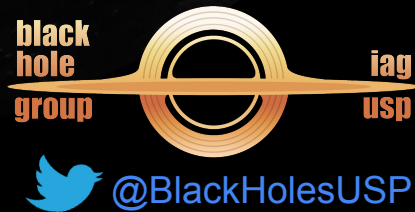


# A quick look at Blazar PKS 2155-304 with *easyFermi*

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# The *Fermi*-LAT

The *Fermi* spacecraft has been observing the  $\gamma$ -ray sky since April 2008

Its instruments are the Large Area Telescope (LAT) and the Gamma-ray Burst Monitor (GBM)

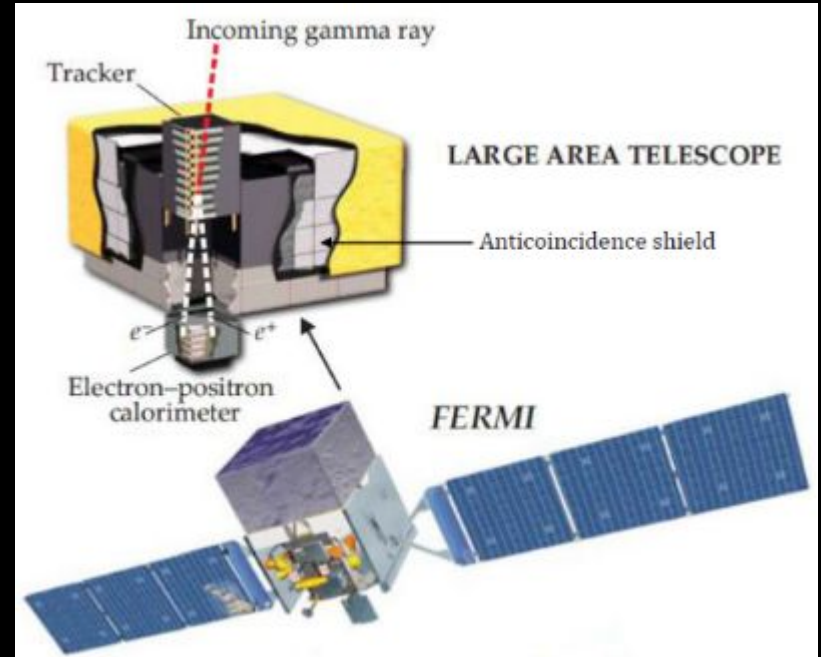


Figure adapted from *Thompson et al. (2012)*

# ***Fermi* data is public, let's use it!**

**0 - Setup easyFermi**

**1 - Choose a target and observation period**

**2 - Query the photon and spacecraft files on**

<https://fermi.gsfc.nasa.gov/cgi-bin/ssc/LAT/LATDataQuery.cgi>

**3 - Make sure you have everything**

**4 - Analysis and profit!**

# 0 - Setup easyFermi

Find support on

<https://github.com/ranieremenezes/easyFermi>

Have Anaconda 3 or [Miniconda](#) installed

To install *Fermitools* in the terminal with conda, do:

```
$ conda create --name fermi -c conda-forge -c fermi python=3.9  
"fermitools>=2.2.0" healpy gammapy
```

Then activate the fermi environment:

```
$ conda activate fermi
```

And simply install *Fermipy* and *easyFermi* with pip:

```
$ pip install fermipy ipython easyFermi
```

# 0 - Setup easyFermi

Find support on

<https://github.com/ranieremenezes/easyFermi>

To launch easyFermi, type while on the fermi

```
$ ipython
```

```
>>> import easyFermi
```

The screenshot shows the 'easyFermi' application window with the following configuration details:

