Measurement of the Internal Conversion Coefficient of ^{119m}Sn

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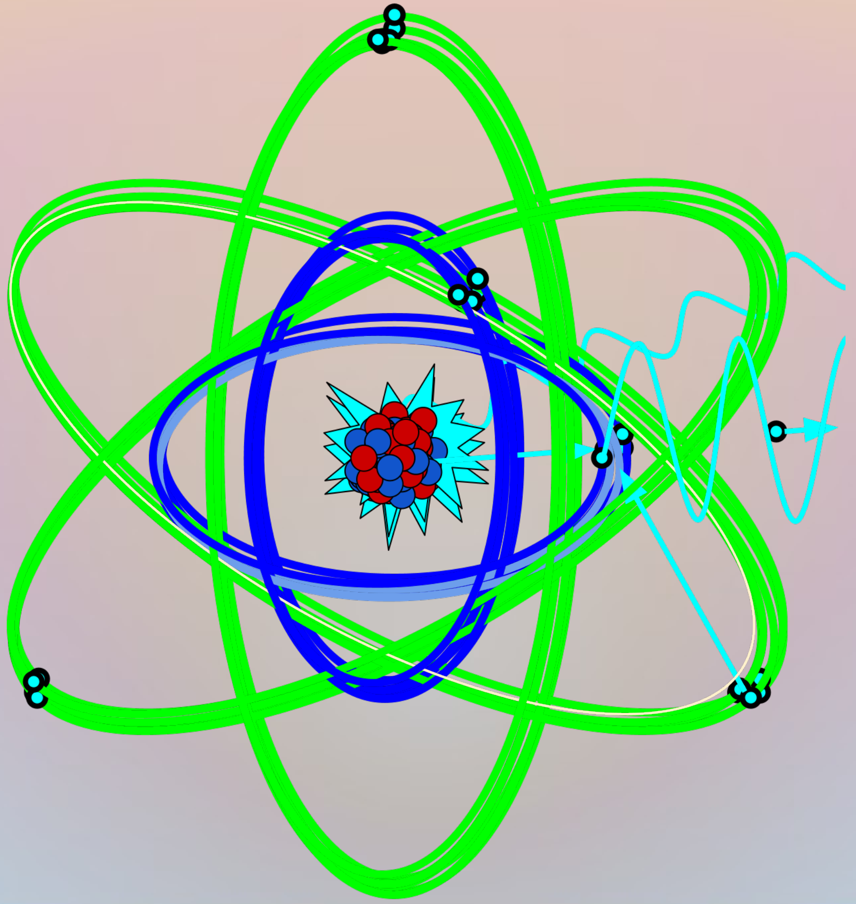
Internal Conversion

Internal Conversion is a form of radioactive decay resulting in the emission of an orbital electron.



