SHAPE CHANGE IN THE ODD-A NEODYMIUM ISOTOPES

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Shape change in the odd-A neodymium isotopes

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In studies of high-spin levels in odd-A transitional nuclei, band structures have been observed and explained by the coupling of a quasiparticle to a nonaxially symmetric even-even core. However, the softness of this core toward changes in the symmetry is not well determined. In the transitional region between heavy rare earths and lead, it is well known that a shape change from prolate to oblate occurs. From our previous results, it appears that the odd-mass $^{133-137}$Nd nuclei have a prolate shape and that the $\beta$-deformation associated with the $h_{11/2}$ structure decreases rapidly when going towards heavier masses (fig.1). The $\gamma$-parameter varies in an opposite way (fig.3) from $\gamma=20^\circ$ ($^{133}$Nd) to $\gamma=28^\circ$ ($^{137}$Nd). From this trend, we might expect a shape change in the vicinity of $N=79$.

In order to look for this shape transition, studies of the levels of $^{139}$Nd have been performed. Previously, only partial information from the $^{140}$Ce($a,5n$) reaction were available. In the reaction $^{128}$Te($^{16}$O,5n)$^{139}$Nd, we observed a group of levels based on the $11/2^-$ isomer. It is apparent that the first $I=j+2=15/2^-$ level is lower than the first $I=j+1=13/2^-$ level (fig.1). This level ordering is opposite to the one found in the $A=133$, 135, 137 Nd isotopes. Such a level structure in $^{139}$Nd can be reproduced by the coupling of an oblate-type core($\gamma=36^\circ$) to an $h_{11/2}$ neutron-hole with the Fermi surface on the $11/2^-$ orbital (fig.2). Thus, a change across $\gamma=30^\circ$ occurs between the $N=77$ and $N=79$ Nd isotopes, though it is not clear whether these $\gamma$ values correspond to rigid shapes or are the rms values of oscillations.

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Fig. 1

Fig. 3