- Menu Credits**
- Config. file:**
  - Standard
    - Catalog: 4FGL-DR3
    - Target cataloged?: Yes
    - RA, Dec (°): [ ]
    - E<sub>min</sub>, E<sub>max</sub> (MeV): 100, 300000
    - Spacecraft file: [ ]
    - Dir. of photon files: [ ]
    - Dir. of diff. emission: [ ]
    - Start: 04/08/2008 15:43:36
    - Stop: 14/10/2008 15:43:00
    - Use external Itcube: [ ]
  - Custom
    - Configuration file (yaml): [ ]
    - Dir. of photon files: [ ]
- Advanced configurations:**
  - Target name/tag: [ ]
  - Change model: Select...
  - Delete sources: [ ]
  - Find extra sources in the ROI:
    - 4.00 Minimum significance
    - 0.50 Minimum separation (°)
  - Diagnostic plots
  - Free source radius:
    - Default
    - Customized
    - Radius (°): [ ]
    - Only norm.
    - Freeze Gal.
    - Freeze Iso.
    - Freeze shape targ.
  - Output format: pdf
- Science:**
  - Light curve:
    - 20 N° of time bins
    - 1 N° of cores
  - SED:
    - 10 N° of energy bins
  - Extension:
    - Disk
    - 2D-Gauss
    - 1.00 Max. size
  - Relocalize
  - TS map:
    - 2.00 Photon index
  - Remove target
- Log:**
  - Output directory: [ ]
  - Go!

0%

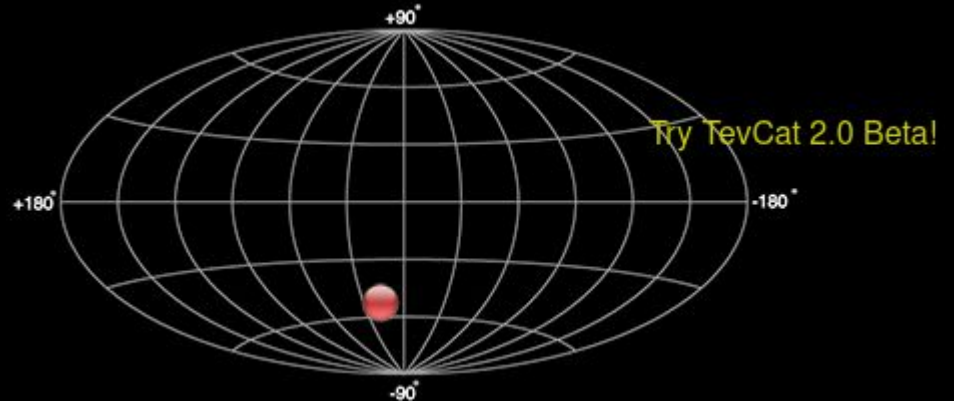
# 1 - Choose a target and observation period

Let's look at **PKS 2155-304**, ( ra, dec ) = ( 329.71694, -30.22559 )

This is a High Synchrotron Peak

BL Lac (HSB) at  $z=0.116$

during 21/02/2020 to 31/05/2020



check out the catalogue of TeV emitters: <http://tevcat.uchicago.edu/>

# 1 - Choose a target and observation period

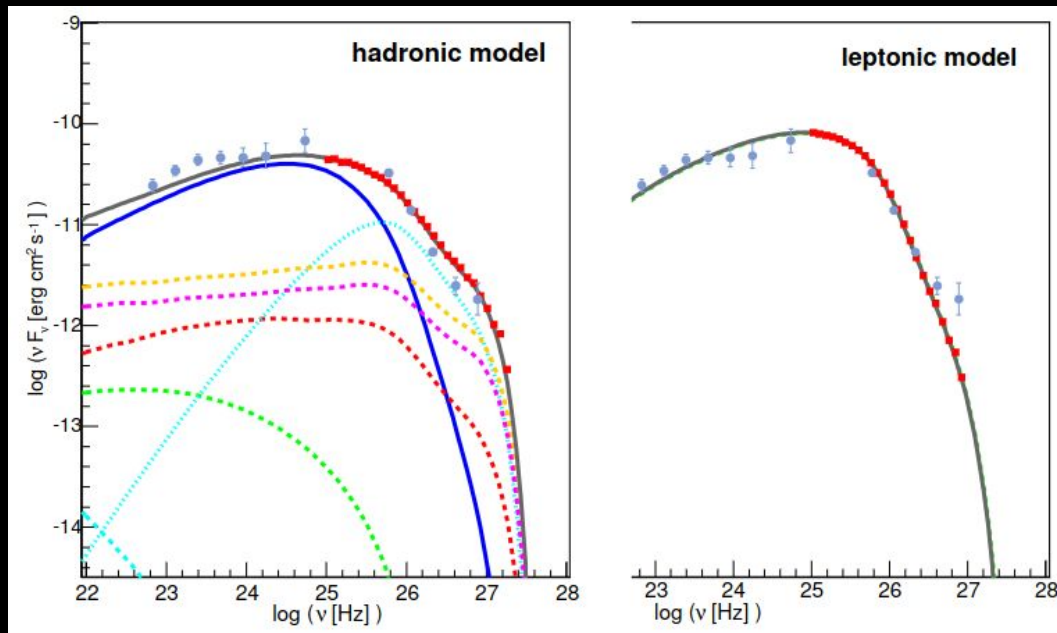
## Expected signatures from hadronic emission processes in the TeV spectra of BL Lacertae objects

