Variables

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1 Defining the Signal Time Series

The Signal Time Series is the predicted time-dependent particle event rate of Heavy Neutral Leptons (HNLs), N, decay. This predicted signal should be at its minimum at Mid-day and its max at midnight due to the rotation of the Earth. This modulation, for our purposes, can be represented as a sinusoidal wave whose amplitude is dictated by the HNLs mass, M_N, and its dipole coupling strength, d_N.

2 Defining the Background Time Series

The Background Time Series is the total resulting time-independent event rate of the different nuclear reactions, beta decays, and others producing neutrinos. This background should be relatively constant throughout time.

3 Computing Expected Background Rate

To compute the Expected Background rate, it is the sum of the different background events per day per a 100T per a N_h. Representing the different backgrounds as $Bkg_0(N_h)$, $Bkg_1(N_h)$, $Bkg_2(N_h)$, ... $Bkg_n(N_h)$. For instance the predicted events per day for polonium 210 at 200 Hits can be $Bkg_0(200)$. By setting a max and min number of hits, H_{min} and H_{max} this background rate can be represented as

$$\sum_{i=0}^{n} \int_{H_{min}}^{H_{max}} Bkg_i(N_h) dN_h \tag{1}$$

where n is the number of backgrounds.

4 Computing Expected Signal Rate in the Off and On Bin

We can set up a sine wave with the formula

$$A \sin\left(\frac{\pi}{12}(t+24)\right) + A \tag{2}$$

where A is the amplitude determined by d_N and M_N. In this formula, the time is measured in hours and it will give us the expected event rate. We can represent the expected number of events in the 12 hour on-bin as

$$\int_0^{12} [A \sin\left(\frac{\pi}{12}(t+24)\right) + A]dt \tag{3}$$

and the expected number of events in the 12 hour off-bin as

$$\int_{12}^{24} [A \sin\left(\frac{\pi}{12}(t+24)\right) + A]dt \tag{4}$$

5 Relations to Poisson Distributions

These computed values with relate to the numbers we sample using Poisson Distributions as the computed expected background of the day multiplied with our 12 hour time bins will let us form a Poisson Distribution with a mean of λ_{bkg} where we can sample numbers for each time bin. We can similarly sample numbers for the expected events for the signal with Poisson Distributions centered around λ_{on} and λ_{off} .