Sources in the Fermi Sky Above 10 GeV

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on behalf of the Fermi Large Area Telescope Collaboration

Summary:

- **A view of the Very High Energy gamma-ray sky using Fermi-LAT data obtained during the first 2 years is shown**
  - → **Flat distribution of sources dominated by AGNs**
- **A clear relation is found between photon flux above 50 GeV and detectability at VHE with Cherenkov Telescopes**
- **We identify new candidate VHE sources which may be detectable with current generation Cherenkov telescopes**
  - → **A list of 13 new candidate VHE sources is given in this poster**

1 – Goal of this work

1.1 – Understand better the Fermi sources at "almost" Very High Energy (>100 GeV, thereafter VHE)

1.2 – Provide a guide to Cherenkov Telescopes (small field of view, ~10% duty cycle) to look for new VHE sources. Before Fermi, the search for new VHE sources (*based on EGRET, X-ray, optical, radio and various assumptions*) was inefficient (~70% time wasted !!).
→In the long term the point 1.2 contributes to the point 1.1

2 – Methodology

2.1 –Use photons above10 GeV (trading off between photon statistics and proximity to VHE)

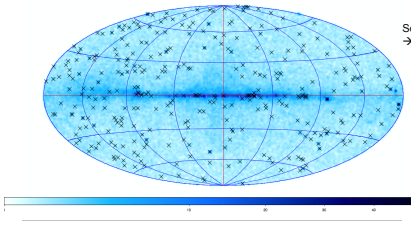
2.2 – Seed photons obtained with the union of three different search algorithms
MR_Filter *(Starck, J.-L., & Pierre, M. 1998, A&AS, 128, 397)*
PGWave *(Damiani, F.,et al.,. 1997, ApJ, 483, 350)*
Minimum Spanning Tree *(Campana, R. et al., 2008, MNRAS, 383, 1166)*

2.3 – Localization performed with pointlike

2.4 – Spectral analysis performed with binned gtlike
IRF : P6V11 DIFFUSE
→ PSF derived from in-flight data
Power law function fitted to data in energy range 10-500 GeV
→ No indication of spectral curvature (*partially due to low photon statistics*)

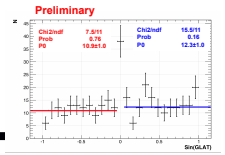
3 – Results: 2 years of LAT photons above 10 GeV

Preliminary

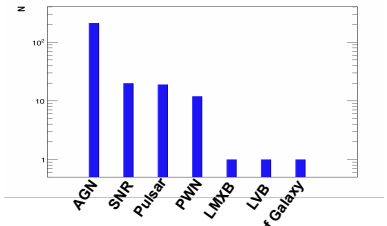


Crosses mark the location of the 334 sources with TS> 25

Some regions of the sky are almost "empty"
→ Low diffuse bkg allows for detection of sources with only few photons



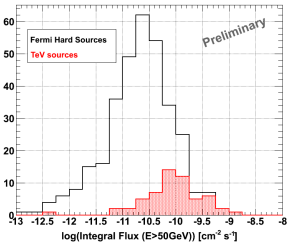
Flat distribution of sources, with the exception of a 5 deg region along the galactic plane, where the density of sources is about 3 times larger than in the rest of the sky



AGN dominate the Fermi-LAT sky above 10 GeV

4 – Source candidates to be detected at VHE energies

4.2 - There is a clear relation: **sources detected at VHE with IACT have high photon fluxes above 50 GeV**
→ **A simple sorting of the sources according to the estimated flux above 50 GeV provides a VHE-biased source list which can be used to find good candidate VHE sources**



Known VHE sources tend to have a high photon flux above 50 GeV

4.3 – Below is a table with the PRELIMINARY list of sources sorted according to decreasing photon flux above 50 GeV.
→ **The table is truncated at the 50th object and contains 13 objects that have not been detected at VHE.**
The complete list of sources will be presented elsewhere
→ The errors in the table show only statistical uncertainties. The systematic uncertainties are estimated to be 20% (see http://fermi.gsfc.nasa.gov/ssc/data/analysis/LAT_caveats.html)

