

# Analysis of Fermi LAT data

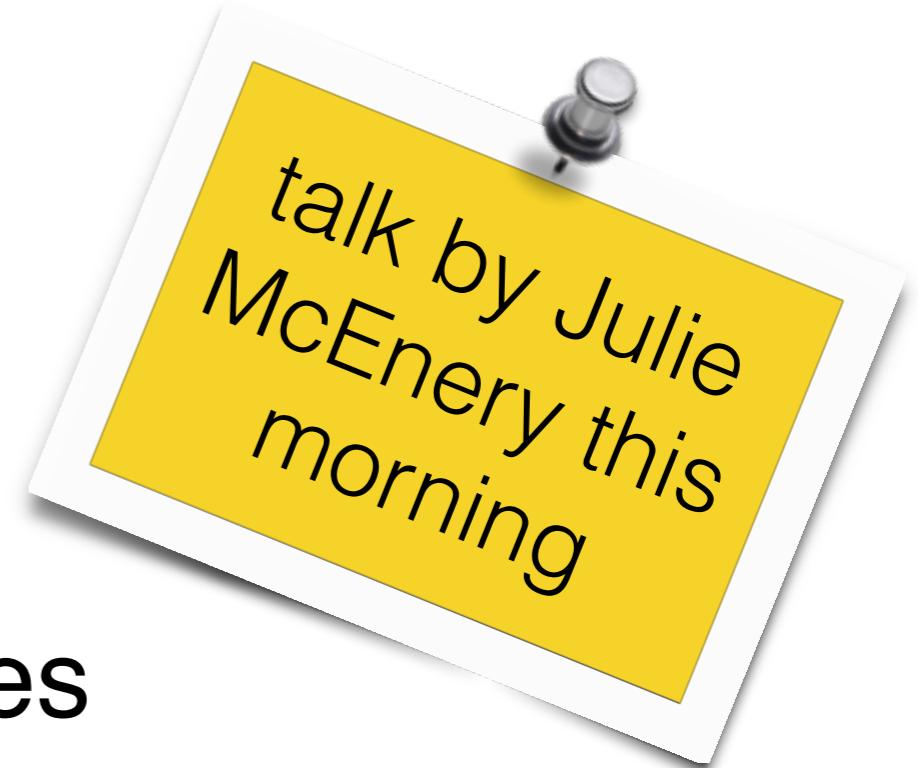
## Hands-on activity

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IAG USP

May 24, 25 2017  
High energy school @ IAG USP

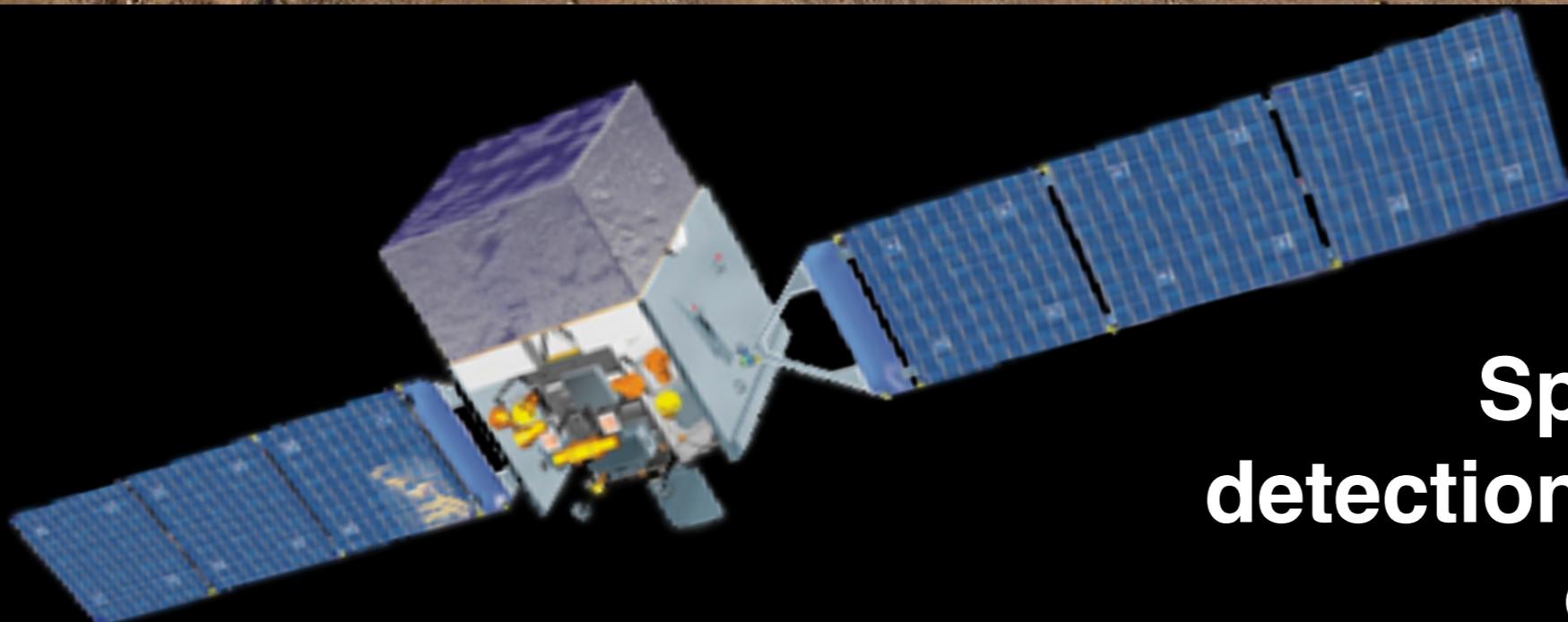
# Day 1 activities

- Fermi LAT and how it works
- Fermi LAT science
- Overview of hands-on activities
- Data and software
- **Hands-on: getting started with Fermi LAT data**



