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 ICC's 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 α_K for the 65.7-keV M4 transition in 119Sn. However, the energy of the 119Sn x-rays is below the energy range that our HPGe detector is accurately calibrated for.

The β-decay of 116In populates states in 116Sn 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 119Sn ICC.

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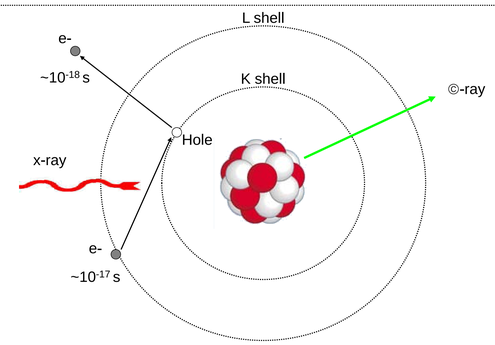
Internal Conversion Coefficient (ICC)



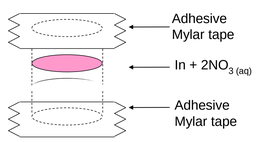
- Nuclear de-excitation energy leads to γ-ray emission or to electron emission
  - Processes occur competitively
  - Electron emission leaves hole; filled by higher level electron with emission of an x-ray
- ICC (α) measures ratio of electrons versus γ-rays emitted
  - Can be expressed as the sum of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

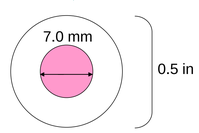
$$\alpha = \sum_i \alpha_i = \alpha_K + \alpha_L + \alpha_M + \ldots$$

$$\alpha_K = \frac{1}{\omega_K} \cdot \frac{I_{Kx}}{I_\gamma}$$

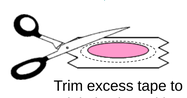
Preparation and Irradiation of the Source

- $In(NO_3)_2$(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
- Created two sources: A and B
  - Irradiated sources by neutron activation at theTexas A&M Nuclear Science Center
- Measured resulting x and ©-rays
- Germanium detector
  - Texas A&M University Cyclotron Institute
  - Relative photopeak efficiencies calibrated to 0.15% above 50 [keV]
- 4 spectra recorded between ~2 and ~20 hours after activation

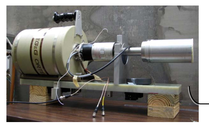


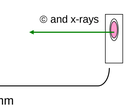


Source ready to be irradiated



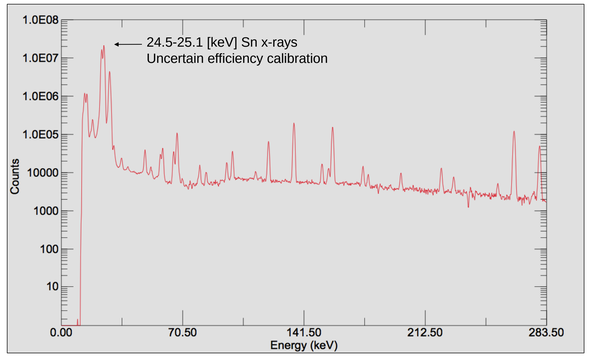
Trim excess tape to minimize impurities



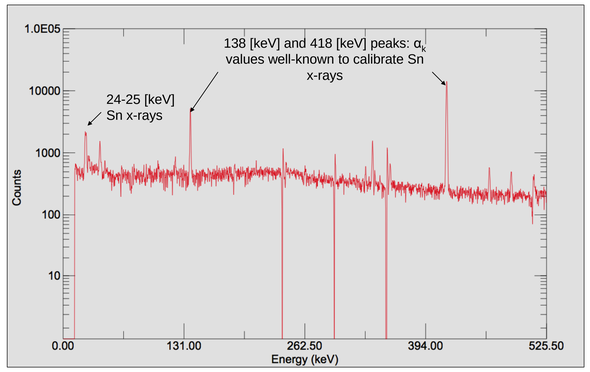


Calibrating Detector for ^{119m}Sn

^{119m}Sn: Number of Photons Detected with Given Energies



^{116}In: Number of Photons Detected with Given Energies



- Values of α_k are well-known for these two peaks
  - Theoretical calculations agree on these values
- 116In ß decays to 116Sn leading to 138 [keV] and 418 [keV] γ rays and to Sn x-rays

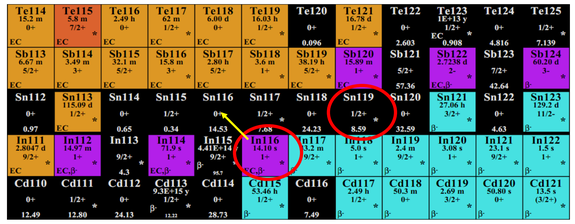
Preliminary Results

^{119m}Sn: α_k Calculations

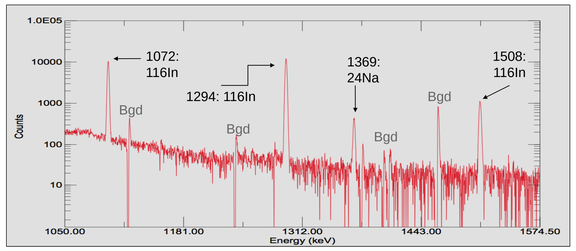
Experimental Value	Theoretical Values
$\alpha_K = 1601(40)$	$\alpha_K(no\ hole) = 1544$
	$\alpha_K(hole) = 1618$

Good agreement between experimental and theoretical values.

Impurity Identification



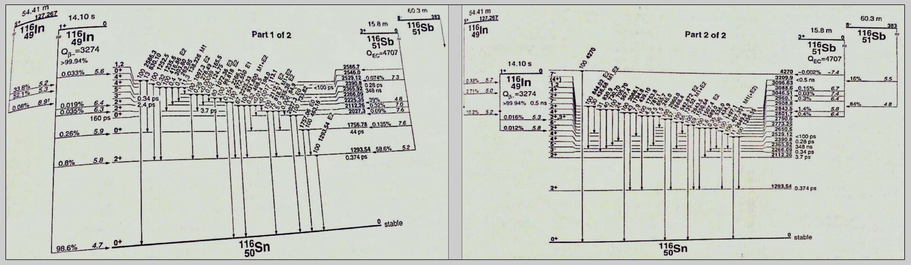
116In: Number of Photons Detected at Given Energies; Source Nuclei of Peaks Labeled



Data has had the room background photon counts subtracted to minimize impurities in spectra.

Typical Impurities:
Other elements with similar Z values, other naturally occurring isotopes
Elements from the mylar substrate
Other phenomena: Escape peaks; Compton background

Decay Schemes



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