Spectral Index in the Unknown γ-Ray Sky

Seth Bruzewski
Candidacy
MJD 58900
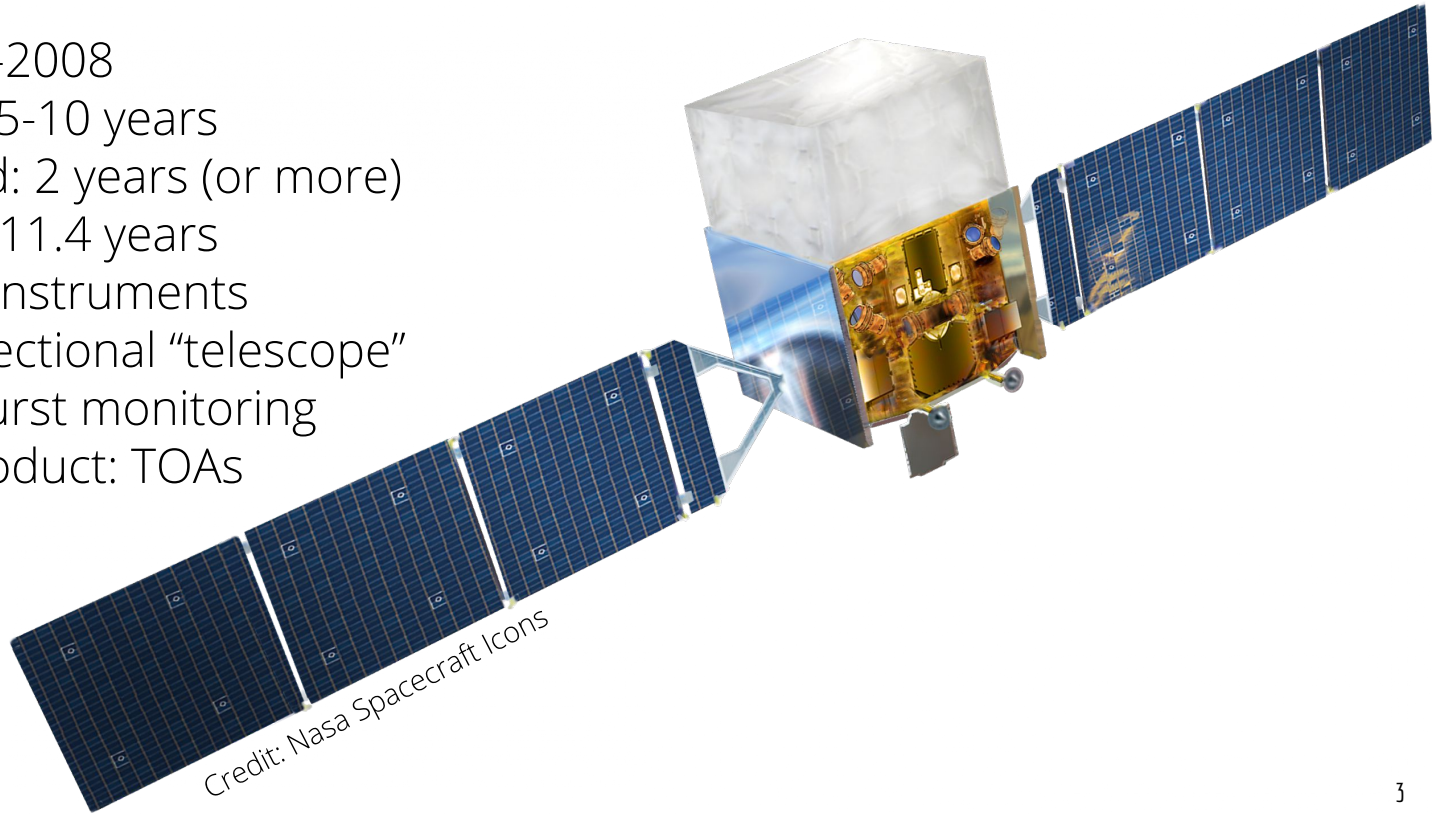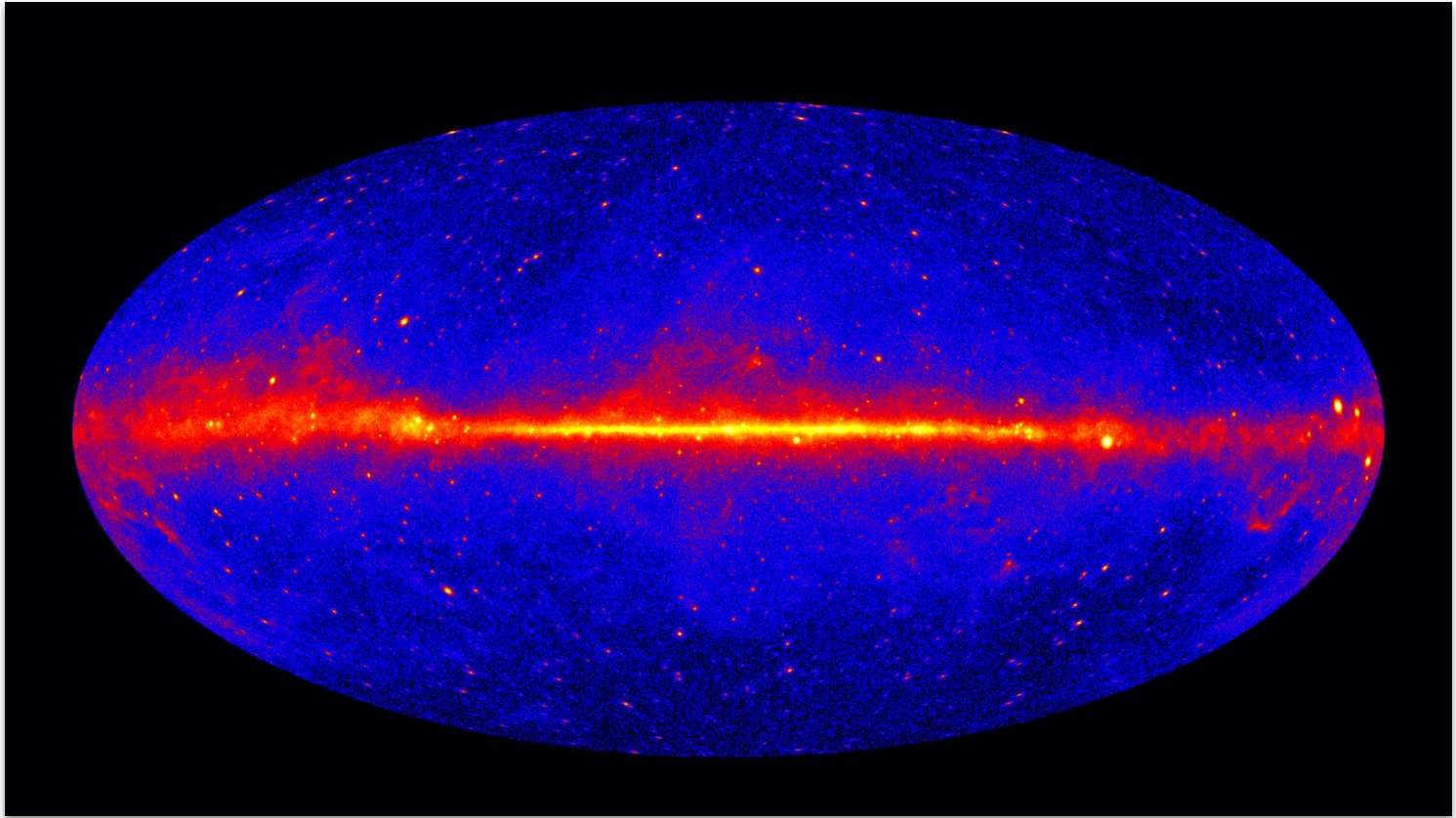
1. Background