# Types of gamma-ray observatories

**Ground-based: indirect  
detection via Cherenkov  
radiation**



**Space-based: direct  
detection using techniques  
of particle physics**

# Fermi Gamma Ray Telescope: LSST for high-energy sky, 20 MeV - 300 GeV, whole sky every 3 hours

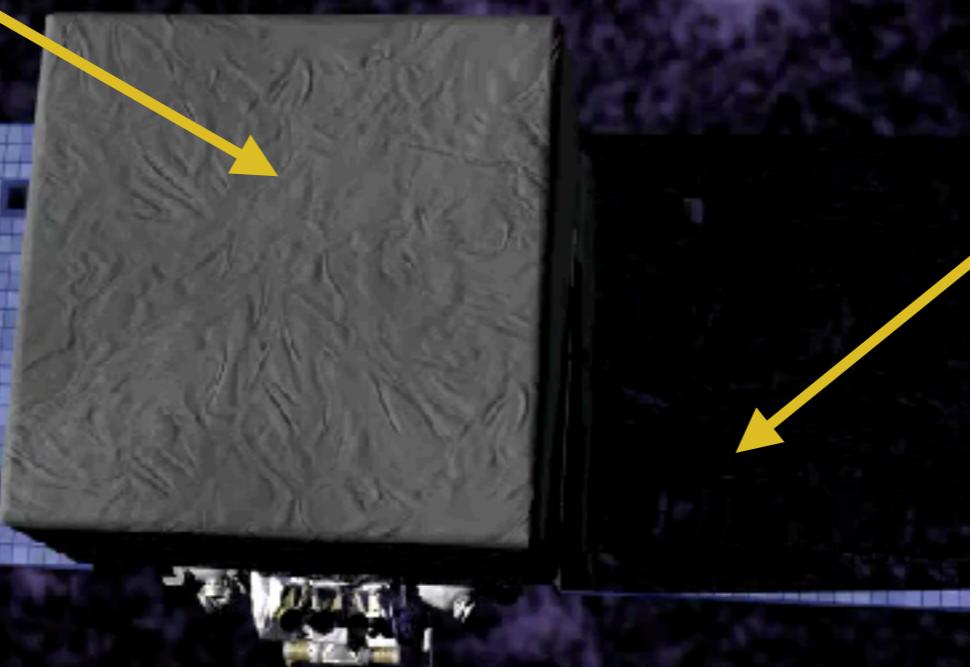
R. Nemmen

## Large Area Telescope (LAT)

Observes 20% of the sky at any instant, entire sky every 3 hrs

20 MeV - 300 GeV

- International and interagency collaboration between NASA and DOE in the US and agencies in France, Germany, Italy, Japan and Sweden



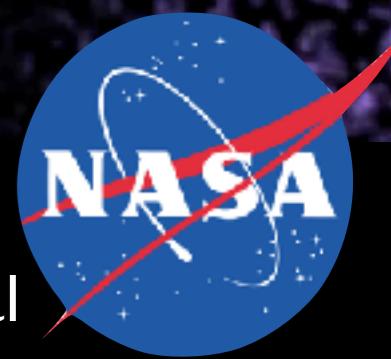
## Gamma-ray Burst Monitor (GBM)

Observes entire unocculted sky  
Detects transients from 8 keV - 40 MeV

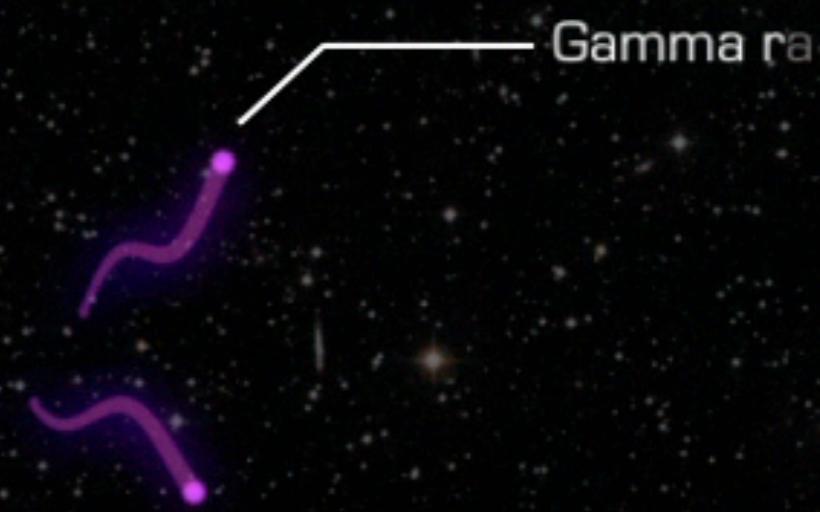
## Unique Capabilities for GeV astrophysics

