Comprehensive LAT paper

Peter Michelson (March 17 e-mail):

Dear Colleagues,

The LAT Collaboration is committed to producing a comprehensive paper on the LAT instrument and the LAT science program before launch; ie., before September 8, 2007. The plan below is to submit the paper to the Astrophysical Journal at the end of September 2006. It will be one of three papers submitted that are associated with the GLAST Mission. The other papers are an instrument/science paper on the GBM and an overview paper about the GLAST mission.

A preliminary outline is also included below.

Schedule for paper:

First draft to science group coordinators: April 6, 2006

Preliminary plans from each science group for figures, plots, proposed to be included in paper (section 4 of outline): April 15, 2006

LAT science group plans for figures, plots proposed to be included in paper: May 1, 2006

First draft of figures and text from science groups: July 1, 2006

Second draft of paper incorporating inputs from science groups: August 1, 2006

Discussion of paper at LAT Collaboration Meeting: end of August 2006

Final draft of paper: September 15, 2006

Submission of paper: September 30, 2006 (goal: acceptance before 1st GLAST International Symposium in February 2007

Nominal scope of contributions from each science analysis group:

The objective should be to summarize the impact of LAT observations on key science questions in each area. This should be done with about 1 page of text (word format, double-spaced) and one to three figures (at most). The groups should also note any tables they propose to include.

LAT paper

The *Large Area Telescope* on the *Gamma-ray Large Area Space Telescope (GLAST)* Mission
Authors: Category 1 paper
OUTLINE
Abstract
1. Introduction
    GLAST Mission summary
    Summary of paper
2. Summary of Key Science Objectives
    2.1 Understand the Mechanisms of Particle Acceleration in AGN, Pulsars, and SNRs
    2.2 Resolve the Gamma-Ray Sky: Unidentified Sources and Diffuse Emissions
    2.3 Determine the High Energy Behavior of Gamma-Ray Bursts and Transients
    2.4 Probe Dark Matter and the Early Universe
3. Large Area Telescope
    3.1 Technical Description
    3.2 Instrument Operations
    3.3 Instrument Modeling
    3.4 Background Rejection
    3.5 Telescope Performance
    3.6 LAT Data Processing and Data Products
        .1 Transient Alerts
        .2 Source Monitoring
        .3 Catalog
        .4 Diffuse Model
        .5 Level-1 Data
(Note: many of the figures and plots in this section will be generated by the Instrument Analysis Methods science group.)
4. Science
Short summary and plot(s) from each science analysis group, e.g. catalog, diffuse, blazars, pulsars and SNRs, unidentified sources, dark matter and new physics, solar, GRBs, other galaxies;
    Importance of multiwavelength observations
5. Summary

Blazar topics + LAT assets (discussed last week)

1) Population studies, BL Lac, FSRQs estimates
Contribution of AGNs to Extragalactic background
Detection of Radio-galaxies
Assets: Sensitivity, uniform exposure

2) Specific issues regarding blazars (« science goals »)
with a few examples illustrating the foreseen approach

- WHAT is the structure (ingredients/content) of the jet in blazars and radio galaxies?

(a) the content of innermost part of the jet (e+-, baryon load, poynting flux)
(b) composition of gamma ray emitting part of jet (e+-, pe or UHECRs, magnetic field)

- HOW are the X-/gamma-ray flares produced in blazars and radio galaxies?

(a) importance of external photon fields (BLR, accretion disk, torus, CMB, ...) for X- & gamma-ray production
(b) relation between flares to dissipation of magnetic energy

- WHERE are the X-rays/gamma-rays produced ?

Assets: Time scales that can be probed in single-band/broad-band variability studies, continuous monitoring (survey mode).

3) EBL
Assets: Energy range extending to few 10 GeV enabling good determination of the IC peak, "many" high-redshift blazars in the sample

