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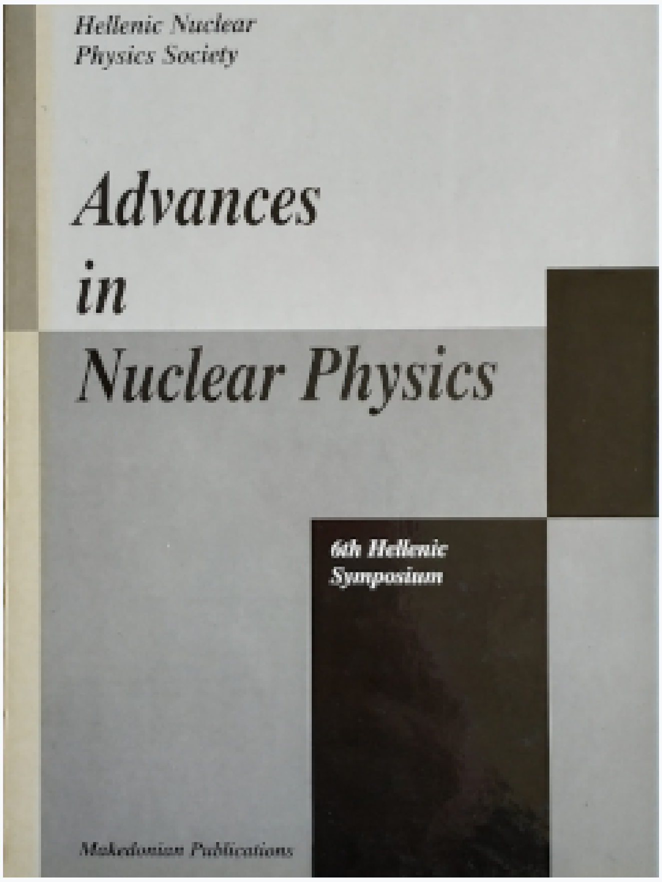

High spin levels in 119Te

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Abstract

High spin levels in ^{119}Te have been populated following the ^{96}Zr (^{30}Si, α 3n) ^{119}Te reaction at a beam energy of 135 MeV. The subsequent deexcitation was studied using γ-ray spectroscopic methods. New levels and several spin and parity assignments up to J^{π} = 55/2$^-$ were established. The decay scheme is characterized by single particle excitations. For the 39/2$^-$ level the fully aligned ν $(h_{11/2})^3$ π $(g_{7/2})^2$ configuration is proposed, while the 55/2$^-$ level could be associated with the π $(d_{5/2})^2$ ν $(h^5_{11/2}\ g^{-2}_{7/2})$ configuration.

1 Introduction

The investigation of collective rotational structures in nuclei in the region of the spherical Z=50 closed shell, have attracted much attention recently [1-3]. These unexpected collective excitation modes in nuclei which are essentially spherical in their ground states have been related to a broken magic core which drives the nucleus towards prolate shape.

[1] Presented by C.T. Papadopoulos

In the doubly closed $^{114}_{50}Sn_{64}$ isotope highly excited deformed rotational cascades have been observed [1] and interpreted as intruder K=5$^-$ bands dominated by the π ($g_{9/2}^{-1}$ $h_{11/2}$) configuration.

In the neighbouring Sb isotopes similar observations have been reported. A rotational band based on the π $h_{11/2}$ intruder orbital has been observed up to high spin in $^{113}_{51}Sb_{62}$, consistent with the experimentally deduced axial prolate deformation $\beta_2 \sim 0.32$ [2]. In the $^{117}_{51}Sb_{66}$, three decoupled ΔI=2 rotational bands have been observed resulting from the $g_{7/2}$, $d_{5/2}$ and $h_{11/2}$ valence proton orbitals coupled to the 2p-2h π ($g_{7/2}^2$ $g_{9/2}^{-2}$) deformed core, as well as two strongly coupled ΔI=1 bands, involving π ($g_{7/2}^2$ $g_{9/2}^{-1}$) configurations [3].

In the heavier iodine and xenon isotopes, for example ^{121}I [4,5] and ^{122}Xe [6], the low lying yrast structures exhibit rotational behaviour, while the high spin structure is dominated by non-collective oblate states. In addition, for ^{113}I [7] and ^{117}I [8], well developped rotational cascades have been observed recently at high spin and high energy, in analogy to the Sb "intruder bands".

In the intermediate $_{52}$Te isotopes, however, no clear evidence for collective rotational structures has been reported, except for the even-even ^{112}Te [9] which represents the only example in the tellurium isotopes with a well developped rotational "intruder" band extending to high spin. All the other Te isotopes published recently in this region (^{115}Te [10], ^{116}Te [11] and ^{117}Te [12,13]) exhibit vibrational-like characteristics at low spin coupled to one and two-quasiparticle shell-model structures [14], while at high spin and high excitation show non-collective behaviour. On the other hand the TRS calculations of ref. [13] for ^{117}Te show persistent prolate collective minima being candidates for rotational bands above spin $\sim 30\hbar$. In addition the strongly downsloping [550]1/2$^-$ intruder orbital from the π $h_{11/2}$ shell coupled to the 2particle-2hole π ($g_{7/2}^2$ $g_{9/2}^{-2}$) state is proposed in ref. [9] to induce deformed shape and hence rotational behaviour in the Te isotopes.

