Exploring nuclear shape and structure of neutron-rich Tc isotopes

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The studies of shape coexistence and shape transitions in the neutron-rich A ~ 100 region have long been of major interest [1, 2]. Our systematic studies in Y-Nb-Tc-Rh (Z=39-41-43-45) neutron-rich isotopes have revealed a shape transition from an axially symmetric shape with large quadrupole deformation in Y isotopes to large triaxial deformations in Tc and Rh isotopes [3-5]. However, the most neutron-rich isotopes reached in this nuclear region before now are ^{109}Tc (N=66) and ^{113}Rh (N=68). It is of interest to explore further their shape and structure along isotopic chains to the region of heavier isotopes.

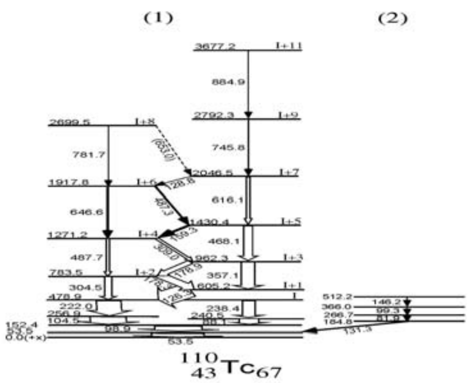

FIG. 1: High-spin level scheme of ^{110}Tc in the present work.

In the present work the high-spin level scheme of N=67 neutron-rich ^{110}Tc (N=67) is established for the first time (Fig. 1), and that of ^{111}Tc (N=68) is extended and expanded (Fig. 2) based on the measurements of prompt γ rays from the spontaneous fission of ^{252}Cf at the Gammasphere [6].

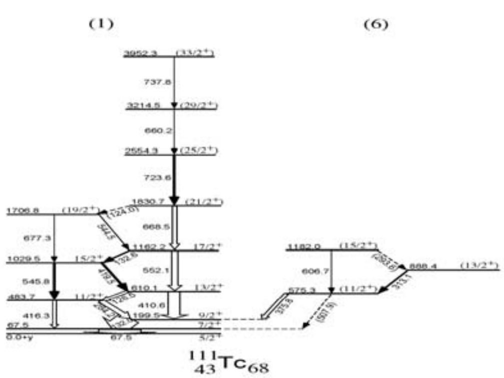

FIG. 2: The α = -1/2 member and the band-crossing of the ground band of ^{111}Tc are observed in the present work.

The ground band of ^{111}Tc reaches the band-crossing region and the new observation of the weakly populated α = -1/2 member of the band provides important information of signature splitting. The systematics of band-crossings in the isotopic and isotonic chains and a CSM calculation suggest that the band-crossing of the ground band of ^{111}Tc is due to alignment of a pair of $h_{11/2}$ neutrons. The best fit to signature splitting, branching ratios and excitations of the ground band of ^{111}Tc by RTRP model calculations result in a shape of ε_2 = 0.32 and $\gamma = -26^0$ for this nucleus. Its triaxiality is larger than that of $^{107,\ 109}$Tc, which indicates increasing triaxiality in Tc isotopes with increasing neutron number (see Fig. 3). The identification of the weakly populated 'K+2 satellite' band provides strong evidence for the large triaxiality of ^{111}Tc. In ^{110}Tc, the four lowest-lying levels observed are very similar to those in ^{108}Tc [7]. At an excitation of 478.9 keV above the lowest state observed, ten states of a ΔI=1 band are observed. This band of ^{110}Tc is very analogous to the ΔI=1 bands in ^{106,108}Tc [7] but it has greater and reverses the sign of signature splitting at higher spins.

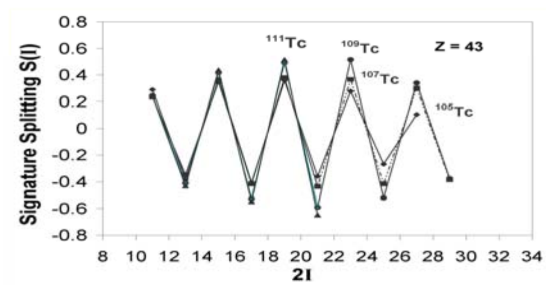

FIG. 3: Experimental signature splittings of the ground bands of $^{105\text{-}111}$Tc, data taken from our papers [4, 6]. The increasing signature splittings are interpreted by the RTRP model calculations as increasing triaxiality with increasing neutron number of the Tc isotopes.

REFERENCES

[1] J. Skalski et al., Nucl. Phys. **A617**, 282(1997).
[2] J.H. Hamilton, *Treatise on Heavy Ion Science, Vol. 8, D. Allan Bromley Ed.,* (Plenum Press, New York 1989) 2.
[3] Y.X. Luo et al., Phys. Rev. **C69**, 024315(2004).
[4] Y.X. Luo et al., Phys. Rev. **C70**, 044310(2004).
[5] Y.X. Luo et al., J. Phys. **G,** Nucl. Part. Phys. **31**, 1303(2005)
[6] Y.X. Luo et al., Phys. Rev. C, in press.
[7] S.J. Zhu et al., in preparation for publication