A. Zech<sup>1</sup>, M. Cerruti<sup>2</sup>, and D. Mazin<sup>3</sup>

Zech et al. (2017)

VHE emitters are prime targets for the exploration of particle acceleration and possible neutrino sources!

The SED of **PKS 2155-304** has a peak at  $\sim 100$  GeV



## 2 - Query the photon and spacecraft files

Go to <https://fermi.gsfc.nasa.gov/cgi-bin/ssc/LAT/LATDataQuery.cgi> and perform the query

### LAT Photon, Event, and Spacecraft Data Query

Object name or coordinates:	<input type="text" value="PKS 2155-304"/>
Coordinate system:	<input type="text" value="J2000"/>
Search radius (degrees):	<input type="text" value="10"/>
Observation dates:	<input type="text" value="58900, 59000"/>
Time system:	<input type="text" value="MJD"/>
Energy range (MeV):	<input type="text" value="100, 300000"/>
LAT data type:	<input type="text" value="Photon"/>
Spacecraft data:	<input checked="" type="checkbox"/>



## 2 - Query the photon and spacecraft files

Go to <https://fermi.gsfc.nasa.gov/cgi-bin/ssc/LAT/LATDataQuery.cgi> and perform the query

### LAT Photon, Event, and Spacecraft Data Query

Object name or coordinates:

Coordinate system:

Search radius (degrees):

Observation dates:

Time system:

Energy range (MeV):

LAT data type:

Spacecraft data:

<u>Filename</u>	<u>Number of Entries</u>	<u>Size (MB)</u>	<u>Status</u>
L2305311542430AB7974463_PH00.fits	183427	17.19	Available
L2305311542430AB7974463_SC00.fits	243571	38.11	Available

Then download all files that show up!

### 3 - Make sure you have everything

We also need the templates of diffuse (galactic) and isotropic (extragalactic) emissions, which can be found at:

<https://fermi.gsfc.nasa.gov/ssc/data/access/lat/BackgroundModels.html>

#### LAT Background Models

Galactic interstellar emission model	Event Selection/ IRF Name	Isotropic spectral template
<a href="#">gll_iem_v07.fits</a> (see below for P8R3 usage notes)	Pass 8 Source (front+back, allPSF, allEDISP) P8R3_SOURCE_V3	<a href="#">iso_P8R3_SOURCE_V3_v1.txt</a>

### 3 - Make sure you have everything

- Let's have a data directory for the photon and spacecraft files
- Another one for the diffuse templates
- And one more just to hold the results of our analysis



Being well organised pays off!

# 4 - Analysis and profit!

easyFermi

Menu Credits

Config. file:

Standard

Catalog: 4FGL-DR3 RA, Dec (°): 6938, -30.225588 Spacecraft file: AB7974463\_SC00.fits Dir. of diff. emission: /easyFermi\_tutor/diffuse Start: 21/02/2020 00:00:00

Target cataloged? Yes E<sub>min</sub>, E<sub>max</sub> (MeV): 100, 300000 Dir. of photon files: S\_2155-304/photons  Use external Itcube: Stop: 31/05/2020 00:00:00

Custom Configuration file (yaml) Dir. of photon files:

Advanced configurations:

Target name/tag: Free source radius:  Default  Customized

Change model: Select... Radius (°)  Only norm.  Freeze Gal.  Freeze Iso.  Freeze shape targ.

