Energy Levels of $^{174}\text{Yb}$ Populated in the Decay of $^{174}\text{Tm}$

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The decay of the $^{174}\text{Tm}$ activity has been studied with Ge(Li) detectors and with a Ge(Li) — NaI(Tl) coincidence arrangement. Gamma ray energies and relative intensities were determined. Five new gamma transitions are reported, four of which have been placed in the decay scheme in addition to the previously observed but unplaced 1305 keV transition. Five energy levels at 1557.7, 1762.1, 1781.1, 1877.5 and 2050.1 keV not earlier reported to be populated in the decay of $^{174}\text{Tm}$ are suggested. Some spin and parity assignments are proposed and the intrinsic structure of several states is discussed in terms of two quasi-particle excitations. For the half-life of $^{174}\text{Tm}$ a value $5.4 \pm 0.1$ min was measured.

1. Introduction

Experimental information about the excited states of the deformed even-even nucleus $^{174}\text{Yb}$ has been obtained from studies of radioactive beta or electron capture decay of adjacent odd-odd nuclides $^{174}\text{Tm}$ and $^{174}\text{Lu}$ and isomeric decay of the 850 µs $^{174}\text{mYb}$ at 1518 keV. In addition, some reaction studies using e.g. $^{173}\text{Yb}(d,p)^{174}\text{Yb}$, $^{174}\text{Yb}(d, d')^{174}\text{Yb}$ and $^{176}\text{Yb}(p, t)^{174}\text{Yb}$ processes have been carried out. It has also been possible to explain theoretically several energy levels.

levels thus discovered in terms of collective or two quasi-particle excitations.

Pairing model calculations of Gallagher and Soloviev\(^{14}\) or Pyatov and Soloviev\(^{15}\) predict also several rather low energy states above the energy gap, which have not been observed in any experimental studies. In order to detect weak gamma rays possibly depopulating the predicted but experimentally unknown states, the decay of \(^{174}\)Tm was carefully studied with several semiconductor detectors.

2. Experimental Procedure

The \(^{174}\)Tm activities were produced through \(^{174}\)Yb\((n, p)\)^{174}\)Tm reaction by bombarding natural ytterbium oxide (purity 99.9\%) with 14–15 MeV neutrons. The activation time varied from 3 to 10 min and the measurement was started 1–2 min after the end of the irradiation in order to reduce contribution due to short-lived activities \(^{176}\)mYb(12 s) and \(^{16}\)N(7.4 s). A number of longer lived contamination activities were also induced in the source, but they could be identified in spectra on the basis of their well-known energies, intensities and half-lives\(^{16–18}\). Due to the small \((n, p)\) cross section (3.5 mb) for \(^{174}\)Yb\(^{9}\) the irradiation was repeated many times. In order to avoid the accumulation of long-lived activities, several Yb\(_2\)O\(_3\) samples were used.

Singles spectra were measured by means of 8 cm\(^3\) and 30 cm\(^3\) Ge(Li) detectors, which were of planar and coaxial type, respectively. In addition a 5 mm thick Ge(Li) X-ray detector was applied for the detection of the low-energy gamma rays. Spectra were recorded with a modified Nuclear Data ND 160 analyser, which was operated in a \(4 \times 10^24\) mode and with a PDP 9/L computer equipped with a NS-625 ADC.

In coincidence measurements the spectra from the 8 cm\(^3\) Ge(Li) detector were gated by a 7.6 cm \(\times\) 7.6 cm NaI(Tl) scintillator. The measurements were performed in a face-to-face geometry with a 5 mm thick Cd–Cu graded Pb-absorber between the source and the NaI(Tl) crystal. The coincidence resolving time was set at 250 ns.

The data were handled by using computer programs, which determine positions of the photopeaks and calculate energy response of the system.