

The observed Galactic GeV γ -ray excess is shown to be probably a result of differences between the locally observed cosmic-ray spectrum and the interstellar spectrum. The cosmic-ray source distribution is compatible with the supernova remnant distribution as traced by recent deep pulsar surveys when variations in H_2/CO are included. This has implications for the mass and distribution of molecular hydrogen in the Galaxy.

The EGRET data are an important source of information on cosmic rays and Galactic structure. There are two puzzling aspects of the subject which have attracted attention: there is an excess around 1 GeV above the emission expected based on the locally-observed cosmic-ray spectrum, and the distribution of cosmic-rays deduced from γ -rays is flatter than that of supernova remnants in the Galaxy, although these are thought to be the cosmic-ray sources. We believe to have the solution to both these problems, thus improving our understanding of the diffuse emission.

Gamma-ray spectrum

We show that the GeV excess is present everywhere on the sky, so cannot be due to unresolved sources, which would be concentrated in the plane. Instead a moderate deviation of the cosmic-ray spectrum from that observed locally can explain the ubiquity of the excess. The main effect is a larger electron intensity, increasing the inverse Compton emission. Important and new is the inclusion of EGRET data above 10 GeV (beyond the standard EGRET data range) which is well fitted by our new model (figure on right), but not by alternative models.

Cosmic-ray sources and molecular gas

Since the time of the COS-B satellite it has been known that the distribution of cosmic-ray sources appears flatter than that of supernova remnants; a new determination of the distribution of pulsars (Parkes Multi-Beam survey), which should have a radial distribution close to that of SNR, shows the discrepancy with gamma-rays is quite marked. We suggest a radial variation in the scaling factor of CO to H_2 column density, which is the basis for computing the gamma-rays associated with molecular hydrogen. The known Galactic metallicity gradient combined with the expected steep dependence of the H_2/CO factor with metallicity imply that this factor increases rapidly with radius. There is thus less H_2 in the inner Galaxy and this compensates the larger cosmic-ray gradient, giving a consistent picture.

As well as improving our understanding of the diffuse γ -ray emission, this will have important consequences for the mass and distribution of molecular gas in the Galaxy.

References:

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- Strong, A.W., et al. (2004) A&A 422, L47

