Analyses of Diffuse Emission in DC2

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Outline

- (Andy Strong) Spectra and profiles of DC2 data
- (Larry Wai) Fitting the DC2 model and various GALPROP models to the DC2 data
- (Jean-Marc Casandjian) [next talk by Isabelle] Emissivity profiles for the DC2 diffuse emission

Although the organizers made the workshop easy to find, Andy, Larry, Riccardo, and Jean-Marc were unable to attend.
High-energy excess

- Results posted by Andy Strong in Confluence and discussed in the Diffuse VRVS meetings
- The analysis was basically plotting data and model components for comparison, using a slight modification of GALPLOT, a friend of GALPROP
  - Once it learns the PSF of the LAT, GALPLOT will be useful for more than just plotting spectra and profiles over large solid angles
  - GALPLOT needs counts and exposure ‘cubes’ as input, and especially for the cubes (weighted average exposures over energy bins) we were not set up to write them directly
High-energy excess (2)

- Spectrum of inner Galaxy ($|l| < 30^\circ$, $|b| < 5^\circ$)

**DC2 data**

**Sanity check with gtobssim**
High-energy excess (3)

- It is evident at high latitudes, too ($|b| > 60^\circ$)

- Andy observed that the excess is ‘structured’, with the implication that it may be related to point sources
Diffuse model fitting in DC2 (Wai)

- Likelihood analysis of the inner Galaxy, with components for Galactic diffuse emission, extragalactic diffuse, and DC2 point sources
- For the Galactic diffuse emission a range of GALPROP models were included in addition to the DC2 diffuse model
  - GALPROP ‘cards’ were provided by Igor Moskalenko
- The residual background is not modeled
- In order to formally model the point sources but not carry them as >100 individual sources in the fitting and calculation of model counts maps. The LAT DC2 catalog sources were implemented in a MapCube, and included in the model with only one adjustable parameter, the overall scale
- Note: Fitting was for range >100 MeV but plots are for >1 GeV
### The diffuse models used

<table>
<thead>
<tr>
<th>Model</th>
<th>Explanation from Igor Moskalenko</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) GALPROP 999729</td>
<td>plain diffusion model tuned to agree with local cosmic ray data, it does not incorporate the GeV excess</td>
</tr>
<tr>
<td>(B) GALPROP 599278</td>
<td>a model with diffuse reacceleration tuned to agree with local cosmic ray data, it does not incorporate the GeV excess</td>
</tr>
<tr>
<td>(C) GALPROP 500180</td>
<td>a conventional diffuse reacceleration model, an earlier version of 599278</td>
</tr>
<tr>
<td>(D) GALPROP 500190</td>
<td>optimized model where the p-, e cosmic ray fluxes are adjusted to pbars and diffuse gamma rays themselves to incorporate the GeV excess.</td>
</tr>
<tr>
<td><em>GP_gamma.fits</em></td>
<td><em>DC2 diffuse emission model</em></td>
</tr>
</tbody>
</table>

GALPROP runs required combining components (IC, $\pi^0$, Bremsstrahlung) into MapCube format; MapCube format can be made an output option of GALPROP.
Example of fit results

- Spatial profiles (>1 GeV)
More quantitatively

<table>
<thead>
<tr>
<th>Model</th>
<th>Point sources</th>
<th>Extragal diffuse</th>
<th>Gal diffuse</th>
<th>max ln L</th>
</tr>
</thead>
<tbody>
<tr>
<td>GALPROP (A)</td>
<td></td>
<td>Oops, not available....</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GALPROP (B)</td>
<td>0.916 ± 0.005</td>
<td>2.26 ± 0.01</td>
<td>1.418 ± 0.003</td>
<td>124666</td>
</tr>
<tr>
<td>GALPROP (C)</td>
<td>1.006 ± 0.005</td>
<td>3.02 ± 0.01</td>
<td>1.800 ± 0.003</td>
<td>120806</td>
</tr>
<tr>
<td>GALPROP (D)</td>
<td>1.036 ± 0.005</td>
<td>1.74 ± 0.01</td>
<td>1.045 ± 0.002</td>
<td>133820</td>
</tr>
<tr>
<td>GP_gamma</td>
<td>1.018 ± 0.005</td>
<td>1.85 ± 0.01</td>
<td>1.005 ± 0.002</td>
<td>138534</td>
</tr>
</tbody>
</table>

(1.0)  (~1.5)  (1.0)

This is just a first effort, and can be expanded to investigate the diffuse emission in more detail. The specific results above are not surprising, rather reassuring that point sources can be handled in a straightforward way, and that we have a (somewhat indirect) way to investigate GALPROP models.