Galactic Plane Flux Profiles

Milagro Memo
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This memo contains the procedure to create galactic plane profile flux plots. The fluxes are compared with GALPROP optimized for the EGRET diffuse data, where we see the model under-predicting the Milagro flux in the inner galaxy. Using the A4 weighted analysis for a 5 epoch scheme gives a flux for the Crab at 12 TeV of (4.68±0.47)x10^{-14} /TeV/cm^2/s. This is consistent with the HEGRA flux at 12 TeV of 4.21x10^{-14} /TeV/cm^2/s. The galactic plane paper (Atkins *et al.,* PRL 95 (2005) 251103) gives an integral flux of the inner galaxy for E>12 TeV of (1.02±0.21±0.32)x10^{-11} /cm^2/s/sr. This analysis gives an integral flux for E>12 TeV of (0.89±0.14)x10^{-11} /cm^2/s/sr. The Cygnus hot spot (MGRO J2019+37) has a flux of (2.42±0.32)x10^{-14} /TeV/cm^2/s. The diffuse region around the hot spot has a flux of (2.91±0.36)x10^{-12} /TeV/cm^2/s/sr for the box defined by longitude in [65°,85°] and latitude in [-3°,3°], and excluding a 3°x3° box around the hot spot.

Procedure

The data used are from July, 2000 to March, 2006. The corresponding run numbers are 2630 through 6872. The data epochs are divided into 5 time periods for COM, OFF, ORCOM, 3 layer, and 2 layer fitters. The data are further divided into various A4 slices (1 to 2, 2 to 3, etc.). Weights are applied per slice based on how likely the events in that slice are actually gammas and not background, and the data is recombined into a final weighted events map of the sky. Only declinations from -2° to +70° are used, as the fluctuations grow rapidly beyond these limits, especially for the low declinations. The simulations and data maps were created with a 45° zenith angle cut.

In terms of the simulations, the same Monte Carlo gamma files are reconstructed based on the settings from the different epochs. Milinda's MMCAnalysis::Sensi is run to determine the expected number of gammas per day for all declinations, (γ/day)(δ). User-defined flux and spectrum are used when running Sensi. For this study, a flux of 10 times the Crab at 1 TeV (2.83x10^{-6} /TeV/m^2/s) and a spectrum of -2.62 are used. This is done for all slices in all epochs. The (γ/day)(δ) is multiplied by the weights for each slice and the days in each epoch (with a 0.9 factor to account for instrumental deadtime) and then summed to give a final total number of weighted events as a function of declination:

$$W(\delta) = \sum_{epoch}\sum_{slice} (\gamma / day)(\delta) * wgt_{slice} * days_{epoch} .$$

This declination dependent weighted number of events is used to remove the declination dependence of the data excess map to give a map in units of the Crab:

$$"Crab\ Map" = excess(\delta) / W(\delta)\ .$$

To get a flux map, a further normalization factor is needed. The inputs include the energy spectrum and the specific energy to do the analysis at. This factor puts the "Crab Map" into units of /TeV/cm^2/s. The median energy of the weighted A4 analysis of 12 TeV and a spectrum of -2.62 are used in this analysis:

$$"Flux\ Map" = "Crab\ Map" * dN / dEd\Omega\ .$$

The $d\Omega$ term is to put the flux in units of per steradian. This is done in the analysis code by dividing by the number of square degrees for the region in question and by $(\pi/180)^2$. The effect from looking at bins off the equator in a spherical geometry is negligible since this analysis is performed in galactic coordinates and for regions on or near the galactic plane (equator).

Results

The flux at different regions is tabulated below. The values for the Crab and the inner galaxy are consistent with the HEGRA Crab flux and the galactic plane PRL flux, respectively. The flux profiles are drawn as a function of longitude for the entire galaxy, and as a function of latitude for both the inner and outer parts of the galaxy. The hot spot, MGRO J2019+37 is seen in the longitude profile as a single high bin in the Cygnus Region. No significant excess is seen in the outer part of the galaxy, as seen in Figure 3. The red lines in the profiles are the GALPROP predictions using the model optimized to fit the EGRET diffuse results.

Crab	MGRO J2019+37	Cygnus Diffuse	Inner Galaxy
$(4.68\pm0.47)\text{x}10^{-14}$ /TeV/cm^2/s	$(2.42\pm0.32)\text{x}10^{-14}$ /TeV/cm^2/s	$(2.91\pm0.36)\text{x}10^{-12}$ /TeV/cm^2/s/sr	(1.19±0..19)x10^{-12} /TeV/cm^2/s/sr

Table 1 Fluxes are at 12 TeV and a spectrum of -2.62. The Cygnus Diffuse flux is from *l*=[65°,85°] and *b*=[-3°,3°] excluding a 3°x3° box around MGRO J2019+37. The Inner Galaxy flux is from the region *l*=[40°,100°] and *b*=[-5°,5°].

