Static quadrupole moments in ^{120}Te nuclei

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Introduction

In recent years the region in the vicinity of tin isotopes has been intensively investigated both from experimental and theoretical perspe ctives. In tellurium nuclei with two protons outside the major shell, the partial level schemes are dominated by the $1g7/2$ orbit leading to 6^+ isomers in the vicinity of N=82 shell closure. At low spin, the Te nuclei are considered to be one of the best examples of quadrupole vibrators. For any nuclei to be vibrational namely three criteria must be satisfied : (i) the R4/2 ratio is equal to 2, (ii) a nearly degenerate two-phonon triplet of 0^+, 2^+ and 4^+ states (iii) collective electric quadrupole transitions between states differing by one phonon and strong hindrance of E2 transition between states differing by more than one phonon.

For the mid-shell ^{120,122,124}Te nuclei the partial level schemes are depicted in Fig. 1 and show the expected vibrational-like structure with equal energy spacing between the phonon states. This observation is in contrast to the measured quadrupole moments (Q_{2^+}) in ^{122,124}Te isotopes [1, 2]. The experimental quadrupole moments reach almost 60% of the rigid rotor values. In the rotational model the following relation exists between the static quadrupole moment Q_{2^+} and the reduced transition probability $B(E2;$ $0^+_{g.s.} \rightarrow 2^+_1)$.

$$Q_{2^+}{=}{-}\frac{2}{7}\sqrt{\frac{16\pi}{5}.B(E2;0^+_{g.s.}\rightarrow 2^+_1)}$$

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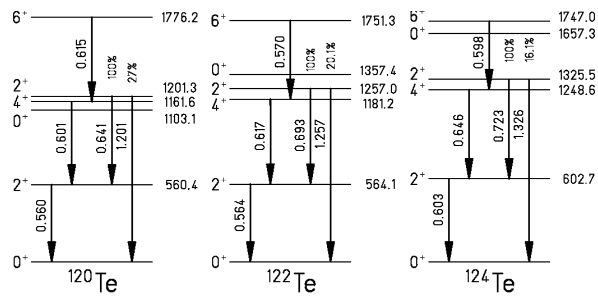

FIG. 1: Partial level schemes of ^{120,122,124}Te [3]. The numbers at the arrows are the predicted E2 matrix elements based on the vibrational model.

In our recent Coulomb excitation experiment [4] at IUAC, New Delhi the B(E2; 0+ $\rightarrow$ 2+) value in ^{120}Te was re-measured with a much higher precision. In addition, the nuclear structure of ^{120,122,124}Te was also investigated by measuring the absolute B(E2$\uparrow$) values to higher lying states. We could clearly notice that the experimental B(E2; $4^+ \rightarrow 2^+$)/B(E2;$2^+ \rightarrow 0^+$) ratios never reach the vibrational limit nor is the static quadrupole moment equal to zero. On the other hand B(E2;$2^+ \rightarrow 2^+$)/B(E2; $2^+ \rightarrow 2^+$) ratios are two orders of magnitude bigger than the axially symmetric rotor model. Based on all experimental findings, level schemes and reduced transition probabilities, for ^{120,122,124}Te one obtains the best agreement with an asymmetric rotor behaviour. The aim of the present measurement was to measure the quadrupole moments (Q_{2^+}) of the first excited states of the stable ^{120}Te using the reorientation effect.

Experimental Details

The present experiment was carried out using ^{32}S beam at 91 MeV from the U-200P cyclotron at Heavy Ion Laboratory, University of Warsaw, Poland. A highly enriched target of ^{120}Te thickness $\sim$ 160 μg/cm^2 with a 10-20 μg/cm^2 carbon backing was used for the measurement.T he gamma rays emitted by the 120Te recoils after Coulomb excitation will be detected by the EAGLE array consisting of 15 HPGe detectors of 70% efficiency equipped with anti-Compton BGO shields.

A compact Coulex chamber (the so-called Munich Chamber), equipped with 48 PIN-diodes of 0.5 x 0.5 cm^2 active area, was used for the detection of backscattered ^{32}S ions to select particle-gamma coincidences in order to perform event by- event Doppler shift correction. The PIN-diodes were placed at angles from 110 to 152 degrees to enhance the probability of double-step excitation. For the same reason, the beam energy was chosen to be as high as possible, while still ensuring a purely electromagnetic interaction between the collision partners. To limit the Doppler broadening of the observed gamma lines, a thin ^{120}Te target of 0.15 mg/cm^2 was used.

Data Analysis and Results

The present data analysis has been performed using a dedicated code written using GO4 software package. A precise Doppler correction was performed for the measured γ-rays for target excitation. The Doppler corrected spectra of ^{120}Te excitation with the first excited 2^+ state at 560.4 keV along with higher lying excited state is shown in Fig. 2. From the Doppler corrected γ ray transitions excitation probabilities for ^{120}Te were determined.

Summary

The Coulomb excitation of ^{120}Te was performed and states upto 6^+ were populated. Further analysis extracting the electromag-

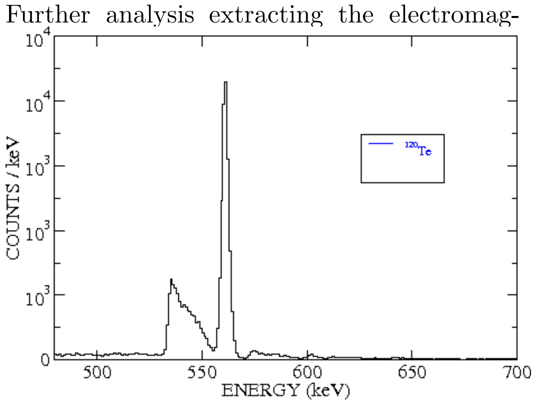

FIG. 2: Doppler corrected γ ray spectra for ^{120}Te + ^{32}S.

netic matrix elements describing the rotaional characteristics of ^{120}Te nuclei will be performed using the GOSIA code.

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