J/ApJS/232/18 The third Fermi-LAT >10GeV catalog (3FHL) (Ajello+, 2017)

3FHL: The Third Catalog of Hard Fermi-LAT Sources.

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Abstract:

We present a catalog of sources detected above 10GeV by the Fermi Large Area Telescope (LAT) in the first 7 years of data using the Pass 8 event-level analysis. This is the Third Catalog of Hard Fermi-LAT Sources (3FHL), containing 1556 objects characterized in the 10GeV-2TeV energy range. The sensitivity and angular resolution are improved by factors of 3 and 2 relative to the previous LAT catalog at the same energies (1FHL). The vast majority of detected sources (79%) are associated with extragalactic counterparts at other wavelengths, including 16 sources located at very high redshift (z>2). Of the sources, 8% have Galactic counterparts and 13% are unassociated (or associated with a source of unknown nature). The high-latitude sky and the Galactic plane are observed with a flux sensitivity of 4.4 to 9.5×10^{-11}ph/cm^2/s, respectively (this is approximately 0.5% and 1% of the Crab Nebula flux above 10GeV). The catalog includes 214 new γ-ray sources. The substantial increase in the number of photons (more than 4 times relative to 1FHL and 10 times to 2FHL) also allows us to measure significant spectral curvature for 32 sources and find flux variability for 163 of them. Furthermore, we estimate that for the same flux limit of 10^{-12}erg/cm^2/s, the energy range above 10GeV has twice as many sources as the range above 50GeV, highlighting the importance, for future Cherenkov telescopes, of lowering the energy threshold as much as possible.

Description:

We have analyzed the first 7 years of Fermi-LAT data from 2008 August 4 to 2015 August 2 using Pass 8 events. Pass 8 improves the photon acceptance and the PSF, reduces the background of misclassified charged particles and extends the useful LAT energy range (10GeV-2TeV). See Figure 1.

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
3fhl.dat	617	1556	LAT point source catalog
roi.dat	62	741	Regions Of Interest (ROI) over which the analysis ran
table1.dat	118	55	Extended sources modeled in the 3FHL analysis (only 48 were detected)

Description of file: The original gll$_{psch}$v13.fit file in FITS format is also available on the FTP and it includes 4 bintables: the "LAT Point Source Catalog", the "Extended Sources" (see table 1), the "ROIs" (Regions Of Interest over which the analysis ran) and the "Energy Bounds" (energy bins in which spectral fluxes are provided in the catalog with the level of the relative systematic uncertainty on the effective area in each band (SysRel column)).

See also:
VII/274 : The Roma BZCAT - 5th edition (Massaro+, 2015)
J/ApJ/716/30 : SED of Fermi bright blazars (Abdo+, 2010)
J/ApJS/188/405 : Fermi-LAT first source catalog (1FGL) (Abdo+, 2010)
J/ApJ/743/171 : The 2LAC catalog (Ackermann+, 2011)
J/ApJ/748/49 : Optical spectroscopy of 1LAC broad-line blazars (Shaw+, 2012)
J/ApJS/208/17 : 2nd Fermi LAT cat. of gamma-ray pulsars (2PC) (Abdo+, 2013)
J/ApJS/209/34 : The first Fermi-LAT >10GeV catalog (1FHL) (Ackermann+, 2013)
J/ApJ/764/135 : Spectroscopic redshifts of BL Lac objects (Shaw+, 2013)
J/ApJS/218/23 : Fermi LAT third source catalog (3FGL) (Acero+, 2015)
J/ApJ/810/14 : Third catalog of LAT-detected AGNs (3LAC) (Ackermann+, 2015)
J/ApJS/224/8 : The first Fermi LAT SNR catalog (1SC) (Acero+, 2016)
J/ApJS/222/5 : The second Fermi-LAT >50GeV catalog (2FHL) (Ackermann+, 2016)
J/A+A/586/A71 : LMC 0.2-100GeV images (Ackermann+, 2016)
J/A+A/598/A134 : γ-ray signature in WHSP blazars (Arsioli+, 2017)
http://fermi.gsfc.nasa.gov/ssc/ : Fermi Science Support Center (FSSC) home
http://tevcat.uchicago.edu/ : TeVCat home page

