What is Fermi?

Two Instruments:

Large Area Telescope (LAT)

PI: P. Michelson (Stanford University)

20 MeV - 300 GeV

>2.5 sr FoV

Gamma-Ray Burst Monitor (GBM)

PI: W. Paciesas (NASA/MSFC)

Co-PI: J. Greiner (MPE)

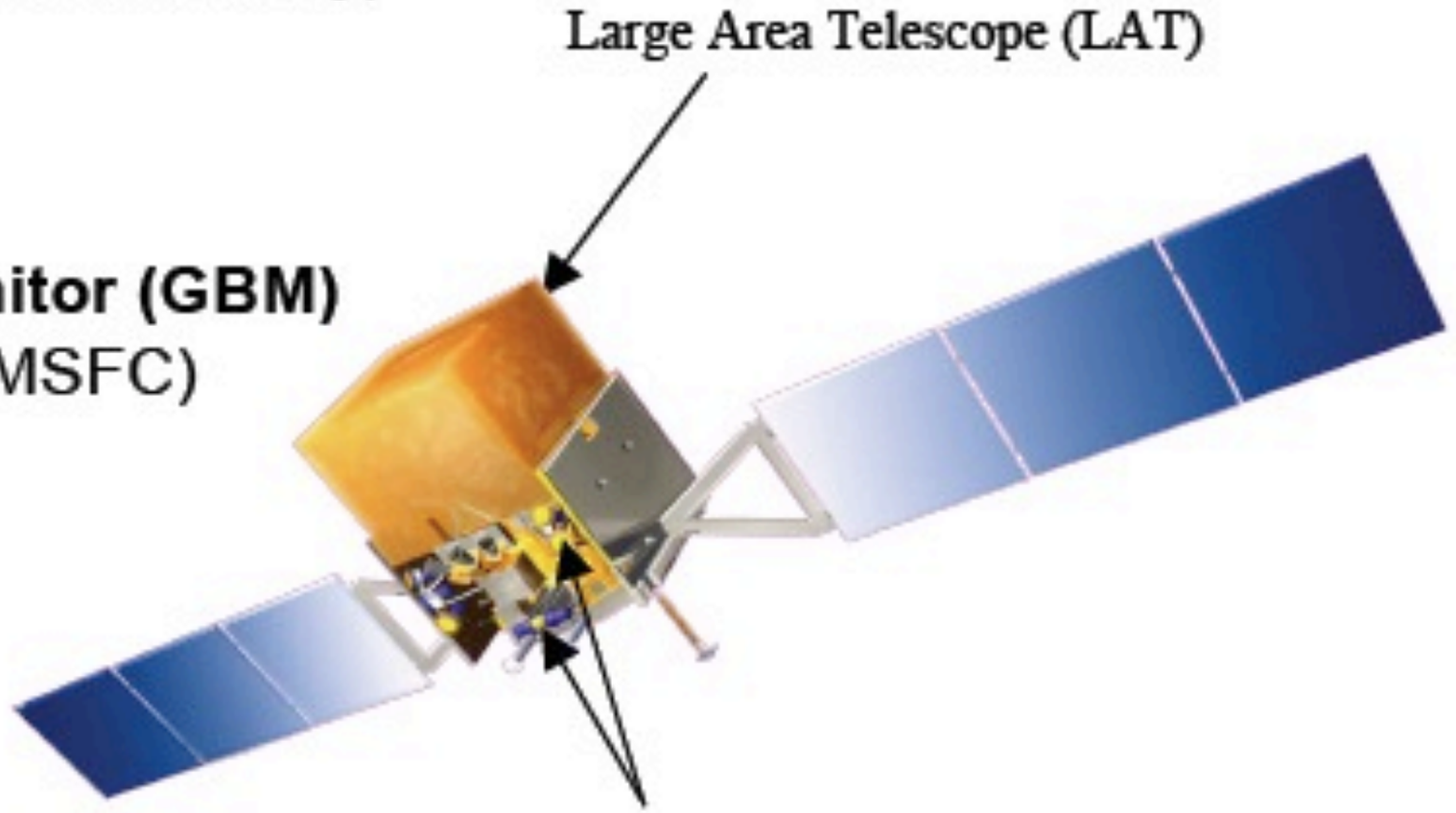
8 keV – 40 MeV

9 sr FoV

Launch: June 11 2008

Lifetime: 5 years (req)