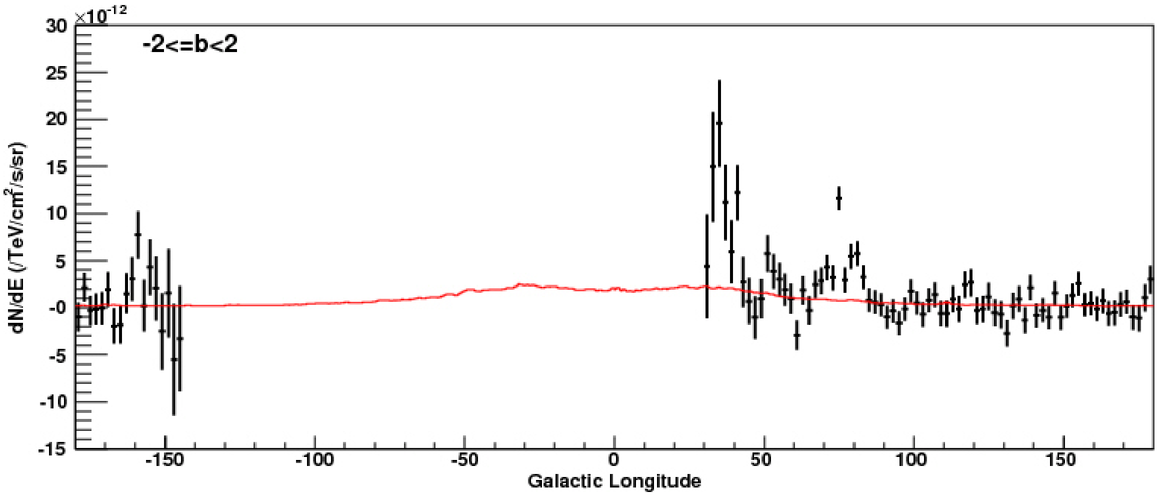

Figure 1 Galactic longitude profile of the flux at 12 TeV for a -2.62 spectrum. The bins are in 2° steps. Notice the single high bin in the region *l*=[65°,85°]. This is the hot spot, MGRO J2019+37. The red line is the GALPROP prediction.

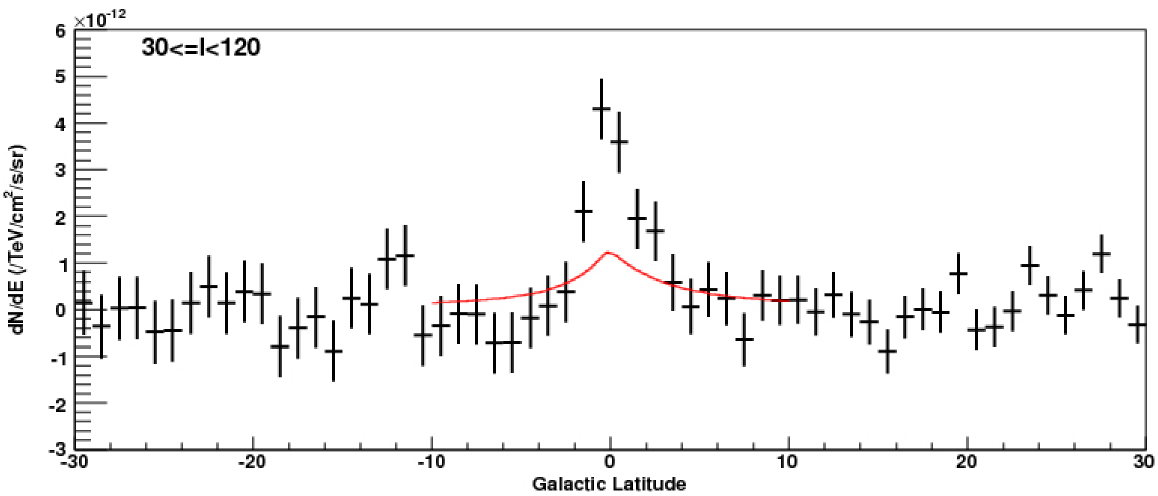

Figure 2 Galactic latitude profile for the inner portion of the galaxy. The bins are in 1° steps. The window in longitude is 30° larger than in the PRL. The red line is the GALPROP prediction.

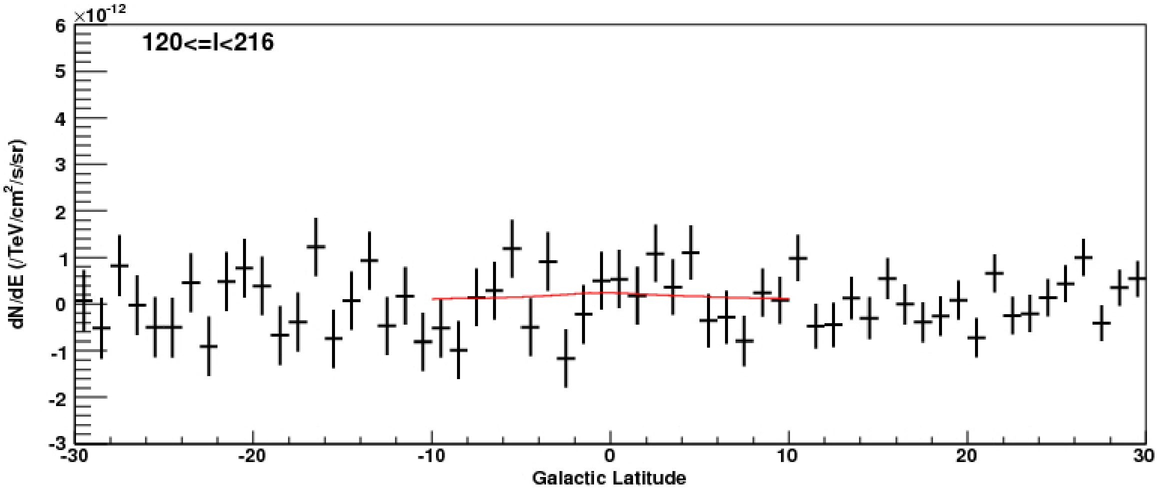

Figure 3 Galactic latitude profile for the outer portion of the galaxy. The bins are in 1° steps. The longitude window is again larger than the region defined in the PRL. The red line is the GALPROP prediction.