SNOLAB Gamma Counting

Exercise 2: Experimental Application

The SNO detector used heavy water to observe solar neutrinos. Heavy water was used because neutrinos with more than 2.2 MeV were able to disintegrate the deuteron through the neutral current reaction (5 neutrons/m^3/year). SNO would then observe the capture of the neutron (roughly 30% capture probability in D_2O).

Unfortunately, gamma rays above 2.224 MeV are also able to disintegrate the deuteron, giving the same neutron signal as the neutrino neutral current reaction. ^{214}Bi from the ^{238}U decay chain has a decay at 2.447 MeV. ^{208}Tl from the ^{232}Th decay chain has a decay at 2.615 MeV. Each of these gamma rays have a roughly 0.2% chance of photo-disintegrating a deuteron.

Using the Mine Dust sample, estimate how far off the SNO Neutral Current measurement would be if 1 teaspoon of mine dust (mostly norite rock) made its way into the SNO acrylic vessel.

If you would like to compare with the real answer, please see: Phys. Rev. C 75 045502 (2007) "Determination of the ν_e and Total ^{8}B Solar Neutrino Fluxes with the Sudbury Neutrino Observatory Phase I Data Set". This first phase of SNO had a livetime of 306.4 days.