Study of Low Spin States in ^{119}Te with the ($\vec{d}$,t) Reaction ◇

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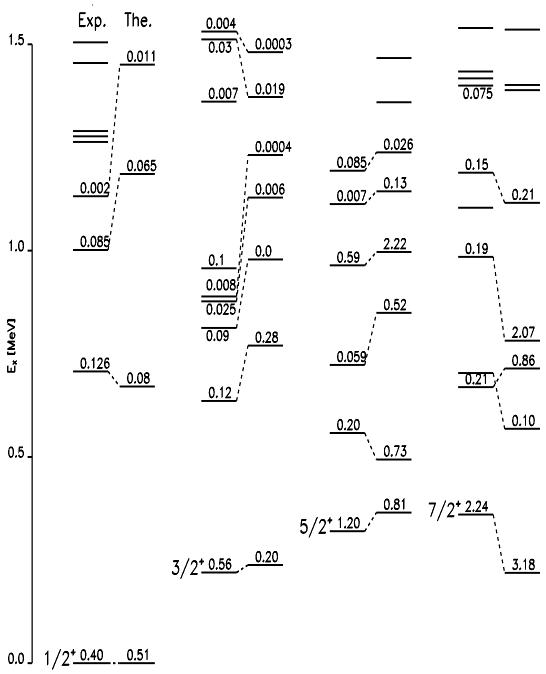
This experiment extended the range of our investigation of the neutron-deficient odd-A Te isotopes (see ^{121}Te in this Annual Report) to the lightest isotope (^{119}Te) that can be studied by a one-neutron transfer reaction. ^{119}Te has been studied before by β-decay [1], $(\alpha, 2n\gamma)$ reaction [2] and by the pickup reactions (d,t) and $(^3\mathrm{He}, \alpha)$ [3]. The later study evidenced levels up to 1.2 MeV excitation but, since it used unpolarized beam, many spin assignments remained ambiguous.

In the present experiment we performed measurements of the ^{120}Te($\vec{d}$,t) reaction at 24.0 MeV, analogous to the one performed for ^{121}Te [4]. A polarized deuterium beam of the Munich Tandem Van de Graaff accelerator was used (with a polarizaton of ≈0.50). The target consisted of 118 μg/cm^2 Te (enrichment of 99.5%) evaporated on a 16 μg/cm^2 carbon backing. Some ^{117}Sn and ^{119}Sn impurities were also found, but the strong peaks of the (d,t) reaction on these nuclei interfered with those of our reaction only at excitation energies below about 800 keV. The reaction products were analyzed with the Q3D magnetic spectrograph and detected in the 1.8 m focal plane detector described in ref. [5], which covered an excitation range up to almost 3 MeV with one magnetic setting of the spectrograph. The FWHM energy resolution of the experiment was about 5 keV. Spectra for the two orientations of the spin have been measured at 10 angles between 8° and 40°. About 80 levels of ^{119}Te have been observed with this reaction up to 2.5 MeV excitation, and, based on the angular distribution and polarization data, unambiguous spin and parity values could be determined for most of them. Thus, at least for the low spins (up to 7/2) one may assume that most of the states at low excitation have been detected.

In an attempt to understand the large number of states observed, calculations are being performed with the Interacting Boson-Fermion Model (IBFM-1). The odd Te isotopes are described by coupling to the even-even Te cores (described by the IBA-1 model) a fermion (neutron hole) allowed to occupy the shell model orbitals of the 50-82 valence shell. Such a description has obvious limitations, especially in view of the fact that in the even-even Te cores important admixtures of intruder (excitations accross the closed shell gap) configurations exist [6]. We take therefore our description as a first order one, hoping that both the rich experimental level systematic and a systematic comparison with these calculations will help to clarify the nature of the many observed states.

Preliminary IBFM-1 calculations were made for the Te isotopes from mass 119 to 129. The IBA-1 parameters of the core have been deduced mainly from the anharmonicities of the two-phonon multiplet, the strengths of the 1- and 2- d-boson exchange terms being kept constant for the whole chain. We could find one set of boson-fermion interaction parameters which gives a reasonably good average description of the low-energy levels for all the isotopes. For each separate isotope, improvements of the description can be obtained starting from this set.

The figure shows the kind of description obtained with these 'general' parameters, for the positive parity states of spin up to 7/2 and excitation up to about 1.5 MeV. The numbers above the states represent the spectroscopic factors for the (d,t) reaction. In calculations, the odd nucleon was allowed to occupy the orbitals $d_{5/2}$, $g_{7/2}$, $s_{1/2}$, $d_{3/2}$ and the strengths of the monopole, quadrupole and exchange interactions were -0.1, 0.2 and 1.00 MeV, respectively. The lowest few levels of each spin could be identified (as indicated) with the calculated states by comparing level energies, decay modes (mainly branching ratios) and spectroscopic factors. For example, the decay of the 877 keV level (assigned to the $3/2^+_4$ state) by two branches and that of the 1531 keV one (assigned to $3/2^+_7$) by 11 branches are well described by the calculations. Some discrepancies may be observed for some spectroscopic factors which are predicted too large. At present, although some excess of experimental states seems to exist, it is difficult to assess, based on this comparison, the presence of states which could be due to intruder configurations. Further systematic studies are in progress.



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