10 years (goal)



Private vs Public

- In the old days, you need to carry out the observations by yourself and all data are private.
- Archival data become popular in high-energy astrophysics community and it is now the norm for all major telescopes around the world.
- However, there is a proprietary period (usually 1 year) and you have to wait for the public release in order to analyse the data. Archival research is still very meaningful.
- Swift and Fermi completely change the rules of the game. All data are in public domain right after the observations.
- If you are quick enough, you can beat the instrumentation team.
- You need to be VERY careful in all the analysis.

631 **INTEGRAL observation of IGR J17269-4737 / XTE J1727-476** — M. Turler, S. Paltani, N. Mowlavi (ISDC, Geneva) -- *16 Oct 2005; 13:49 UT*

630 **Classification of SNe 2005gl and 2005gm** — The Nearby Supernova Factory: N. Blanc, S. Bongard, Y. Copin, E. Gangler, L. Sauge, G. Smadja (Institut.... -- *14 Oct 2005; 23:09 UT*

629 **Infrared detection of XTE J1727-476=IGR J17269-4737** — D.Steeghs, M.A.P.Torres (CfA), K.Koviak, P.McCarthy (OCIW), P.G.Jonker (SRON/CfA) -- *13 Oct 2005; 15:38 UT*

628 RFO:**Optical Counterpart of J1726-47** — Dipankar Maitra, Bethany Cobb, Charles Bailyn, Jenica Nelan (Yale), David Gonzalez(CTIO/SMARTS) -- *12 Oct 2005; 23:19 UT*

627 **M31 Optical Transient TSS J004420.7+412311** — R. Quimby, M. Sellers, P. Hoeflich, J. C. Wheeler (University of Texas), and C. Gerardy (Imperial.... -- *12 Oct 2005; 19:30 UT*

626 **Swift/XRT observations of XTE J1727-476/IGR J17269-4737** — J. A. Kennea (PSU), D. Palmer (LANL), D. Burrows (PSU), N. Gehrels (GSFC) -- *12 Oct 2005; 17:58 UT*

625 **Swift Imaging Observation of XTE J1726-476/IGR J17269-4737** — Albert K.H. Kong (MIT) -- *12 Oct 2005; 16:48 UT*

624 RFO:**New X-ray transient IGR J17269-4737 discovered with INTEGRAL** — M. Turler (ISDC, Geneva); M. Cadolle Bel (CEA Sacaly); R. Diehl (MPE, Garching); N.-J. Westergaard (DSRI.... -- *10 Oct 2005; 15:47 UT*

623 **New X-ray Transient, XTE J1726-476** — A. M. Levine (MIT), D. Lin (MIT), and R. A. Remillard (MIT), for the ASM team at MIT and NASA/GSFC -- *10 Oct 2005; 15:03 UT*

622 **Type-I X-ray bursts from XTE J1739-285** — S. Brandt (DNSC, Denmark), E. Kuulkers (ESA/ESAC, Spain), A. Bazzano (IASF/INAF, Rome), T.J.-L. Courvoisier.... -- *8 Oct 2005; 22:36 UT*

