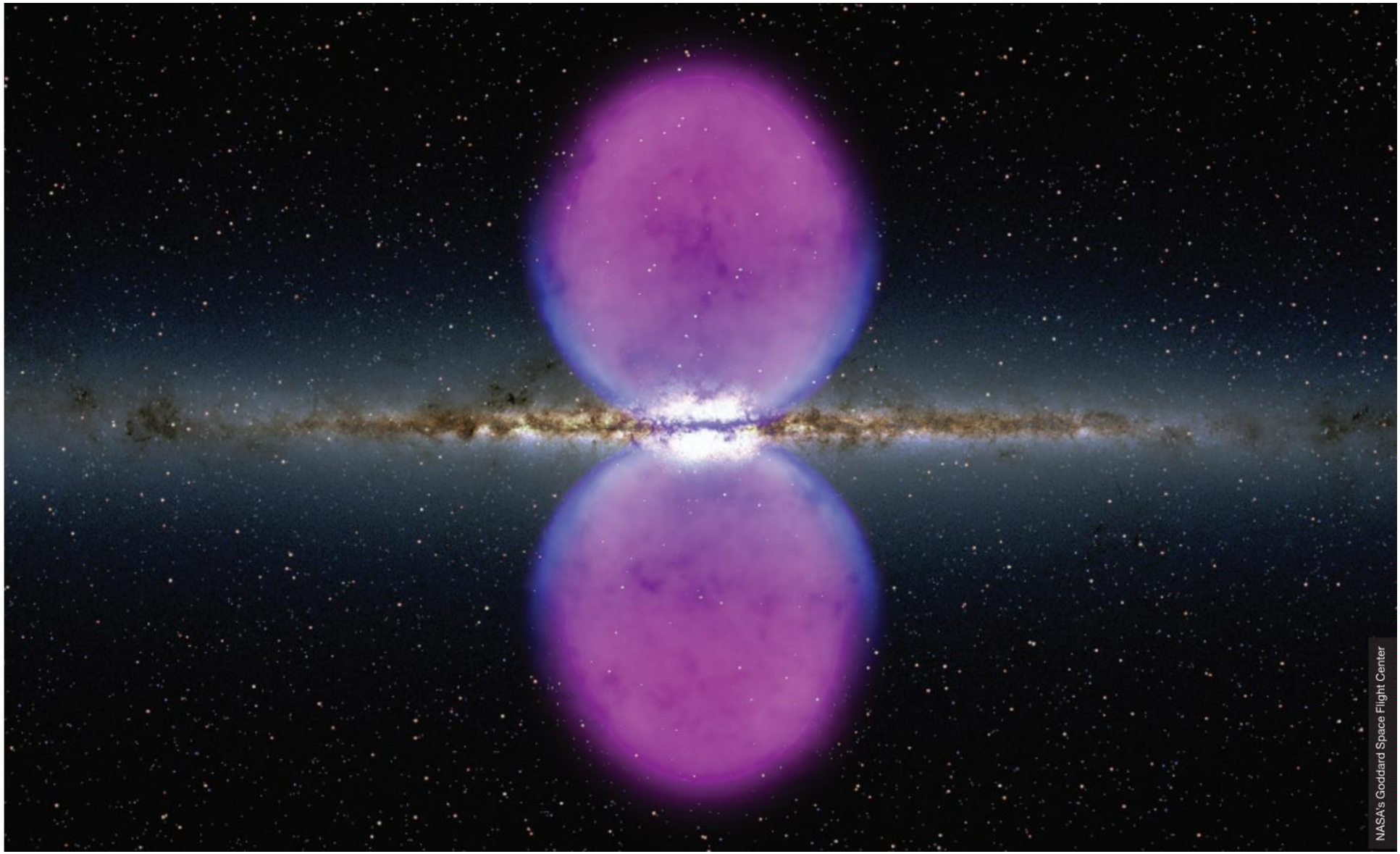
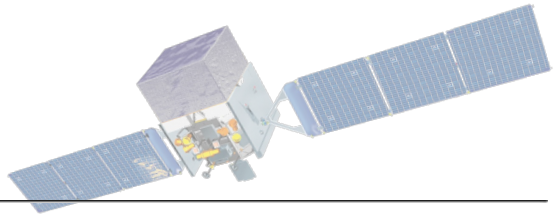
National Aeronautics and Space Administration



Diffuse Gamma ray emmision ”bubbles” at the center of our galaxy. For more information visit http://fermi.gsfc.nasa.gov/

Studying Diffuse Emissions



Viewing Diffuse Emission with Fermi

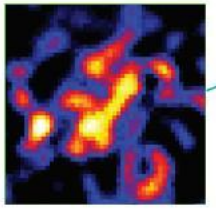
Continuum diffuse gamma-ray emission is produced in our Galaxy by interactions of high-energy cosmic rays (CRs) with interstellar matter and low-energy radiation fields. Weaker diffuse components are observed with almost isotropic distribution over the sky, and so is thought to be extragalactic in origin – these components are referred to as extragalactic gamma-ray background (EGB). A large fraction of EGB emission is attributed to unresolved sources, however, many production methods have been proposed (e.g. cosmological structure formation).