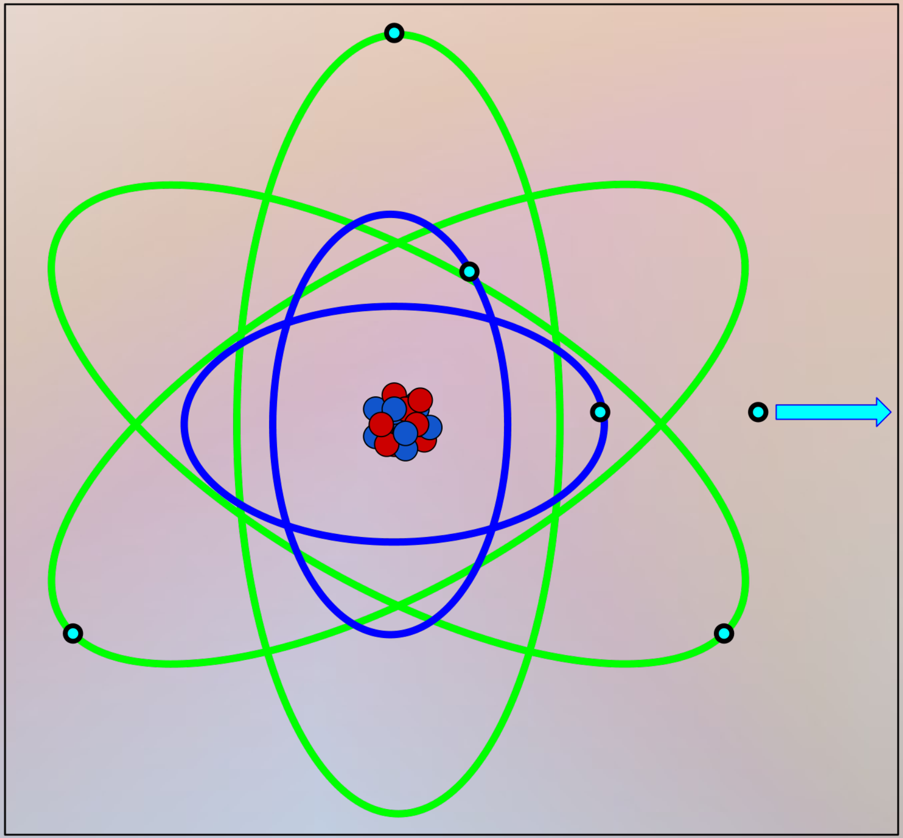
Internal Conversion Coefficient

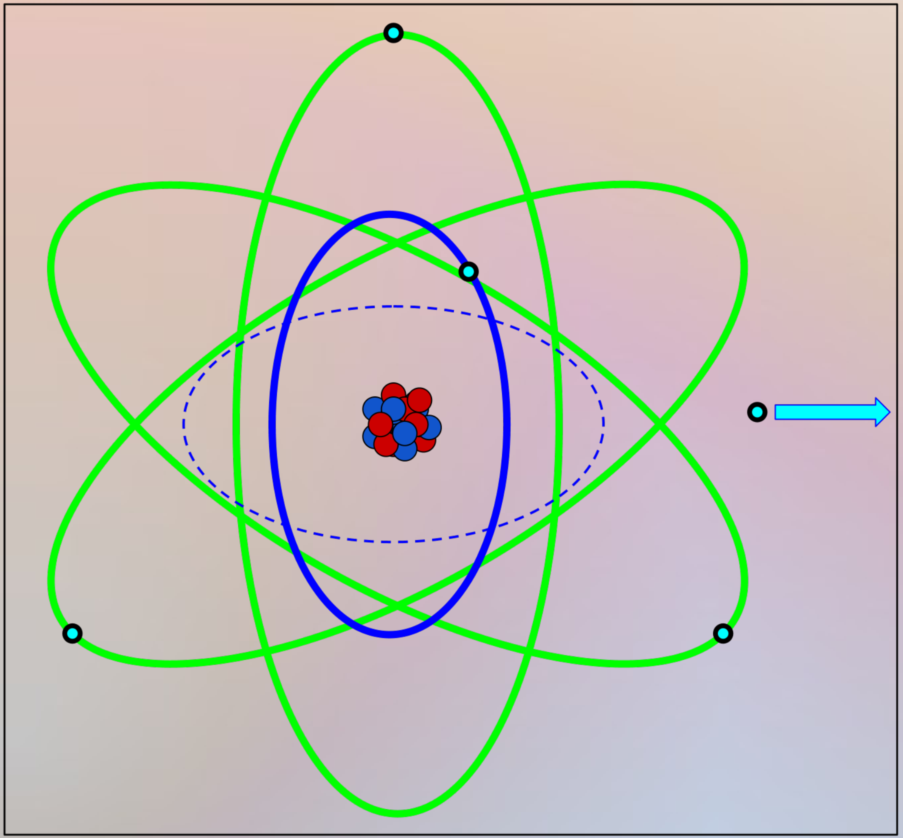
- The ICC, α, of a nuclide is defined as the ratio between the Internal Conversions and the γ-rays.
- We are interested only in the conversions occurring in K shell electrons; the corresponding coefficient is α_K.
- Because it is difficult to measure the electrons given off from Internal Conversion, we used the number of K x-rays given off to calculate α_K.