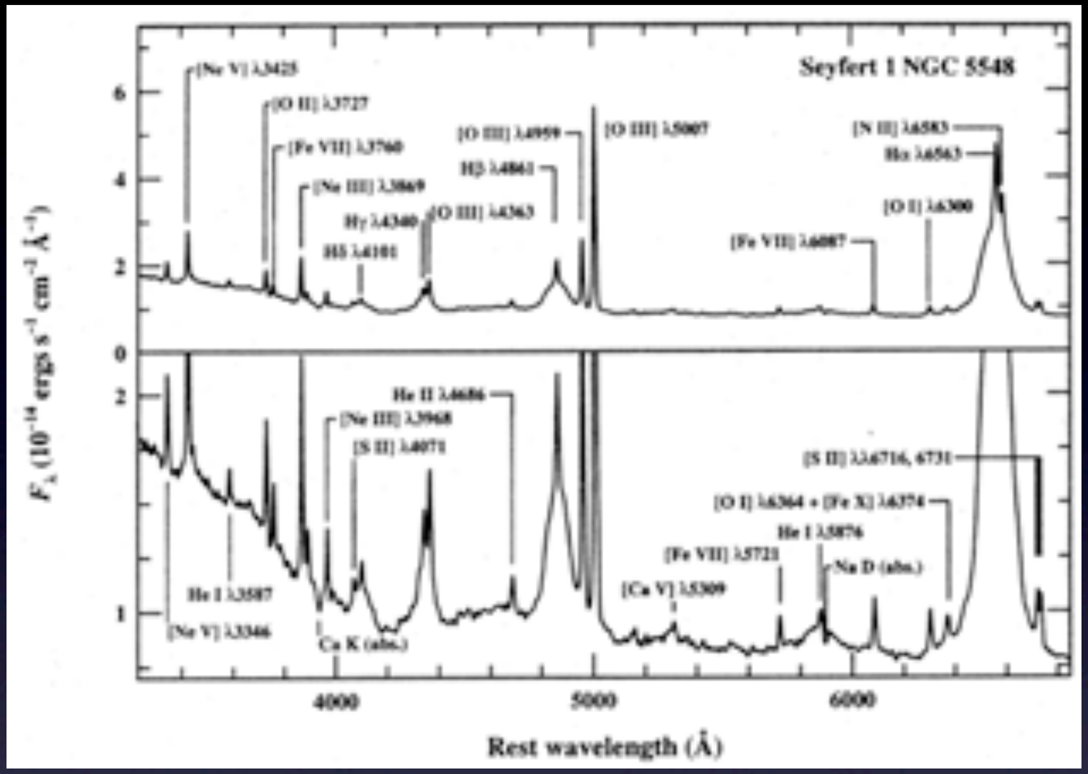
621 **Radio Observations of SN2005bf** — A. M. Soderberg, S. R. Kulkarni (Caltech) and D. A. Frail (NRAO) -- *6 Oct 2005; 20:28 UT*

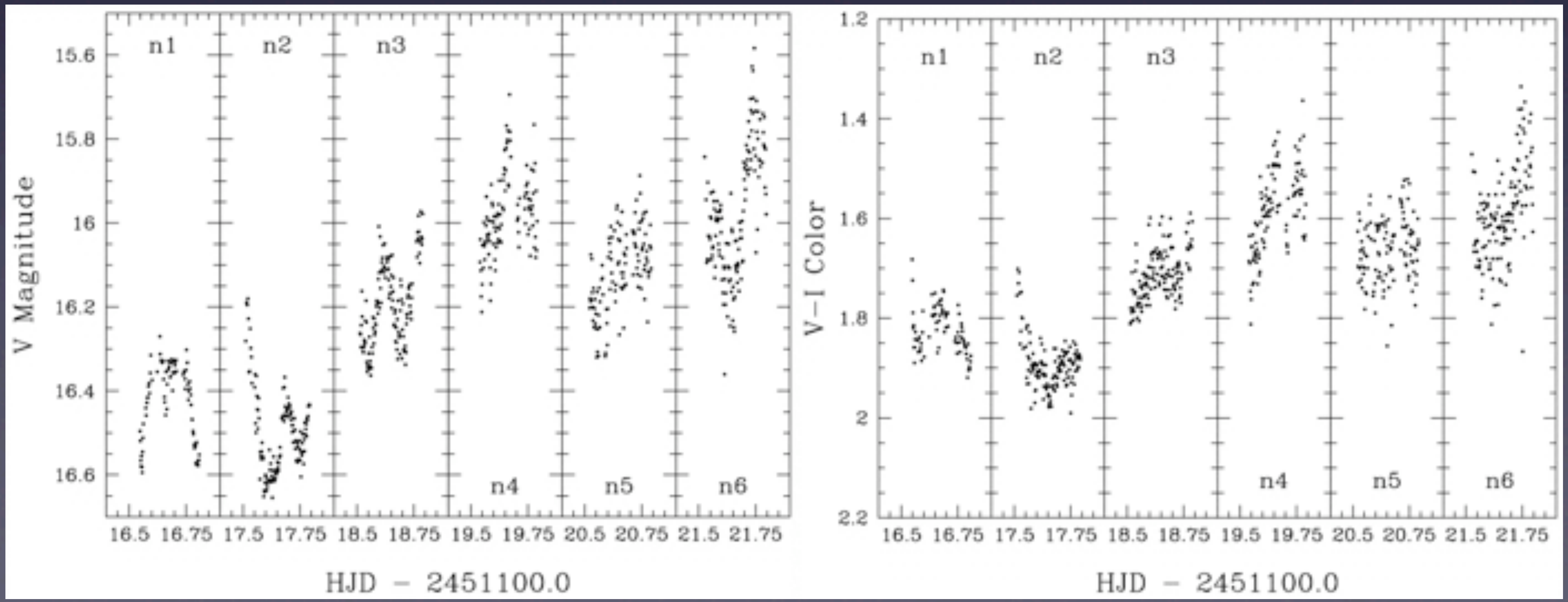
620 **Three Type Ia Supernovae: SN 2005eu, SNF20051003-003, SNF20051004-001** — The Nearby Supernova Factory: G. Aldering, S. Bailey, D. Kocevski, B. C. Lee, S. Loken, P. Nugent, S..... -- *6 Oct 2005; 19:07 UT*