→ The text of the table is color coded: **GREEN: Sources detected at VHE before Fermi operation**
BLUE: Sources detected at VHE during Fermi operation
RED: Candidate VHE sources which may be detectable with IACTs

PRELIMINARY

RA [deg]	DEC [deg]	Association	Redshift	Type	Flux (E>10 GeV) [10^{-10} ph cm^{-2} s^{-1}]	Photon Index	Flux (E>50 GeV) [10^{-10} ph cm^{-2} s^{-1}]	Flux (E>50 GeV) Crab Nebula units**
166.123	38.207	MRK421	0.031	Blazar	41.2 ± 2.5	1.78 ± 0.07	12.4	1.28
83.626	22.021	CRAB	2 kpc	PWN	71.1 ± 3.3	2.34 ± 0.07	9.7	1
276.13	-13.852	HESSJ1825-137	3.9 kpc	PWN	27.2 ± 3.7	1.90 ± -0.13	6.6	0.68
329.726	-30.21	PKS 2155-304	0.117	Blazar	23.7 ± 2.0	2.01 ± 0.10	4.8	0.49
238.934	11.188	PG1553	0.5	Blazar	21.5 ± 1.9	1.97 ± 0.11	4.7	0.48
253.484	39.756	Mrk501	0.034	Blazar	12.7 ± 1.4	1.72 ± 0.12	4.3	0.44
279.332	-6.991	HESS J1837-069	???	UNID	6.9 ± 1.4	1.45 ± 0.20	4.1	0.42
284.295	2.819	HESS J1857+026	???	UNID	3.9 ± 1.1	1.30 ± 0.28	3.5	0.37
35.657	43.042	3c66a	0.444	Blazar	21.9 ± 1.8	2.15 ± 0.11	3.5	0.36
77.023	67.621	1ES 0502+675	0.341	Blazar	7.6 ± 1.0	1.59 ± 0.13	3.3	0.34
185.34	30.183	1es1218	0.182	Blazar	5.2 ± 0.9	1.53 ± 0.19	3.1	0.32
243.97	-51.982	HESS J1614-518	???	Masive Star Cluster	3.7 ± 1.1	1.41 ± 0.27	2.6	0.27
94.31	22.58	IC443	1.5 kpc	SNR	26.6 ± 2.1	2.61 ± -0.14	2.4	0.25
80.436	21.21	VER J0521+211	???	AGN (unknown type)	8.7 ± 1.2	1.94 ± 0.17	2.4	0.25
216.765	23.802	PKS 1424+240	???	Blazar	15.4 ± 1.6	2.34 ± 0.15	2.0	0.21
72.379	-43.841	PKS 0447-439	0.2	Blazar	10.4 ± 1.3	2.11 ± 0.16	2.0	0.20
240.946	-49.049	J1603-4904	???	???	10.3 ± 1.3	2.12 ± 0.17	1.8	0.19
300.308	43.881	MAGIC J2001+435	???	Blazar	10.0 ± 1.2	2.17 ± 0.17	1.8	0.18
161.247	-59.699	Eta Carinae	???	LBV	5.3 ± 1.1	1.83 ± 0.23	1.5	0.15
248.633	-47.661	???	???	???	5.9 ± 1.5	1.91 ± 0.26	1.4	0.15
266.463	-28.983	TeV Galactic Centre	8.5 kpc	UNID	18.0 ± 2.1	2.59 ± 0.20	1.4	0.14
45.871	-24.114	PKS 0301-243	0.26	Blazar	6.4 ± 1.0	2.00 ± 0.20	1.3	0.14
290.818	14.145	W51C	5 kpc	SNR	14.4 ± 1.7	2.50 ± -0.18	1.3	0.13
278.659	-7.111	SNR G024.7+00.6		SNR	5.5 ± 1.3	1.91 ± 0.28	1.3	0.13
302.365	-48.826	PKS 2005-489	0.071	Blazar	4.9 ± 0.9	1.87 ± 0.22	1.3	0.13