$$\alpha_K = \frac{Number\ of\ K\ shell\ conversions}{Number\ of\ \gamma\ emissions}$$

Motivation

There are two methods of calculating the ICC



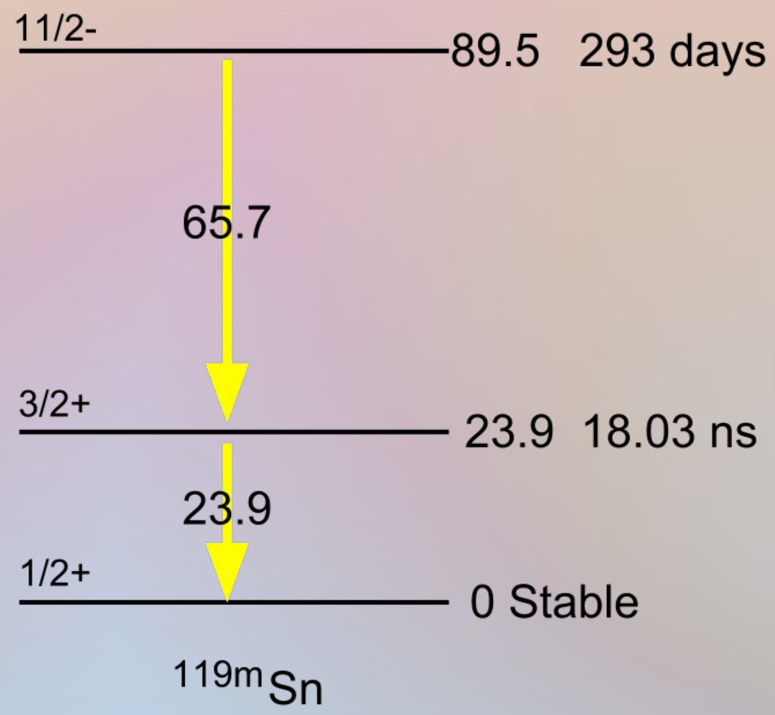


Motivation

- The previous method of calculation has been used for years, and these values are listed in many tables.
- To demonstrate which method is correct, the J.C. Hardy research group at Texas A&M has made precision measurements of several ICCs.
- This experiment is possible with this isotope because the theories give two values for α_K which are far enough apart to be measurable.

About ^{119m}Sn

We chose ^{119m}Sn because it has a lower atomic number than previously studied isotopes, but is not so light as to make measurement impossible.