Tips to beat the big guys

- Work hard (Genius is 1% talent and 99% hard work - Albert Einstein)
- Identify a good strategy especially for time critical events
- Read the manuals; High-energy astrophysics community usually provides the best user manuals for their instrumentations.
- Read papers written by the instrumentation team.
- Read not only the users manuals, but also the calibration documents.
- Reproduce some known results and build up your confidence.

Image, Spectrum, and Lightcurve





Event List

- High-energy astronomers usually call their data as "event list".
- Event list contains spatial, spectral, and timing information of each photon. Therefore we can study the properties of every photon. This is called photon counting.
- It is unusual in optical astronomy. Why?
- It is common that we can have images, spectra, and lightcurves at the same time. For optical astronomers, they may have to replace their instruments to achieve this.

All-Sky Survey Mode vs Pointed Observation

- In survey mode, the LAT observes the entire sky every two orbits (~3 hours). Each point on the sky receives ~30 min exposure.
- For pointed observations, we can specify the targets and take a long exposure.
- For comparison, Chandra, XMM, Suzaku, and Swift are performing pointed observations.

FITS Data Files

- Standard format for astronomical data
- FITS stands for Flexible Image Transport System
- Designed to store scientific data sets consisting of multidimensional arrays such as:
  - 1-D spectra
  - 2-D images
  - 3-D data cubes
  - Tables containing rows and columns of data
- "Header" to store information about the dataset

