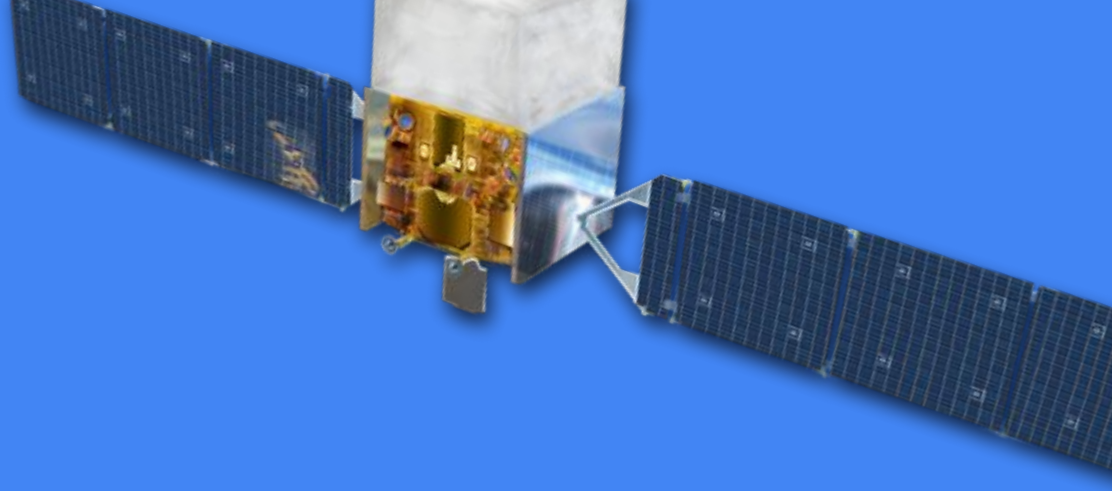
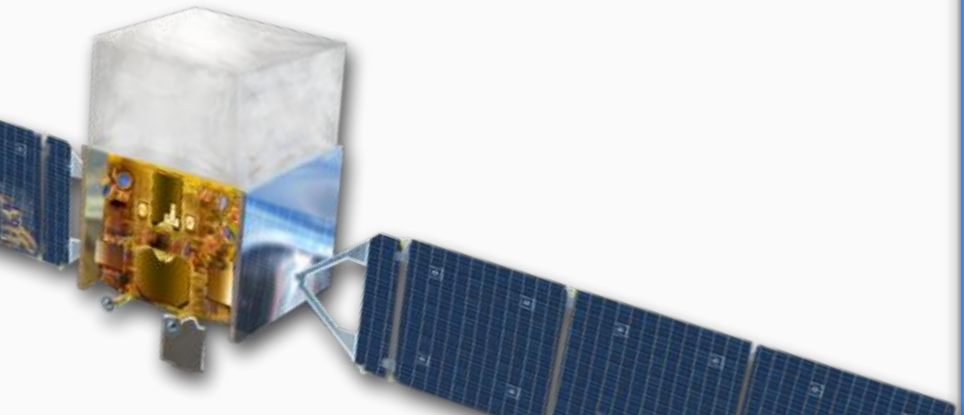


LAT Status

Jeremy S Perkins (NASA/GSFC)
Fermi User Group Meeting F2F, August 17, 2016

Overview



Overall Message

The collaboration continues to release products to the community.

Overview

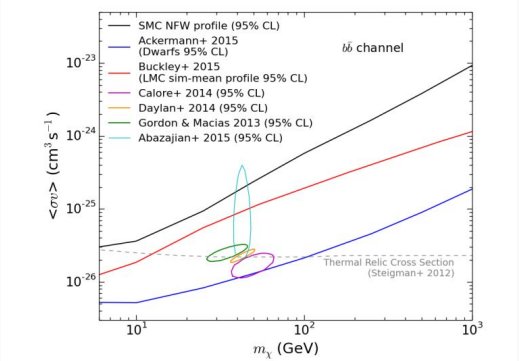
- Science Highlights
- Future Projects/Analysis Status

Looking Forward

Expect new products coming out from the LAT team and directly released or released via the FSSC. These include new catalogs, new software, and new alerts.

