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POSSIBLE OBLATE ROTATIONAL BANDS IN N=84 NUCLIDES†

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ABSTRACT

Strong coupling rotational bands built on 11^- [33/2+ for odd-A] states with configuration $\nu(i_{13/2}, h_{9/2})$ [$\Pi(h_{11/2})$ $\nu(i_{13/2}, h_{9/2})$ for odd-A] have been identified in N=84 nuclei with $Z \leq 65$. These are the first levels observed in this region with proven oblate deformation.

We have reanalyzed published data [1-6] for all even-A, N=84 nuclides and identified groups of levels which seem to form oblate rotational bands. These are presented in Fig. 1.

All of these band-like groups of levels have the following features in common:

1. All are built on levels with spin-parity of 11^- and excitation energy of $\gtrsim$ 4 MeV.
2. $\Delta I=1$ between the adjacent levels of the groups.
3. Transition energy $\Delta E(I\rightarrow I-1)$ as a function of I shows similar oscillatory behavior in all the bands, see Fig. 2.
4. Transition energies $\Delta E(I\rightarrow I-1)$ between corresponding levels in various even-even nuclides are similar.

The odd-A N=84 nuclide, $^{149}_{65}Tb_{84}$, displays similar features. Here the band is built on a 33/2+ level with configuration $\Pi(h_{11/2})$ $\nu(i_{13/2}, h_{9/2})$.

The nature of these strong coupling bands with large K and significant odd-even shift can be understood through inspection of Nilsson diagram for neutrons (Fig. 3). The $K^{\pi}=11^-$ state can be built in terms of the two unpaired neutrons if we assume that they occupy the Nilsson levels 13/2+ [606] ($i_{13/2}$) and 9/2-[505] ($h_{9/2}$), respectively. These levels are amongst the closest levels to the Fermi surface for N=84 only for $\beta<0$ and very sharply increase in energy for positive β. Hence, we can expect that in N=84 nuclides one of the lowest $I=11^-$ states comprises of neutrons in 13/2+ [606] and $9/2^-$ [505] orbitals and they give rise to oblate shape ($\beta<0$). The oscillatory behavior of the transition energy $\Delta E(I\rightarrow I-1)$ with angular momentum I is perhaps indicative of Coriolis effect which is brought about by large value of j = 13/2 and 9/2. The K=33/2+ state

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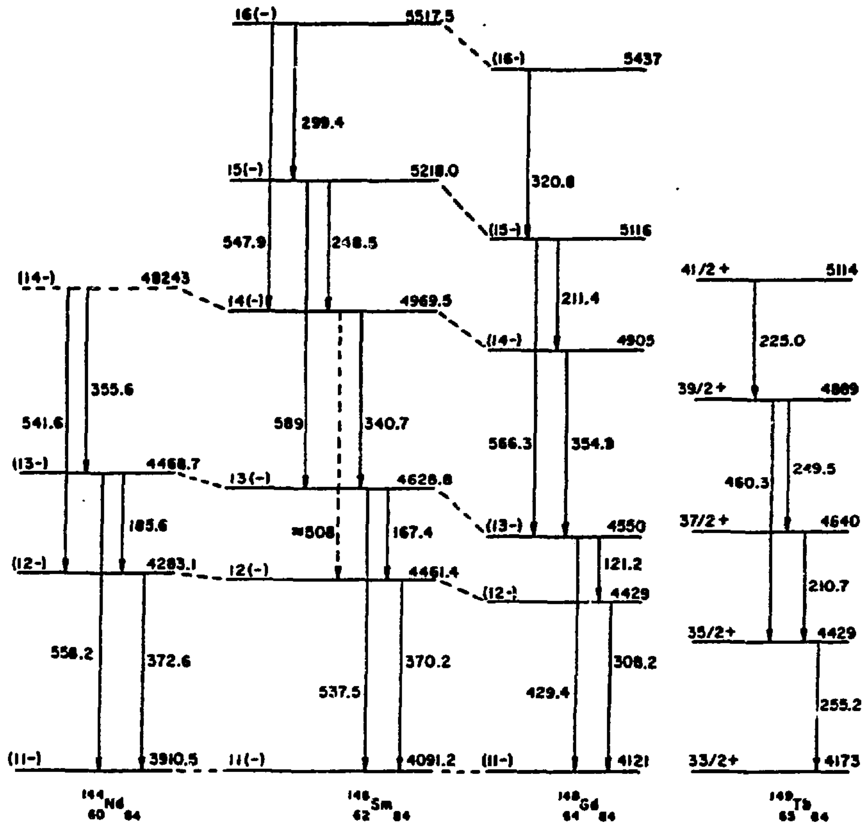

