis cranking (TAC) calculations indicated could be soft chiral vibrational bands [2]. Recently one of the earlier proposals for chiral doublets in ^{134}Pr was shown to not have all of the experimental properties of chiral bands [3].

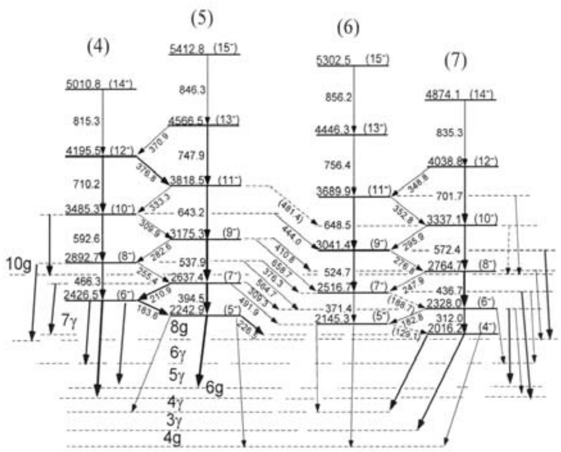

FIG. 1: Odd-parity doublet bands in ^{110}Ru.

With our high statistical data at Gammasphere, we have carefully investigated levels in $^{108, 110, 112}$Ru, populated in the spontaneous fission of ^{252}Cf. We observed odd-parity doublet bands in $^{108, 110, 112}$Ru, as shown in FIG. 1 for ^{110}Ru. The many decay-out transitions uniquely yield band head spins and parities of 4^- and 5^- (and 5^- and 6^-). Their 0dd-Z neighboring nuclei show evidence for a transition from axially symmetric shapes to maximum triaxiality in going from ^{99}Y to ^{113}Rh [4]. The doublet bands seen in $^{108, 110, 112}$Ru have some remarkable similarities: their band head energies are close, 2111 keV (4^-) and 2424 keV (5^-) in ^{108}Ru; 2016 keV (4^-) and 2243 keV (5^-) in ^{110}Ru; and 2003 keV (5^-) and 2334 keV (6^-) in ^{112}Ru, and the branching ratios E2/(M1 + E2) ~ 6 are identical for the two bands in each nucleus and are nearly the same in all three nuclei. The moments of inertial for the doublet bands in $^{110, 112}$Ru are remarkably equal and constant with spin, as they should be in chiral bands.

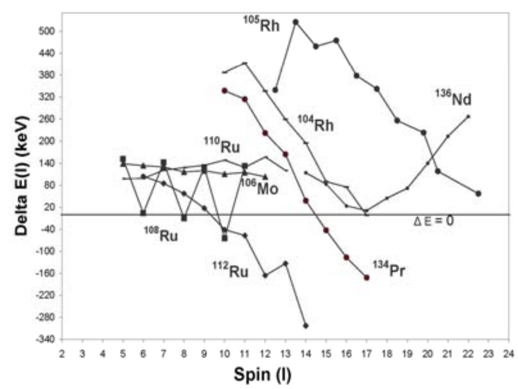

FIG. 2: $E(I)_a - E(I)_b$ of the doublets.

The TAC calculations for ^{112}Ru provide some support for these bands being soft chiral vibrational bands but do not reproduce all the data. One of the real puzzles is seen in FIG. 2 where the energy differences for states of the same spin in the two bands are shown. For rigid chiral rotation, this difference should approach zero. In FIG. 2 one sees a very different pattern for each of $^{108, 110, 112}$Ru. Why are these so different when their branching ratios and their band head energies are so close? The branching ratio agreements strongly indicate these doublet bands are not accidental degeneracies. If these are chiral doublets, the data are more complex than represented by present TAC calculations. On the other hand, the data may be pointing to some new symmetry we have not yet understood.

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