Contribution ID: **77** Type: **poster**

A hard spectrum diffuse gamma-ray component associated with HII gas in the Galactic plane

We analyzed 12-year Fermi Large Area Telescope gamma-ray data in the inner Galaxy centered at (l=30 degree, b=0 degree) and (l=330 degree, b=0 degree). We found significant hardening of the spectrum of the diffuse gamma-ray emission in these regions as previously reported. We further deduced that the diffuse gamma rays can be divided into two components from the likelihood analysis. One component is associated with the total gas column density and reveals a soft spectrum, while the other is associated with the HII gas and presents a hard spectrum. Assuming the diffuse gamma-ray emissions are mainly produced through the interaction between cosmic rays (CRs) and the ambient gas, these two components are produced by the CR populations with spectral indices of 2.8 (”soft”) and 2.3 (”hard”), respectively. We argue that the hard CR population may come from the vicinity of the CR accelerators. The soft CR population has a similar spectral shape and density as measured in the solar neighborhood, which implies a uniform CR “sea” with a similar density and spectral shape in the Galaxy.

Summary

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