Current draft

2.2.1 *Blazar AGN Jets*

With its detection of more than 60 AGN, almost all blazars (Hartman 1999), EGRET has strengthened the unified model of AGN as supermassive black holes with accretion disks and jets. Extrapolation of the EGRET Log*N*-Log*S* curve, shown in *Figure 2.6*, using values from Stecker & Salamon (1996) indicates that the LAT will detect ~10,000 AGN in two years. This is more than the number of currently identified blazars. Population studies with this large sample will allow tests of the unified AGN model, studies of jet formation and evolution with redshift, and studies of jet properties with AGN type and orientation. The likely EGRET detection of Cen A (Sreekumar 1999) suggests that other classes of AGN may be detectable. With the LAT's sensitivity and broad energy coverage, quiescent emission and spectral transitions to flaring states can be measured. *Figure 2.7* shows how well the LAT will measure AGN spectra. $\gamma\gamma$ transparency calculations can constrain the bulk Lorentz factors of the outflowing plasma and the location of the acceleration and radiation sites in the inner jet. For many sources, localizations provided by the LAT will permit high-confidence associations with X-ray, optical and radio counterparts for multiwavelength studies. Magnetic field strength can be estimated from combined X-ray and gamma-ray observations (Catanese 1997). The LAT's wide FOV will allow AGN variability to be monitored on time scales from minutes to years. Flares as bright as that observed by EGRET from 3C 279 (Kniffen 1993) will be measurable with a 2-minute resolution (*see Figure 2.8*).

Current figures (1)

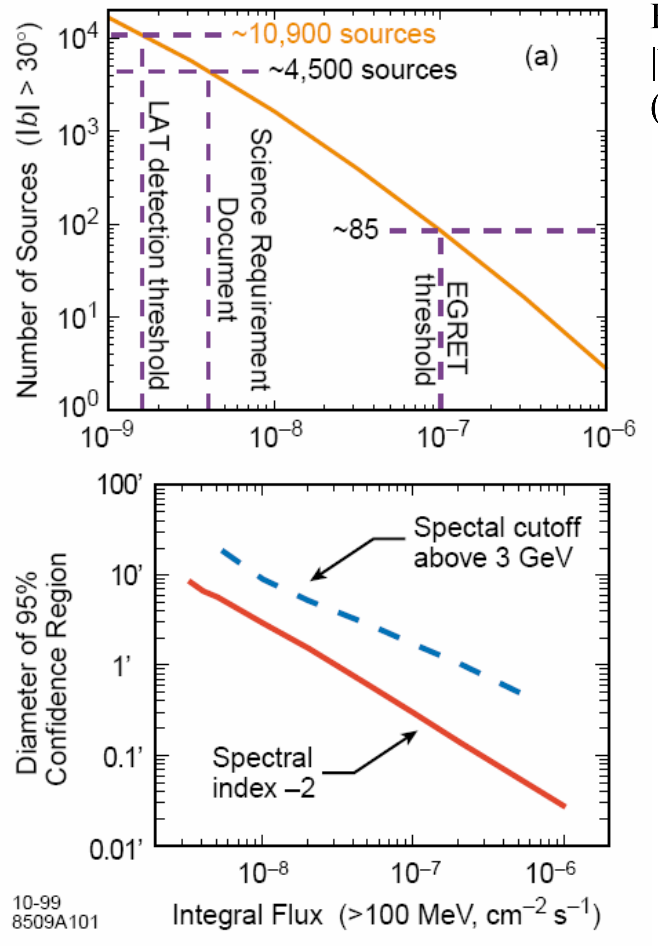


Figure 2.6: (a) The expected number of AGN detected with LAT at |b|> 30° and, (b) one year, all sky-survey source localization capability. (Note: s/c systematics will limit capability to ≥ .3′).