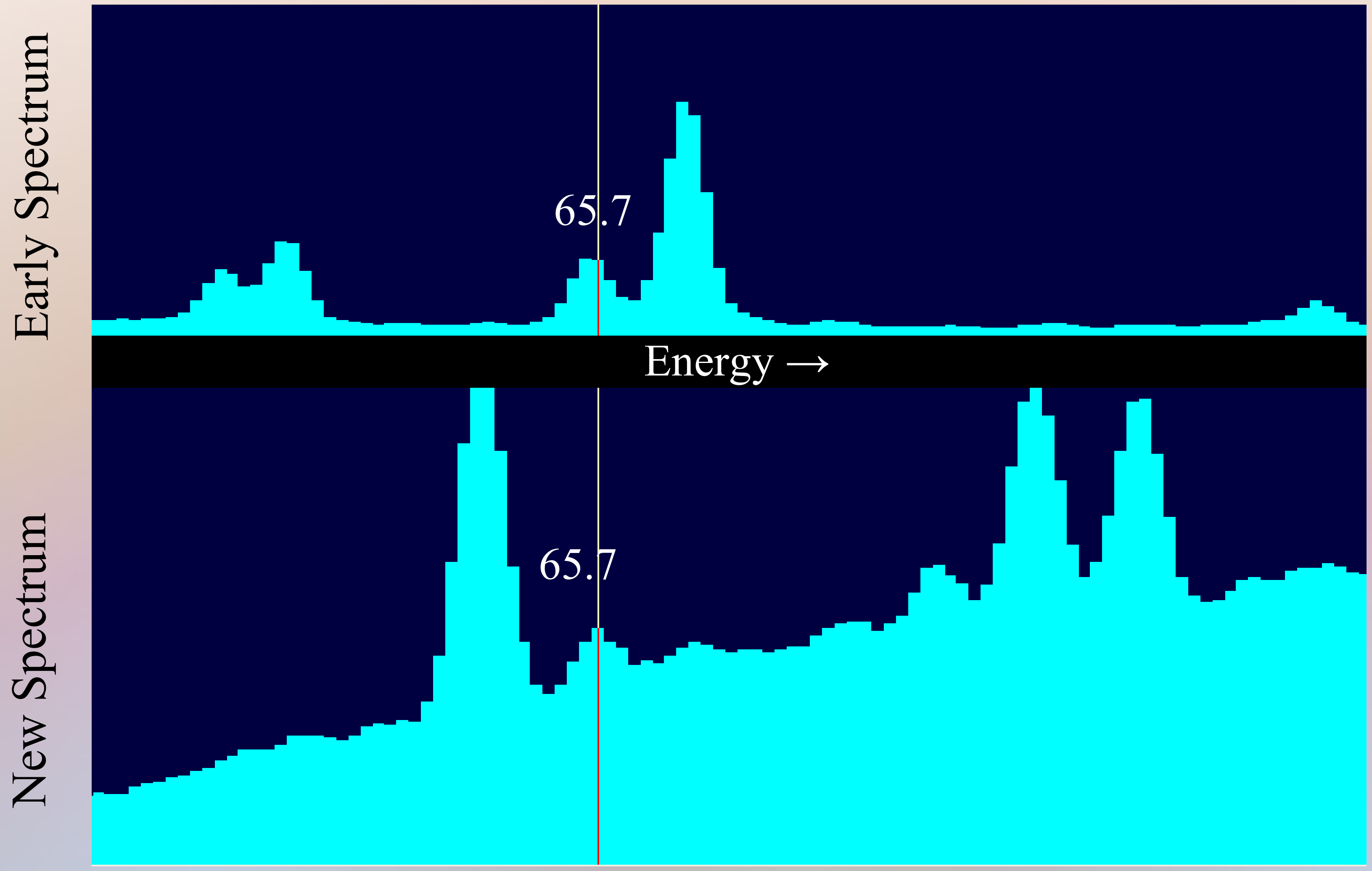


The two calculations for α_K of ^{119m}Sn are 1544 (no-hole) and 1618 (Frozen-Orbital).

Preparation

- We began with a foil enriched to 98.8% ^{118}Sn (natural abundance: 24%)
- This was irradiated with neutrons to produce ^{119m}Sn.
- Not 100% pure → contaminants
  - Initial Spectra had a lot of ^{182}Ta
- It was allowed to decay for a year to allow for easier measurement

