Unusual rotational behaviour of ^{120,122,124}Te nuclei.

Mansi Saxena[1],* R. Kumar[2], A. Jhingan[2], S. Mandal[1], A. Stolarz[3], R.K.Bhowmik[2], A. Banerjee[1], S. Dutt[4], J. Kaur[5], V. Kumar[6], V.R.Sharma[7], and H. J. Wollersheim[8]
[1]*Department of Physics and Astrophysics, University of Delhi, INDIA*
[2]*Inter University Accelerator Centre, New Delhi, INDIA*
[3]*Heavy Ion Laboratory, Warsaw University, Pasteura 5a, 02-093 Warsaw, Poland*
[4]*Department of Physics, Bareilly College, INDIA*
[5]*Department of Physics, Panjab University, Chandigarh 160014, INDIA*
[6]*Department of Physics, SLIET, Sangru 148106, INDIA*
[7]*Accelerator Laboratory, Department of Physics, A.M. University, INDIA and*
[8]*GSI Helmholtzzentrum fur Schwerionenforschung, Darmstadt, GERMANY*

Introduction

In Tellurium nuclei (Z=52) with two protons outside the major shell Z=50, the $1g_{7/2}$ orbit dominates the partial level scheme. As shown in Fig. 1, in the vicinity of N=82 a seniority scheme is apparent while from the variation of the energies of the first excited 2^+ and 4^+ for ^{120}Te a vibrational picture seems to be a better description. The discovery of sizeable static electric quadrupole moments [1] has led to a considerable revision of the traditional picture of these states as simple one phonon harmonic surface vibrations, since this implies vanishing quadrupole moments.

The aim of the measurement was to probe the nuclear structure of these neutron deficient Te nuclei, more precisely to investigate the collectivity of the above mentioned nuclei by extracting B(E2↑) values with higher experimental accuracy. This can be acheived by comparing the B(E2↑)'s to either ^{122}Te or ^{124}Te which have been studied to a high precision. Also the B(E2↑) values for the ($2^+ \rightarrow 0^+$) transitions are predicted to follow a parabolic behaviour around the mid shell.

In this report experimental B(E2) values will be presented which has been measured by Coulomb excitation technique.

*Electronic address: mansi.saxena12@gmail.com

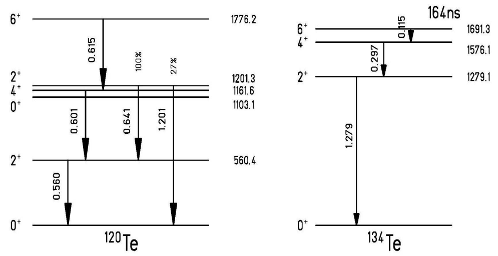

FIG. 1: The partial level scheme[2] of ^{120}Te and ^{134}Te nuclei.

Experimental Details

The present experiment was carried out using ^{58}Ni beam at 175 MeV from the 15UD tandem accelerator at Inter University Accelerator Centre (IUAC), New Delhi. Three targets, ^{120}Te, ^{122}Te and ^{124}Te each of thickness $\sim$ 160 μg/cm^2 with a 10-20 μg/cm^2 carbon backing were used. The scattered beam particles and the recoils were detected in an annular gas-filled parallel plate avalanche counter (PPAC), having an entrance window of 10μm thick Mylar foil. The PPAC was placed 11cm from the target position, covering an angular range of $15° \leq \theta_{lab} \leq 45°$ in the forward direction. The PPAC was position sensitive for both the azimuthal ϕ and the polar θ angles. The azimuthal angle was obtained from the anode foil which was divided into 20 radial sections of 18° each. The polar θ angle was determined from the cathode which was patterned in concentric conductor rings of constant tanθ, each 1 mm wide, with an insulating gap of 0.5 mm between them.

The de-exciting gamma rays were detected in the four clover detectors, having a energy resolution of about 2.5 keV, mounted at angle ~ 135° relative to the beam direction at a distance of 18±2 cm from the target position. The ϕ_γ angles for the clover detectors were ±50° and ±130° relative to the vertical direction. Three consecutive measurements were performed to Coulomb excite the three stable Te isotopes to determine the relative excitation probabilities. Individual energies and timing from the 16 crystals were recorded in coincidence with the PPAC cathode (20 signals) event by event. For improved accuracy, ^{120}Te and ^{122}Te targets were exchanged periodically after every four hours of measurement.

Data Analysis and Results

A precise Doppler correction was performed for the measured γ-rays for target and projectile excitation. We could differentiate between the reaction partners on the basis of the energy loss calculations using SRIM. Fig. 2 shows, for the close collision events (150° $\leq \theta_{CM} \leq$ 120°), the Doppler corrected spectra of ^{120,122}Te excitation with the first excited 2^+ state at 560.4 keV for ^{120}Te and 564.1 keV for ^{122}Te being well resolved. A γ ray resolution of about 3.5 keV was obtained for target excitation. It is apparent that higher excited states of 4^+, 2_2^+ and 0_2^+ were also populated.

From the Doppler corrected γ ray transition of $(2^+ \rightarrow 0^+)$, excitation probabilities for ^{120}Te and ^{122}Te, normalized to the first excited 2^+ state in ^{58}Ni at 1454 keV were determined. The double ratio $[I_\gamma(^{120}\mathrm{Te})/I_\gamma(^{58}\mathrm{Ni})]/[I_\gamma(^{122}\mathrm{Te})/I_\gamma(^{58}\mathrm{Ni})]$ of the gamma ray yield was calculated. This double ratio was then corrected for the different Ge detector efficiency. This γ-ray ratio makes a direct measure of the B(E2↑) of ^{120}Te. Coulomb excitation calculations were performed using the Winther-de Boer Coulex code [3]. The calculations included the feeding from 4^+, 6^+, 2_2^+ and 0_2^+ states. The $(0^+ \rightarrow 2^+)$ matrix element in ^{120}Te was adjusted in the Coulex calculations to reproduce the experimental double ratio.

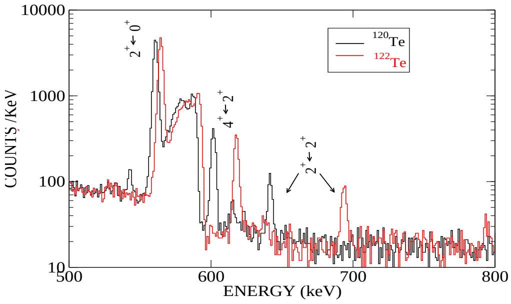

FIG. 2: Doppler corrected γ ray spectra for ^{120}Te + ^{58}Ni and ^{122}Te + ^{58}Ni.

Summary

The collectivity of the different Te isotopes were determined from the B(E2↑;$0^+ \rightarrow 2^+$) values while the nuclear structure was extracted from the higher lying excited states which shows an unusual rotational behaviour. The final results will be presented along with IBM predictions.

Acknowledgments

The authors would like to thank the Pelletron staff at Inter University Accelerator Centre for providing a stable ^{58}Ni beam throughout the experiment.

References

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