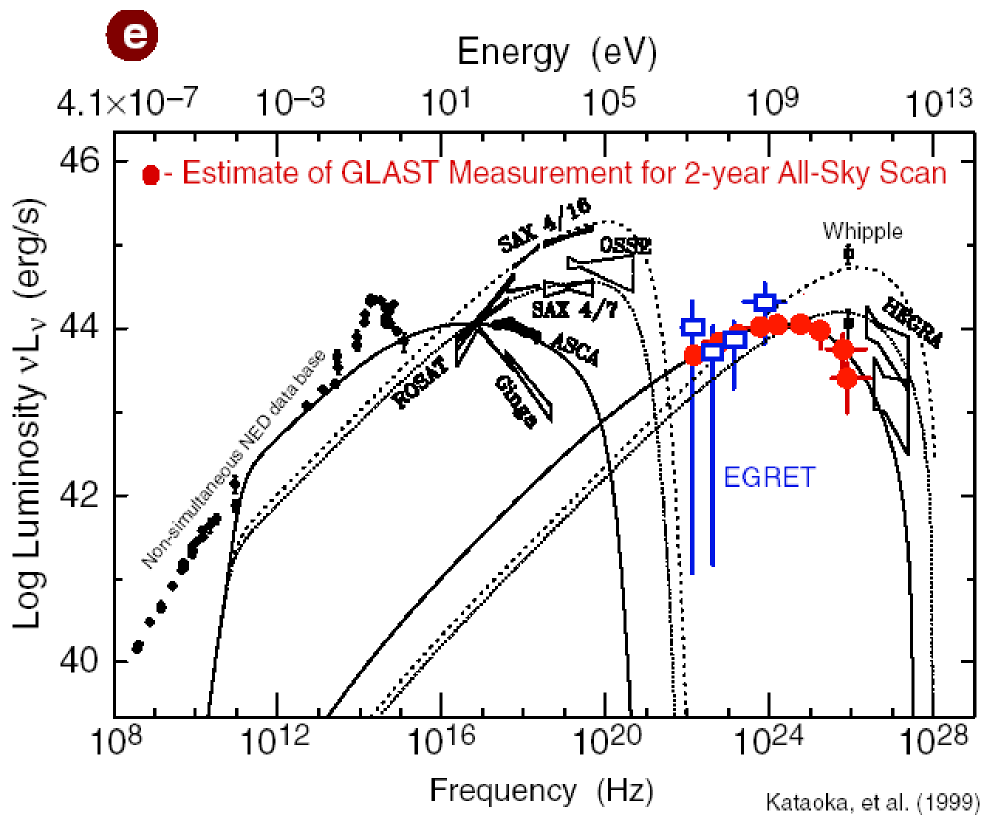
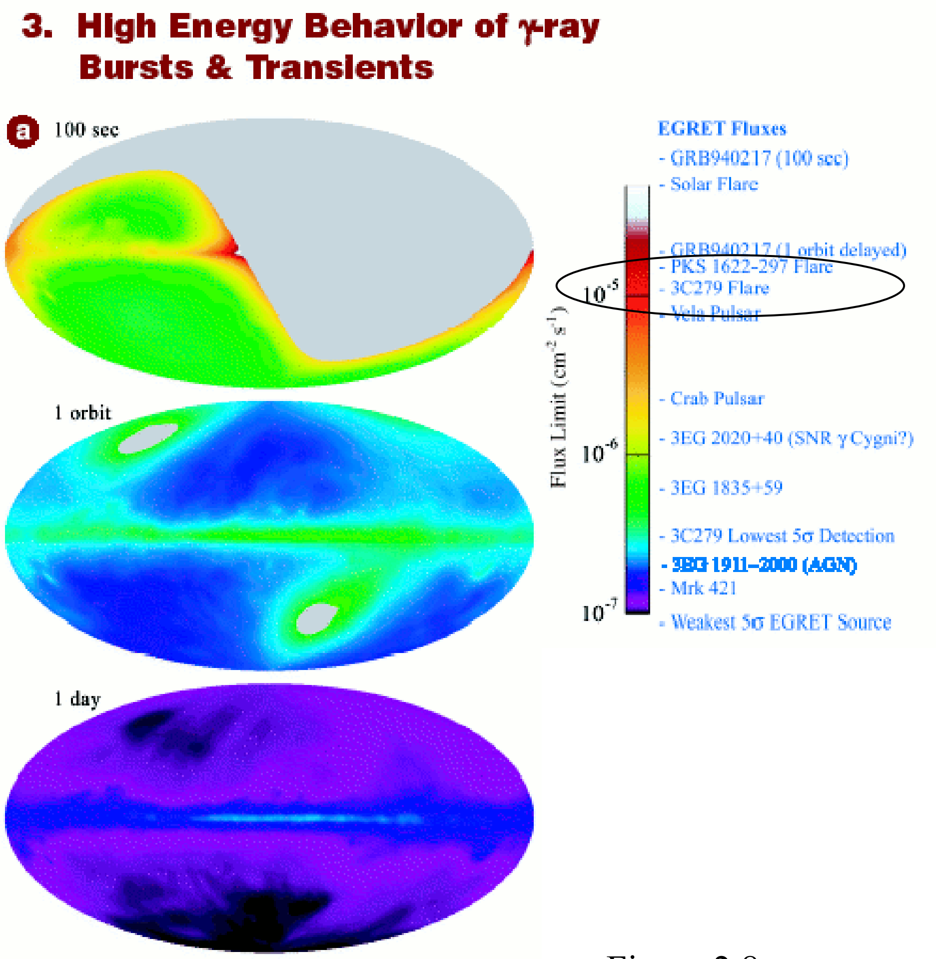


Figure 2.7: Estimated LAT measurement of AGN spectra.

