Further Measurement to Test Electron Conversion Theory: $^{116}$In Measurement for Detector Calibration

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**ABSTRACT**

Precise internal conversion coefficients (ICCs) are vital to the study of nuclear decay schemes, determining transition rates, spin and parity designations, and branching ratios. However, there are very few experimental tests of the calculated ICCs and in fact there are only ~10 measurements available with errors of less than 1%. Such a paucity of data complicates scientists’ efforts to determine what theoretical calculations should be used to model the ICC.

The goal of our present experiment is to determine the $\alpha_k$ for the 65.7-keV M4 transition in $^{119}$Sn. However, the energy of the $^{119}$Sn x-rays is below the energy range that our HPGe detector is accurately calibrated for. The $\beta$-decay of $^{116}$In populates states in $^{116}$Sn which produce a few strong transitions with well established conversion coefficients. This allows us to calibrate our detector at the energy of the Sn x-rays, which is an essential requirement for the measurement of the $^{119}$Sn ICC.

**Preparation and Irradiation of the Source**

- In(NO$_3$)$_2$(aq) placed on Mylar tape to produce micron-thick film of indium nitrate
- In is isotopically purified to minimize impurities
- Adhesive Mylar tape placed on film following solvent evaporation

**Calibrating Detector for $^{119m}$Sn**

- Nuclear de-excitation energy leads to γ-ray emission or to electron emission
- Electron emission leaves hole; filled by higher level electron with emission of an x-ray
- ICC ($\alpha$) measures ratio of electrons versus γ-rays emitted
- Can be expressed as the sum of ratios for each energy shell

$\alpha = \sum \frac{\alpha_k \cdot \gamma \cdot n \cdot i}{\gamma \cdot n \cdot i}$

**Preliminary Results**

- $^{119m}$Sn: $\alpha_k$ Calculations
  - Experimental Value
  - Theoretical Values
  - $\alpha_k = 1601$ (40)
  - $\alpha_k$ (no hole) = 1544
  - $\alpha_k$ (hole) = 1618

  Good agreement between experimental and theoretical values.

**Impurity Identification**

- $^{116}$In: Number of Photons Detected at Given Energies; Source Nuclei of Peaks Labeled
- Values of $\alpha_k$ are well-known for these two peaks
- Theoretical calculations agree on these values
- $^{116}$In decays to $^{116}$Sn leading to 138 [keV] x-rays and to Sn x-rays

**Decay Schemes**

Decay Scheme of $^{116}$In (and $^{116}$Sb) Transitions to $^{116}$Sn.