Fermi Gamma-Ray Space Telescope

- Launched 06-2008
  - Mission: 5-10 years
  - Extended: 2 years (or more)
  - Elapsed: 11.4 years
- Two primary instruments
  - LAT - Directional "telescope"
  - GBM - Burst monitoring
- Main data product: TOAs
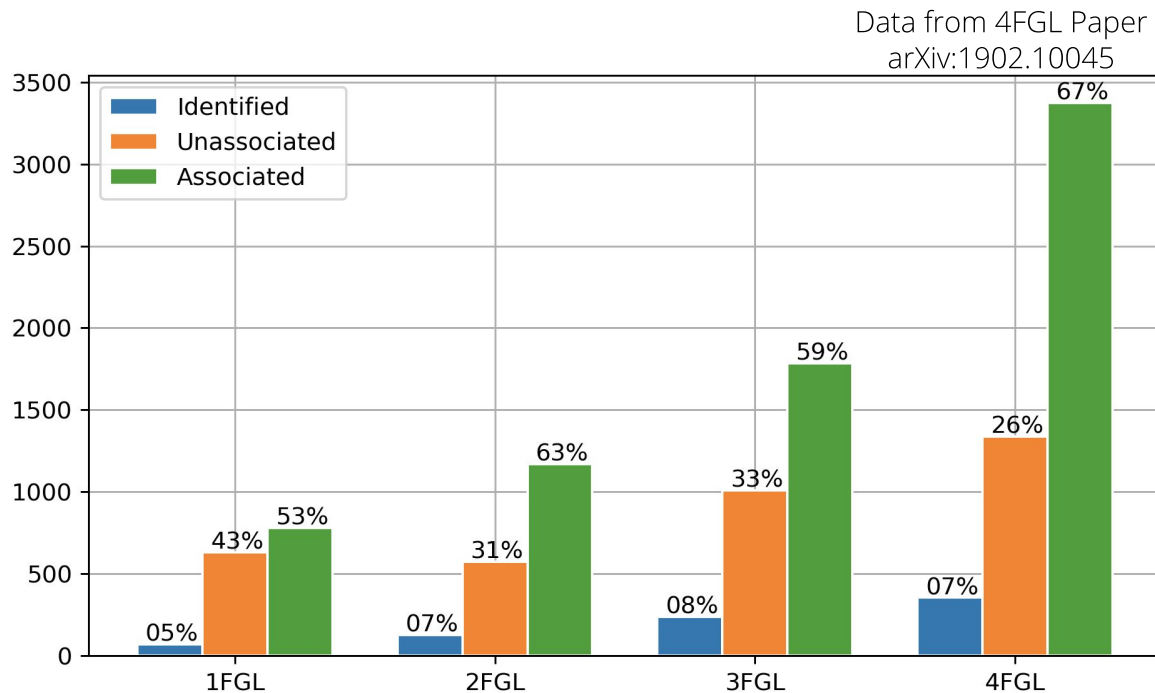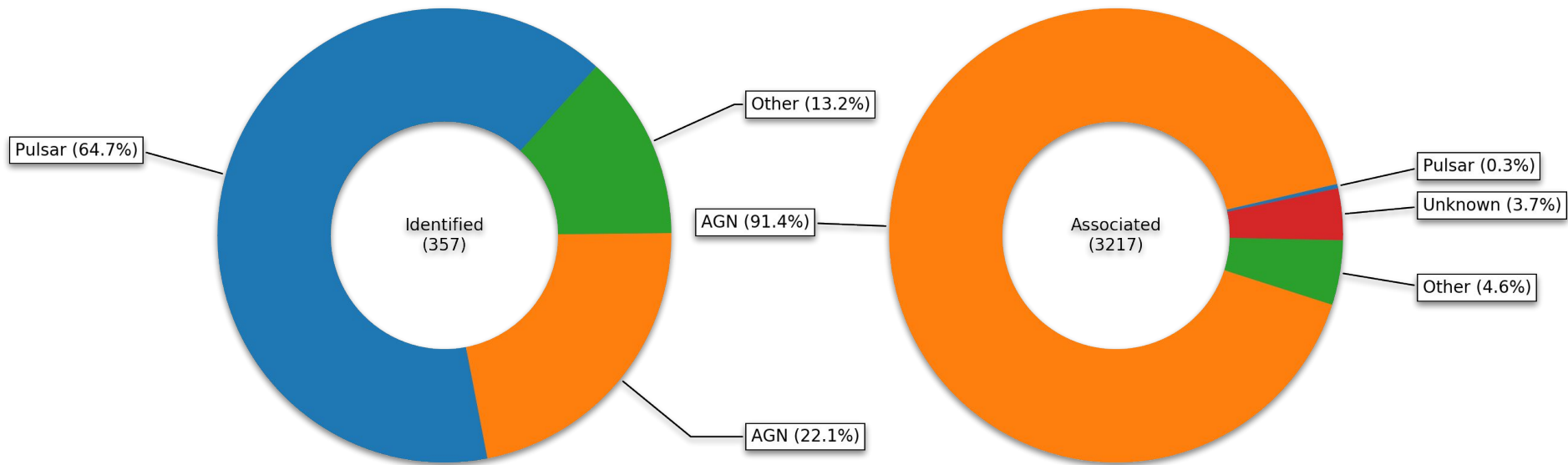
Credit: Nasa Spacecraft Icons

The Gamma-Ray Sky

Credit: NASA Goddard Media Studios

The FGL Catalogs

- FGL = Fermi Gamma-ray LAT
- Releases about every 2^n years
  - Delta ➡️ 5FGL
- 3 Groups:
  - Identified
  - Unassociated
  - Associated

Gamma-Ray Pie
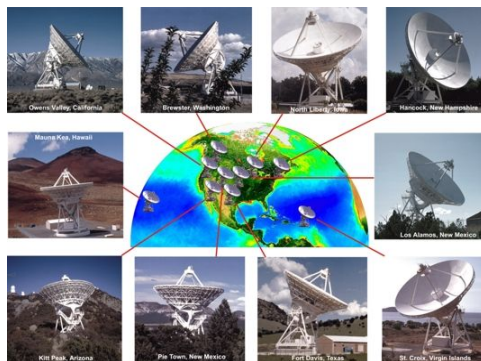
2. Unassociate Field Searches

