Search for transient sources on monthly time scale

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Abstract

Gamma-ray catalogs produced with data of the Large Area Telescope (LAT) on board the Fermi Gamma-ray Space Telescope typically integrate years of exposure. Since Active Galactic Nuclei (AGNs) are characterized by strong and fast variability, their emission could be diluted by long-time data integration. For this reason these sources can be more easily detected over short time scales. In order to search for these transient sources we have analyzed the first 10 years of data (as for the 4FGL-DR2 Catalog [1]) collected by the Fermi-LAT integrating over 1-month time intervals. The analysis was performed between 0.1 and 300 GeV using the Pass-8 event-level selection. In the analysis we considered only photons with Galactic latitude |b| > 10° to exclude the Galactic plane and therefore to avoid confusion with low latitude diffuse emission. We have also excluded all sources closer than 50 arcmin from any 4FGL-DR2 source. We have analyzed 120 months and also performed a 15-day shift of each month in order to not lose any flare at the edges of each time bin. The list of those transient sources will be reported in the first Fermi-LAT catalog of long-term γ-ray transient sources (1FLT catalog [2]).

Starting from this work, we have constructed a pipeline dedicated to the routine search of the transient sources on monthly time scale, complementary to the routine search on shorter time scales (day and week) done by the Fermi-LAT Flare Advocate activity and Fermi All-sky Variability Analysis (FAVA). The incremental source list will be soon available on (http://www.ssdc.asi.it/fermi1flt).

Sources

The monthly datasets were analyzed using a wavelet-based source detection algorithm [3] that provided the candidate new transient sources. After the seed extraction we performed the standard Fermi-LAT Maximum Likelihood analysis (https://fermi.gsfc.nasa.gov/ssc/data/analysis/) on all seeds that had Galactic latitude |b| > 10° (to avoid the dominance of the Galactic diffuse emission at low Galactic latitudes) and that had an angular distance greater than 50 arcmin from any 4FGL-DR2 source. All sources detected with a statistical significance above 4σ (TS>25) in at least one monthly bin were listed in the final catalog (142 sources, see Fig. 1). 72 1FLT sources are flagged as low-confidence (each individual low-confidence source has a probability of about 34% of being spurious). We looked for possible counterparts with sources in other wavelengths using Bayesian association and searching within the error ellipses of each 1FLT source with the use of SSDC Tools (https://tools.ssdc.asi.it/) and VOU-Blazar Tool [4] (http://www.openuniverse.asi.it/). About 70% of 1FLT sources and are associated with soft AGN-type counterparts, principally BCU and FSRQ. Approximately 30% of these sources remain unassociated.

