Prospects for Observations of Microquasars with GLAST LAT

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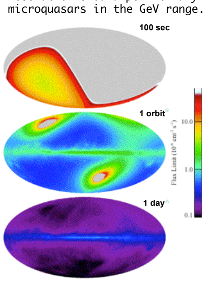
Abstract

The Gamma-ray Large Area Space Telescope (GLAST) is a next generation high energy gamma-ray observatory due for launch in Fall 2007. The primary instrument is the Large Area Telescope (LAT), which will measure gamma-ray flux and spectra from 20 MeV to > 300 GeV and is a successor to the highly successful EGRET experiment on CGRO. The LAT will have better angular resolution, greater effective area, wider field of view and broader energy coverage than any previous experiment in this energy range. This poster will present performance estimates with particular emphasis on how these apply to studies of microquasars. The LAT's scanning mode will provide unprecedented uniformity of sky coverage and permit measurements of light curves for any source. We will show results from recent detailed simulations that illustrate the potential of the LAT to observe microquasar variability and spectra, including source sensitivity and ability to detect orbital modulation.briefly.

GLAST Overview

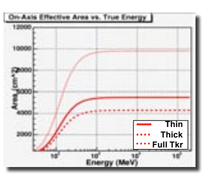
In normal operations the LAT will continually scan the sky, obtaining essentially complete sky coverage every 3 hours (two orbits). This uniformity of sky coverage together with the large effective area and good angular resolution should permit many advances in the study of microquasars in the GeV range.



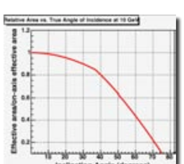
With 2.4 str FOV plus rocking, GLAST will see the entire sky daily at the 10^{-7} sensitivity level in survey mode

LAT Performance

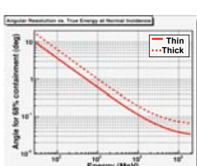
Energy Resolution: ~10% (~5% off-axis)
PSF (68%) at 100 MeV ~ 3.5° front; 5° total
PSF (68%) at 10 GeV ~ 0.1°
Field Of View: 2.4 sr
Point Source sens. (>100 MeV): 3×10^{-9} cm^{-2} s^{-1}



Good effective area essential for sensitivity to flares and faint sources



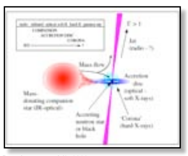
Wide FOV essential for survey mode and continuous monitoring of the full sky - and all microquasar candidates



Leverage better PSF at higher energies to better determine source location while reducing diffuse background

http://www-glast.slac.stanford.edu/software/IS/glast_lat_performance.htm

Microquasars and GLAST



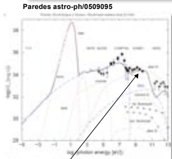
Standard picture of Microquasars

X-ray binary with relativistic jets
Thought to be small scale analogues of quasars

18 candidates in the Milky Way

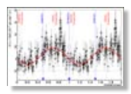
HESS and MAGIC have seen variability on the orbital timescale. There is expected to be a connection between variability in the relativistic jet and the accretion disk cycle.

Paredes astro-ph/0509095

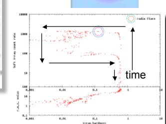


Improve and extend EGRET measurements

Example of High Energy variation during orbit



LS5039: HESS astro-ph/0607192 E > 200 GeV



Radio flare seems to signal trigger of relativistic jet

GX 339-4 data from Homan & Belloni (2006)

Microquasar Simulations

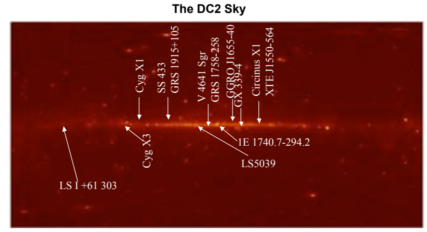
GLAST's Data Challenge 2 (DC2) provided a detailed simulation of the sky and the LAT's response. 5 x-ray binaries were included with flux and spectra from EGRET measurements and known orbital periods.