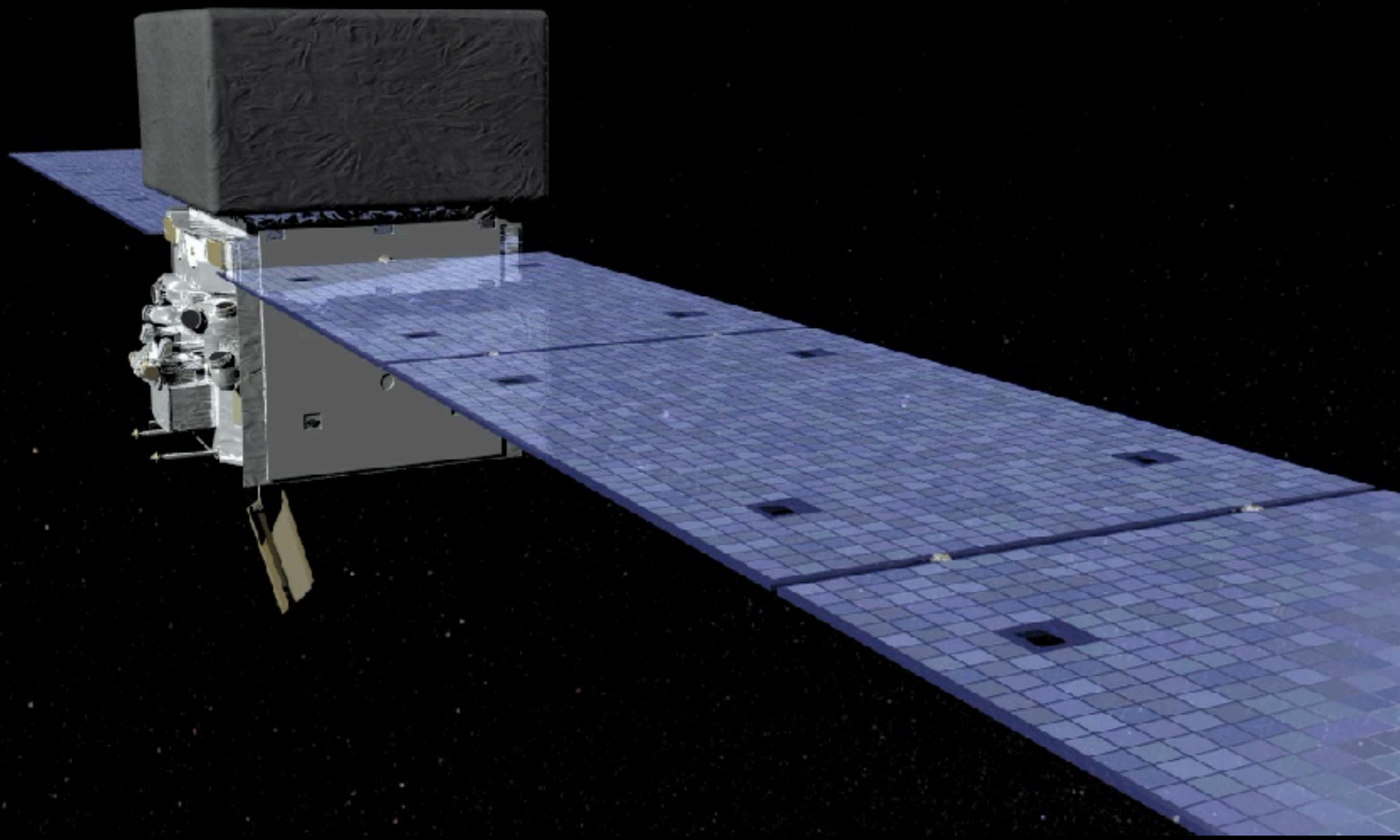
- Large effective area
- Good angular resolution
- Huge energy range
- Wide field of view