Science Highlights

Search for DM via Annihilation in the SMC



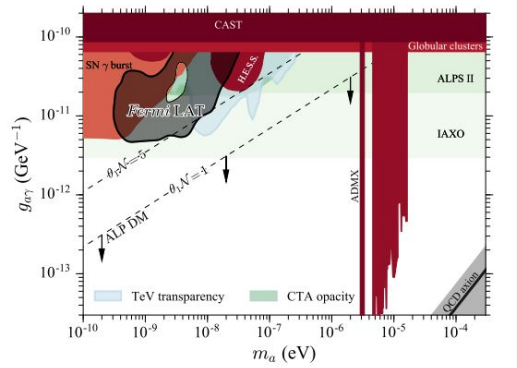
Editor's Suggestion, PRD **93**, 062004 (2016)

See the DM White Paper

Incredible effort by a large group of people. *JPhysRep* ***05****, 001 (2016)*

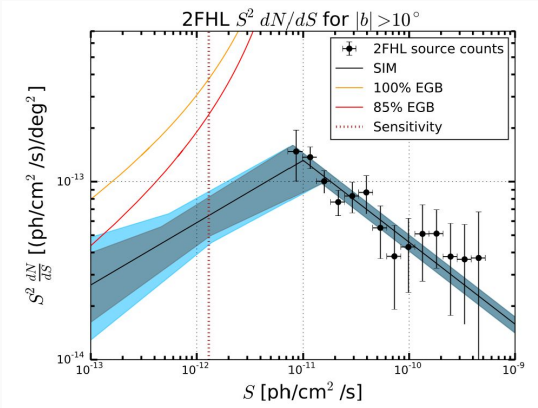
Expanding our Search for Dark Matter
http://go.usa.gov/xDrq3

Search for DM via Axionlike-Particles



Editor's Suggestion, PRL **116**, 161101 (2016)

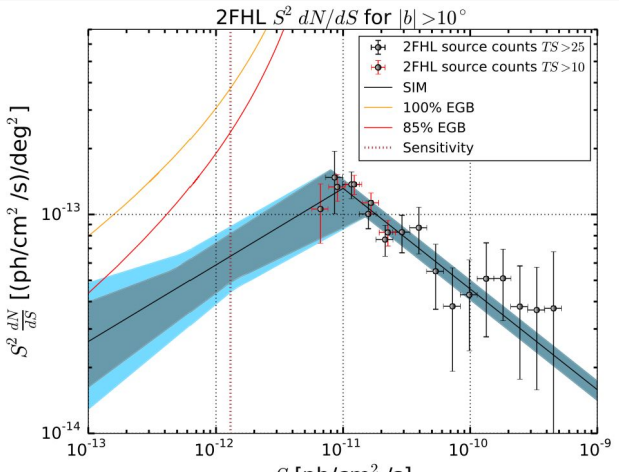
Resolving the EGB Above 50 GeV

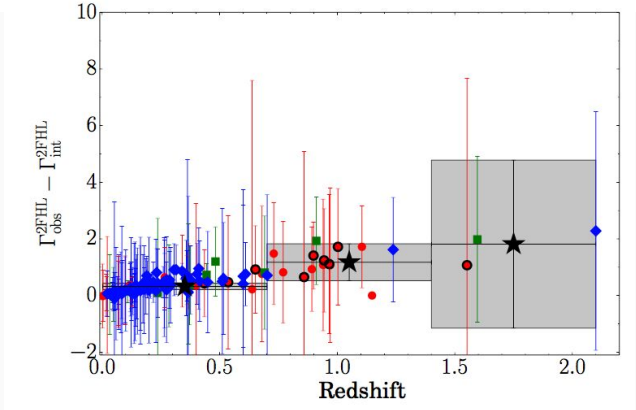


Featured in Physics & Editor's Suggestion, PRL **116**, 151105 (2016)