Previous Work

- VLA/ATCA survey of unassociated sources at 5/7 GHz
- Hunting for AGN
  - 10x deeper than previous surveys
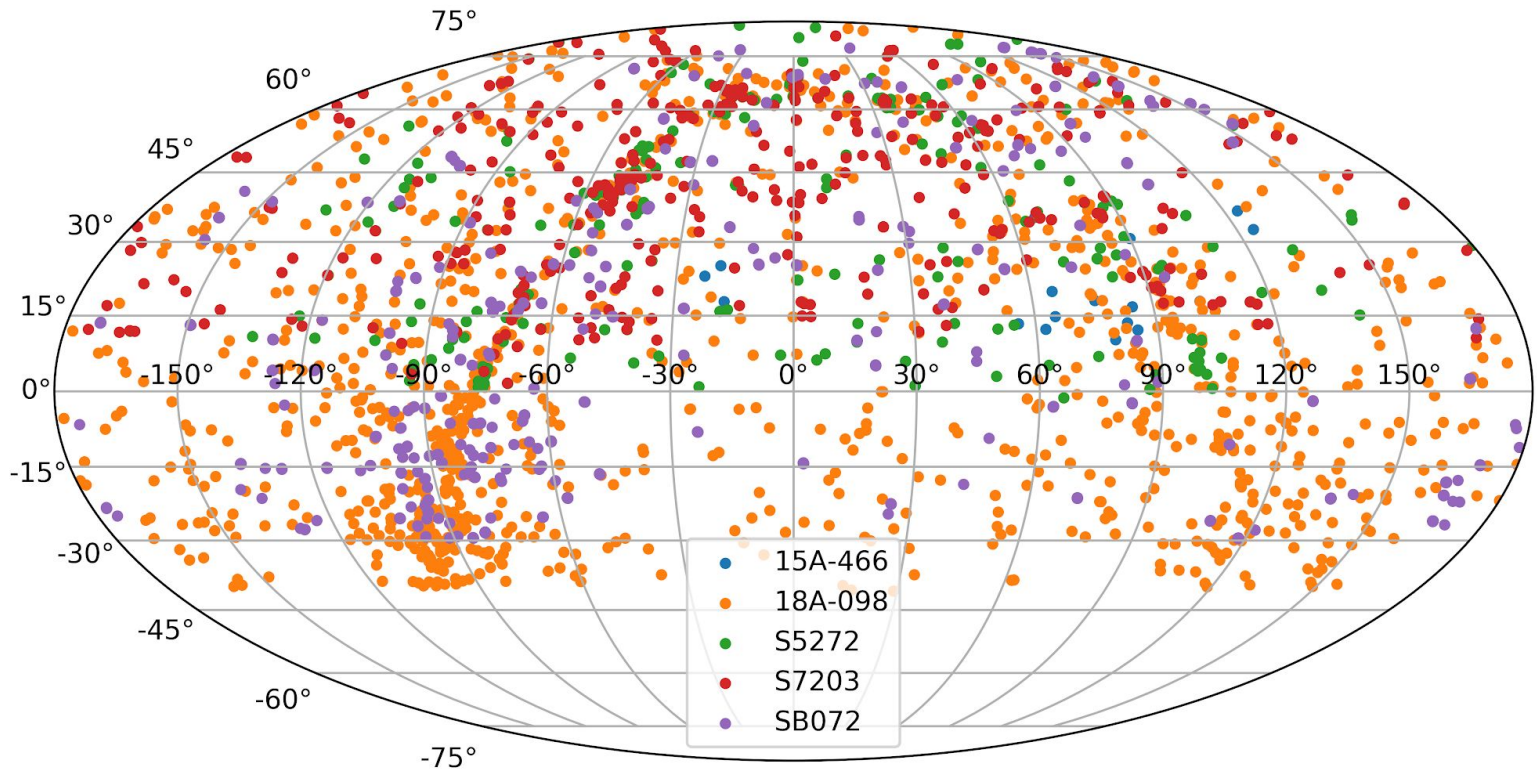- AIPS Source Fitting
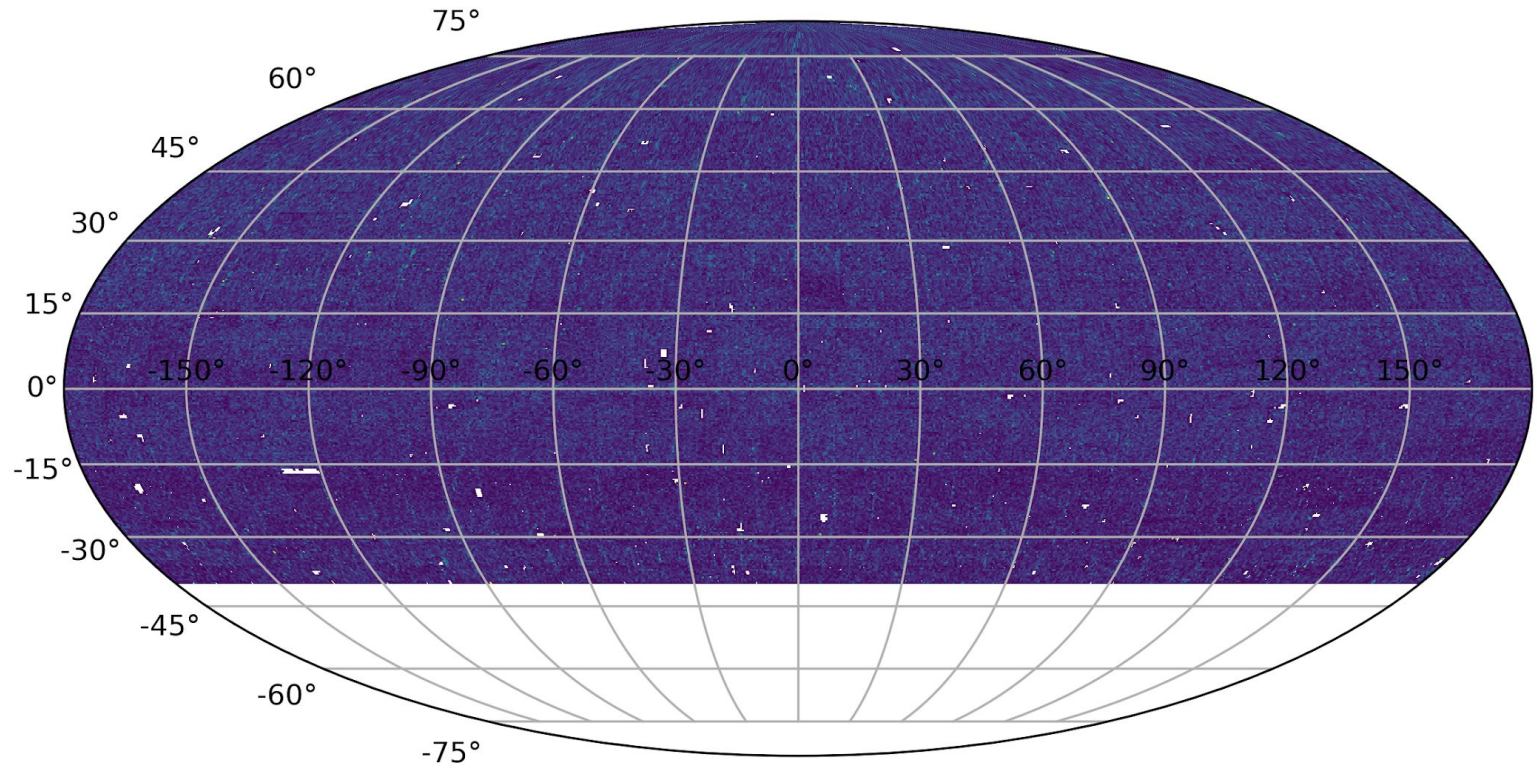- Two sub-bands
  - Spectral index
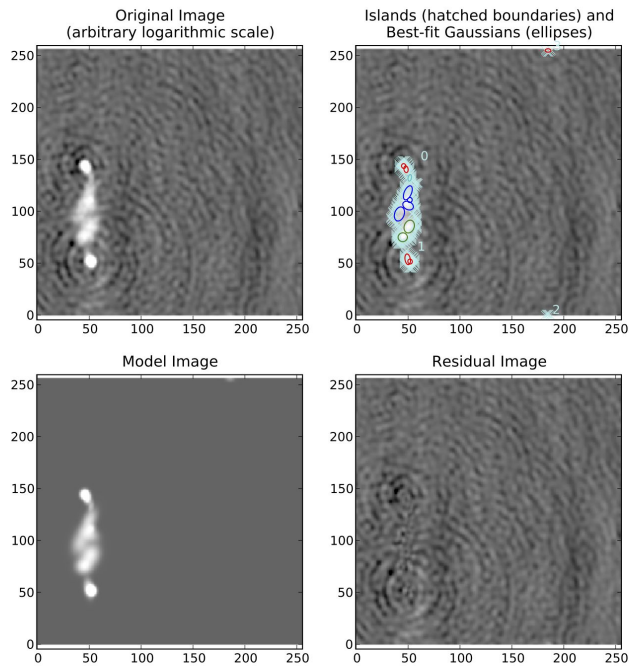