Mission Lifetime: 5 year requirement, 10 year goal

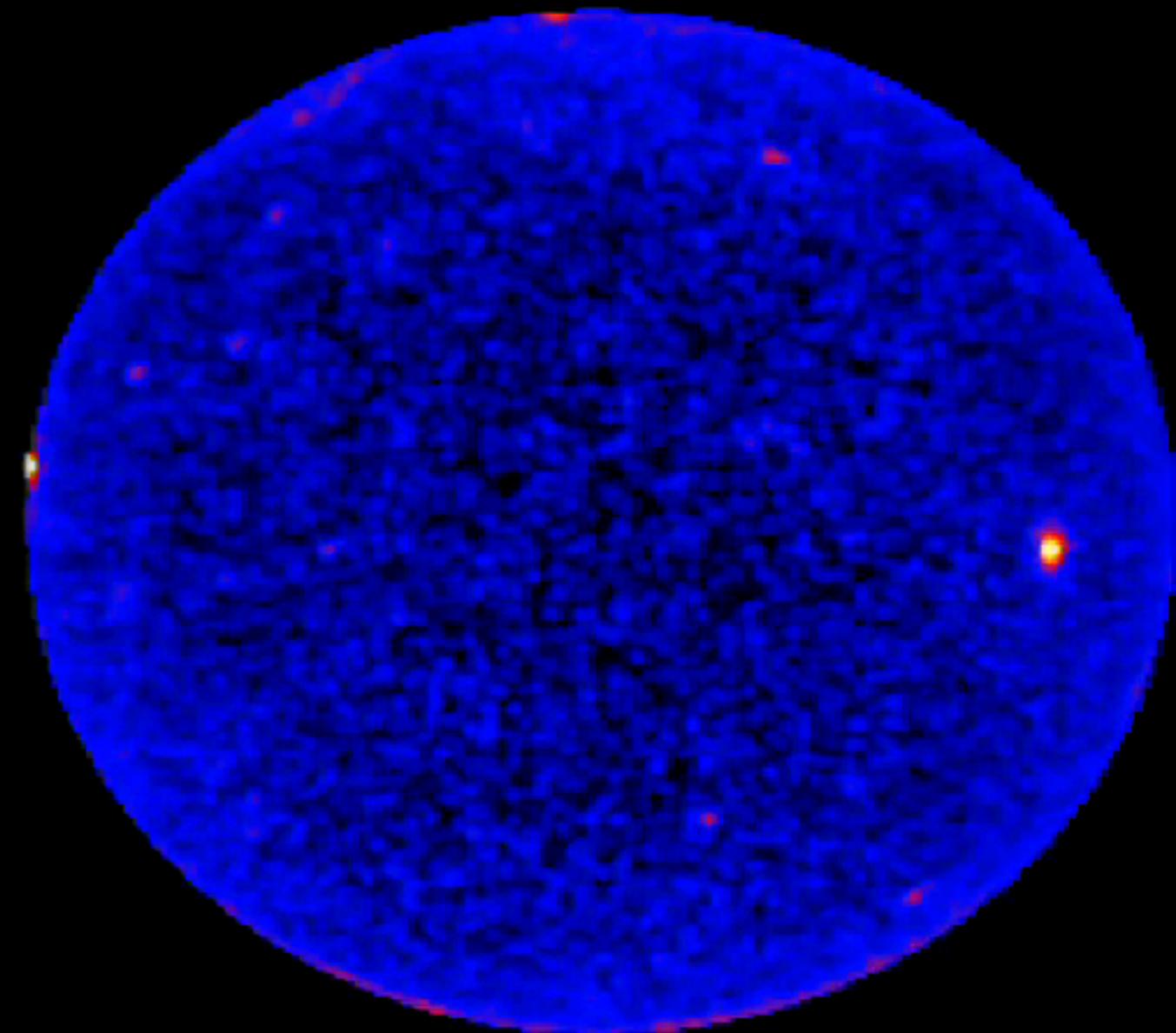
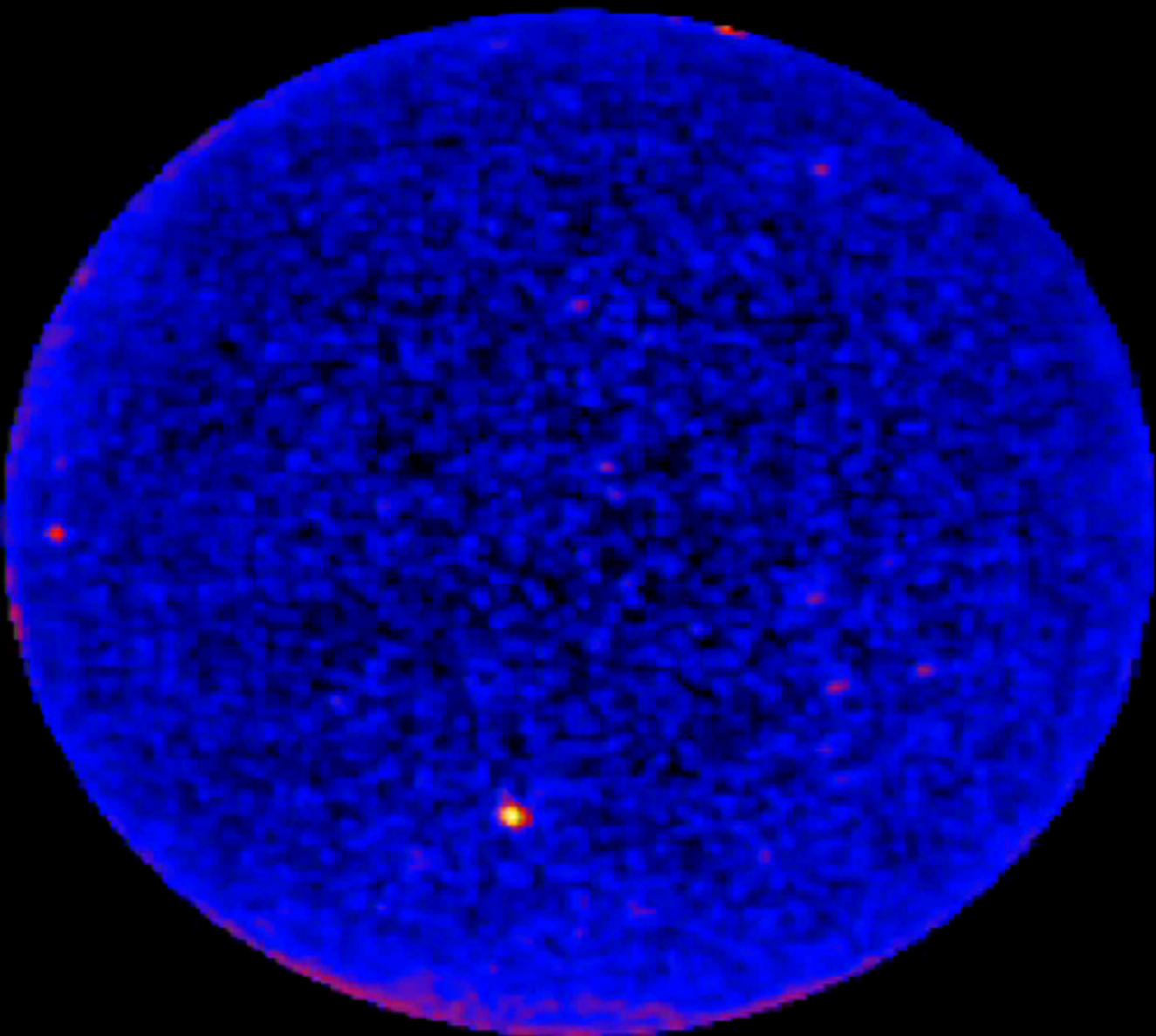