Highlight: Second Hard Source Catalog (2FHL) Continues to Produce

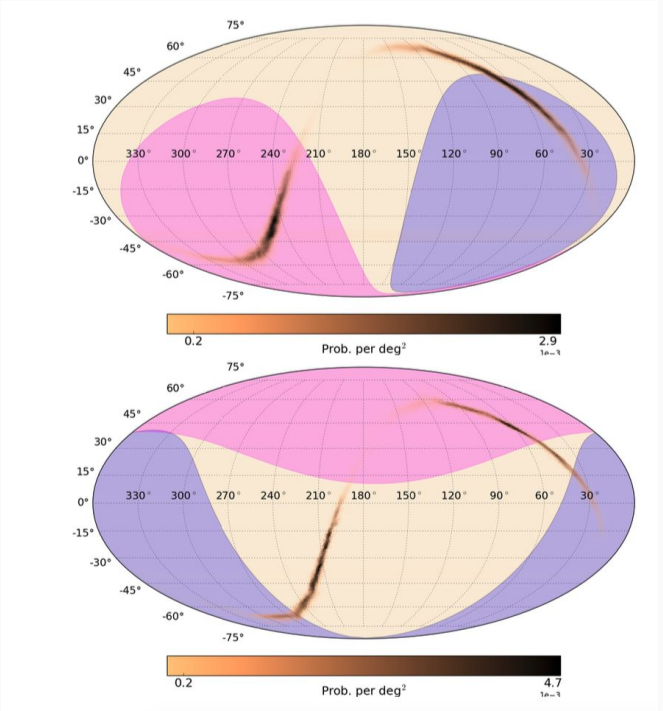
- The 2FHL is a catalog of sources developed using 80 months of Pass 8 data between 50 GeV and 2 TeV. Contains 360 sources.
- Many follow-on studies:
  - Spectral Analysis: ApJ 813, 34 (2016)
  - LogN-LogS: PRL, 116, 151105 (2016)
- More coming
  - Extended hard sources (see dedicated slide later).
  - 3FHL (see dedicated slide later).





Highlight: Fermi-LAT Observations of Gravitational Wave Events

- We are now in the era of gravitational wave (GW) astronomy and Fermi-LAT is one of the best instruments for searching for EM.
  - Large FoV, immense energy range, survey mode
- Under the Fermi-LAT, LIGO, and VIRGO MOU we were able to access information about LIGO and VIRGO events prior to public release.
  - Data Sharing and confidentiality.
- Performed searches on three events.
  - Automated and offline on various timescales
  - No signals seen; upper limits reported
- Corollary: Developing tools to do blind searches for transients. Applications are numerous and will enable science inside out outside the team.



Highlight: Other Highlights

Fornax A

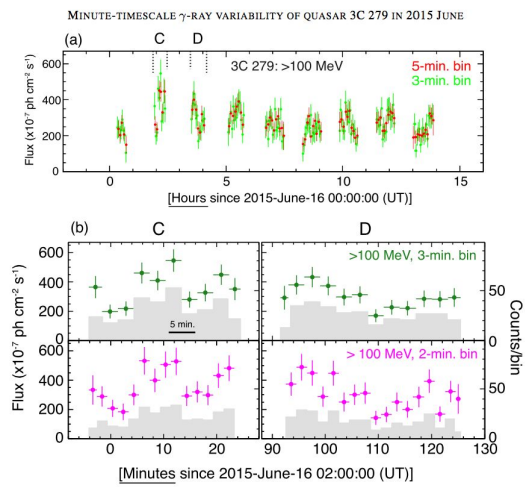
Second extragalactic extended object (after Cen A). Extension measurement enabled by Pass 8: *ApJ, accepted*

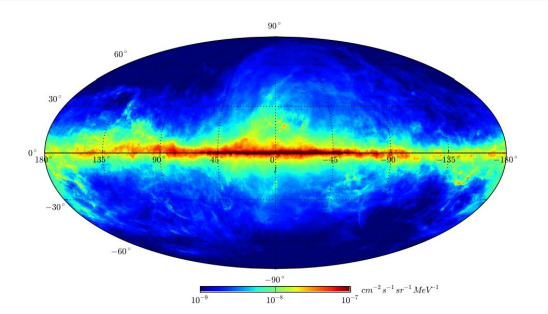
3C 279

Giant outburst from this flat spectrum radio quasar on 2015 June 6. Flux doubling times less than 5 minutes: *ApJL, accepted*

LAT Diffuse Model

Definitive paper on the Galactic diffuse model used in almost all standard point-source analysis of LAT data: *ApJS, 223, 26 (2016)*





LAT Team Products: What’s Coming

What does the team produce (and why should you care)?

