Twinned Identical Superdeformed Bands in the $A=80$ Region:
A Further Probe of Nuclear Deformation


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Since the report of the first superdeformed (SD) band in the medium-mass nucleus $^{83}$Sr [1], nearly twenty new SD bands have been discovered in the $A=80$ region. Here, we report the first observation of twinned identical SD bands in this region. Such SD bands, first observed in the $A=150$ region, may be attributed to the presence of $K = 1/2$ single-particle orbitals with decoupling parameter $a = 1$ near the Fermi surface [2].

Two experiments were performed at the LBNL 88" cyclotron with the Gammasphere spectrometer and the "Microball" charged-particle detector system. Fusion-evaporation reactions $^{58}$Ni($^{28,29}$Si, 3$p$)$^{83,84}$Y at beam energies of 130 and 128 MeV, respectively, were used. Steps of data analysis included kinematical corrections of recoils, proper charged-particle gating, and removal of contaminating channels. Two of the SD bands established in $^{83}$Y and $^{84}$Y were found to have nearly identical $\gamma$-ray energies to two SD bands in their isotones $^{83}$Sr [3] and $^{84}$Sr, respectively. Figure 1 illustrates the identification of the band in $^{83}$Y by removing the contamination from $^{82}$Sr.

To understand the nature of the identical SD bands in the $A=80$ region, we have performed Nilsson-Strutinsky cranking calculations for several sets of shape parameters. The $[310]1/2^-$ proton orbital, which offers a natural explanation for these identical bands, approaches the Fermi surface for $Z \sim 39$ at deformations of $\beta_2 \simeq 0.5$. The location of this orbital, however, is very sensitive to the deformation parameters assumed in the calculations. The presence of these identical bands, therefore, may be used to further constrain the deformation parameters deduced from lifetime measurements. Lifetime measurements for a second SD band in $^{83}$Y indicate that its $Q_1$ value is similar to that for $^{82}$Sr, but smaller than the value for $^{84}$Zr [4].

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**Fig. 1:** Spectra obtained by double gating on transitions in the SD bands of $^{82}$Sr (4p gated, middle) and $^{83}$Y (3p with contamination from 4p, bottom). The normalized difference (top) shows the clean SD spectrum in $^{83}$Y. Transitions from ND bands are indicated by filled triangles ($^{83}$Y), opened triangles ($^{82}$Sr), and stars ($^{82}$Y).