# How to Detect a Gamma-ray?

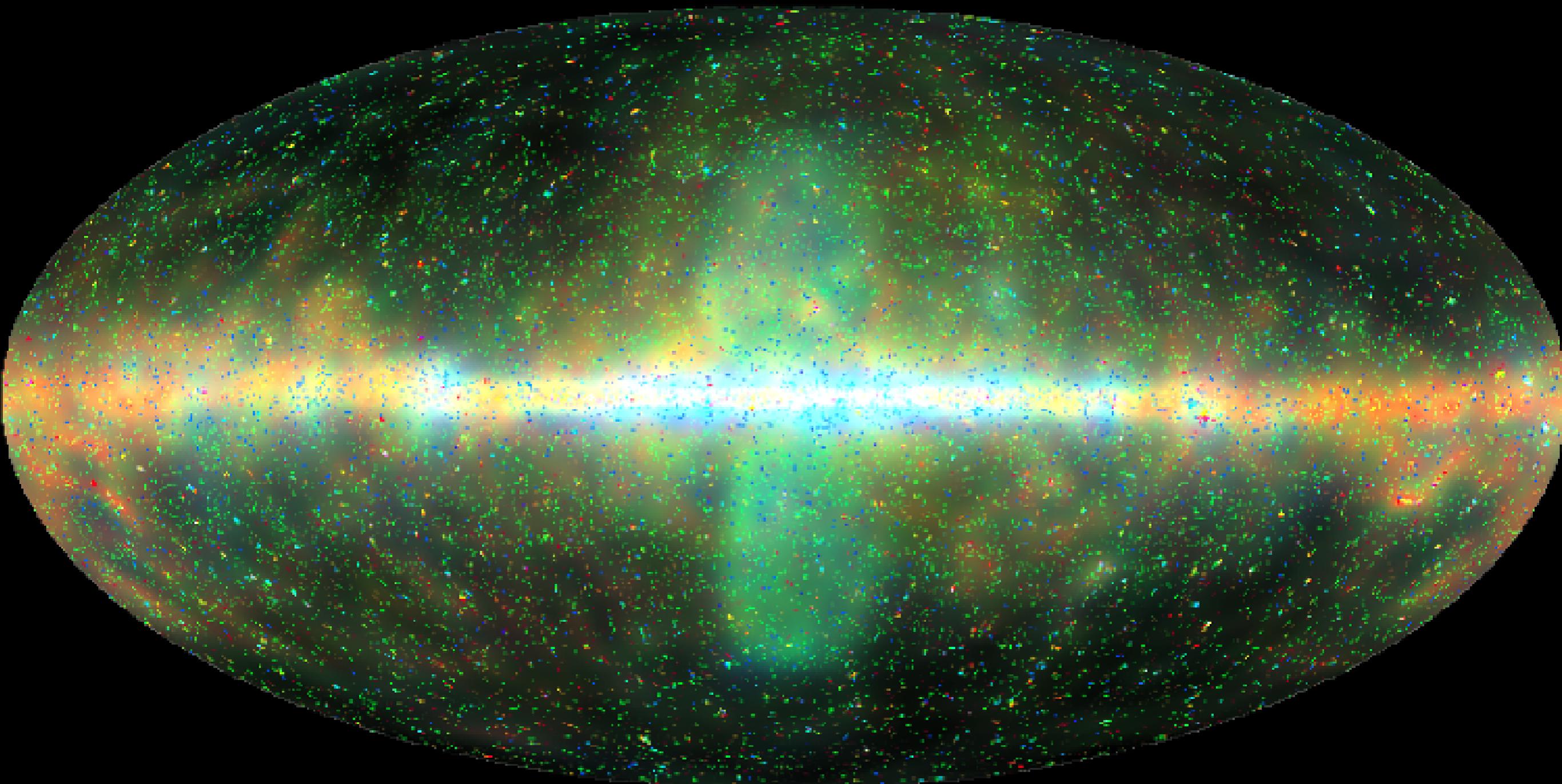




**Fermi LAT: 20 MeV - 300 GeV. Views entire sky  
every 3 hours**



# Gamma-ray sky after 7 years



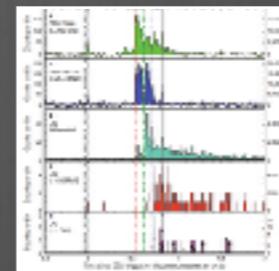
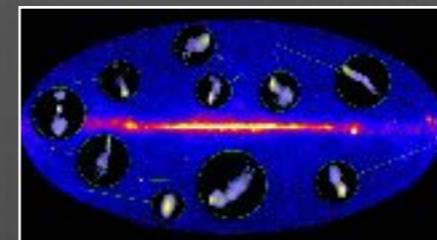
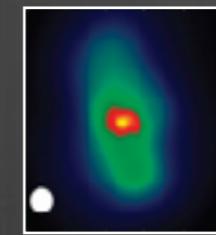
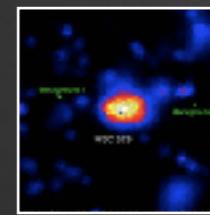
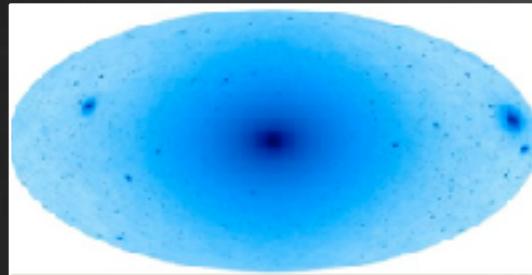
Energies 100 MeV - 300 GeV

