Iodine-131 is a fissile product which can be released into the atmosphere during an accident scenario. Moreover it has been used for many years for medical purposes, mainly for thyroid diseases. Due to the high volatility of iodine, these isotopes are mobile in the environment and must be monitored. For these reasons, I-131 has been extensively studied since the early sixties. However, the knowledge of the decay scheme is still poor, and the results obtained in earlier work exhibit a large dispersion and high uncertainties.

I-131 decay scheme and source preparation

Activity measurements

4π β-γ coincidence method

Activity concentration: 5.869 (15) MBq.g⁻¹

- β-channel: pill-box proportional counter (CH₄ at atmospheric pressure).
- γ-channel: 3 x 3 NaI(Tl) scintillator detector.
- Efficiency-extrapolation technique addition of multiple gold-coated VYNS foils.
- Coincidence counting using a γ window (200 keV < E < 800 keV).

Using this setting, the ratio Nᵢ / Nᵥ varied between 0.93 and 0.98. (Nᵢ: coincidence counting rate, Nᵥ: γ-counting rate)

4πγ counting method

Activity concentration: 5.874 (23) MBq.g⁻¹

Detector: large well-type NaI(Tl)

Counting system: based on separate NIM modules:
- Amplifier + MTR2 discriminator (based on extendable dead time and live-time technique).
- ADC + energy histogram used to estimate the zero-energy extrapolation correction.
- Dual counter/timer for counting and live-time measurements.

Detection efficiency: calculated with Monte Carlo simulation (Geant4):
- Calculated detection efficiency: 0.922 (2).

Photon spectrometry

HPGe detector
- N type - Volume: 93 cm³
- Full-energy peak (FEP) efficiency calibration using standard sources from LNHB.
- Relative combined uncertainties:
  - 1-2 % (30-120 keV),
  - 0.6 % (120-1500 keV),
  - 1 % (> 1500 keV).

Absolute photon emission intensities:

$$I_{α} = \frac{n_{α} \Pi C_{α}}{ε_{α} \cdot A}$$

nᵢ: count rate in the peak corresponding to energy Eᵢ,
εᵢ: detector FEP efficiency for Eᵢ,
A: geometric arrangement,
Cᵢ: source activity (Bq),
εᵢ,A: correction factors.

Results

The absolute emission intensities of 15 gamma-ray lines in the decay of I-131, and those of the two K X-ray lines of xenon were determined.

Moreover, for comparison purposes, the relative photon emission intensities of I-131 were calculated, using the 364.5-keV line as the reference (100%):

$$I_{α} = \frac{n_{α} \Pi C_{α}}{n_{α} \Pi C_{α} + \sum_{β} C_{β} \cdot ε_{β} \cdot ε_{α} \cdot A} \cdot 100$$

The present results are generally in agreement, within the uncertainty limits, with the other published values, especially with the most recent X-ray ones of Chand et al. (1989) and the gamma-ray measurements of Meyer, (1990) and the uncertainties assessed for the present study are significantly lower.