Delete sources:  Find extra sources in the ROI: 4.00 Minimum significance 0.50 Minimum separation (°)

Diagnostic plots Output format: png


Science:

Light curve: 15 N° of time bins 1 N° of cores

SED: 10 N° of energy bins  Extension:  Disk  2D-Gauss: 1.00 Max. size

Relocalize  TS map: 2.00 Photon index  Remove target

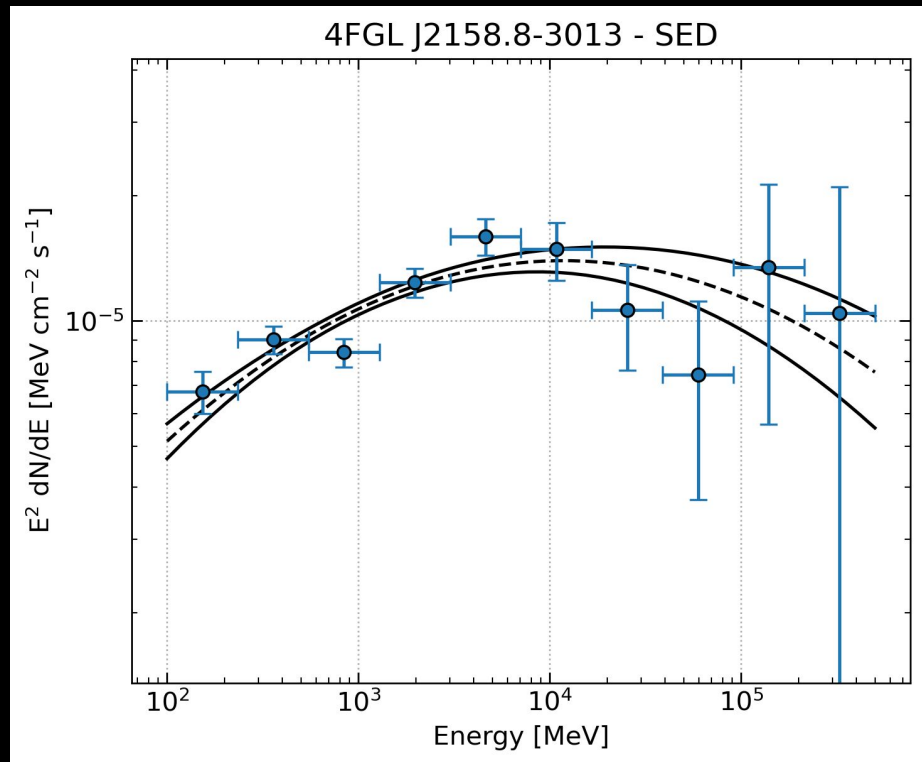
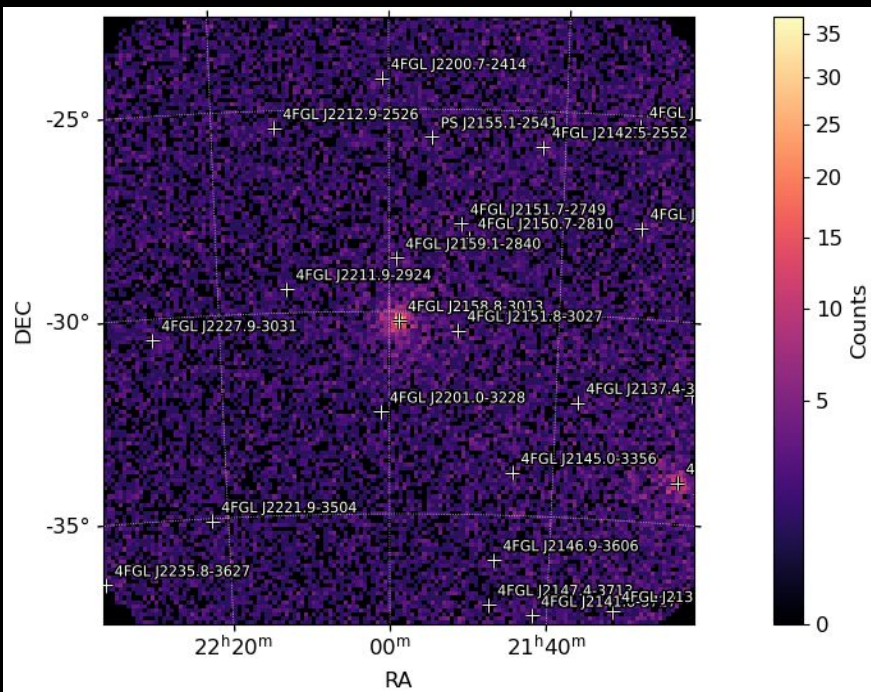
Log:



Output directory: 5-304/results Go!

0%

# 4 - Analysis and profit!



4FGL J2158.8-3013 is  
the name of PKS 2155-304 in the Fermi's source catalogue