Bühler+15

# Fermi Highlights and Discoveries

Slide: J. McEnery

Dark Matter

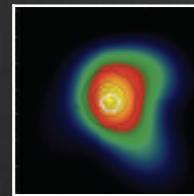


GRBs

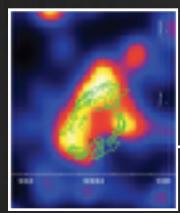
Blazars

Radio Galaxies

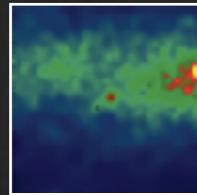
Starburst Galaxies



Globular Clusters



SNRs & PWN



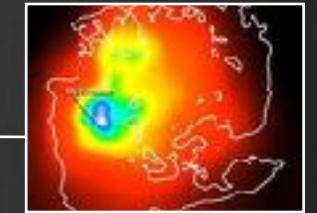
Novae

Galactic

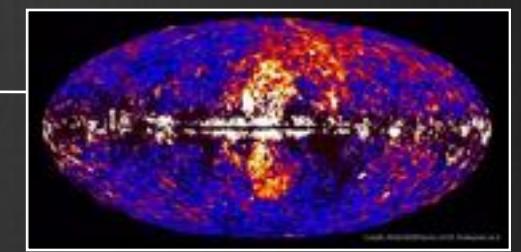
$\gamma$ -ray Binaries

Extragalactic

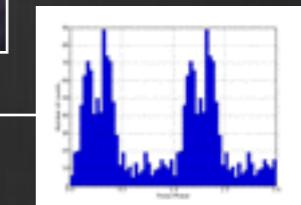
LMC & SMC



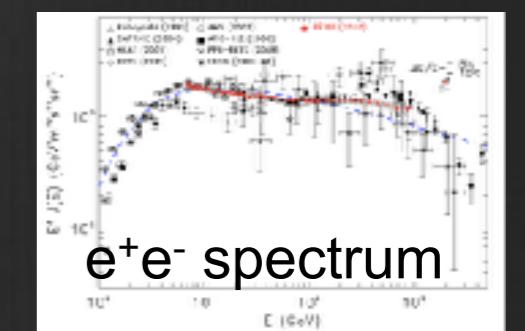
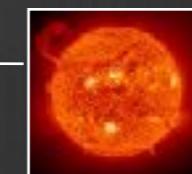
Fermi Bubbles



