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GLAST Large Area Telescope High-Energy Multiwavelength Activities: An Invitation

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Abstract: High-energy gamma-ray sources are inherently nonthermal, multiwavelength objects. With the launch of the Gamma-ray Large Area Space Telescope (GLAST) in early 2008, the GLAST Large Area Telescope (LAT) Collaboration invites cooperative efforts from observers at all wavelengths. Among the many topics where multiwavelength studies will maximize the scientific understanding, three stand out. (1) Active Galactic Nuclei: The multiwavelength study of the parsec-scale jets of AGN can help link the accretion processes close to the black hole with the large-scale interaction of the AGN with its environment. Gamma-ray AGN are also important in measuring the effects of extragalactic background light absorption at high redshifts. (2) Unidentified Gamma-ray Sources: After new gamma-ray sources are identified with known objects by position, spectrum, or time variability, multiwavelength studies can be used to explore the astrophysical implications of high-energy radiation from these sources. (3) Pulsar Timing: Although the LAT will be capable of some blind searches for new gamma-ray pulsars, the deepest studies of these rotating neutron stars will come from having known timing solutions. The need for long LAT observations calls for timing solutions valid (at least piecewise) over years. Observers interested in providing coordinated observations should contact the authors.

The Value of Multiwavelength Studies

As can be seen in Figure 1, all known classes of high-energy gamma-ray sources are multiwavelength objects, with emission seen across much of the electromagnetic spectrum. Because astrophysical gamma rays are produced by nonthermal processes involving high-energy particles, a broad spectral range is expected. Understanding such objects is inherently a multiwavelength challenge. A full picture can only be obtained by finding all the sources of radiation.

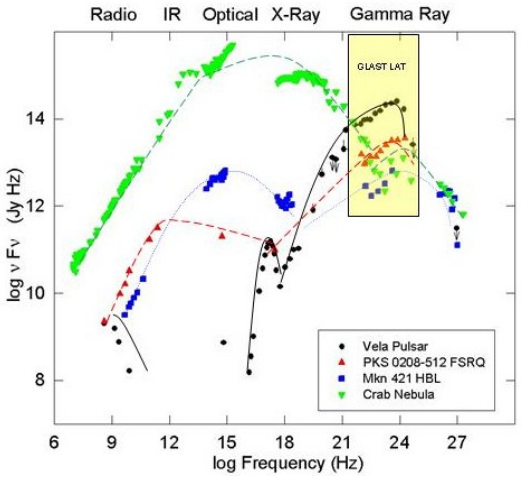

Figure 1: Broad-band spectral energy distributions of example gamma-ray sources. Lines are guides for the eye, not fits.

For gamma-ray observations, multiwavelength studies are also essential for identifying sources in the first place. With the exception of bright pulsars (recognizable by a measured period and period derivative), gamma-ray observations are unlikely to yield an identification by themselves. Finding counterparts at other wavelengths provides the critical identification information: precision source location, distance, mass and composition, and overall energetics.

LAT Team Multiwavelength Planning

Programs for known source classes

The LAT team is currently working with many observers on planning for studies of known gamma-ray source classes:

1. Pulsars. Independent timing information from radio and X-ray observations is needed, since the gamma-ray data are sparse compared to the rotation period of pulsars. Radio and X-ray proposals have been submitted, and some timing programs are underway. More information is always welcome.

2. Blazars. These bright, highly-variable sources require a wide range of planning efforts (*c.f.* [1,2]). The LAT may detect more blazars than are currently cataloged, so finding new blazars at other wavelengths is important. Example programs include CGraBS [3], a combination of radio and optical studies, and VLBA Imaging and Polarization Survey (VIPS) [4], a program using radio polarization with optical follow-up. Multiwavelength monitoring is also critical, because few patterns of variability have been found. Some example cooperative efforts include MOJAVE [5], RATAN-600, and U. Michigan in the radio, and the Global Telescope Network (GTN), Perugia, and Pan-STARRS in the optical. Finally, multiwavelength campaigns of two types are being planned. First, Target of Opportunity (ToO) campaigns are important for catching flaring sources (see [1]), and a variety of methods are under development to ensure quick communication during a ToO campaign. Second, Planned Intensive Campaigns (PIC) will mobilize the maximum number of resources by setting up preplanned observations, and several of these have been proposed by the LAT team.