Above: VLA
Below: VLBA

Above: ATCA
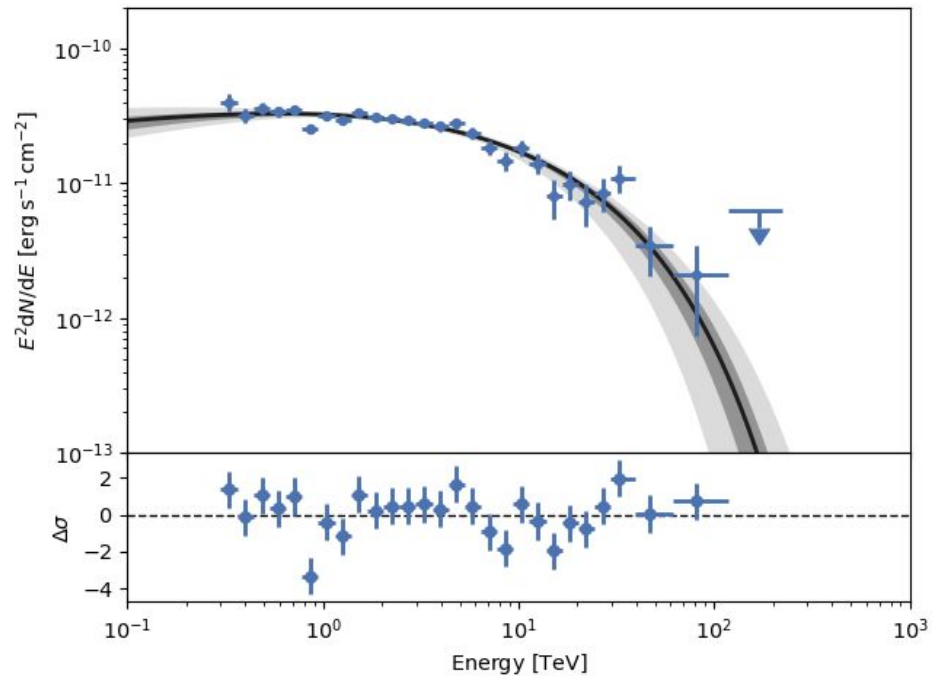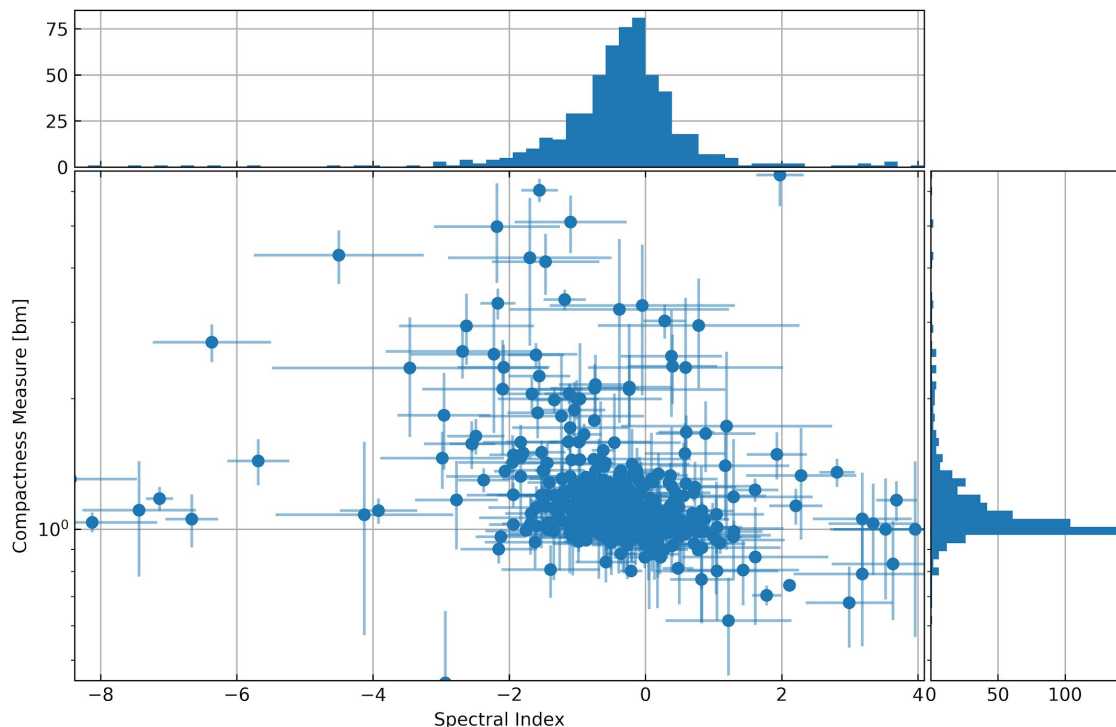Below: LBA

Previous Pointings

VLASS / V-LASS / VLA-S-S

PyBDSF

Naima

Getting to Spectral Information

Date Product 1: Sources

- For AGN
  - Flat spectrum
  - Follow-up
  - More on that soon
- For PSRs
  - Frail 2017
  - 'Image based'
  - Spectral Index
    - Bates et al 2013
    - arXiv:1302.2053