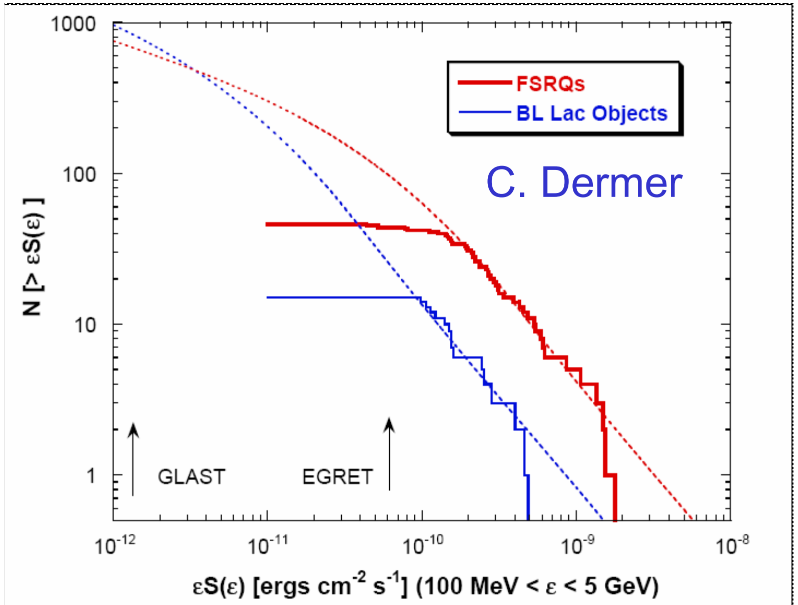
Current figures (2)



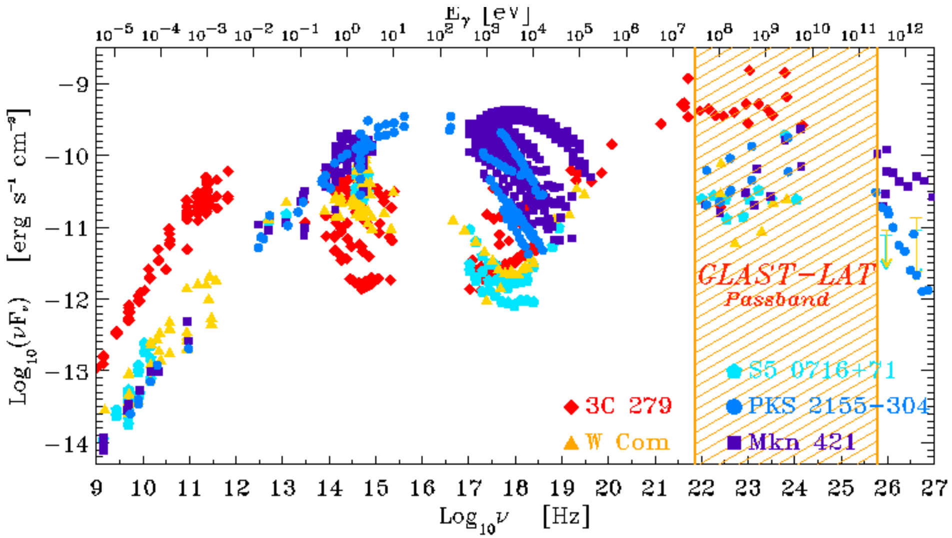
(a) In scanning mode LAT will achieve after one day a sensitivity sufficient to detect (5σ) the weakest EGRET sources.

