GAMMA RAY BURSTS

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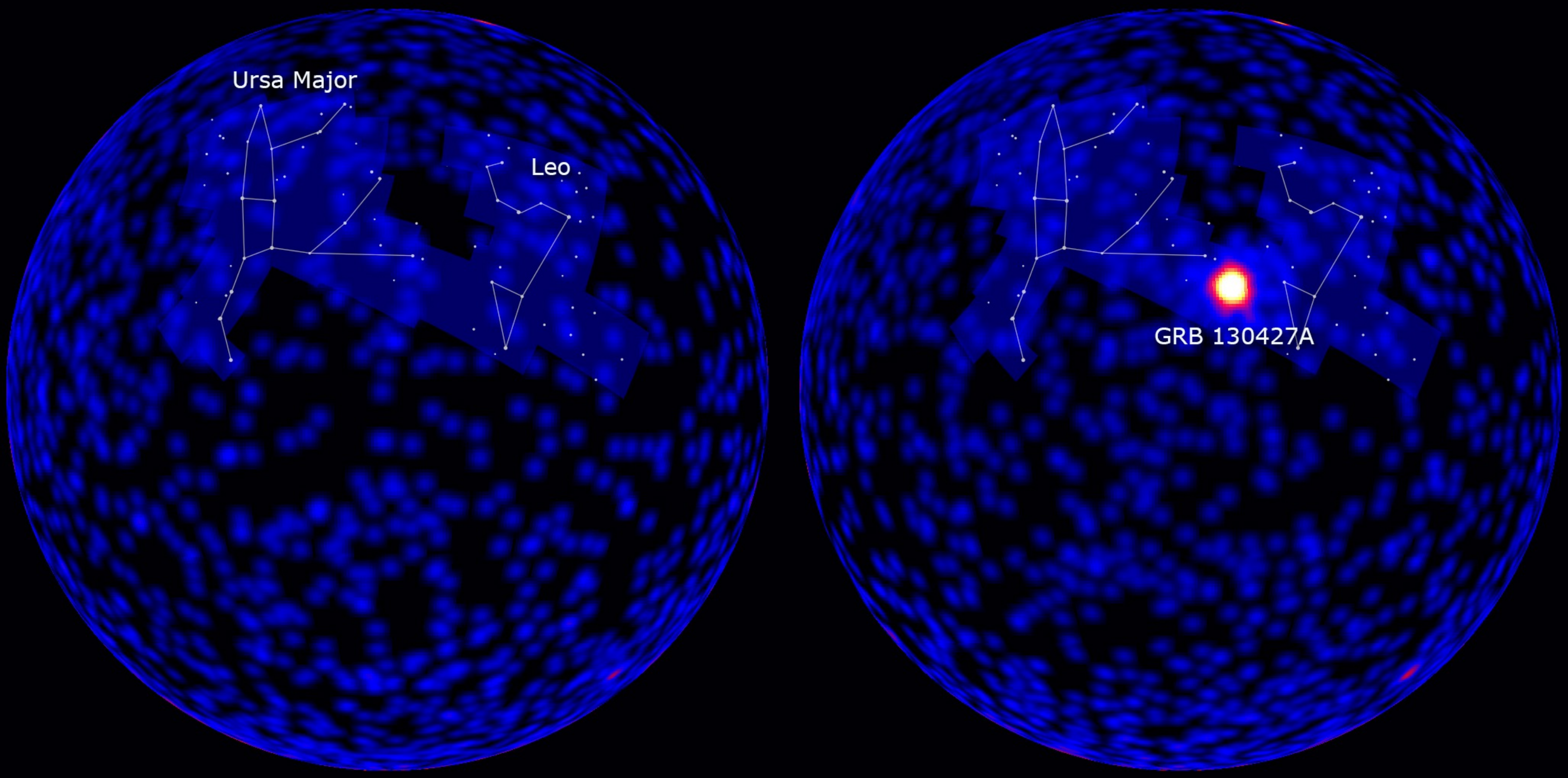


Before and after Fermi LAT views of GRB 130427A, centered on the north galactic pole

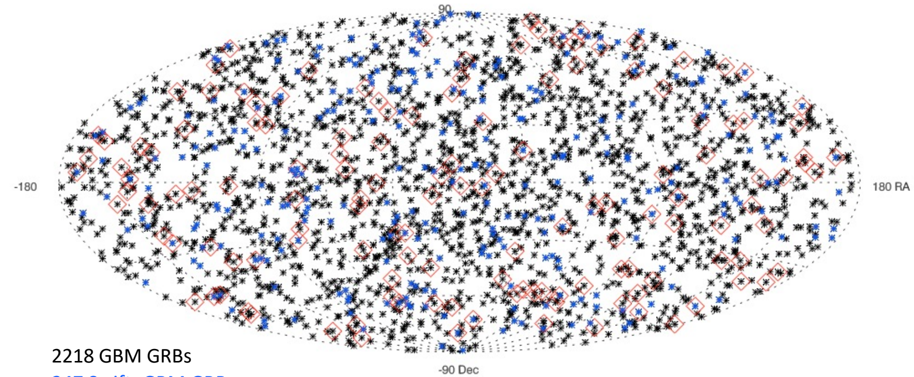
GRBs are ‘shockingly bright’ in Gamma Rays