Initial Spectrum vs. After Decay Period

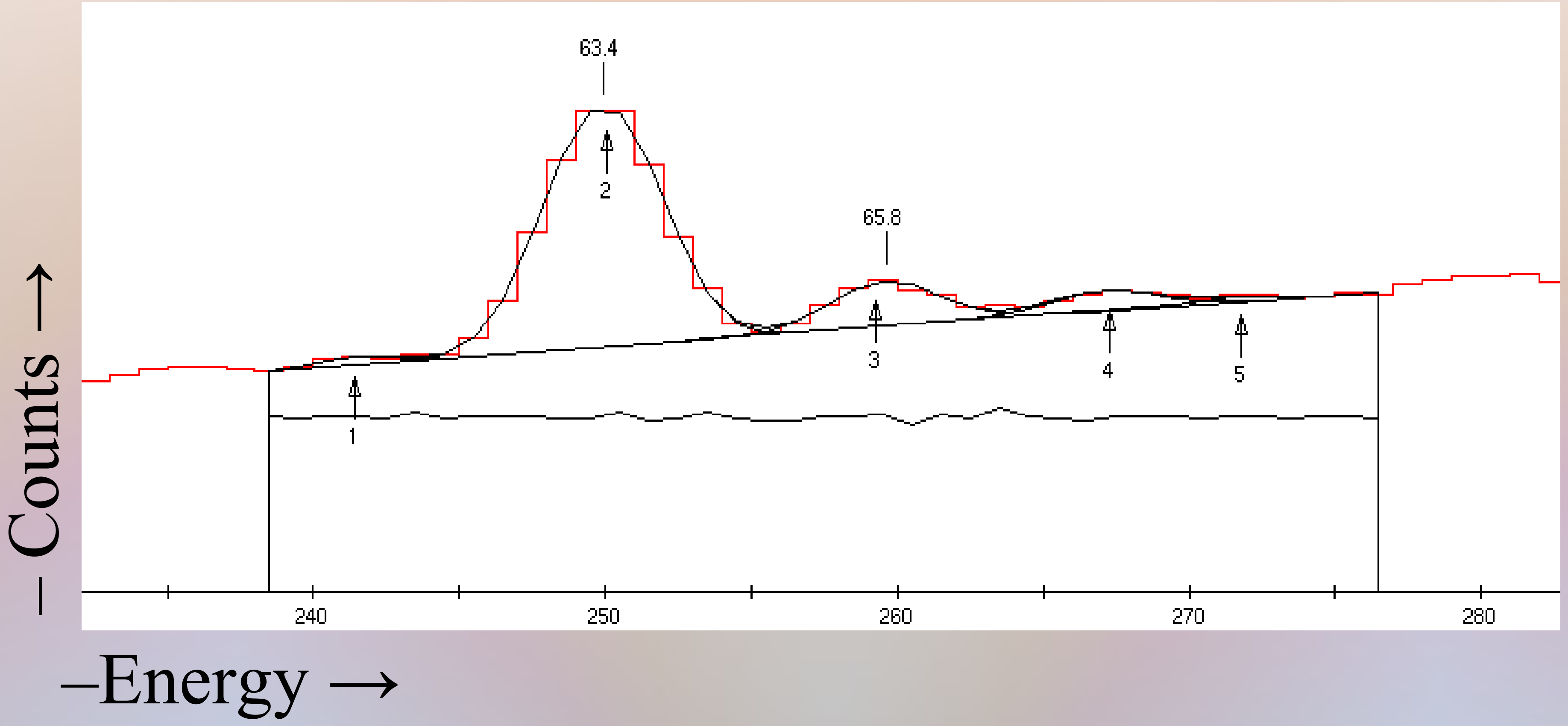


Goal

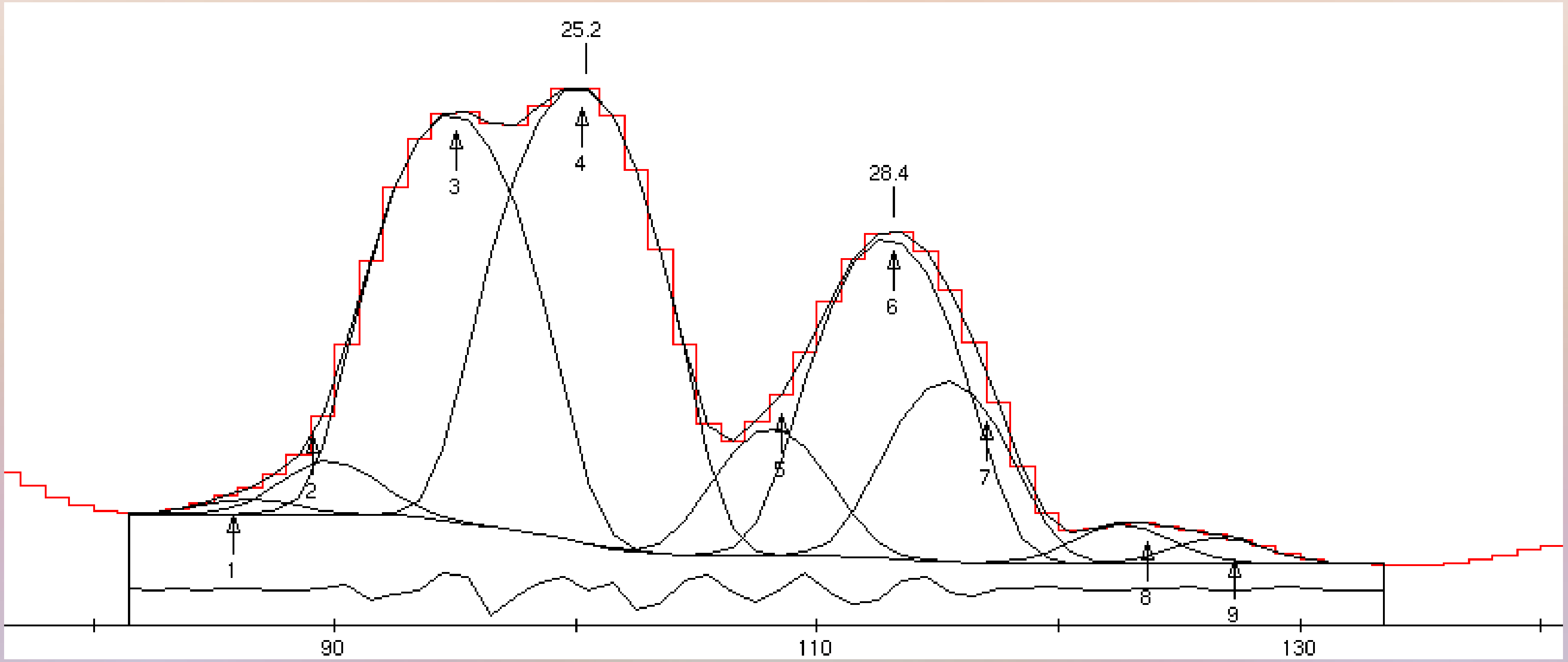
- Measure the area of the ^{119m}Sn γ-ray peak at 65.7 keV
- Measure the areas of the K x-rays of ^{119m}Sn. These occur around 25 keV and 28 keV
- Use known detector efficiencies and the fluorescence yield, ω_K, to calculate α_K:

$$\alpha_K \cdot \omega_K = \frac{N_K}{N_\gamma} \cdot \frac{\varepsilon_\gamma}{\varepsilon_K}$$