Measurements of the EGB

The LAT has performed a new measurement of the EGB spectrum - from 100 MeV up to 820 GeV. This represents the first measurement of the EGB spectrum above 100 GeV. The data is well fit by a power law with an exponential cutoff at ~250 GeV. Comparing the EGB spectrum and spectra of resolved extragalactic LAT sources indicates a significant portion of the EGB is due to populations of unresolved sources.

Diffuse emission in the Fermi era

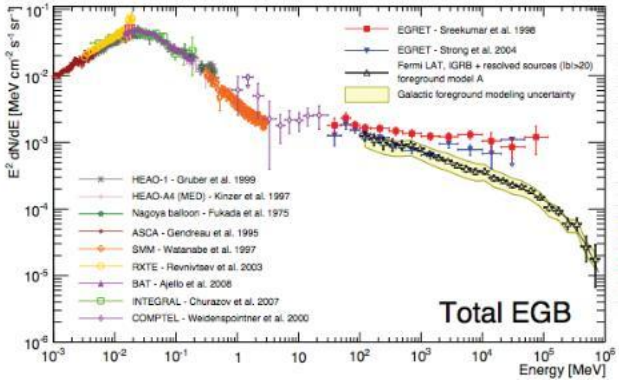
LAT Measurements show that basic production processes for interstellar galactic emission are understood, prompting the refinement of these models. This is critical for the study of both gamma-ray sources and fainter diffuse components (e.g. EGB), as well as understanding the galactic interstellar environment. One of the most surprising findings by the LAT is the indication of cosmic-ray densities larger than expected in the outer Galaxy – this excess density may be due to a thick propagation halo, or to non-uniform diffusion or convection processes, or, alternatively, to emission models that have underestimated the amount of gas present in these regions. LAT measurements are helping trace gas throughout the Milky Way and are complementing studies of the interstellar medium across the electromagnetic spectrum, revealing large amounts of material dark to radio/microwave lines, as well as variations of the CO luminosity-to-H2 mass ratio and evolution of the dust grain properties.

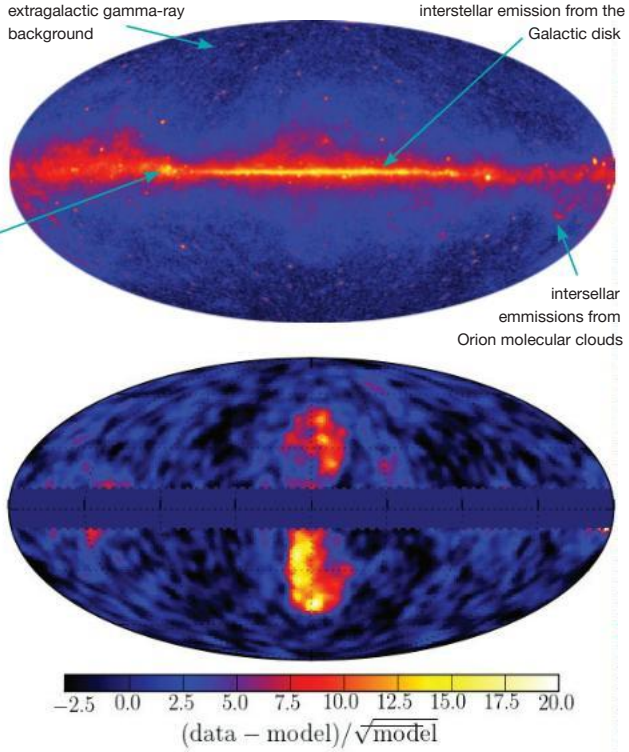


Cygnus X region

Features of the Fermi diffuse sky

LAT measurements unveil gamma-ray features not accounted for by large-scale interstellar emission models. e.g. At large angular scales, the mysterious “Fermi bubbles” that appear to emanate from the Galactic center, or, at smaller angular scales, the cosmic-ray “cocoon” in the Cygnus X region.





Fermi Sky Maps

TOP: Fermi 5-year sky map. > 80% of the photons detected by the LAT come from diffuse emissions.

Cygnus X region: Detail shows a “cocoon” of freshly accelerated cosmic rays created by the activity of the thousands of massive stars formed there. (Ackermann et al. 2011, Science, 334, 1103)

ABOVE: Whole-sky residual map of >6.4 GeV emission showing the “Fermi bubbles”, gigantic structures that seem to be connected to the center of the Galaxy. (Ackermann, M. et al., ApJ, 793,1 (2014))

LEFT: Spectral energy distribution of the EGB, comparing the LAT with previous measurements

FS-2023-11-178-GSFC