Data Product 2: Missed Field Catalog

- Two problems:
  - Sources 'move'
  - Big sources

- Generate list of fractional coverages

- Know what to hit with follow-up
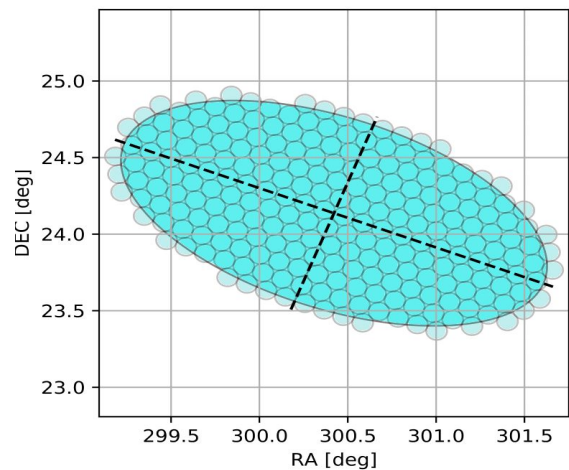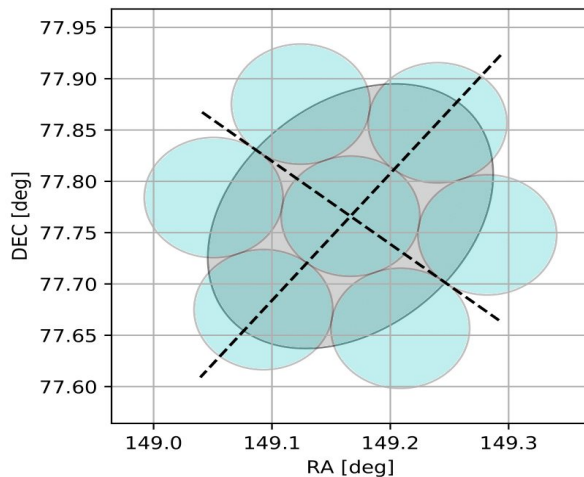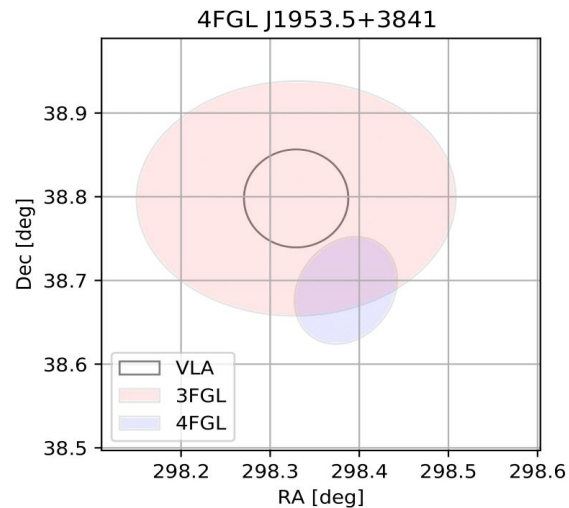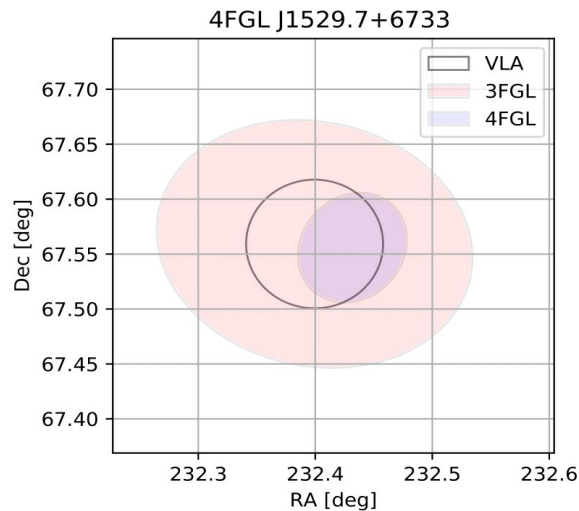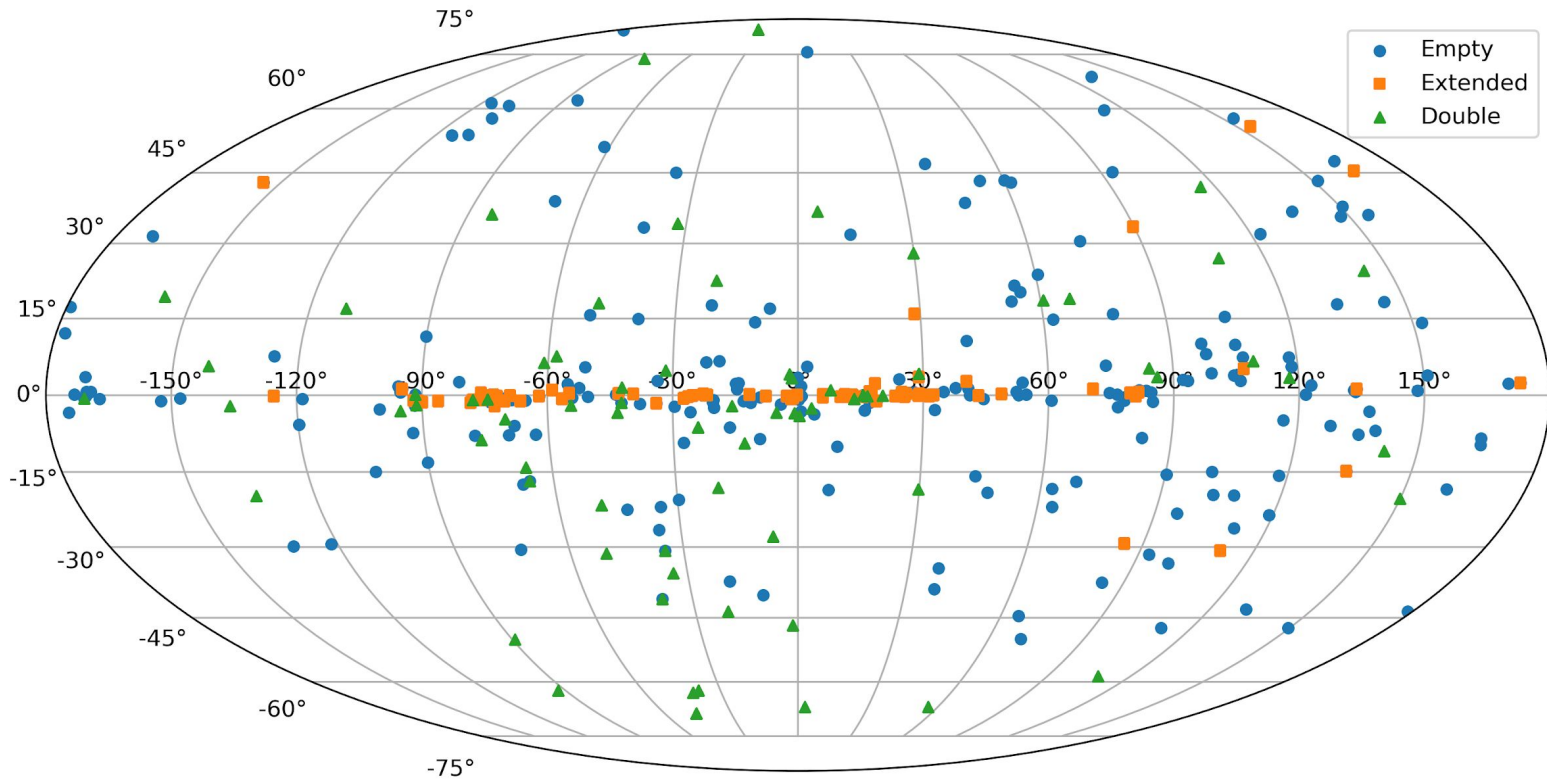
Data Product 3: Empty Fields