Peak Fitting: γ-ray



Peak Fitting: x-ray



– Counts →

–Energy →

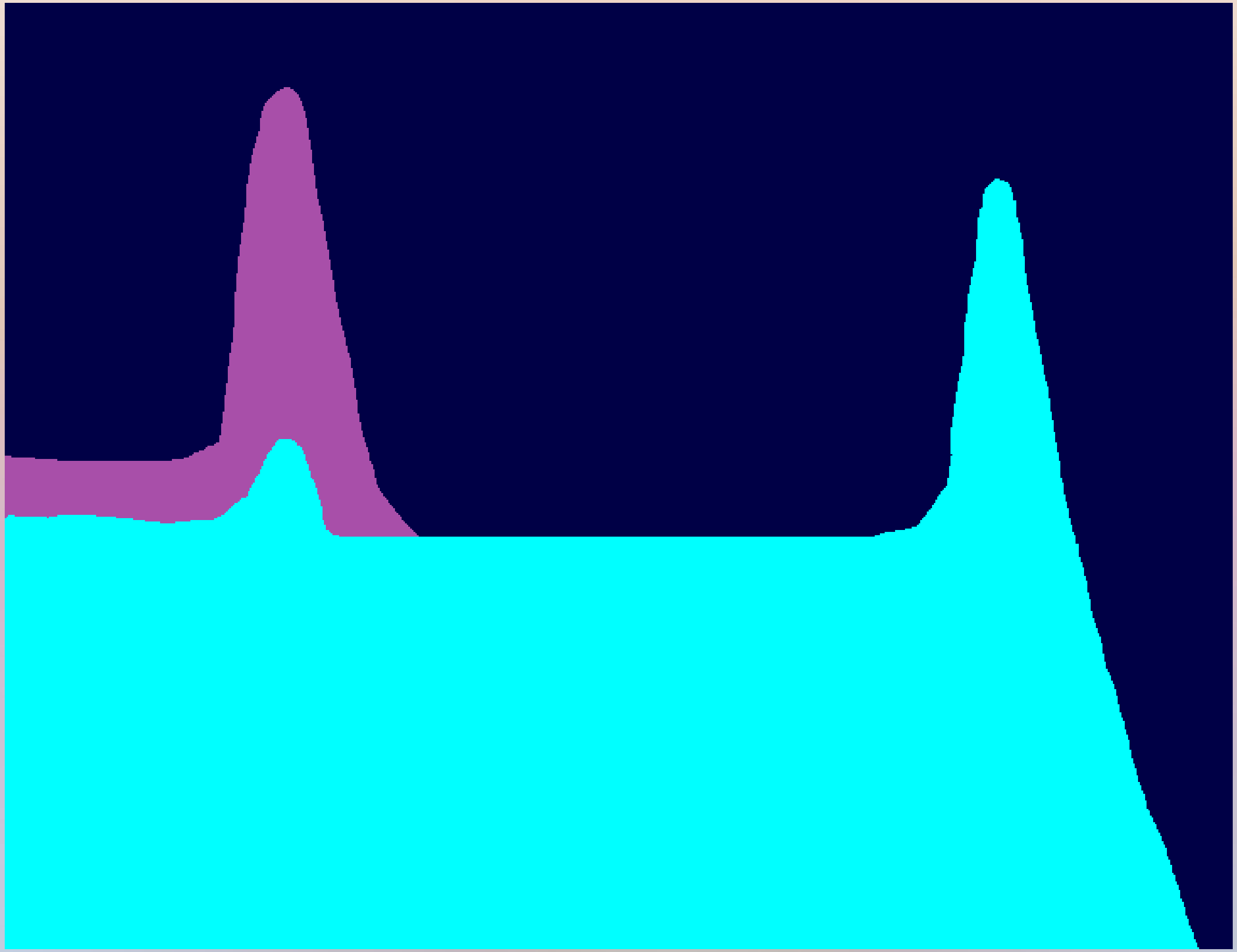
Contaminants

The main contaminants identified in our sample:

- ^{60}Co
- ^{65}Zn
- **^{75}Se**
- **^{113}Sn**
- **^{125}Sb**
- **^{182}Ta**

- Main subtractions needed: ^{125}Sb peak at 24 keV, ^{125}Sb and ^{113}Sn at 27, ^{182}Ta at 65, and ^{75}Se at 66 keV.

Subtraction



Subtraction

- We used known peak-intensities to subtract the areas of contamination peaks.
- ^{75}Se gives off several γ-rays, one of them overlapping with an area of interest. The intensity of this peak (at 66 keV) is 1.112.
- Another peak occurs at 264 keV with intensity 58.9.

$$\frac{A_1}{A_2} = \frac{I_1}{I_2} \qquad \frac{I_1}{I_2} = \frac{N_1}{N_2} \cdot \frac{\varepsilon_2}{\varepsilon_1}$$

Calculation

- Dr. Nica and I each did our own calculations of α_K, using our own fits of the spectra.
  - My calculation: α_K=1668
  - Ninel's calculation: α_K=1647
- So our current measurement is: α_K=1658±45
- These agree with the "Frozen Orbital" method of calculation of α_K=1618, which is physically more accurate.

Further Work

- This is a preliminary measurement for two reasons:
  - Work is still needed to account for the effects of photon scattering in the air and off of experimental apparatus.
  - Because of high background, there are discrepancies about how to calculate the uncertainty in our measurement.
- However, this measurement is precise enough to indicate which theoretical description is more accurate.

Acknowledgements

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