New Data Products (like Pass 8)

The data reconstruction, selections, and processing is done by the LAT team.

New Software

We provide new tools, features and bug fixes.

High Level Products

For example: Light curves, gcn alerts, astronomical telegrams and flare alerts.

Catalogs

Not only needed for standard analysis but open up new avenues for research.

New Diffuse Models

These are needed for standard analysis and for generating our catalogs.

IRFs

Necessary for understanding the instrument.

Flare Advocates: A Service to the Community

The FA group is a small sub-group within the LAT team **dedicated to searching for transient and flaring sources**. Their goal is to get the information out to the community as fast as possible to **facilitate multiwavelength follow-up.**

In the past year they've reported on new gamma-ray sources like flaring blazars not previously detected and novae.

They also monitor peculiar, gamma-ray variable objects like the Crab, Cygnus X-3, and Recurrent Novae.

This group also works hard to promptly trigger *Swift* ToO to associate flares.

Flare Advocates: New Features

Searches for high-energy (>10 GeV) photon clusters in two categories:

- Consistent with known cataloged sources (already working, see Atel 9010 and follow-up by the TeV community).
- Not Consistent with known sources - new candidates (coming soon).

Looking for changes in spectral shapes (particularly hardening of blazars, mainly FSRQ). See Atel 8740 for an example.

- This is a way to catch high-redshift blazars in interesting states.

We are in constant communication with our MWL partners (and the community at large) via the *Fermi*-MWL and -VHE mailing lists.

The FA in the Multi-messenger Era.

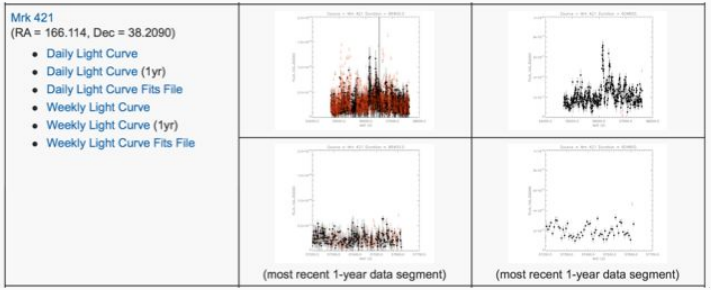
Since Oct. 2015, the FOT started downlinking data more frequently which enables fast response to external triggers.

We've started follow-up of IceCube neutrino detections:

- Preliminary reports are promptly available (see Atel 9303)

Already mentioned our follow-up of GW detections.

- Currently these results distributed to the LV-MoU list but they are public when the GW notice is public.



We continue to produce products like light curves and try and make these more useful to the community.

Update: The Fourth Fermi-LAT Source Catalog (4FGL)

7 years of Pass 8 data, energy range from 50 MeV to 1 TeV, utilize the new features of Pass 8

Other Advances

Weighted logLikelihood, energy dispersion, energy dependent zenith angle cuts, new extended sources, pulsar spectral handling, new Sun/Moon Templates.

Timeline

Driven by the availability of the diffuse model; there will be a 6 month clock that starts as soon as the diffuse model is ready (but there is interplay in the diffuse model generation and the catalog production). An additional 3 months is needed to draft the paper.

LAT Diffuse Model

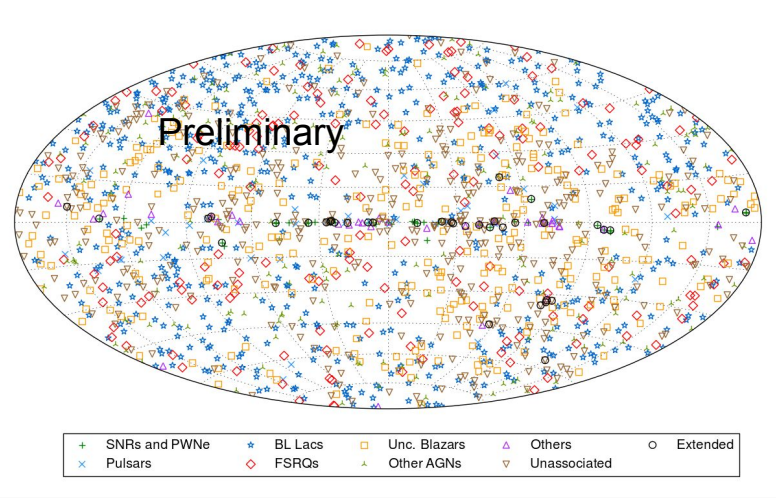
Need an improved model that extends to lower energies and better describes the diffuse emission (such as new gas maps). The schedule is mainly driven by the availability of personnel.