3. Gamma-ray Bursts. Planning for studies of GRBs involves drawing on the many highly successful efforts already in place, including Swift, the GCN communications system, and the Interplanetary Network.

Source identification planning

The GLAST LAT team is developing Figure of Merit approaches for the statistical association of unidentified LAT sources with possible new object classes. This process involves many catalogs at various wavelengths, augmented by additional data such as spectra and variability information (*e.g.* [6]). Specific examples will be needed to confirm such associations and move beyond identification toward understanding the sources. Some possible approaches for association include (see also [7], [8]) (1) "Top-Down" approach: look for an X-ray or TeV counterpart with better source localization; (2) "Bottom-Up" approach: look for a flat-spectrum radio counterpart that might be a blazar; and (3) "Variability/Spectral Modeling" approach: look for consistency across the spectrum.

Scientific Community Involvement

In planning one's involvement in GLAST science, it is important to remember that both GLAST instruments have huge fields of view. With GLAST operating in scanning mode (the default for planning), both the GBM and the LAT will survey the entire sky about every three hours. The consequence is that whatever your favorite source is, GLAST will observe it. Involvement can be determined by the science, not the GLAST observing plan. The GBM data (bursts) become public immediately. The LAT data are not generally public during Cycle 1, but there are exceptions, and the LAT team is eager to cooperate with observers with correlative data.

Multiwavelength blazar studies

Below are some specific suggestions for anyone interested in participating in LAT blazar studies.

Pre-launch:

- Help identify new blazars.

- Join the GTN or the Whole Earth Blazar Telescope (WEBT) to monitor blazars or participate in campaigns.

- Sign up for the Gamma-ray Multiwavelength e-mail list by contacting :

David.J.Thompson@nasa.gov.

During the first year (when most LAT data are not public):

- Use the public data (light curves and spectral information) from ~20 prominent sources for your scientific analysis. Most of these sources are blazars. See http://glast.gsfc.nasa.gov/ssc/data/policy/LAT_Year_1_Data_Release.html.

- Bright blazar flare data will also be made public, along with the name of a LAT contact who will help coordinate analysis. Join us or use the data on your own. ToO proposals for other observations can be based on these announcements.

Source identification planning
Below are some specific suggestions for anyone interested in participating in LAT source identification studies.

Pre-launch:

- Model candidate gamma-ray sources to predict which ones might be observable.

- Start learning about the LAT data system through the GLAST Science Support Center.

During the first year:

- Bright flare data from unidentified sources will be made public, along with the name of a LAT contact who will help coordinate analysis. Join us or use the data on your own.

- A preliminary list of high-confidence source detections will be released in the middle of the first year. Many are likely to be unidentified, and those can become targets for correlated observations and/or modeling.

Other resources

Multiwavelength information, including a link to the LAT web page for planning, can be found at http://glast.gsfc.nasa.gov/science/multi/. Many LAT scientists are active in multiwavelength planning and would be glad to discuss plans. They include, for blazars: Jim Chiang, Stefano Ciprini, Werner Collmar, Luigi Foschini, Benoit Lott, Greg Madejski, Julie McEnery, David Paneque, Rita Sambruna, Gianpiero Tagliaferri, and Gino Tosti; for pulsars: David Smith, Steve Thorsett and Roger Romani; and for unidentified or diffuse sources: Patrizia Caraveo, Seth Digel, Stefan Funk, Isabelle Grenier, Olaf Reimer, and Kent Wood.

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