Recreated from Schinzel
et al 2017

3. Follow-up

AGN Follow-up

- VLBA/LBA targets sources inside ellipses
- Expect parsec scale emission from AGN
- Associate via likelihood (Λ > 8)

$$\Lambda \propto \frac{e^{-\frac{d^2}{2\sigma^2}}}{d^2} S^{1.2088}$$

Credit: Schinzel et al 2017
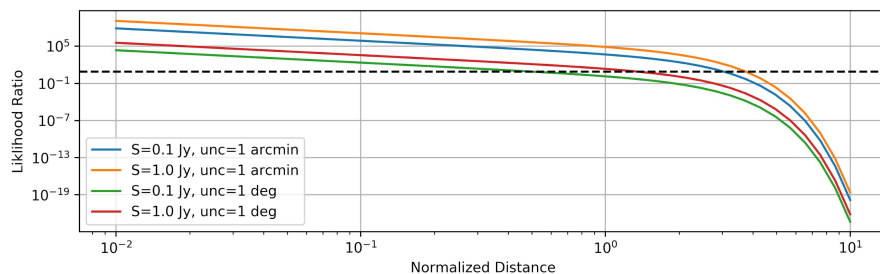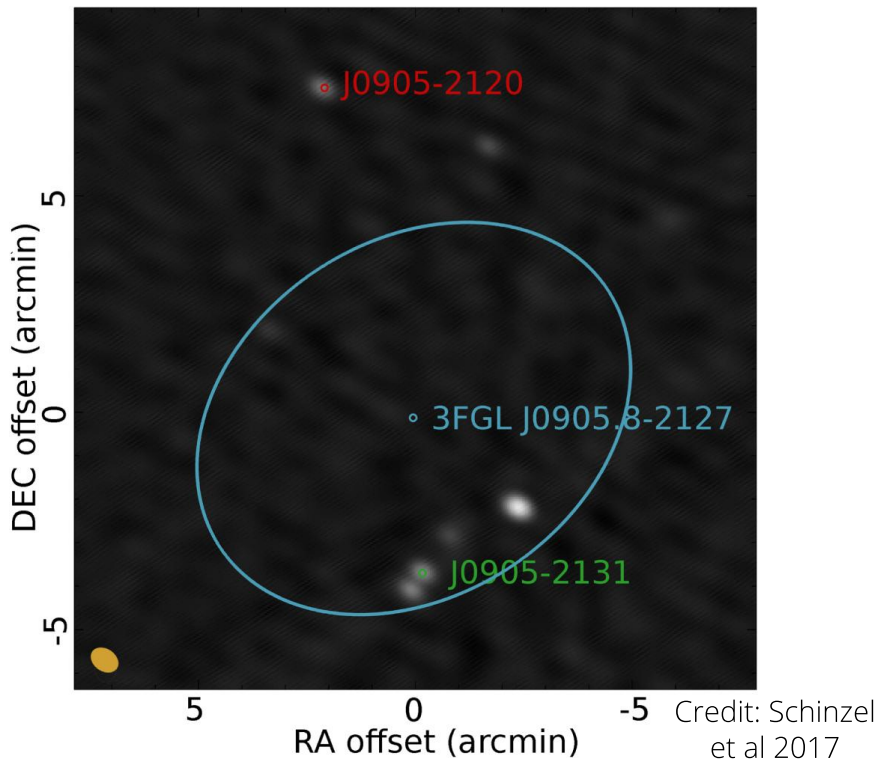
Pulsar Follow-up

- Find steep-spectrum PSR candidate
- Work with Pulsar Search Consortium
  - arXiv:1205.3089
- E@H can search gamma-ray better
- Can search for pulsations with:
  - Single Dish: Arecibo, Effelsberg, GBT
  - Arrays: LWA!
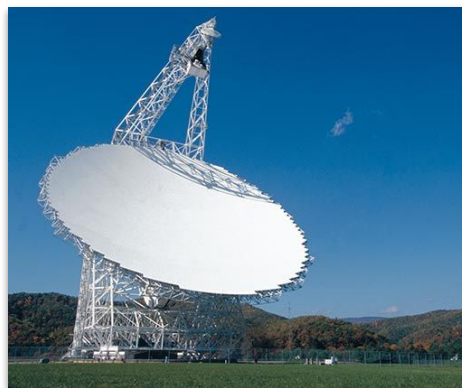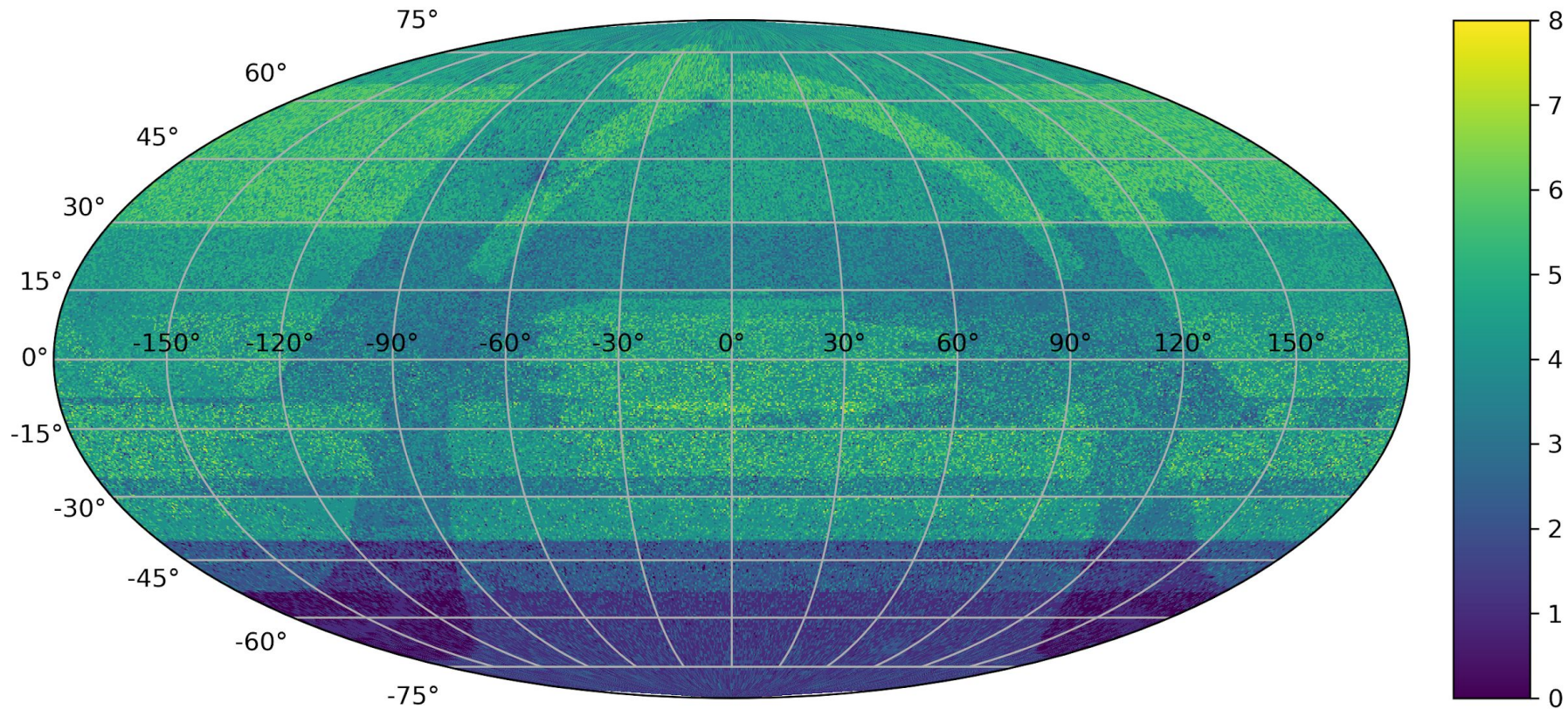
Future Prospects