Third LAT Catalog of High Energy Sources

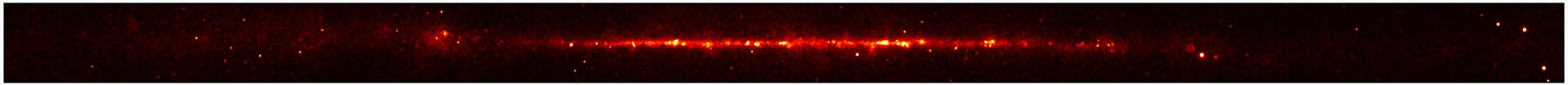
7 Years of Pass 8 above 10 GeV

- Directly comparable to the 1FHL (same energy range).
- 514 sources in 1FHL and 1720 in the 3FHL.
- 75% extragalactic (lots of AGN).
- Different population than the 2FHL/3FGL.
- Clear signs of EBL attenuation at z~2.

358 new sources (not in 1FHL/2FHL/3FGL/TevCat)



New Projects: Other Highlights (not less important, just don't have time…)

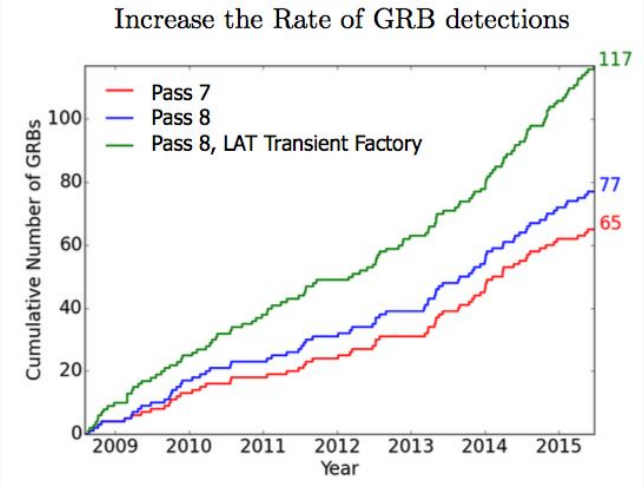


Extended Sources above 10 GeV

2FHL work prompted a search for hard extended sources. More than 30 sources.

Second LAT GRB Catalog

The second LAT GRB Catalog effort is now underway. Due to Pass 8 and other analysis improvements the rate of LAT GRB detections has increased by >50%.



Solar Flare Catalog

Light curves and SED for all flares covering the majority of the 24th solar cycle (~40). 4x larger than the number detected prior to the LAT (since the 1980s).

Science Tools Improvements

Upcoming Science Tools Improvements:

Developed by LAT Team Members and will be part of an upcoming release.

- New Models - SpatialDisk and SpatialGaussian
- Bug Fixes - □□□□□□□□□
- Minor Improvements - ✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓

Upcoming New Tools: FitScanner, gttscube, and gthealcube

These are tools that perform fast scans of adding a single test source to an existing model of a region and calculate the Test Statistic.

- Results are the same as gtlike (with assumptions; fits normalization in energy bins)
- This is **very fast**. gttscube scanning over an 8°x8° region at 0.1° resolution takes < 2 minutes!
- Output allows you to:
  - Find new sources
  - Localize them
  - Fit their spectra
  - Derive upper limits for various directions
  - Stack locations, even using different spectral forms or normalizations

Also see: **fermipy,** a python package that facilitates LAT analysis (http://fermipy.readthedocs.io)

Summary

1. Our current products are still being produced.
2. Updates soon: science tools, catalogs.
3. Very open to suggestions and comments.