Nuclear Structure Studies of ^{123,125}Te ◇

V. Bondarenko [a], J. Honzátko [b], I. Tomandl [b], T. v. Egidy, J. Ott, W. Schauer, C. Doll, H.-F. Wirth, D. Bucurescu [c], A. Gollwitzer, G. Graw, R. Hertenberger, and B. D. Valnion

[a] Nuclear Research Center, LV 2169 Salaspils, Latvia

[b] Nuclear Physics Institute, 250 68 Řež, Czech Republic

[c] Institute of Atomic Physics, Bucharest, Romania

The lowest excitations in the odd-A Te nuclei are expected to result from the $g_{7/2}$, $d_{5/2}$, $s_{1/2}$ and $d_{3/2}$ neutron states or the unique-parity $h_{11/2}$ state coupled to the U(5) or O(6) boson core. The coupling of the $h_{11/2}$ orbital is of particular interest, since in this case interaction with other high-lying negative-parity orbits is only of minor importance. In accordance with the systematics found in a wide region Z=44-57 the aligned coupling scheme of the $h_{11/2}$ orbital is one of the most fundamental excitation modes in nuclei near Z=50. Most studies performed so far have been limited to high-spin states of the $h_{11/2}$ family. The appearence of the low-spin branch of the same family is also expected in the framework of the simple picture suggested in Refs. [1,2] which could be interpreted as antialigned members (with antiparallel angular momenta of a particle and the core) of the $h_{11/2}$ family.

These structures could be described also by interacting boson-fermion model (IBFM) [3], the pairing-plus-recoil rotor model [4], and the triaxial rotor model [5] as good as or better than by the simple models [1,2].

The deeper understanding of various aspects mentioned above needs extensive and complete experimental information. Continuing our systematic studies of Te isotopes we investigated ^{123,125}Te nuclei with different and complementary reactions (n,γ), (d,p) and $(^3He,\alpha)$.

Single γ-ray spectra and $\gamma-\gamma$ coincidences following thermal neutron capture in ^{122,124}Te were measured with semiconductor detectors at the light-water reactor LWR-15 at Řež. Single γ-ray spectra were taken with a 22% HPGe detector with a resolution of 2.0 keV at 1332 keV. The (d,p) measurements were performed with 17 MeV deuterons at two scattering angles of 15° and 30° that partly avoids the problem of the interference of Te peaks with background contaminations. The $(^3He,\alpha)$ experiment was carried out with a 32 MeV He beam under only one angle of 10°.

The present measurements led to a significant extension of the level schemes of ^{123,125}Te nuclei. About 106 levels together with about 360 deexciting γ transitions were found below 2.5 MeV in ^{125}Te. Approximately the same number of states is expected in ^{123}Te after completing the evaluation of the experimental data.

In accordance with the previous experience we observe expected strong cascade transitions from the 3/2-, 5/2-, 7/2-, 9/2- states to the parent 11/2- state. It should be emphasized that only few weak branches were found to the positive-parity levels. At the same time the observed "antialigned" states tend to occur at lower energies than their aligned partners with the same core angular momentum. Current studies show that the stripping and pickup intensities of all the "antialigned" members are one to two orders of magnitude smaller than for the parent $h_{11/2}$ state.

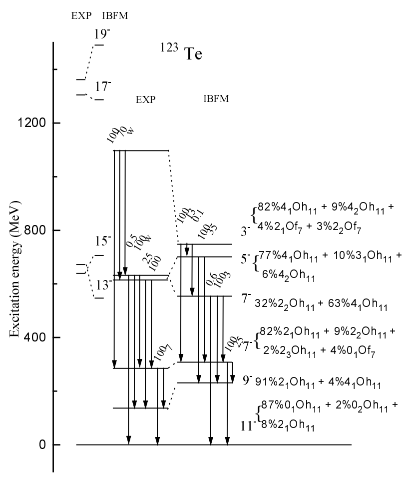

Fig. 1: Comparison between the experimental (left) and calculated (right) negative-parity levels and branching ratios of ^{123}Te. The spins are multiplied by 2. Calculated wave function structures are also given.

In previous studies [6,7] the Xe÷Ba isotopes (mainly the high-spin states) were described by performing IBFM calculations. Here we have extended these descriptions to the Te nuclei. For consistency we used practically the same IBM-1 parameters and similar set of interaction strength parameters A_0, Γ_0 and Λ_0. Besides the $h_{11/2}$ neutron orbital the $f_{7/2}$ and $h_{9/2}$ states from the next shell are taken into account. Finally, slight readjustment was performed ($A_0 = -0.22$, $\Gamma_0 = 0.51$ and $\Lambda_0 = 0.93$) which gave a good description of low-spin states as well as of high-spin members of the $h_{11/2}$ family. Employing the IBFM wave functions we calculated the electromagnetic-transition rates and branching ratios of the low-spin states with the negative parity in both Te nuclei. As seen from fig. 1, agreement between the calculated and experimental data is reasonably good. The lowest negative-parity states $3/2^-$, $5/2^-$ and $7/2^-$ are dominated by the $h_{11/2}$ orbital confirming their suggested "antialigned" origin.

References

[1] H.A. Smith, Jr. and F.A. Rickey, Phys. Rev. **C14** (1976) 1946
[2] T. Pedersen and E. Osnes, Nucl. Phys. **A303** (1978) 345
[3] R.F. Casten *et al.*, Phys. Rev. **C21** (1980) 65
[4] A. Henriquez *et al.*, Phys. Rev. **C27** (1983) 1302
[5] D. Liberz *et al.*, Nucl. Phys. **A529** (1991) 1
[6] D. Bucurescu *et al.*, Phys. Rev. **C43** (1991) 2610
[7] Gh. Cata-Danil *et al.*, J. Phys. **G20** (1994) 1051

◇ This work was supported by Volkswagen Foundation and by the Grant Agency of the Czech Republic (No. 202/93/0361).