Three steps to produce data products

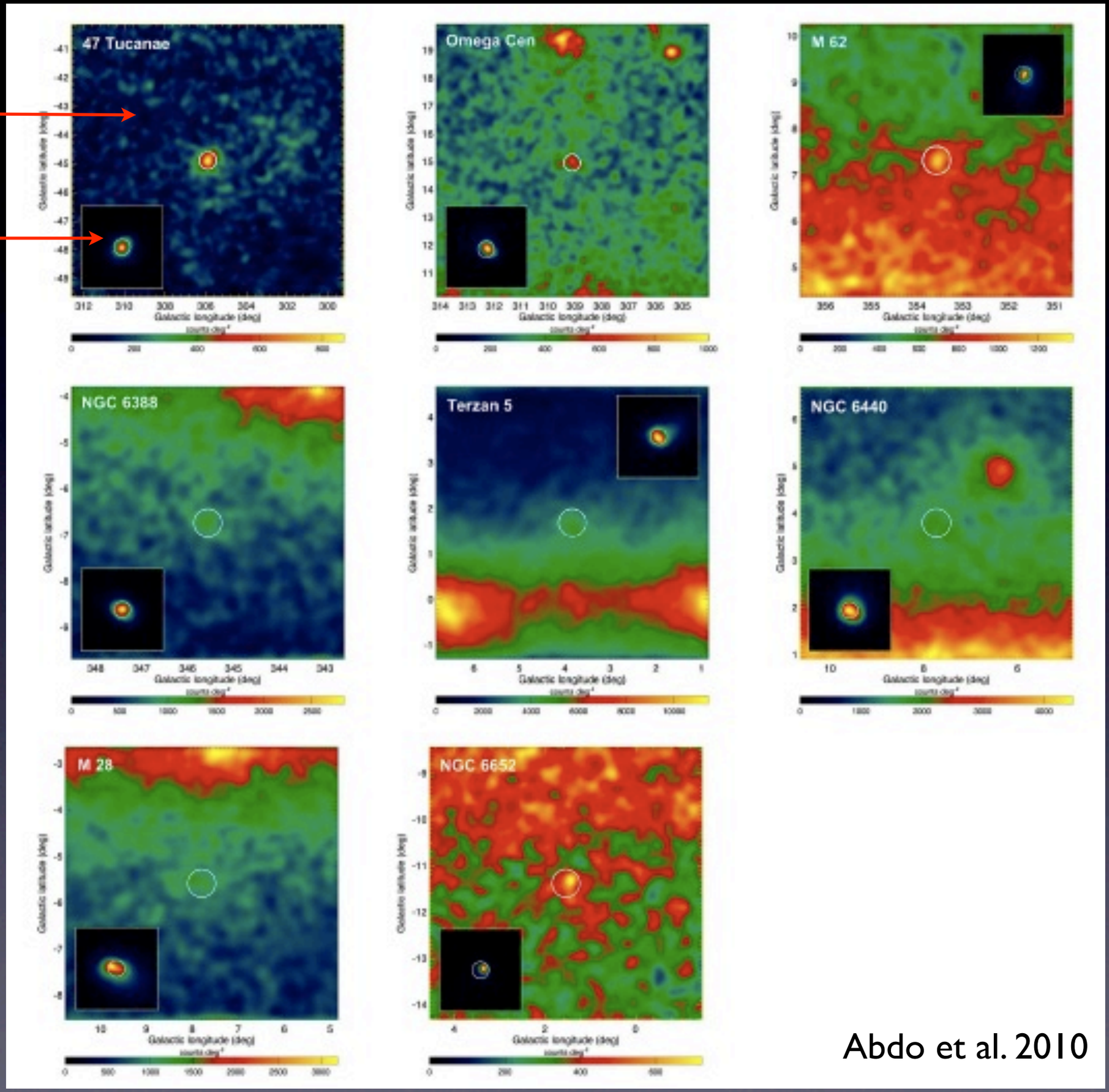
- gtselect [select region of interest (ROI), energy range, time range,.....]
- gtmktime [select good time interval (GTI)]
- gtbin (image: count map; spectrum; lightcurve)

Source Finding

- To find a source in some images can be quite tricky especially in the Galactic plane.
- We need to subtract all known Fermi source and diffuse emission.
- We then look for excess in the source subtracted image (TS Map).

Image

TS map
(significance map)



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TS Map

- TS map is probably one of the most time consuming processes in Fermi data analysis
- It is easy to take 12-24 hours to finish a stamp-size image (20x20 pixels). In my Terzan 5 paper, the map took almost a week with a MacPro.
- Four steps to produce a TS map. gtltcube (take ~3 hours); gtexpmap; define model file; gttsmap
- Ideally, TS map should be done after the spectral fitting because you then have better spectral parameters to describe all the nearby sources around the target.

gttsmap

Event data file[grs1915_0.2-100gti.fits]
Spacecraft data file[L10061811030E0D2F37E49_SC00.fits]
Exposure map file[expMap.fits]
Exposure hypercube file[expCube.fits]
Source model file[mymodel.xml]
TS map file name[TSMap.fits]
Response functions to use[P6_V3_DIFFUSE]
Optimizer (LBFGS|MINUIT|DRMNGB) [MINUIT]
Fit tolerance[1e-05]
Number of X axis pixels[20]
Number of Y axis pixels[20]
Image scale (in degrees/pixel)[0.2]
Coordinate system (CEL|GAL) [CEL]
X-coordinate of image center in degrees (RA or l)[288.798333]
Y-coordinate of image center in degrees (Dec or b)[10.945556]
Projection method (AIT|ARC|CAR|GLS|MER|NCP|SIN|STG|TAN) [STG]

Model File: terzan5model.xml

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