Discovery of a GeV blazar shining through the galactic plane

SCINEGHE 2010 • Trieste • September 2010

The galactic plane in gamma-rays
Gamma-ray flares in the plane

- Gamma-ray emission in the plane very stable
- Periodic flux variations from pulsars and x-ray binaries
- Flares from known Galactic sources only from x-ray binaries Cyg X-3 (Abdo et al. 2009) and Cyg X-1 (Sabatini et al. 2010)
- 6 reported flares in the galactic plane in first 24 months of Fermi operation
- EGRET detection of GRO 1838-04 hints to unknown flaring source class
Detection of blazar J0109+6134

ASP detection on 1\textsuperscript{st} February, first of 9 ATels

Fermi LAT detection of a flaring, new GeV source near the Galactic plane: J0109+6134

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Distributed as an Instant Email Notice (Request for Observations)
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The Large Area Telescope (LAT), one of the two instruments on the Fermi Gamma-ray Space Telescope, has observed an increasing gamma-ray flux from a source ~1 degree from the Galactic plane. Preliminary analysis indicates that, over the two-week period ending February 1, 2010, the source had a gamma-ray flux of \((0.5^{+0.6}_{-0.5}) \times 10^{-6}\) photons \(\text{cm}^{-2}\) \(\text{s}^{-1}\), with a photon index of 2.4 \(+0.1\). The preliminary flux estimate for the one-day period February 1, 2010 UTC is \((0.8^{+0.3}_{-0.3}) \times 10^{-6}\) photons \(\text{cm}^{-2}\) \(\text{s}^{-1}\), with a photon index of 2.2 \(+0.2\). Fluxes are above 100 MeV. Uncertainties are statistical only. The position estimate from the two-week analysis is \(\text{RA} = 17.459\) deg, \(\text{Dec} = 61.568\) deg (L = 125.121 deg, B = -1.226 deg), with a 95\% error circle radius of 0.088 deg. Several possible counterparts lie within the error circle. In particular, the radio source VCS2 J0109+6133 (RA = 01 09 46.34439, Dec: +61 33 30.4557, J2000, Fomalont, E. B. et al., 2003, AJ, 126:2562-2566) is 0.012 deg from the best fit position estimate. This is a new GeV source: the nearest source in the first-year Fermi LAT catalog (http://fermi.gsfc.nasa.gov/ssc/data/access/lat/lyr_catalog/) is IFGL J0131.2+6121, an unassociated source 2.57 deg offset from the flaring source. Multi-wavelength observations are requested to identify the source and in particular to determine whether it is Galactic or extragalactic. Because Fermi operates in an all-sky scanning mode, regular gamma-ray monitoring of this source will continue. For this source the Fermi LAT contact person is J. Vandenbroucke (justin@stanford.edu). The Fermi LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.
LAT results

Not detected in 10 months Aug 4 2008 – May 30 2009 (TS=3)

Detected significantly in 9 months May 30 2009 – Feb 23 2010:

- Flux = $(0.93 \pm 0.05) \times 10^{-7} \text{ cm}^2/\text{s}$ above 200 MeV
- TS = 639
- Photon index = $2.59 \pm 0.06$
- $l = 125.138^\circ$, $b = -1.243^\circ$
- Error circle $0.03^\circ$ radius (68%)

Not seen in 3EG or EGR or 1FGL
Nearest 1FGL $2.55^\circ$ away, unass.
Chandra position confirmed the IPHAS optical candidate

Image: Chandra counts
White arc: LAT error circle
Green circle: Paredes et al. optical
Black +: radio
Red circle: IPHAS optical
Blue circle: Chandra error circle
Gamma-ray and X-ray light curves

Gamma-ray:
- ~month variability
- 2 sub-flares
- no variation in photon index

X-ray:
- no sig. variation in ~3 weeks Feb. 2010

Increase by factor $\geq 30$
Keck spectrum and redshift

J0109+6134
z=0.783

S/N too low to estimate equivalent width

Equivalent width > 5 Å
Spectral energy distribution

Fit 3rd degree polynomial to each bump:
- Synchrotron peak $\sim 10^{13}$ Hz
- Compton peak $\sim 10^{22}$ Hz

$\Gamma_x = 1.2$

$\Gamma_{\gamma} = 2.6$
Position in distributions of SED paper

Low synchrotron preak FSRQ
Conclusions and Outlook

Detection of new gamma-ray source at $b = -1.2$ deg:

- X-ray, radio and optical counterparts identified
- Redshift 0.78 and SED Blazar $\rightarrow$ shining through the plane
- Example for this scenario and for MW effort to get association


Led to additional effort of systematically studying flux variation:
  $\rightarrow$ Several further blazar candidates in the plane identified
  $\rightarrow$ Expect further results soon..
Backups
Large-scale radio morphology: 1.5 GHz VLA
(from Albert Zijlstra)

~10 arcsec = ~100 kpc
Small-scale radio morphology: 8.6 GHz VCS2 VLBI

~4 mas = ~30 pc
EGRET flare GRO 1838-04

- 3.5 days long flare at 5.9 sigma, with peak flux of $(4 \pm 1) \times 10^{-6} \text{ cm}^{-2} \text{ s}^{-1}$ above 100 MeV

- No blazar counterpart found, new source class?

Tavani et al. 1997
Unidentified Fermi transients

- >10σ detection
- X-ray and flat spectrum radio sources within radius → possibly blazars
- J1057-6027 has no radio counterpart, but is only ~5σ detection

See E. Hays HEAD meeting poster