Weak Transitions in $^{160}$Tb Decay.

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Summary. — The decay scheme of the 72.3$d^{160}$Tb and $\gamma$-transitions in $^{160}$Dy has been studied by $\gamma$-ray spectroscopy with high-efficiency Ge(Li) and HPGe detectors. The intensity of the 1004.8 keV $\gamma$-ray is measured to be $0.04 \pm 0.01$ relative to 30 for the 879.353 keV $\gamma$-ray. Gamma-rays of energies 707.6 and 239.70 keV with relative intensities $0.010 \pm 0.005$ and $0.002 \pm 0.001$ are observed and assigned to $^{160}$Dy. The energies and relative intensities of all other $\gamma$-rays are remeasured to remove anomalies in the previous reports. A new $\beta$-group of intensity $(0.032 \pm 0.012)\%$ and $\log f_t 11.2 \pm 0.2$ is proposed to feed the 1288.6 keV level in $^{160}$Dy. The total conversion coefficient of the 197.008 keV transition in $^{160}$Dy is measured to be $0.22 \pm 0.08$. The total and $K$-shell conversion coefficients of the 86.796 keV transition in $^{160}$Dy are remeasured and the results obtained are $4.71 \pm 0.20$ and $1.54 \pm 0.12$, respectively. The results of the branching ratios of $\beta$ and $\gamma$ transitions are discussed. The band-mixing parameter $z_2$ for $^{160}$Dy is determined and it is observed that the measured $\gamma$-ray branching ratios do not lead to a unique value of $z_2$ for $^{160}$Dy.

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1. - Introduction.

The level scheme of the doubly even nuclide $^{160}$Dy has been investigated by many authors from the decay of $^{160}$Tb and $^{160}$Ho, and by the $(p, t)$, $(d, d')$ and $(\alpha, x\gamma)$ reactions (1). Although many features of the level scheme, the

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ground-state rotational band and the gamma-vibrational band are well estab-
lished, several discrepancies still exist.

The $5^+$ level at 1288.8 keV in the gamma-vibrational band is reported to
be weakly populated in the $^{160}$Tb decay by $\gamma$-transition from a higher state, and
de-exciting to the $4^+$ member of the ground-state band by a 1005 keV transition
for which an intensity limit of $< 0.1\%$ is reported ($^2$). In comparison
with the $^{160}$Ho decay ($^1$) one should expect, in addition to this transition, a
few more transitions to other levels in the ground-state band and the gamma-
vibrational band. Owing to the inexact knowledge of the intensities of the
de-exciting $\gamma$-rays from the $5^+$ level, no information is available regarding
any $\beta$-feeding to this level in the $^{160}$Tb decay. Besides, there is considerable
discrepancy in the reported intensities of a few other weak $\gamma$-rays in the decay
of $^{160}$Tb ($^1$).

The total conversion coefficient of the $4^+ \rightarrow 2^+ 197$ keV transition in the
ground-state band in $^{161}$Dy is not reported although the nature of this transition
is established to be $E2$ from the measured $K$ conversion coefficient and
the conversion electron intensities.

A few recent investigations ($^3$-$^7$) have been concerned with the determination
of the band-mixing parameter $\varepsilon_2$ which describes the coupling of the gamma-
vibrational and the ground-state band in $^{161}$Dy. It is observed from some of
the investigations ($^4$-$^6$) that the values of $\varepsilon_2$ obtained from the various transitions
from the $2^+, 3^+$ and $4^+$ levels of the gamma-vibrational band to different
levels of the ground-state rotational band are inconsistent with the predictions
of a constant value of $\varepsilon_2$ for all interband transitions, although one report
gives consistent values ($^7$). The determination of $\varepsilon_2$ requires accurate intensities
of the relevant $\gamma$-transitions. Precise knowledge of the decay characteristics
of $^{160}$Tb and the properties of transitions in $^{161}$Dy is also necessary because
$^{160}$Tb can serve as a useful calibrating source for Ge(Li) detectors, with 20
prominent $\gamma$ lines in the $(86-1312)$ keV energy range and a convenient half-
life of 72 days. Recently reported ($^7$) intensities of some of the prominent
$\gamma$-rays in the decay of $^{160}$Tb disagree significantly with the earlier reported
values ($^1$).

The present work was undertaken to resolve the above-mentioned problems
in the decay of $^{160}$Tb by $\gamma$-ray spectroscopy with Ge detectors with emphasis
on the measurement of intensities and conversion coefficients.

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