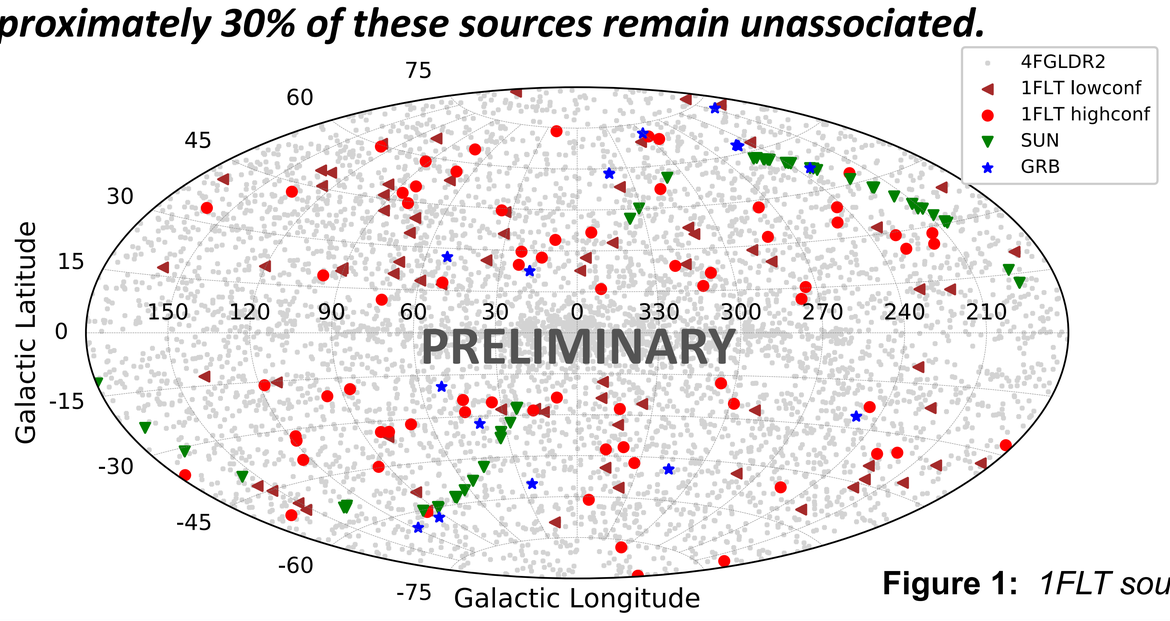

Figure 1: *1FLT sources*

Source Properties

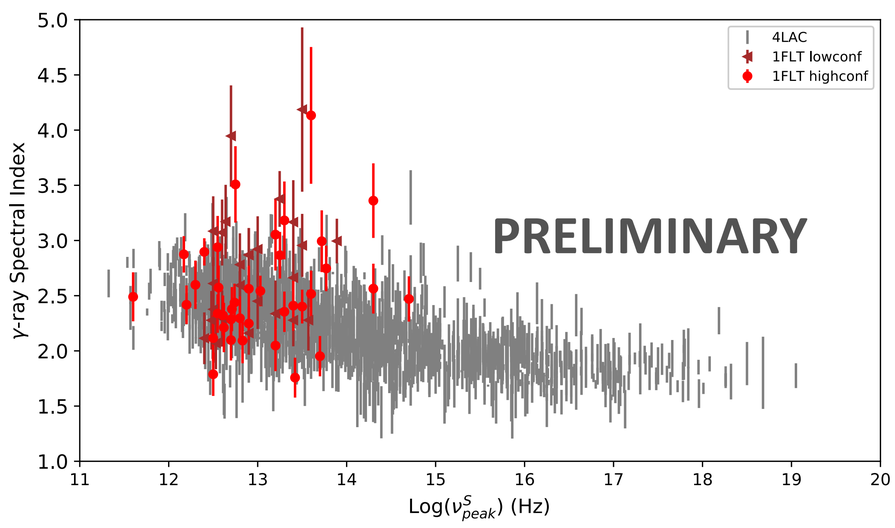

Figure 2: Power-law *index vs γ-ray luminosity*

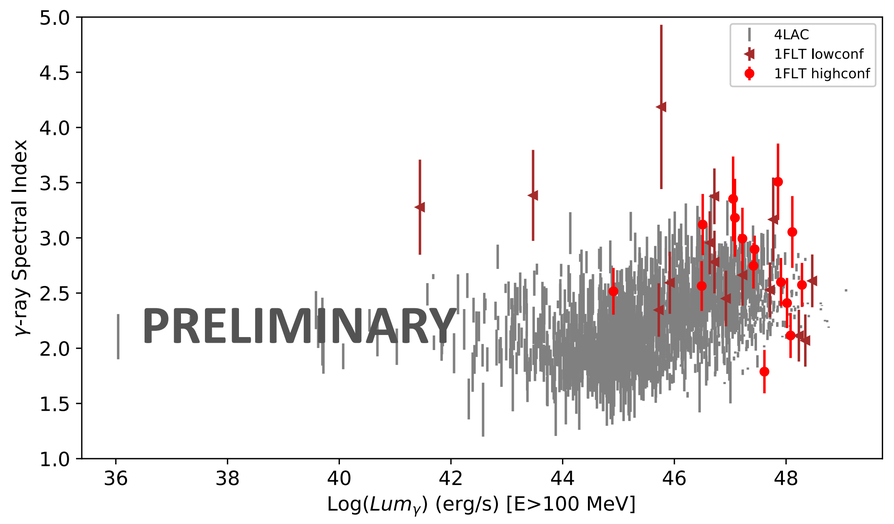

Figure 3: *Power-law index vs synchrotron peak*

AGN-like monthly transients show very soft spectral indices and reach high γ-ray luminosity (with respect to the 4LAC [5] sources, see Fig. 2). Where possible, we fitted the Spectral Energy Distribution (SED) synchrotron peak with a third degree polynomial function and we found that the counterparts of these sources are Low Synchrotron Peaked (see Fig. 3).

Conclusions

The monthly time scale permits us to detect sources with softer spectral indices than the 4LAC sources. This confirms that these soft sources are not distinguishable from the diffuse background when considered over multi-year integration times. These sources are detected during active flaring state. For this reason they show a high γ-ray luminosity with respect to the 4LAC. The detection of new γ-ray sources, not present in any previous xFGL general catalog [6,7,8,9] or in the 2FAV catalog [10], shows that integrating over different time intervals does not reproduce the same sky and that the discovery space of Fermi-LAT remains large.

The incremental source list will be updated yearly.

References

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