Pulsars: isolated, binaries, & MSPs



Sun: flares & CR interactions

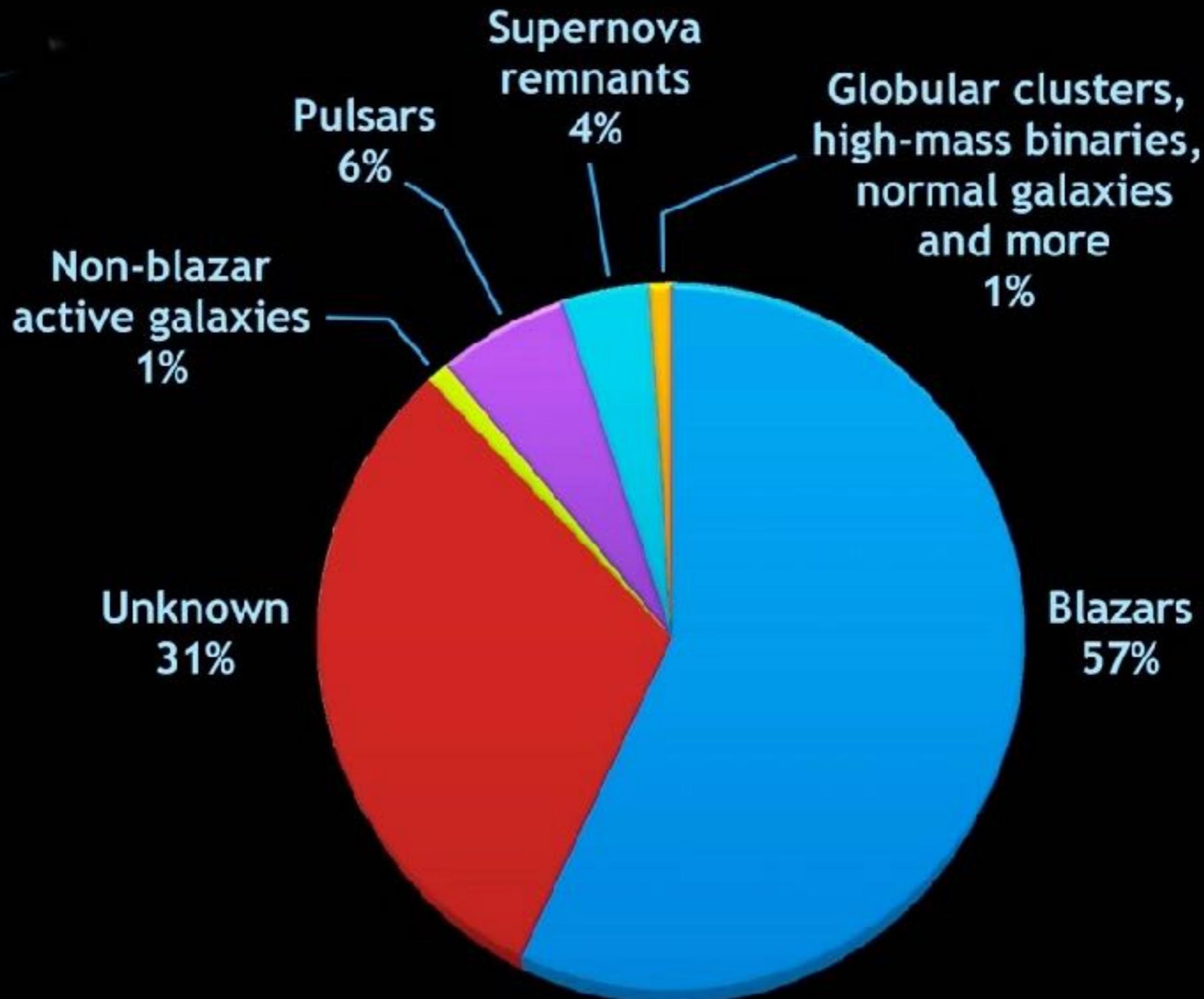


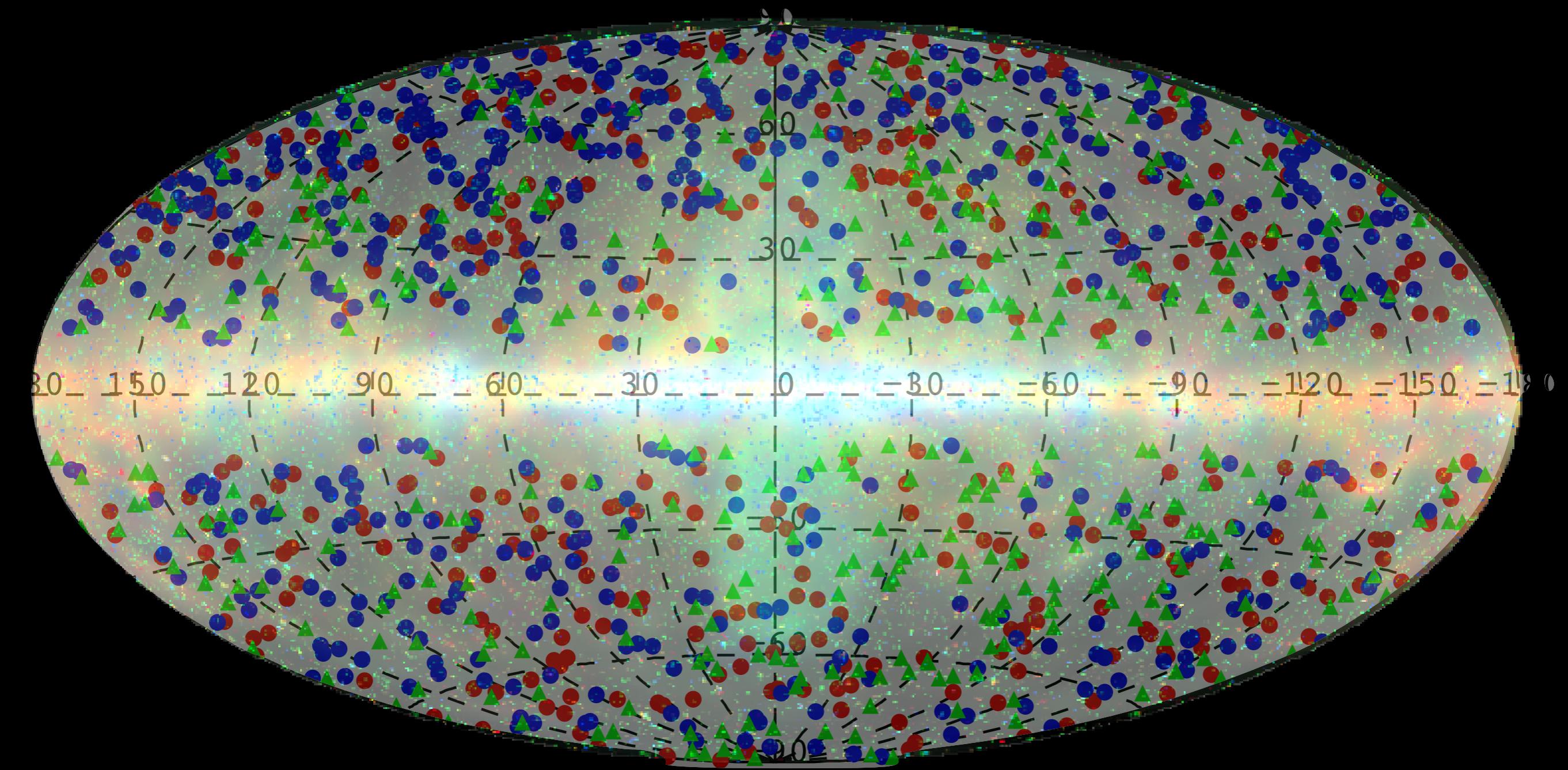
Terrestrial  $\gamma$ -ray Flashes



Unidentified Sources

# Types of sources seen by *Fermi LAT*

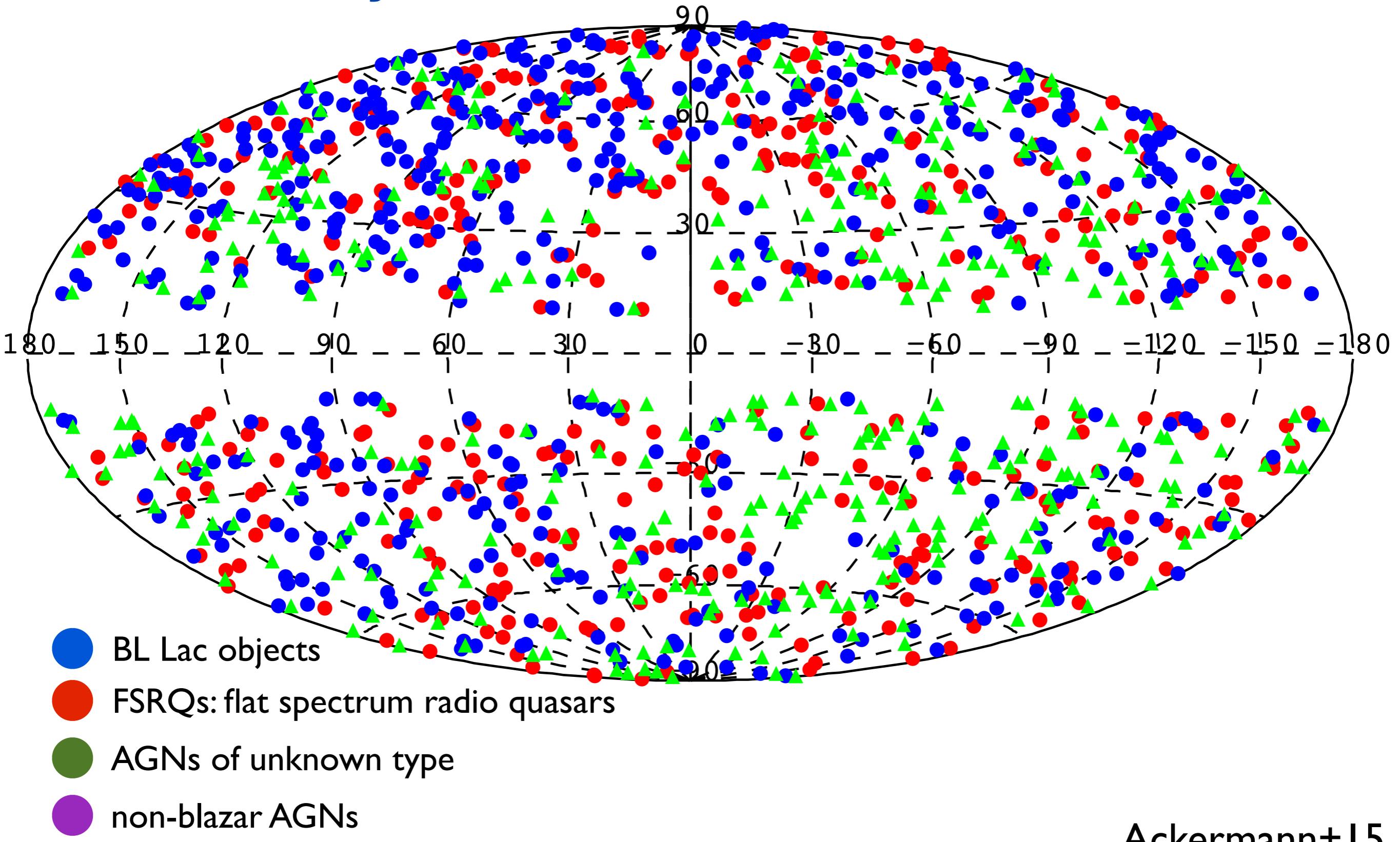




Energies 100 MeV - 300 GeV

Bühler+15

# Gamma-ray sky observed by *Fermi* LAT is dominated by blazars



Ackermann+15

# Overview of activities

## Day 1

- Introduction, overview
- Obtaining and exploring LAT data
- Inspecting the data: counts map

## Day 2

- Introduction: Basics of modeling
- Likelihood analysis of a blazar
- Create a SED
- Produce a light curve

# Fermi LAT data

**All LAT data products are public**

**Fermi Science Support Center**

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

**Data formats:**

- FITS files
- XML source models
- text-based supporting files  
(more details in the hands-on)

# Analysis software tools

- *Fermi Science Tools*: for general analysis
- *DS9*: FITS file viewer
- *Enrico*: helpful Python scripts for analysis

(more details in the hands-on)

**All required software is pre-installed in  
the VM and ready to use**

# Tutorial website

<https://github.com/rsnemmen/Fermi-LAT-tutorial>



**Please do not download large files  
during the tutorial or the WIFI network  
will *overload***

**We will distribute the software and data  
you need via USB sticks**



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	Facebook	<a href="http://facebook.com/rodrigonemmen">http://facebook.com/rodrigonemmen</a>
	Bitbucket	nemmen
	Blog	<a href="http://astropython.blogspot.com">http://astropython.blogspot.com</a>
	figshare	<a href="http://bit.ly/2fax2cT">http://bit.ly/2fax2cT</a>

Director's cut  
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