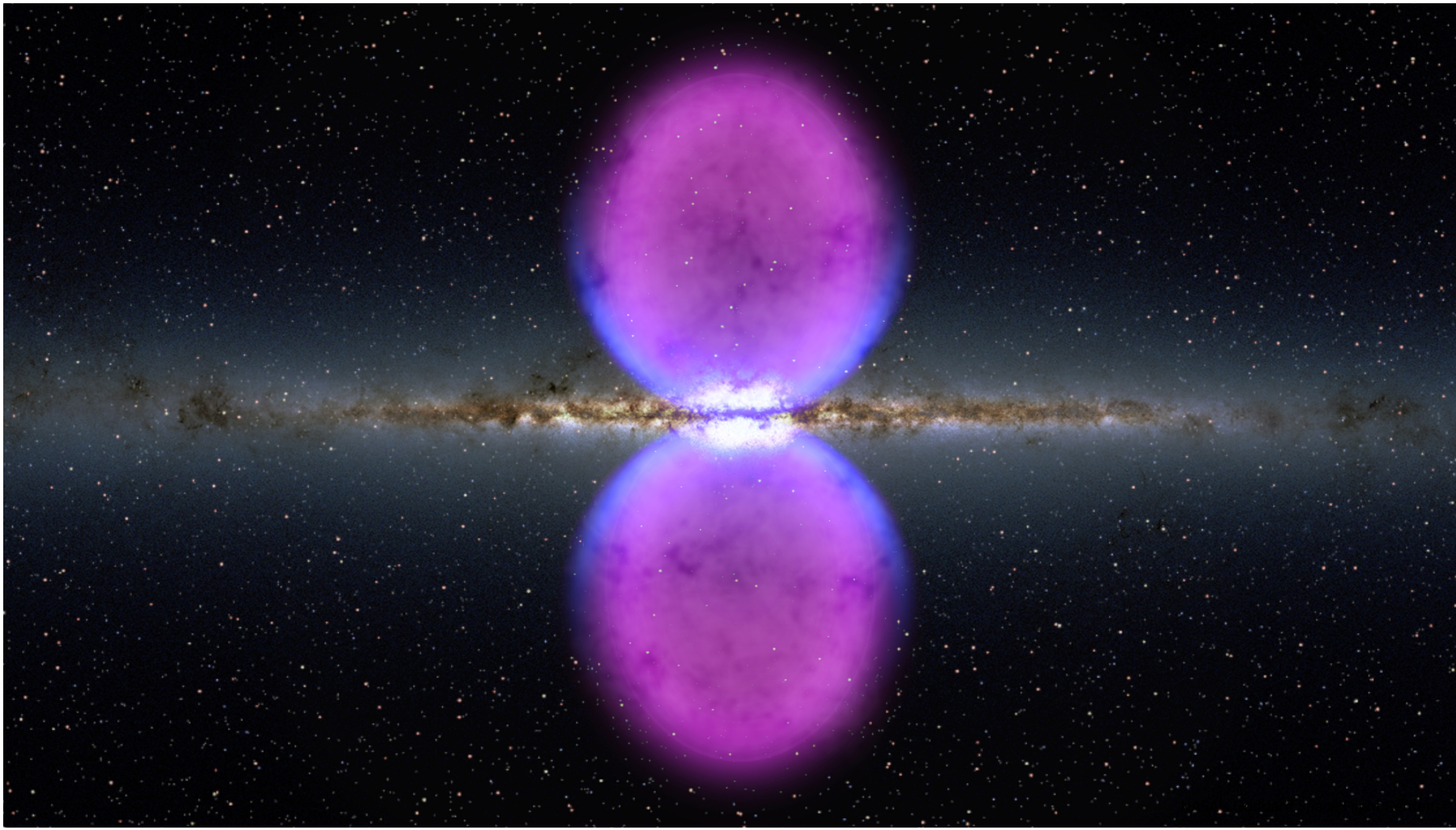
Studying Diffuse Emission

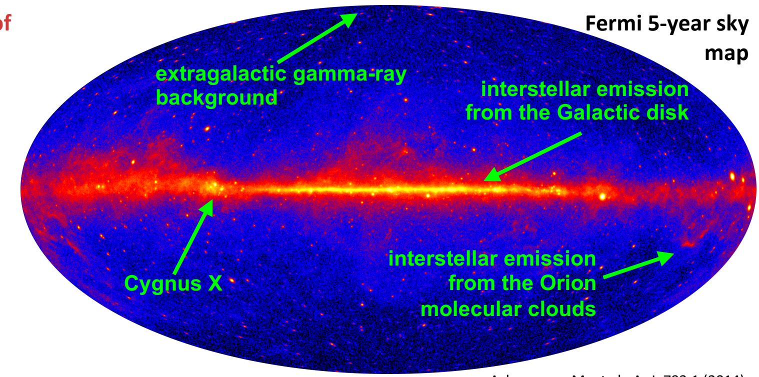


Viewing Diffuse Emission with Fermi

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. A weaker diffuse component is observed with almost isotropic distribution over the sky, and thus is thought to be extragalactic in origin. This emission is usually referred to as the **extragalactic gamma-ray background (EGB).** Its nature is still unclear: a large fraction is often attributed to unresolved sources, but many processes which might produce truly diffuse extragalactic emission have been proposed (e.g., cosmological structure formation).

