

POSITIVE PARITY STATES IN $g_{9/2}$ ODD-PROTON NUCLEI

Alexander C. Xenoulis

Nuclear Research Center Demokritos, Athens,
Greece

Recently we have compared the levels in Tc isotopes with quasiparticle-phonon coupling calculations [1]. Only qualitative agreement has been observed. There is mounting experimental evidence that nuclei in this region exhibit quasirotational structure [2,3]. In an extension of the Alaga model, the coexistence of quasivibrational and quasirotational features has been achieved [4]. Here we present an alternative approach in which the presence of small deformation removes the spherical degeneracy of the $g_{9/2}$ shell-model orbital giving rise to five quasiparticle states with positive parity and spin between 1/2 and 9/2. These five states in turn, constitute band heads on which rotational states are built.

The relative spacing of the five states can be obtained with the equation

$$E_{\Omega} = E_0(n\ell j) + \frac{206\beta}{A^{1/3}} \left[\frac{3\Omega^2 - j(j+1)}{4j(j+1)} \right] \text{ MeV,} \quad (1)$$

which gives good agreement with Nilsson solutions for small values of the deformation parameter β . More realistic excitation energies can be calculated by considering the pairing interaction effect,

$$E(\Omega) = ((E_{\Omega} - \lambda)^2 + \Delta^2)^{1/2} \quad (2)$$

where E_{Ω} are the eigenvalues from eq. 1. For the ^{95}Tc nucleus, using eqs. 1 and 2 with $\lambda = 2.94$ MeV and $\Delta = 0.98$ MeV, the energies shown in fig. 1 are obtained as a func-

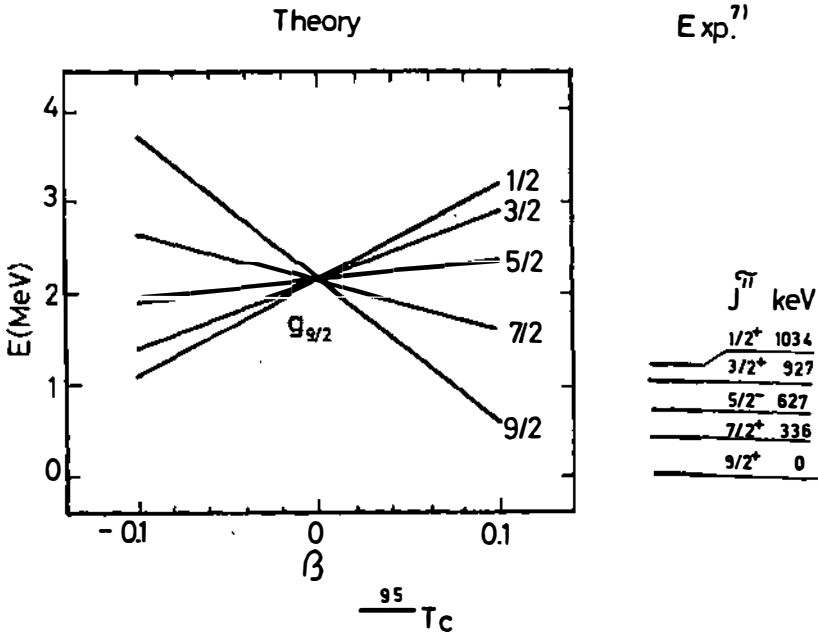


Fig.1

Fig.1. The splitting of the $g_{9/2}$ shell-model orbital in ^{95}Tc under the influence of small nuclear deformation. The effect of the pairing interaction was also taken into account. The experimental data are also shown.

tion of β . It is obvious that, assuming a small prolate deformation, the spectrum of the low-lying positive parity states in ^{95}Tc is reproduced. It should be mentioned, however, that the Coriolis coupling is an important residual interaction, especially for small deformation.

The rest of nuclear states, other than those mentioned, are rotational in nature and arise as a result of the quasiparticle-core rotational coupling. For small deformation it has been shown [5] that when the coupling is considered to be $\vec{R} = \vec{I} - \vec{j}$, where R and j are the angular momenta of the core and particle, respectively,

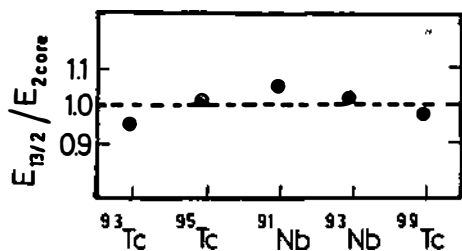


Fig.2

Fig.2. Comparison of the excitation energy of the $13/2^+$ state for a number of nuclei with that of the 2^+ state of the respective even-even core.

and I the spin of the nuclear states, "decoupled" bands should be observed which have the energy spacing of the core and $\Delta I=2$. This property arises as a consequence of the fact that for maximum I the quasiparticle and core angular momentum vectors must be parallel. As a result of this alignment the Coriolis interaction vanishes and therefore the energy of the state with $I=R+j$ would be primarily

determined by the energy of the core state.

Of special importance for this deformed model are the first $13/2^+$ states which arise as the maximum spin states in the coupling of the $9/2^+$ quasiparticle with the 2^+ core rotation. According to the above arguments these states should lie very close to the excitation energy of the core state. In fig. 2 we compare the excitation energy of the $13/2^+$ with that of the 2^+ state of the even-even core for $^{93,95}\text{Tc}$ and $^{91,93}\text{Nb}$. In this comparison it is obvious that the $13/2^+$ state indeed closely follows the 2^+ core state.

A leftward bending in $2J/\hbar^2$ vrs $\hbar\omega$ plots observed in "spherical" even-even Mo isotopes, which can be explained on the basis that either the deformation of the nucleus changes in the excited states or the pairing effect is weakened by Coriolis forces, gives further credence to the model we are adopting for the odd nuclei in this region. Nevertheless, further experimental and

theoretical study is necessary in order to test this model. In particular, it is important to search for the higher spin states of the ground state band which must be readily observed in heavy-ion induced reactions. Further theoretical analysis is also needed in order to study the effect of the Coriolis coupling on the band-head-quintet energies.

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