GAMMA TRANSITIONS IN $^{127}$Te

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ABSTRACT

This study of the $^{127}$Te $\beta$ decay was carried out by means of gamma spectroscopy measurements using high resolution Ge detector, in the region from 150 keV up to 1000 keV, aiming to get a better understanding of the $^{127}$Te nuclear structure. Several gamma transitions were confirmed when compared with those published in the last compilation. These data resulting in lower uncertainty.

1. INTRODUCTION

The low-lying levels of odd mass iodine isotopes (127-133$I$) can be investigated by $\beta$ and $\gamma$ decay of the parent tellurium isotopes. These tellurium parent isotopes have shown that properties of low-lying levels vary smoothly through the odd- mass: while the ground state in $^{127}$I is $5/2^+$ with the increasing $A$, the $5/2^+$ level moves up becoming the first excited state in $^{129}$I (at 27 keV), in $^{131}$I (at 150 keV) and also in $^{133}$I (304 keV). According to the last compilation by Firestone [1] several studies have been performed related to decay scheme of $^{129-133}$Te but, basically, the results of the study performed by Apt et al., in 1970 [2] established the features of the $\beta\gamma$ decay of $^{127}$Te. The absence of experimental data from $^{127}$Te decay is mainly due to the fact that 98.8% of its $\beta^-$ decay populates the ground state; the remaining (~1%) populating the excited states up to 0.8 MeV. In an attempt to propose a well established $\beta^-$ decay schema of $^{127}$Te motivated us to perform an investigation of excited levels in $^{127}$Te. For this purpose, singles measurements were performed using high resolution HPGe spectrometer and enriched $^{126}$Te in an attempt to identify these $\gamma$-rays of low intensity.

2. EXPERIMENTAL PROCEDURE

The radioactive sources of $^{127}$Te ($T_{1/2} \sim 9$ hs) were obtained from the $^{126}$Te ($n,\gamma$) $^{127}$Te nuclear reaction. Approximately 5 mg of enriched tellurium (98.6%) was irradiated with a thermal neutron flux of $\sim 10^{12}$ n/cm$^2$s, for 5 minutes, in the IEA- R1 Nuclear Reactor at IPEN/CNEN-SP. Singles spectra were carried out using an ORTEC Model GEM-60195 detector (FWHM=1.89 keV at 1320 keV transition of $^{60}$Co) and an ORTEC 671 amplifier, in pile up rejection mode, coupled to a MCA ORTEC 919E connected to a PC. The background radiation as well as the escape peaks was reduced by employing the iron shield. The source-detector distance in this experimental apparatus is 12 cm. In this experimental condition several spectra were taken with standards ($^{60}$Co, $^{109}$Cd, $^{133}$Ba, $^{137}$Cs and $^{152}$Eu) [3] for the purpose of the precise energy calibration of $\gamma$ transitions. The sources of $^{133}$Ba and $^{152}$Eu [3]
were used for the relative efficiency calibration of the detectors. Areas of the gamma rays peaks were evaluated by using the IDF computer code [4].

3. RESULTS

The direct gamma-ray spectrum from about 150 keV up to 1000 keV was recorded over more than 530 hours of live counting. In order to positively identify the origin of the γ-rays, spectra were accumulated through four successive half-lives. The gamma rays identified in this study are shown in figure 1. The half-lives behavior of the each gamma transition observed is in agreement with the established [4].

![Gamma Ray Spectrum](image1)

**Figure 1.** Partial gamma ray singles spectrum of $^{127}$Te observed with HPGe.

The gamma rays energy are shown in table 1. The background contribution under each gamma transition was determined by a least-squares fit considering the regions adjacent to...
both side of the peak [5]. In this table the data from reference 2 are also included for comparison.

Table 1. Gamma ray energy from $\beta^-$ decay of $^{127}$Te.

<table>
<thead>
<tr>
<th>$E_\gamma$ (keV)</th>
<th>$E_\gamma$ (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>present study</td>
<td>Apt et al [2]</td>
</tr>
<tr>
<td>203.355 ± 0.007</td>
<td>202.9 ± 0.1</td>
</tr>
<tr>
<td>215.645 ± 0.008</td>
<td>215.1 ± 0.1</td>
</tr>
<tr>
<td>360.811 ± 0.006</td>
<td>360.3 ± 0.1</td>
</tr>
<tr>
<td>418.396 ± 0.006</td>
<td>417.9 ± 0.1</td>
</tr>
</tbody>
</table>

4. DISCUSSION

According to table 1 the energies obtained in the present study are in agreement with data reported earlier [2].

In this study the primary reaction (n, $\gamma$) using enriched $^{126}$Te diminished the activities of the Te isotopes; in addition the gamma ray spectrum measured with a HPGe (198 cm$^3$) of high resolution (1.87 keV), comparatively to Ge(Li) detectors used by Apt et al [2] (18 cm$^3$ with FWHM = 2.1 and 26 cm$^3$ with FWHM = 2.4 keV), resulting is lower uncertainty for these energies.

5. CONCLUSION

In this study gamma rays have been identified in the range of 150 keV up to 1000 keV from $\beta^-$ decay of $^{127}$Te. Ours results confirm the energies previously established.

ACKNOWLEDGMENTS

The authors acknowledge the financial support from FAPESP and SEESP

REFERENCES