Gamma Cross Sections

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Gamma Cross Sections

- Analyzing the Data
- Issues encountered in Analysis
- Resolution of Those Issues
- References

The general theory of each step will be interspersed throughout.

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PHA Spectra - Gaussian Fits

$$f(x) = \frac{N}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} + Ax + B$$

We fit all the peaks to this function because we didn't trust the ROI settings and their consistency.

PHA Spectra - Gaussian Fits

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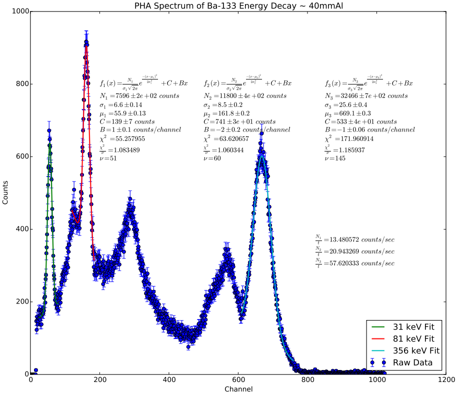
Gaussian Fits to Data



Notes:

- Notice the fit function - linear background
- $\tilde{\chi}^2$ - gives confidence in the form of the fit as well as the fit itself

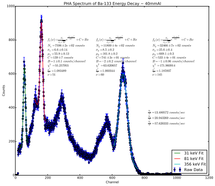
Gaussian Fits to Data

Fit Function:

$$f(x) = \frac{N}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} + Ax + B$$

- Linear background is not a rate in time; it's a rate over the channels
- $\implies$ Background measures:
  - susceptibility (to noise) by channel - A
  - overall susceptibility (to noise) - B
- We assume that this noise is random and is not caused by our apparatus
  - $\implies$ It comes from another source(s)
- Why aren't they delta functions?
  - energies are one value, width comes from detector

Gaussian Fits to Data

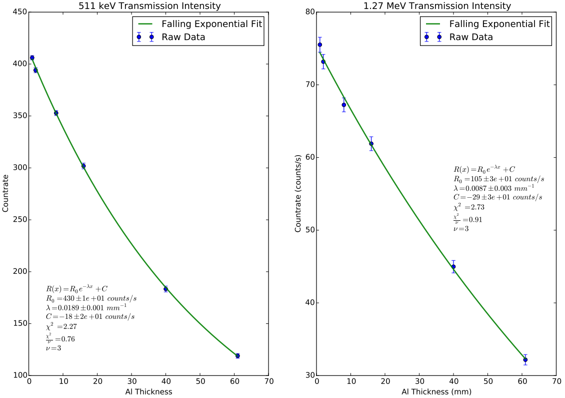


Then what are these other peaks?

- Compton Edge and Backscatter
  - Peak energies are known - ignore these other features[†]

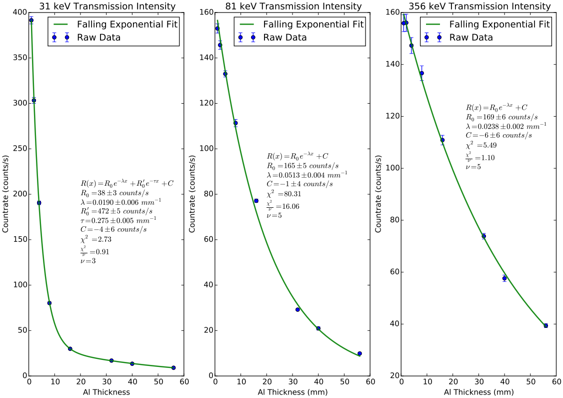
[†]We should never ignore features, but once we verify that we aren't interested in them we can effectively ignore them.

Fitting to Find Countrates



Good fits, good agreement with the theory (for the fit at least)

Fitting to Find Countrates



Return to the Ba countrate fits later on

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How do we stack up?

So the Na fit is good, are the values any good?

$$\mu = \frac{\mu}{\rho}\, x\, \rho = 0.223 cm^{-1}$$

[1]

Uh oh...

$$\lambda_{exp} \pm \sigma_\lambda = 0.19 \pm 0.01\, cm^{-1}$$
$$\sigma_\lambda = .01$$

$+3\sigma \implies$ we either made a discovery or we have a confidence of

$$100 - 99.74 = 0.26\%.$$

[3]

How do we stack up?

All is not lost, however! We should test the next measurement.

$$\mu = \frac{\mu}{\rho} x \rho = 0.143 cm^{-1}$$

Hmm, not looking good.

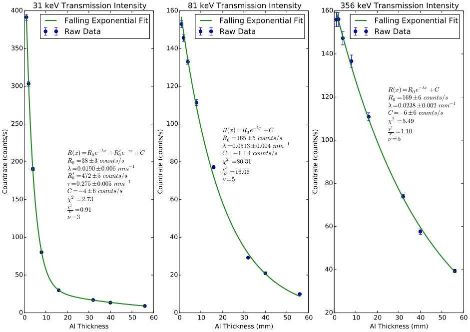
$$\lambda_{exp} \pm \sigma_\lambda = 0.09 \pm 0.03\, cm^{-1}$$
$$\sigma_\lambda = .03$$

$-1.67\sigma \implies$ confidence of

$$100 - 90.5 = 9.5\%$$

[3] which just tells us we're using student-grade lab equipment in a room of people doing the same experiment.

Ba Silliness



$$R(x) = R_0 e^{\lambda x} + R_0' e^{\tau x} + C \quad 31\ keV$$

$$R(x) = R_0 e^{\lambda x} + R_0' e^{\tau x} + C$$

$R_0 e^{\lambda x} + C$ is the normal expression.

- Does not account for photoelectric effect dominance at low energies (like 31 keV)!
- λ = <u>Compton</u> effect linear attenuation coefficient
- τ = <u>Photoelectric</u> effect linear attenuation coefficient
- $\lambda + \tau = 2.94\, cm^{-1}$

Ba Silliness

So, what's the literature value?

$$\mu = 2.98\, cm^{-1}$$
$$(\lambda + \tau) \pm \sigma_{\lambda+\tau} = 2.94 \pm 0.11\, cm^{-1}$$
$$\implies 0.36\sigma$$

Which gives us a confidence value of

$$100 - 28.12 = 71.88\%$$

in our measurement!

Note that the extra significant figures were added to give a sense of how close the value is, the measurement is properly reported as $2.9 \pm 0.11\, cm^{-1}$

And the other energies?

Well those are easy.

μ	$\lambda \pm \sigma_\lambda$	σ
$0.533\ cm^{-1}$	$0.51 \pm .04\ cm^{-1}$	0.17σ
$0.260\ cm^{-1}$	$.23 \pm .02\ cm^{-1}$	0.67σ

values of lambda are not right on, just best I could find

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other stuff here???

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References

- Physics.NIST.gov - Table of XRay Mass Attenuation Coefficients http://physics.nist.gov/PhysRefData/XrayMassCoef/ElemTab/z13.html
- University of Chicago, PHYS 211 Lab Manual - P211 Wiki
- An Introduction to Error Analysis - John Taylor