- **55 day simulated orbit**
- **full GEANT4 simulation of LAT response**
- **Full time dependence in simulations: AGN, solar flares, GRBs**
- **~ 200k CPU hrs to produce**

Source	l (deg)	b (deg)	Flux > 10 MeV cm^{-2}s^{-1}	Γ	Period	Comment
LSI +61 303	135.7	1.09	9.3 10^{-6}	2.21	26.5d	Gregory (2002, ApJ, 575, 427) for period and phase
AO535	181.5	-2.64	2.5 10^{-6}	2.6	111d	Flux, variability (40%) and spectral index (2.6) as suggested by Diego Torres. Period (111 d) from Maisack et al. (1993, A&AS, 120, 179)
CenX3	292.1	0.34	8.0 10^{-6}	1.8	Flare	Vestrand et al. (1997, ApJ, 483, L49)
LS5039	16.9	-1.29	4.6 10^{-6}	2.19	3.91d	Boettcher & Dermer (2005, ApJ, 634, L81)
GRS 1915	45.4	-0.22	1.72 10^{-6}	1.85	Flare	Atoyan & Aharonian (1997, astro-ph/9706061)

Very simple modeling of microquasars in this exercise:
- **Simple power law**
- **Complete orbital modulation**

The DC2 Sky



Milky Way itself (1)	1,704,807
Pulsars (414)	140,596
Plerions (7)	9780
SNR (11)	22,592
XRB (5)	9000
OB associations (4)	295
Small molecular clouds (40)	1741
Dark matter (~2)	5158
'Other 3EG' (120)	112,386
Sun (1 flare)	4669
Moon (1)	10,523

3,340,146 total in full sky

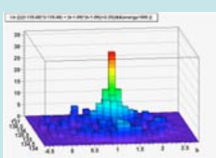
Composition of the Milky Way:
~ 1/2 of total generated photons on the sky

Feasibility Analysis of LS I +61 303 and LS 5039

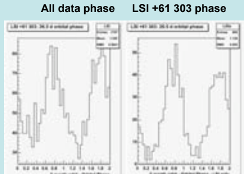
LS I +61 303 in 55 days

E> 500 MeV

Fit to double gaussian + flat bkg:
(l,b) = (135.7±0.02,1.09 ± 0.01)



All data phase **LSI +61 303 phase**

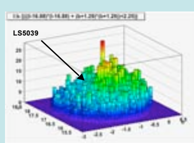


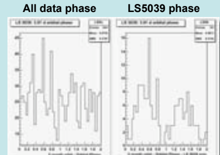
E> 100 MeV
Orbital phase for assumed period

Spectral index fit yields Γ=2.21

LS 5039 in 55 days

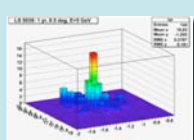
All data phase **LS5039 phase**





Too difficult to do anything in 55 days!
Dominated by galactic diffuse - 1:15 LS5039:diffuse

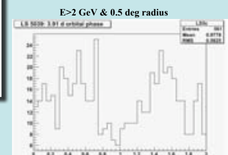
LS 5039 in one year



E>5 GeV & 0.5 deg radius

Fit to double gaussian + flat bkg:
(l,b) = (16.90±0.05,-1.32 ± 0.02)

E>2 GeV & 0.5 deg radius



Summary:

- **Preliminary feasibility analysis!**
- **GLAST will leverage survey mode to provide continuous monitoring of all microquasars**
  - **complicated regions will take longer observing periods**
- **Will exploit better PSF at higher energies to refine locations**

Still to be done:

- **Study localization of microquasar candidates using the likelihood analysis tools and Galactic diffuse emission models being developed for LAT data analysis**
  - **pursue detection ability in complicated regions**
- **monitor all known microquasar candidates, leveraging survey mode**
- **develop blind search tools for cases where orbital period is not known**