It would be thus interesting to extend the investigation in other Te isotopes. In the present work the ^{119}Te isotope has been studied up to high spin 55/2$^-$ and excitation energy 9.7 MeV.

2 Experimental Procedure

High spin levels in ^{119}Te were populated using the ^{96}Zr (^{30}Si, α 3n) ^{119}Te fusion-evaporation reaction at a bombarding energy of 135 MeV. The beam was provided by the 20 MV tandem Van de Graaff accelerator at the NSF, Daresbury. The enriched ^{96}Zr target, 500μg/cm^2 thick, was deposited on

10mg/cm^2 ^{197}Au backing. The γ-rays emitted in the reaction were detected in the EUROGAM Compton-suppressed HPGe detector array [15,16].

Events with fold greater than or equal to 3 were unfolded into double γ-γ events and incremented into a symmetrized γ-γ matrix. This matrix contained approximately 2×10^9 events. Gamma-gamma matrices gated in known transitions of ^{119}Te were also constructed to produce clear spectra. Another two matrices were also built for rings of 5 detectors at angle 158° and 9 detectors at angles 94° and 86° ($\tilde{90}$°) in order to extract the experimental DCO ratios $I_\gamma(158°, \tilde{90}°)$ / $I_\gamma(\tilde{90}°, 158°)$. From these ratios the multipolarity of several transitions has been determined. The ordering of the transitions in the construction of the level scheme is based on the coincidence relationship between them and on energy and intensity balance arguments.

3 Results and discussion

The construction of the level scheme was quite complicated due to the large number of exit channels produced by the reaction. Ten isotopes ($^{117-120}$Te, $^{120-122}$I and $^{120-122}$Xe) were intentified in the spectra while studying the ^{119}Te isotope. Filtered matrices, built in coincidence with characteristic transitions of ^{119}Te, were found very effective to extract clean spectra.

The partial level scheme of ^{119}Te, deduced in the present work, is shown in Fig. 1. The level scheme was previously known [17] up to spin $23/2^-$. The low-lying states $11/2^-$, $15/2^-$, $19/2^-$ and $23/2^-$ have been observed in the experimental investigation of all A-odd Te nuclei and interpreted [14] as aligned coupling of $h_{11/2}$ neutron to the 0^+, 2^+, 4^+ and 6^+ vibrational states of neighbouring even Te isotopes.

In the adjacent odd-N Te isotopes (^{115}Te [10] and ^{117}Te [12,13]) the fourth transition of the level scheme has been assigned as E1 transition $25/2^+ \rightarrow 23/2^-$ with the $25/2^+$ state interpreted as $\nu\ (h^2_{11/2}\ d^{-1}_{5/2})_{25/2^+}$ from the analogy with the 7^- state observed in the neighbouring even-N Te isotopes [14]. From the present data, in the next odd-N ^{119}Te no indication has been observed for such a strong E1 transition feeding the $23/2^-$ state. The 1075.9 keV transition feeding strongly the $23/2^-$ state has been definitely assigned as E2 transition $27/2^- \rightarrow 23/2^-$. This is probably due to the fact that in the previous even-N ^{118}Te isotope (observed also in the present data [18]) the 7^- state has been very weakly populated in the reaction, while the 8^+ state carries the bulk of the intensity to the 6^+ state.

Above level $23/2^-$ at 2272.5 keV most of the intensity is carried by a sequence of E2 transitions extended up to level $43/2^-$. The level $39/2^-$ at 5447.2 keV excitation energy is fed by five transitions. A similar level at 5584.7 keV has been observed in ^{117}Te [13]. For this state the full alignment configuration ν $(h_{11/2})^3_{27/2}$ π $(g_{7/2})^2_6$, supported also by TRS calculations, has been suggested by Duyar et al [13]. The same configuration could be proposed for the $39/2^-$ level of ^{119}Te. This ν $(h_{11/2})^3$ π $(g_{7/2})^2$ configuration could also contribute to the configuration of the states between $27/2^-$ and $39/2^-$, without excluding the ν $(h_{11/2})^3$ configuration coupled to the 0^+, 2^+, 4^+ and 6^+ phonon states.

The $43/2^-$ state is fed by six transitions of different energies and multipolarities one of them (the 108.2 keV) leading to the $45/2^-$ state on which a sequence of strong γ-rays of comparable energies is built up to $55/2^-$. Another decay out of this $55/2^-$ state deexcites down to the $43/2^-$ state via several paths. All this region between $43/2^-$ and $55/2^-$ states is characterized by a complicated pattern of single particle levels connected by L=1 and L=2 transitions. The configuration of these levels could be associated with two protons occupying the $g_{7/2}$ and /or $d_{5/2}$ orbitals coupled to five $h_{11/2}$ neutrons and two $(g_{7/2})^{-2}$ neutron holes. For example, the $55/2^-$ could be interpreted as full alignment of π $d^2_{5/2}$ ν $(h^5_{11/2}$ $g^{-2}_{7/2})$ configuration.