8. Questions?

| Description	Identified		Associated	
	Designator	Number	Designator	Number
Pulsar, identified by pulsations	PSR	231	...	...
Pulsar, no pulsations seen in LAT yet	...	...	psr	10
Pulsar wind nebula	PWN	12	pwn	6
Supernova remnant	SNR	24	snr	16
Supernova remnant / Pulsar wind nebula	SPP	0	spp	92
Globular cluster	GLC	0	glc	30
Star-forming region	SFR	3	sfr	0
High-mass binary	HMB	5	hmb	3
Low-mass binary	LMB	1	lmb	1
Binary	BIN	1	bin	0
Nova	NOV	1	nov	0
BL Lac type of blazar	BLL	22	bll	1080
FSRQ type of blazar	FSRQ	42	fsrq	639
Radio galaxy	RDG	6	rdg	32
Non-blazar active galaxy	AGN	1	agn	16
Steep spectrum radio quasar	SSRQ	0	ssrq	2
Compact Steep Spectrum radio source	CSS	0	css	5
Blazar candidate of uncertain type	BCU	3	bcu	1152
Narrow line Seyfert 1	NLSY1	3	nlsy1	5
Seyfert galaxy	SEY	0	sey	1
Starburst galaxy	SBG	0	sbg	7
Normal galaxy (or part)	GAL	2	gal	2
Unknown	UNK	0	unk	118
Total	...	357	...	3217
Unassociated	...	...	...	1525