Fig. 1. Strong coupling rotational bands in N=84 nuclides.

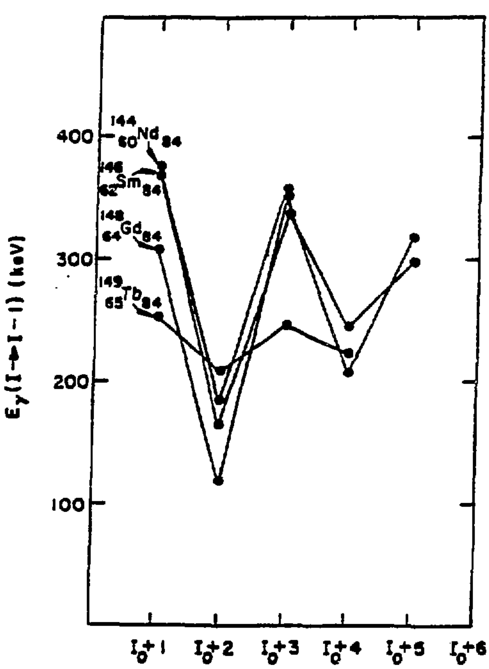

Fig. 2. E_γ vs. I for cascade γ-transitions.

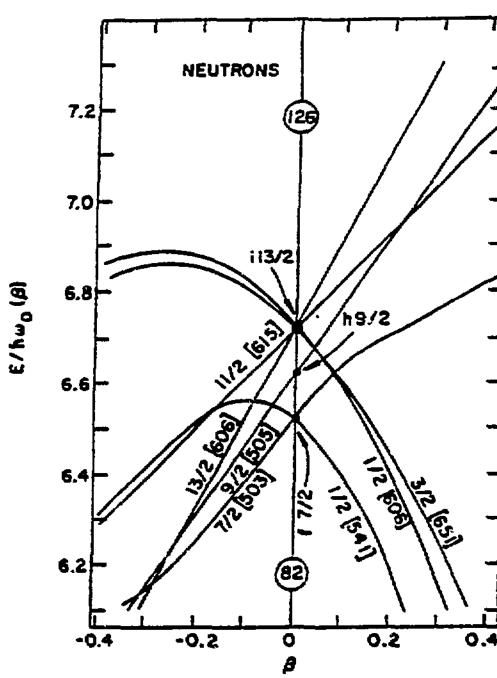

Fig. 3. Partial Nilsson level diagram.

in the odd mass $^{149}_{65}$Tb nucleus is expected to be even more oblate than the $K=11^-$ states in the even-A N=84 nuclides because the 11/2-[505] $(h_{11/12})$ orbital occupied by 65th proton also sharply decreases in energy with increase in oblate deformation. This increase in oblateness is reflected in increase in moment of inertia, and therefore, in the smaller observed level spacings in ^{149}Tb band compared with the even-A nuclides. Also the increase in oblateness reduces the Coriolis coupling which is reflected in the observed weaker oscillations in the intraband transition energy with spin (Fig. 2).

In conclusion, it is the first time that nuclei in this region have been seen to assume oblate shapes at an excitation of $\gtrsim$ 4 MeV while being spherical or near spherical in their ground states.

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