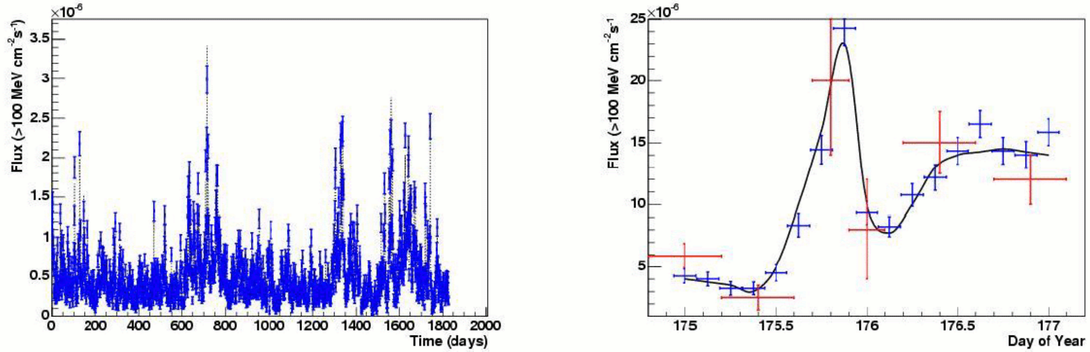
Figure 2.8

New figures (examples)



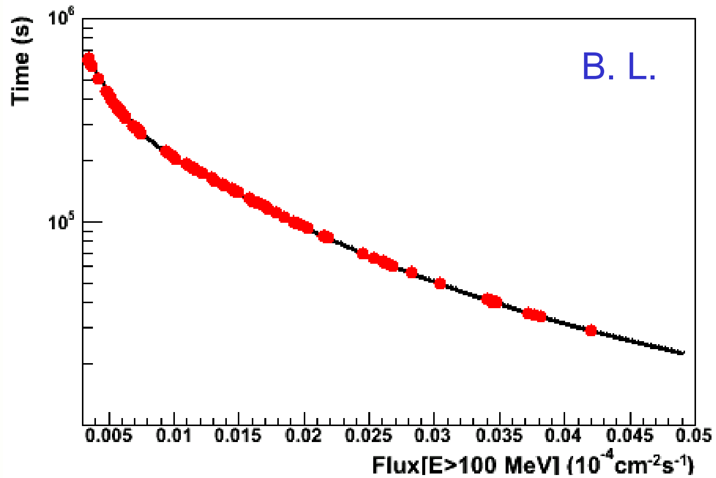
S. Ciprini





J. McEnery

Figure 4. (a) the left hand plot shows a 5 year LAT observation of a simulated lightcurve, (b) the right hand plot shows EGRET (open red circles) and simulated LAT (solid blue squares) observations of an intraday flare seen in 1995 from PKS 1622-297



Current draft

2.5 *Use high-energy gamma-rays to probe the early universe to $z \geq 6$*

Photons above 10 GeV can probe the era of galaxy formation through absorption by near UV, optical, and near IR extragalactic background light (EBL). The latter depends sensitively on star formation rates and the presence of dust (Stecker 1992; Madau & Phinney 1996; MacMinn & Primack 1996). Too few sources have been detected so far to separate intrinsic turnovers from EBL absorption effects.

With as many as 10^4 AGN detectable up to $z \geq 6$ (Figure 2.1), the LAT data will yield conclusive results (Salamon & Stecker 1998, Chen & Ritz 1999). Spectra to more than 50 GeV can be determined for several hundred sources. The ratio of integrated flux above 10 GeV to that above 1 GeV as a function of redshift is shown in Figure 2.11 for one EBL absorption model (Stecker 1999). The large number of detected blazars over a broad energy range will provide the data necessary to evaluate the gamma-ray optical depth as a function of redshift and energy, and will mitigate peculiar effects of individual sources.

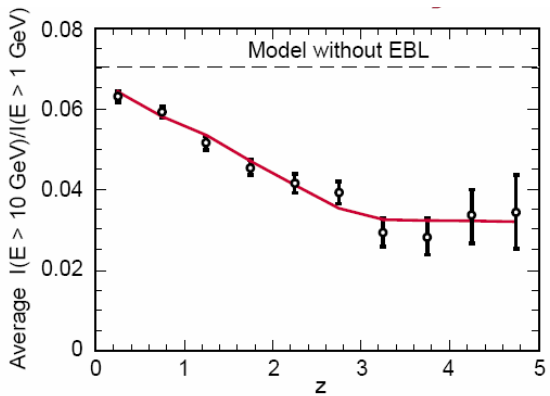


Figure 2.11: LAT probes optical-UV Extragalactic Background Light by measurement of high-energy spectral roll offs of AGN: Shown is a simulation of the ratio of integrated flux above 10 GeV to that above 1 GeV as function of redshift for the EBL absorption model of Stecker et al. (1999).