More than 80% of the photons detected by the Fermi LAT come from diffuse emission

Fermi 5-year sky map



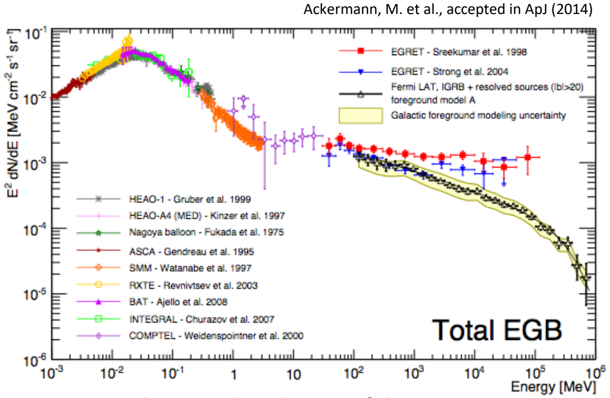
Ackermann, M. et al., ApJ, 793,1 (2014)

Measurements of the EGB

The LAT has performed a new measurement of the EGB spectrum, covering the energy range of 100 MeV to 820 GeV. This result 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.

A comparison between the EGB spectrum and the spectra of resolved extragalactic LAT sources indicates a significant portion of the EGB is due to populations of unresolved sources.

Ackermann, M. et al., accepted in ApJ (2014)



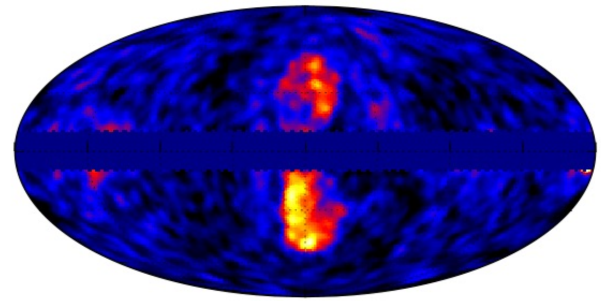
Spectral energy distribution of the EGB, comparing the LAT with previous measurements

Diffuse emission in the Fermi era

Measurements by the Fermi Large Area Telescope (LAT) have shown that the basic production processes for interstellar Galactic emission are understood, stimulating the refinement of these models. Such models are fundamental both for studying gamma-ray sources and fainter diffuse components (like the extragalactic background) and for understanding the interstellar environment of the Galaxy.

Interstellar emission traces the densities of cosmic rays throughout the Galaxy. One of the most surprising findings by the LAT is the indication of cosmic-ray densities **larger than expected** in the outer Galaxy. The excess CR density might 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.

The measurements by the LAT are tracing gas throughout the Milky Way and complementing studies of the interstellar medium across the electromagnetic spectrum to reveal large amounts of gas dark to radio/microwave lines, as well as variations of the CO luminosity-to-H2 mass ratio and evolution of the dust grain properties.

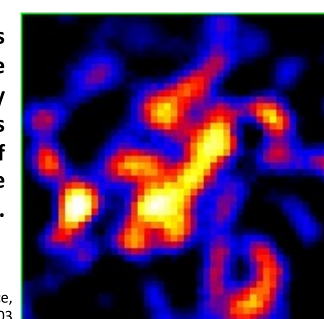


Whole-sky residual map of >6.4 GeV emission showing the "Fermi bubbles", gigantic structures that seem to be connected to the center of the Galaxy.

Features of the Fermi diffuse sky

LAT measurements unveil gamma-ray features not accounted for by large-scale interstellar emission models. For example, 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.

Residual map in the Cygnus X region, showing the "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

For more information, visit http://fermi.gsfc.nasa.gov/

NASA's Fermi mission is an astrophysics and particle physics partnership managed by NASA's Goddard Space Flight Center in Greenbelt, Md., and developed in collaboration with the U.S. Department of Energy, with important contributions from academic institutions and partners in France, Germany, Italy, Japan, Sweden and the United States.

Fermi Gamma-ray Space Telescope