Byte-by-byte Description of file: 3fhl.dat

Bytes	Format	Units	Label	Explanations
1- 4	A4	---	---	[3FHL]
6- 18	A13	---	3FHL	3FHL name (JHHMM.m+DDMMe) (Source_Name)
20- 29	F10.6	deg	RAdeg	Right ascension; J2000 (RAJ2000)
31- 40	F10.6	deg	DEdeg	Declination; J2000 (DEJ2000)
42- 51	F10.6	deg	GLON	Galactic longitude (GLON)
53- 62	F10.6	deg	GLAT	Galactic latitude (GLAT)
64- 69	F6.4	deg	C95amaj	[0.008/0.2]? Error radius at 95% confidence ($Conf_{95}$SemiMajor)
71- 76	F6.4	deg	C95bmin	[0.008/0.2]? $Conf_{95}$SemiMajor in 3FHL ($Conf_{95}$SemiMinor)
78- 87	E10.3	deg	C95PA	[-1e+38]? error circle; NULL in 3FHL ($Conf_{95}$PosAng)
89- 91	I3	---	ROI	[1/728] ROI number (ROI_num)
93- 98	F6.2	---	Sig	[4/169] Source significance in σ units over the 10GeV to 2TeV band (Signif_Avg)
100-105	F6.2	GeV	EPvt	[11/195] Energy at which error on differential flux is minimal (Pivot_Energy)
107-114	E8.3	ph/cm2/GeV/s	S	Differential flux at Pivot_Energy (Flux_Density)
116-123	E8.3	ph/cm2/GeV/s	e_S	1σ error on S (Unc_{Flux}Density)
125-132	E8.3	ph/cm2/s	Flux	Integral photon flux from 10GeV to 1TeV obtained by spectral fitting (Flux)
134-141	E8.3	ph/cm2/s	e_Flux	1σ error on Flux (Unc_Flux)
143-150	E8.3	10-3W/m2	EFlx	Energy flux from 10GeV to 1TeV obtained by spectral fitting; in erg/cm^2/s (Energy_Flux)
152-159	E8.3	10-3W/m2	e_EFlx	1σ error on EFlx (Unc_{Energy}Flux)
161-164	F4.2	---	SigCve	[0/6] Significance (in σ units) of the fit improvement between power-law and LogParabola (Signif_Curve) (1)
166-176	A11	---	SpT	Spectral type (PowerLaw or LogParabola); see section 2.4 (SpectrumType)
178-182	F5.2	---	SInd	[0.9/9.1] Best-fit photon number index at Pivot_Energy when fitting with LogParabola (Spectral_Index)
184-187	F4.2	---	e_SInd	[0.04/4.1] 1σ error on SInd ($Unc_{Spectral}$Index)
189-195	F7.4	---	beta	[-0.8/1] Curvature parameter β when fitting with LogParabola (beta)
197-202	F6.4	---	e_beta	[0.001/9.3] 1σ error on beta (Unc_beta)
204-208	F5.2	---	PLInd	[1/9.1] Best-fit photon number index when fitting with power law (PowerLaw_Index)
210-213	F4.2	---	e_PLInd	[0.02/4] 1σ error on PLInd ($Unc_{PowerLaw}$Index)
215-223	E9.3	ph/cm2/s	F1	Integral photon flux in 10-20GeV spectral band (Flux_Band1)
225-233	E9.3	ph/cm2/s	F2	Integral photon flux in 20-50GeV spectral band (Flux_Band2)
235-243	E9.3	ph/cm2/s	F3	[0/] Integral photon flux in 50-150GeV spectral band (Flux_Band3)
245-253	E9.3	ph/cm2/s	F4	[0/] Integral photon flux in 150-500GeV spectral band (Flux_Band4)
255-263	E9.3	ph/cm2/s	F5	[0/] Integral photon flux in 500-2000GeV spectral band (Flux_Band5)
265-273	E9.3	ph/cm2/s	e_F1	? 1σ lower error on F1 (Low_{Unc}Flux_Band1) (2)
275-283	E9.3	ph/cm2/s	E_F1	? 1σ upper error on F1 (Low_{Unc}Flux_Band2) (2)
285-293	E9.3	ph/cm2/s	e_F2	? 1σ lower error on F2 (Low_{Unc}Flux_Band3) (2)
295-303	E9.3	ph/cm2/s	E_F2	? 1σ upper error on F2 (Low_{Unc}Flux_Band4) (2)

