High Resolution

$L$- and $M$-subshell Internal Conversion Studies

of Low Energy Transitions in $^{149}$Sm and $^{151}$Eu

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The internal conversion subshell intensities of the (21.529 ± 0.014) keV transition in $^{151}$Eu and the (22.494 ± 0.011) keV transition in $^{149}$Sm have been determined in a high resolution investigation using a double-focussing iron-core spectrometer. The subshell ratios yielded unambiguous $M1 + E2$ multipole mixtures for both transitions. 

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1. Introduction

The 22.49 keV $\frac{7}{2}^- \rightarrow \frac{5}{2}^-$ transition in $^{149}$Sm and the 21.53 keV $\frac{7}{2}^+ \rightarrow \frac{5}{2}^+$ transition in $^{151}$Eu are the low energy transitions which terminate the trend in the systematic behaviour of the odd mass number europium and samarium isotopes in the mass number region 145 to 151. At mass number region 153 the picture changes drastically from the single particle character of the low lying states of the isotopes with mass numbers 145–151. A rotational pattern appears in the excited states of the nuclei with mass numbers 153 and higher. The two transitions mentioned above are the ground state transitions from the first excited states of the europium and samarium nuclei lying on the boundary of the deformed region above mass number 153. Furthermore these transitions, which are predominantly of $M1$ character, have been shown to be retarded $M1$ transitions in the europium and samarium nuclei with mass numbers 147, 149 and 151. It was thus found worthwhile to investigate the possible existence of anomalous internal conversion effects in these transitions.

This investigation was performed by making accurate intensity determinations of both $L$- and $M$-subshell internal conversion intensities for the two transitions observed at high resolution. Earlier determina-
tions\textsuperscript{1-6} yielded information on the $L$-subshell ratios only and, as can be seen from Tables 1 and 2, the discrepancies between different authors are serious.

2. Source Preparation and Instrumentation

The gadolinium activity was produced by bombarding natural erbium targets with 660 MeV protons in the synchrocyclotron of Dubna, USSR. The gadolinium fraction was chemically separated using chromatographic methods. The active gadolinium was dissolved in water and isopropanol was added. Sources were produced by the method of molecular plating forming sources with $1 \times 20 \text{ mm}^2$ area. The source backings were 0.8 mg/cm\textsuperscript{2} nickel foils and the back-scattering effects from these foils were found to be negligible. As these sources were intended for measurements in the very low energy region, the source thickness had to be very small in order to reduce scattering in the source material. That this was, in fact, achieved can be seen from Figs. 1 and 2; the tailing of the lines is small even at electron energy as low as 13 keV. The measurements were started seventeen days after irradiation and at this stage the source strength corresponded to a dose rate of about 20 mR/h at a distance of 4 cm.

The relative amounts of different activities present in the sources were investigated with a Ge(Li) detector system. This consisted of a 2.6 cm\textsuperscript{3} Ge(Li) detector DC-coupled to the FET input stage of the preamplifier. The detector and the input stage was included into a cryogenic vacuum system operated with liquid nitrogen. The radiation entered the vacuum system through a thin beryllium window. The pulses from the preamplifier were fed to a fast gaussian pulse shaping linear amplifier and subsequently to a 4,096 channel analogue to digital converter and to a 1,024 channel memory. Energy calibration was provided internally by the presence of the transitions in the $^{146}\text{Gd} \rightarrow ^{146}\text{Eu} \rightarrow ^{146}\text{Sm}$ decay chain. These were accurately energy calibrated with the double-