

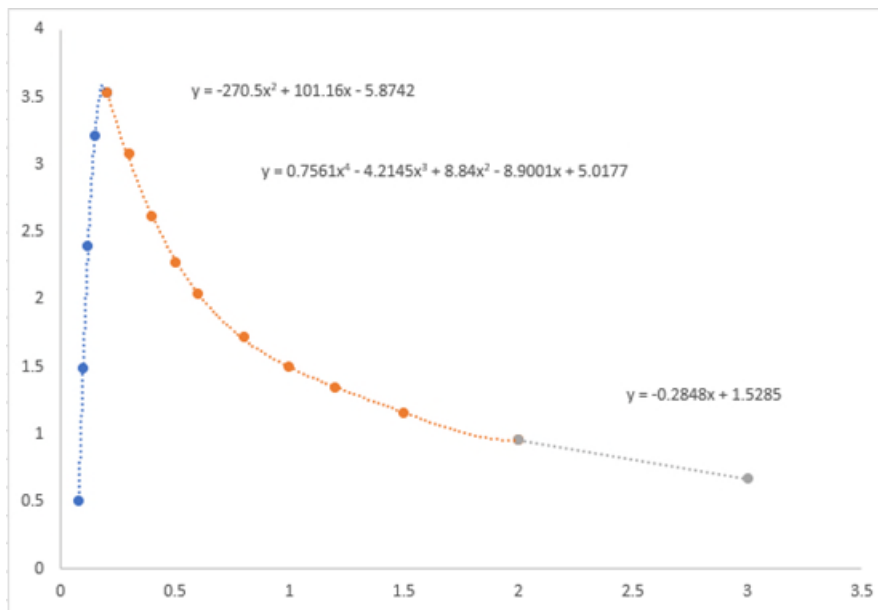
Exercise 2 Solution

Mine Dust Gamma Counting:

Livetime = 5160.28 s

Mass = 884.4 g

Fit of Mine Dust efficiency:



^{232}Th activity calculation:

Using the 2614 line:

Counts = 326 +/- 30 from cambio.

Efficiency = 0.0078 +/- 0.0008 (from fit, assumed 10% uncertainty)

BR = 0.358 (99% for ^{208}Tl , 35.9 for $^{212}\text{Bi} \rightarrow ^{208}\text{Tl}$)

$A = C / (LT / \epsilon / BR / M)$

$\sigma_A = A \sqrt{(\sigma_C / C)^2 + (\sigma_\epsilon / \epsilon)^2 + \text{smaller terms}}$

^{232}Th activity = **0.0256 +/- 0.0035 decays/gram/sec**

²³⁸U activity calculation:

The 2448 Line in this sample is too small to see. Use the 351 line instead:

351 Line:

Counts = 911 +/- 68

Efficiency = 0.0281 +/- 0.0028

BR = 0.358

²³⁸U Activity = 0.0198 +/- 0.0025 decays/gram/sec

1 teaspoon in SNO:

Norite Density = 3 g/cm³

1 tsp = 4.9 cm³ = 14.7 g

Phase 1 = 304.6/365.25 years = 0.84 years

²⁰⁸Tl:

$N = m * A * BR * p_N * p_D * LT$

14.7 g * 0.0256 decays/g/s * 0.358 gammas/decay * 0.002 neutrons/gamma * 0.3 detections/neutron * 31557600 sec/year * 0.84 years

$\sigma_N = N \text{ sqrt}((\sigma_A/A)^2 + \text{smaller terms})$

= 2140 +/- 290 detected neutrons

²¹⁴Bj:

BR = 1.57%

= 73 +/- 9 detected neutrons/year

SNO:

6 m radius

V = 904 m³

5 neutrons/m³/year * 904 m³ * 0.3 detections/neutron / 365.25 days/year * 304.6 days/ phase 1= **1130 detected neutrons in phase 1**

1 tsp of mine dust would add 190% to the neutral current signal.

Comparison with SNO paper:

<https://www.sno.phy.queensu.ca/sno/papers/045502.pdf>

Table VI shows the neutron background budget. Overall, they estimated they should see 71 neutrons from photodisintegration in the analysis region.

SNO used a reduced fiducial volume to help exclude events from near the acrylic vessel. Appendix A, Section E shows that although the neutron capture probability is roughly 30%, including this fiducial volume reduces the detection probability to 14% for neutrons produced within the entire D2O volume. Table XVIII shows that SNO detected 576.5 neutrons from neutrino interactions. Scaling our prediction by 14/30, we would have predicted 527 neutrons in the SNO dataset.