305-313	E9.3	ph/cm2/s	e_F3	? 1σ lower error on F3 (Low_{Unc}Flux_Band5) (2)
315-323	E9.3	ph/cm2/s	E_F3	? 1σ upper error on F3 (Up_{Unc}Flux_Band1) (2)
325-333	E9.3	ph/cm2/s	e_F4	? 1σ lower error on F4 (Up_{Unc}Flux_Band2) (2)
335-343	E9.3	ph/cm2/s	E_F4	? 1σ upper error on F4 (Up_{Unc}Flux_Band3) (2)
345-353	E9.3	ph/cm2/s	e_F5	? 1σ lower error on F5 (Up_{Unc}Flux_Band4) (2)
355-363	E9.3	ph/cm2/s	E_F5	? 1σ upper error on F5 (Up_{Unc}Flux_Band5) (2)
365-373	E9.3	10-3W/m2	nuFnu1	Spectral energy distribution in 10-20GeV, in erg/cm^2/s (nuFnu1)
375-383	E9.3	10-3W/m2	nuFnu2	Spectral energy distribution in 20-50GeV, in erg/cm^2/s (nuFnu2)
385-393	E9.3	10-3W/m2	nuFnu3	[0/] Spectral energy distribution in 50-150GeV, in erg/cm^2/s (nuFnu3)
395-403	E9.3	10-3W/m2	nuFnu4	[0/] Spectral energy distribution in 150-500GeV, in erg/cm^2/s (nuFnu4)
405-413	E9.3	10-3W/m2	nuFnu5	[0/] Spectral energy distribution in 500-2000GeV, in erg/cm^2/s (nuFnu5)
415-420	F6.2	---	TS1	[0/134] Square root of the Test Statistic in 10-20GeV ($Sqrt_{TS}$Band1)
422-427	F6.2	---	TS2	[0/89] Square root of the Test Statistic in 20-50GeV ($Sqrt_{TS}$Band2)
429-434	F6.2	---	TS3	[0/60] Square root of the Test Statistic in 50-150GeV ($Sqrt_{TS}$Band3)
436-441	F6.2	---	TS4	[0/34] Square root of the Test Statistic in 150-500GeV ($Sqrt_{TS}$Band4)
443-448	F6.2	---	TS5	[0/16] Square root of the Test Statistic in 500-2000GeV ($Sqrt_{TS}$Band5)
450-455	F6.1	---	Npred	[4/3734] Predicted number of events in the model (Npred)
457-463	F7.2	GeV	HEPE	[11.9/1997] Highest energy among events probably coming from the source (HEP_Energy)
465-468	F4.2	---	HEPP	Probability of that event to come from the source (HEP_Prob)
470-471	I2	---	Var	[1/15]? Number of Bayesian blocks from variability analysis (1=not variable) (Variability_BayesBlocks)
473-489	A17	---	ExName	Cross-reference to the ExtendedSources extension ($Extended_{Source}$Name)
491-508	A18	---	Assoc	Correspondence to previous γ-ray source catalog (ASSOC_GAM) (3)
510	A1	---	f_TName	TeVCat flag (TEVCAT_FLAG) (4)
512-532	A21	---	TName	Name of likely corresponding TeV source from TeVCat, if any (ASSOC_TEV)
534-540	A7	---	Cl	Class designation for associated source see Table 2 (CLASS) (5)
542-567	A26	---	Assoc1	Name of identified or likely associated source (ASSOC1)
569-591	A23	---	Assoc2	Alternate name or indicates whether the source is inside an extended source
593-596	F4.2	---	PBay	? Probability of association according to the Bayesian method ($ASSOC_{PROB}$BAY)
598-601	F4.2	---	PLR	? Probability of association according to the Likelihood-Ratio method ($ASSOC_{PROB}$LR)
603-608	F6.4	---	z	[0.003/2.6]? Redshift of counterpart, if known (Redshift)
610-617	E8.3	Hz	NuPk	? Frequency of the synchrotron peak of counterpart, if known (NuPeak_obs)

Note (1): A value greater than 3 indicates significant curvature.

Note (2): Separate 1σ errors are computed from the likelihood profile toward lower and larger fluxes. The lower error is set equal to NULL and the upper error is derived from a Bayesian upper limit if the 1σ interval contains 0 (TS<1).