GRBs are the most luminous explosions in the Universe. These short bursts of radiation in gamma rays can be detected in galaxies out to the edge of the visible Universe (up to redshift 9.4).

There are two observational varieties that are known to result from different types of progenitor systems. Long-duration GRBs are due to the death of a rare type of massive star that produces a Type Ic supernova with powerful relativistic jets. Short-duration GRBs are due to mergers of binary systems (neutron star-neutron star or neutron star-black hole), which create a “central engine” that launches relativistic jets of ejected material similar to those thought to power long bursts. GBM detects 90% of the total energy of short bursts within less than 2 seconds after the trigger. Powerful gravitational waves have been detected recently from the short GRB 170817A, providing the "smoking gun" for a binary neutron star merger origin of short GRBs.

Fermi has two instruments that work together to detect, localize, and characterize the temporal and spectral properties of GRBs: the Gamma-ray Burst Monitor (GBM, sensitive in the 8 keV-40 MeV energy range) and the Large Area Telescope (LAT, sensitive in the 20 MeV to >300 GeV energy range).

Fermi GRBs as of November 26, 2017



2218 GBM GRBs
247 Swift+GBM GRBs
139 LAT GRBs

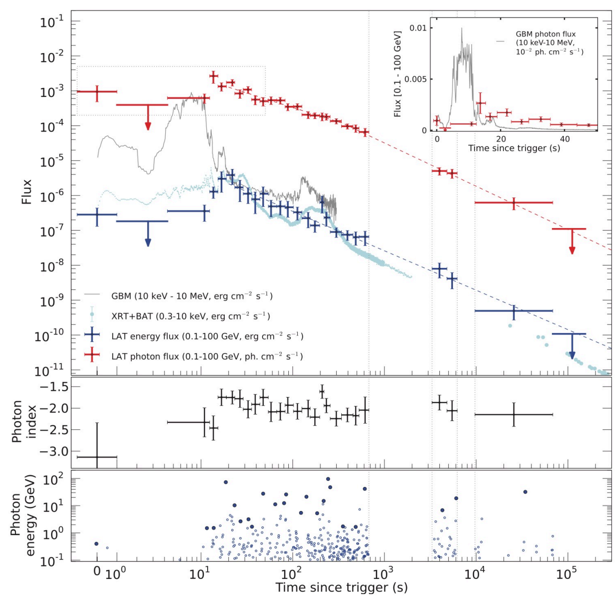
GRB Science with the GBM

The Gamma-ray Burst Monitor (GBM) has 14 detectors (12 NaIs, 2 BGOs) that together cover the full earth unocculted sky and detect ~250 bursts per year with spectral coverage from 8 keV – 40 MeV.

The GBM detects more GRBs than any other instrument in orbit. Its wide energy coverage for hundreds of GRB observations is providing constraints on the physical emission mechanisms powering these stellar explosions.

The GBM detected GRB170817A, the first short burst associated with a binary neutron star merger, confirmed by the joint gravitational wave detection (GW170817) with Advanced LIGO. The GBM is the most prolific detector of short GRBs and will constrain physical models of binary neutron star mergers.

M. Ackermann et al., Science, 343, 42 (2014)



Comparing the GBM and LAT light curves shows that the high-energy GeV emission peaks later and lasts longer than the MeV emission typically associated with GRBs.

GRB Science with the LAT

The Large Area Telescope (LAT) detects the brightest, most energetic GRBs: ~15 per year with spectral coverage from 20 MeV – 300 GeV. Together with the GBM, these observations are triggering follow-up observations in other wavelengths and stimulating theoretical ideas to explain prompt and afterglow emission.

LAT-detected bursts are not only exceptionally energetic, but they also have bright broadband afterglows and ultra-relativistic jets. The brightest of the LAT-detected bursts show several interesting new features. These include the detection of:

A short delay between the GBM detection and the onset of LAT-detected emission.

Multiple spectral components, including a power-law component that extends from 8 keV to >10 GeV energies.

Long-duration emission seen at energies > 100 MeV. This may be related to the broadband afterglow that has been observed from the radio to the X-ray for many hundreds of GRBs by Swift and other ground and space based telescopes.

Fermi Gamma-ray Space Telescope

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.