228.507	-59.256	MSH-15-52	5.2 kpc	PWN	5.5 ± 1.0	1.96 ± -0.23	1.2	0.12
271.175	-21.599	HESS J1804-216	6 kpc	UNID	5.1 ± 1.3	1.93 ± 0.29	1.2	0.12
356.764	51.71	1ES 2344+514	0.044	Blazar	2.8 ± 0.6	1.61 ± 0.24	1.2	0.12
24.122	39.093	BZB J0136+3905	???	Blazar	6.3 ± 1.0	2.09 ± 0.21	1.1	0.12
102.697	25.101	1ES1647+250	0.2	Blazar	3.8 ± 0.8	1.79 ± 0.24	1.1	0.11
299.997	65.143	1ES1959+650	0.049	Blazar	7.0 ± 0.9	2.16 ± 0.18	1.1	0.11
49.169	41.308	IC310	0.019	AGN (Unknown type)	1.1 ± 0.4	1.30 ± 0.39	1.1	0.11
244.392	-51.039	HESS J1616-508	6.5 kpc	PWN	4.9 ± 1.2	1.99 ± 0.26	1.0	0.11
278.689	-8.771	HESS J1834-087	4 kpc	UNID	4.9 ± 1.3	1.99 ± 0.30	1.0	0.10
84.692	-44.079	PKS 0537-441	0.894	Blazar	13.5 ± 1.5	2.62 ± 0.18	1.0	0.10
250.18	-46.622	HESS J1640-465	8.6 kpc	PWN	4.5 ± 1.2	1.95 ± 0.28	1.0	0.10
49.966	41.515	NGC1275	0.018	FR1	10.1 ± 1.2	2.48 ± 0.19	0.9	0.10
8.396	-19.374	BZBJ0033-1921	???	Blazar	3.3 ± 0.7	1.81 ± 0.26	0.9	0.10
49.968	18.801	RBS 0413	0.19	Blazar	1.8 ± 0.6	1.50 ± 0.35	0.9	0.10
195.966	-63.199	HESS J1303-631	???	PWN	2.4 ± 0.8	1.65 ± 0.31	0.9	0.09
304.894	40.824	VER J2019+407	???	UNID	3.7 ± 1.0	1.89 ± 0.29	0.9	0.09
186.212	21.364	4C +21.35	0.432	Blazar	8.7 ± 1.2	2.42 ± 0.21	0.9	0.09
247.936	-47.956	HESS J1632-478	???	PWN	7.5 ± 1.5	2.33 ± 0.30	0.9	0.09
122.447	52.306	1ES 0806+524	0.138	Blazar	2.9 ± 0.6	1.81 ± 0.25	0.8	0.09
153.79	49.416	1ES 1011+496	0.212	Blazar	6.4 ± 1.0	2.30 ± 0.21	0.8	0.08
149.432	55.38	4C 55.17	0.895	Blazar	6.7 ± 0.9	2.35 ± 0.21	0.8	0.08
354.765	21.39	BZBJ2338+2124	???	Blazar	1.1 ± 0.4	1.39 ± 0.41	0.8	0.08
34.249	8.612	BZBJ0217+0837	???	Blazar	1.5 ± 0.5	1.53 ± 0.40	0.7	0.08
217.147	42.658	H 1426+428	0.129	Blazar	2.8 ± 0.6	1.86 ± 0.28	0.7	0.08
277.307	-24.333	???	???	???	1.6 ± 0.6	1.59 ± 0.38	0.7	0.07

*** In this work we define the Crab Nebula flux unit as F_{CNU} (E>50 GeV) = 9.7 x 10^{-10} ph cm^{-2} s^{-1}*

Source redshifts and source types were obtained from
http://tevcat.uchicago.edu/

A complete list of the LAT sources detected above 10 GeV, as well as a characterization of the variability and population implications from these sources will be presented elsewhere