Note (3): In the order 3FGL > 2FHL > 1FHL > 2FGL > 1FGL > EGRET.

Note (4): Flag as follows:
P = positional association with non-extended source in TeVCat
E = associated with an extended source in TeVCat,
N = no TeV association
C = TeV source candidate as defined in Section 3.4

Note (5): Class of the most likely associated source (from table 2) as follows:

Class	Description	Number
psr	= Pulsar	6
PSR	= Pulsar	53
pwn	= Pulsar wind nebula	8
PWN	= Pulsar wind nebula	9
snr	= Supernova remnant	17
SNR	= Supernova remnant	13

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      spp     = Supernova remnant/Pulsar wind nebula        9
      hmb     = High-mass binary                            1
      HMB     = High-mass binary                            4
      BIN     = Binary                                      1
      glc     = Globular cluster                            2
      sfr     = Star-forming region                         1
      SFR     = Star-forming region                         1
      sbg     = Starburst galaxy                            4
      bll     = BL Lac type of blazar                     731
      BLL     = BL Lac type of blazar                      19
      fsrq    = FSRQ type of blazar                       142
      FSRQ    = FSRQ type of blazar                        30
      agn     = Non-blazar active galaxy                    1
      NYLS1   = Narrow-line seyfert                         1
      rdg     = Radio galaxy                                9
      RDG     = Radio galaxy                                4
      bcu     = Blazar candidate of uncertain type        290
                Total associated                         1220
                Total IDENTIFIED                          136
      unk     = Unclassified                               23
                Unassociated                              177
                Total in 3FHL                            1556
     ---------------------------------------------------------------------------
      The designation "spp" indicates potential association with SNR or PWN.
      Designations shown in capital letters are firm identifications;
      small letters indicate associations.
      Note that the PWN N 157 B in the LMC is counted as Galactic.
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Byte-by-byte Description of file: roi.dat

Bytes	Format	Units	Label	Explanations
1- 3	I3	---	ROI	[1/741] Running sequence number of the ROI (ROI_num)
5- 12	F8.4	deg	RAdeg	Right ascension; J2000 (RAJ2000)
14- 21	F8.4	deg	DEdeg	Declination; J2000 (DEJ2000)
23- 29	F7.3	deg	GLON	Galactic longitude
31- 37	F7.3	deg	GLAT	Galactic latitude
39- 42	F4.2	deg	Rad	[2.5/9] Radius (RADIUS)
44- 47	F4.2	---	Par1	[0.5/1.4] iso_{P8V3}Source Normalization (PARNAM1)
49- 52	F4.2	---	e_Par1	[0.03/0.2]? Par1 uncertainty (Unc_PARNAM1)
54- 57	F4.2	---	Par2	[0.8/1.7] $gal_{4yearP8V6}$v3 Prefactor (PARNAM2)
59- 62	F4.2	---	e_Par2	[0.01/0.2]? Par2 uncertainty (Unc_PARNAM2)

Byte-by-byte Description of file: table1.dat

Bytes	Format	Units	Label	Explanations
1- 13	A13	---	3FHL	3FHL name (1)
15- 33	A19	---	Name	Name of the source that has been modeled as spatially extended
35- 52	A18	---	Changes	Name of the source in previous catalog in case of a change
54- 64	A11	---	Mod	Spatial model
66	A1	---	f_Mod	[a]
68- 72	F5.3	deg	Ext	[0.1/3] Radius (or semimajor axis) (Extent) (2)
74- 77	F4.2	deg	bmin	? Semiminor axis (3)
78	A1	---	f_bmin	Elliptical 2D shapes (3)
80-118	A39	---	Ref	Reference

Note (1): Sources without a 3FHL name did not reach the significance threshold in 3FHL.
Note (2): Indicate the radius for Disk (flat disk) sources, the 68% containment radius for Gaussian sources, the outer radius for Ring (flat annulus) sources, and an approximate radius for Map (external template) sources.
Note (3):
: = The 2D shapes are elliptical; each pair of parameters (Ext, bmin) represents the semimajor and semiminor axes.

History:
From electronic version of the journal

(End) Emmanuelle Perret [CDS] 14-Nov-2017

The document above follows the rules of the Standard Description for Astronomical Catalogues; from this documentation it is possible to generate f77 program to load files into arrays or line by line