4 Conclusions

In summary, the lower part of the level scheme exhibits vibrational like characteristics coupled to one and possibly three $h_{11/2}$ neutrons at higher energies. In the intermediate region a five quasi-particle configuration is proposed with the $39/2^-$

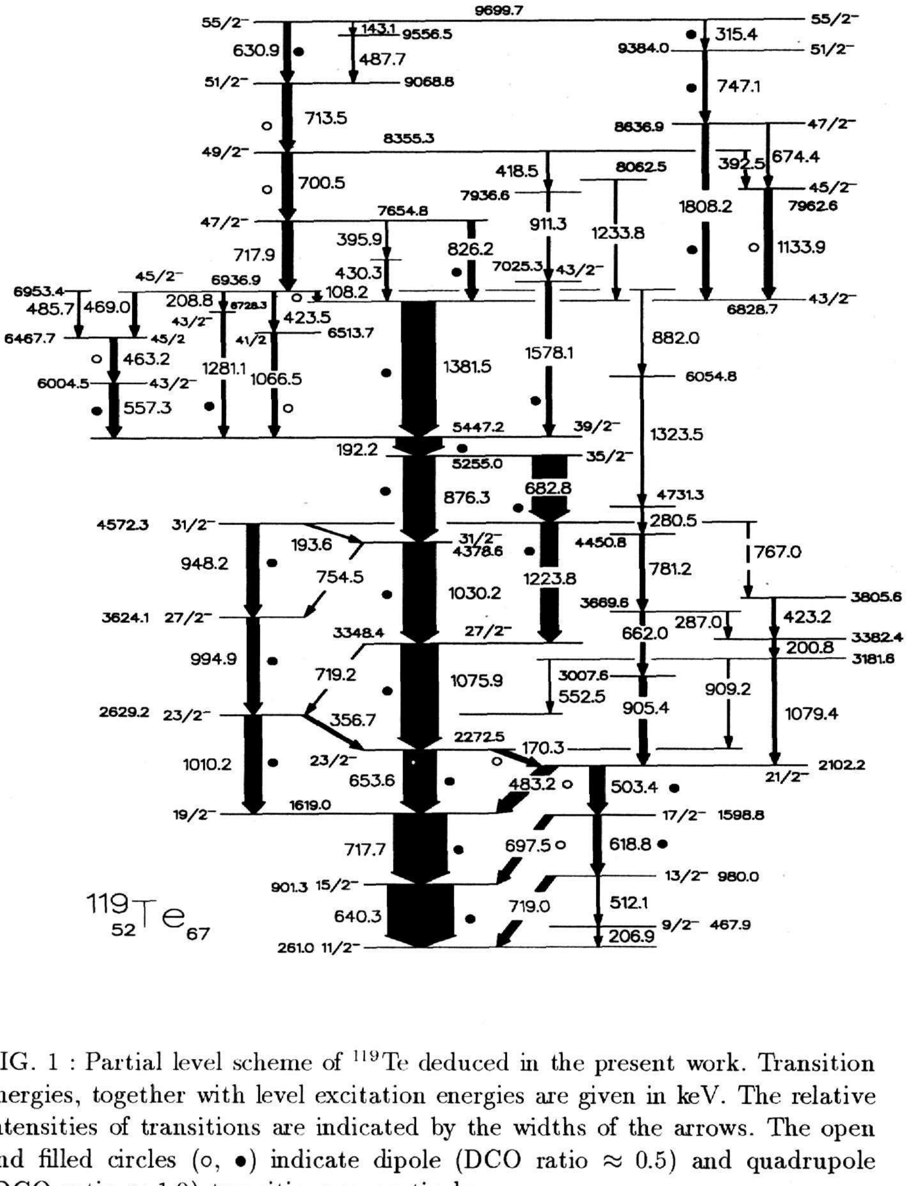

FIG. 1 : Partial level scheme of ^{119}Te deduced in the present work. Transition energies, together with level excitation energies are given in keV. The relative intensities of transitions are indicated by the widths of the arrows. The open and filled circles (o, •) indicate dipole (DCO ratio $\approx$ 0.5) and quadrupole (DCO ratio $\approx$ 1.0) transitions respectively.

level being interpreted as a maximally alligned ν $(h_{11/2})^3_{27/2}$ π $(g_{7/2})^2_6$ configuration. For the upper part of the level scheme, protons from the $g_{7/2}$ and $d_{5/2}$ orbitals as well as $h_{11/2}$ neutrons and neutron holes from the $g_{7/2}$ orbital could be responsible for the single particle character of this region.

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