NOTE—The designation 'spp' indicates potential association with SNR or PWN. Designations shown in capital letters are firm identifications; lower case letters indicate associations.
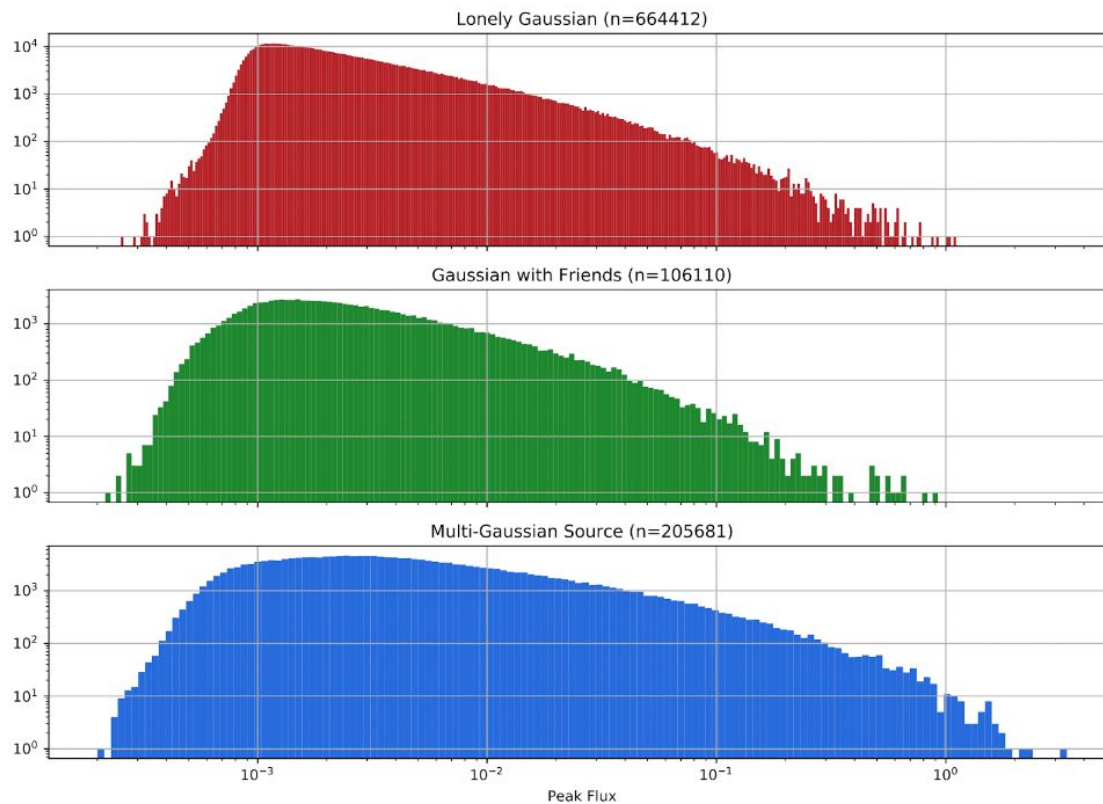
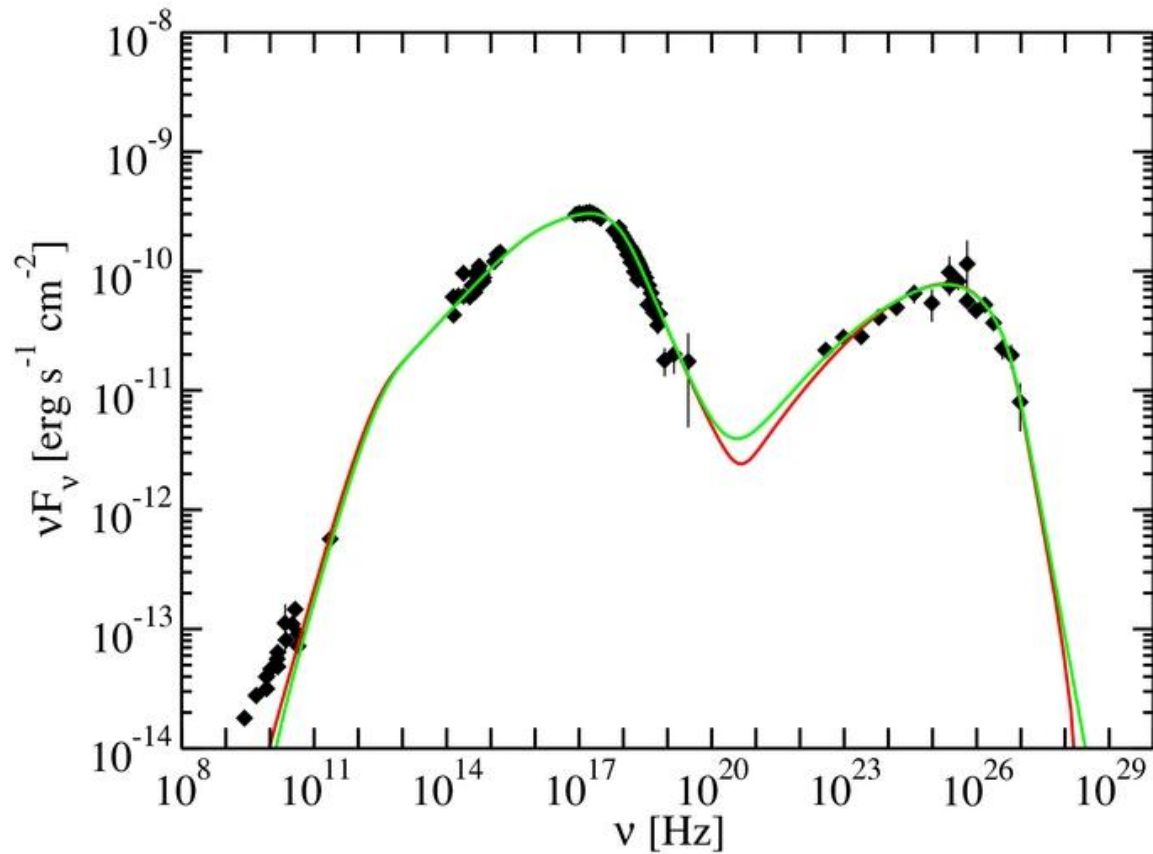# Bonus Slide: Source Breakdown
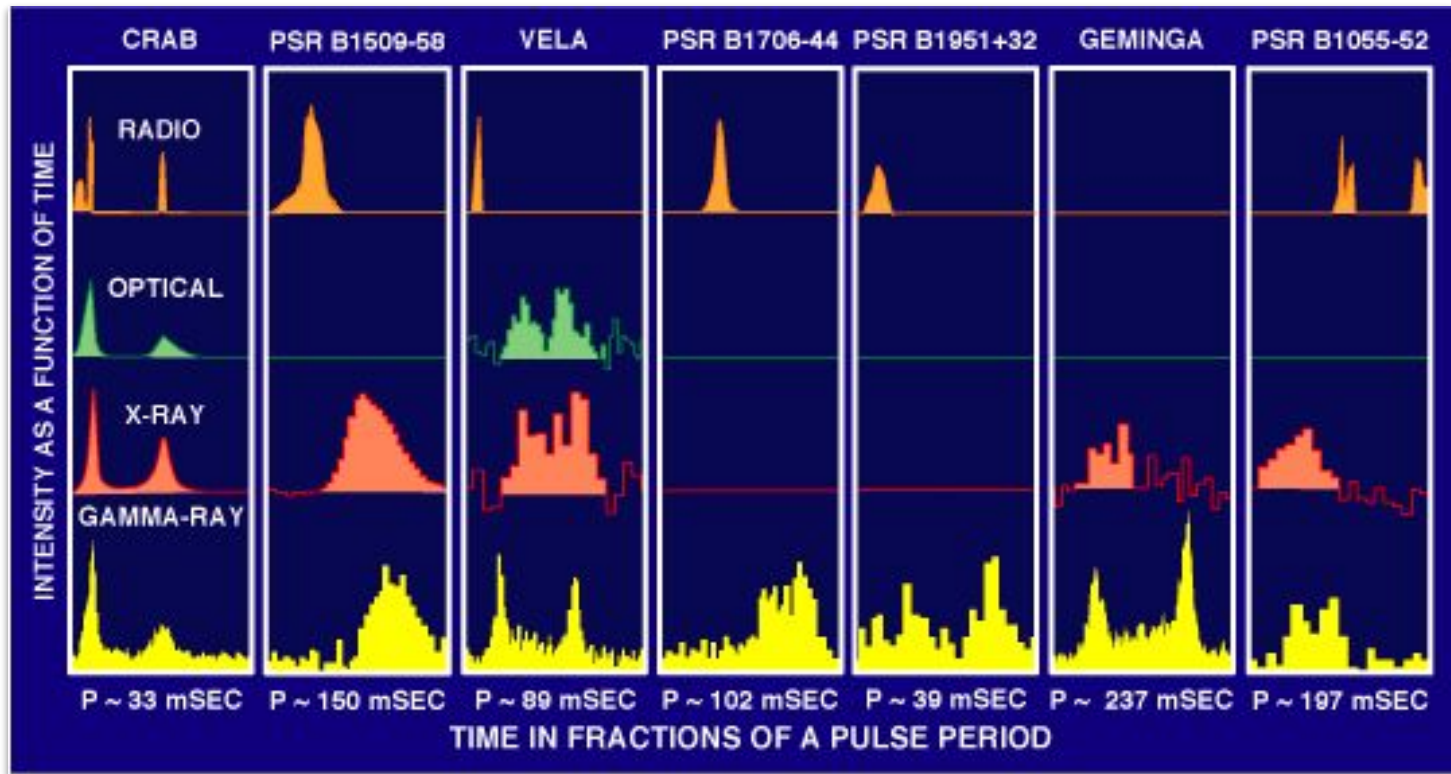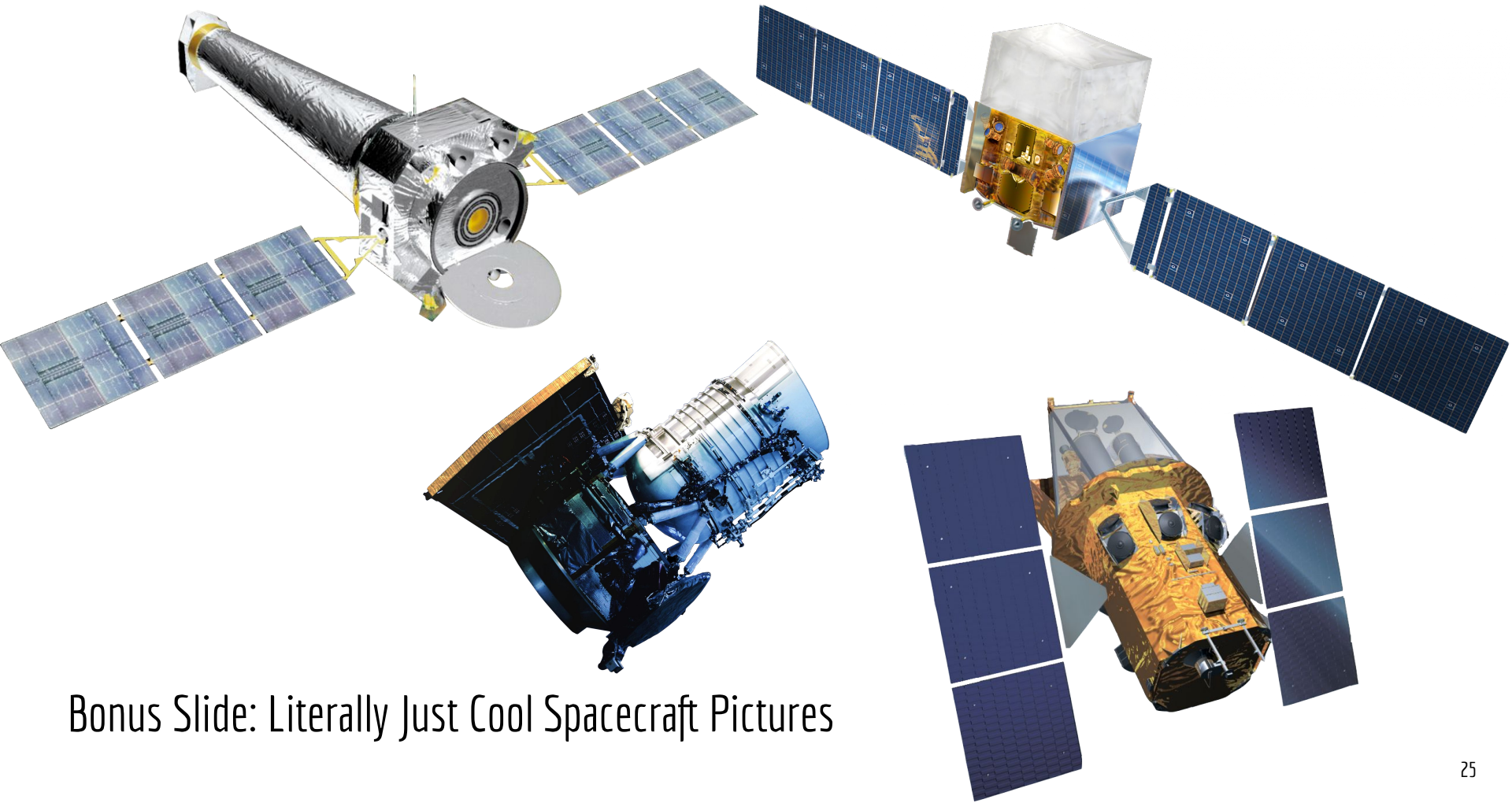
Bonus Slide: Pulsars at Multi-Wavelength
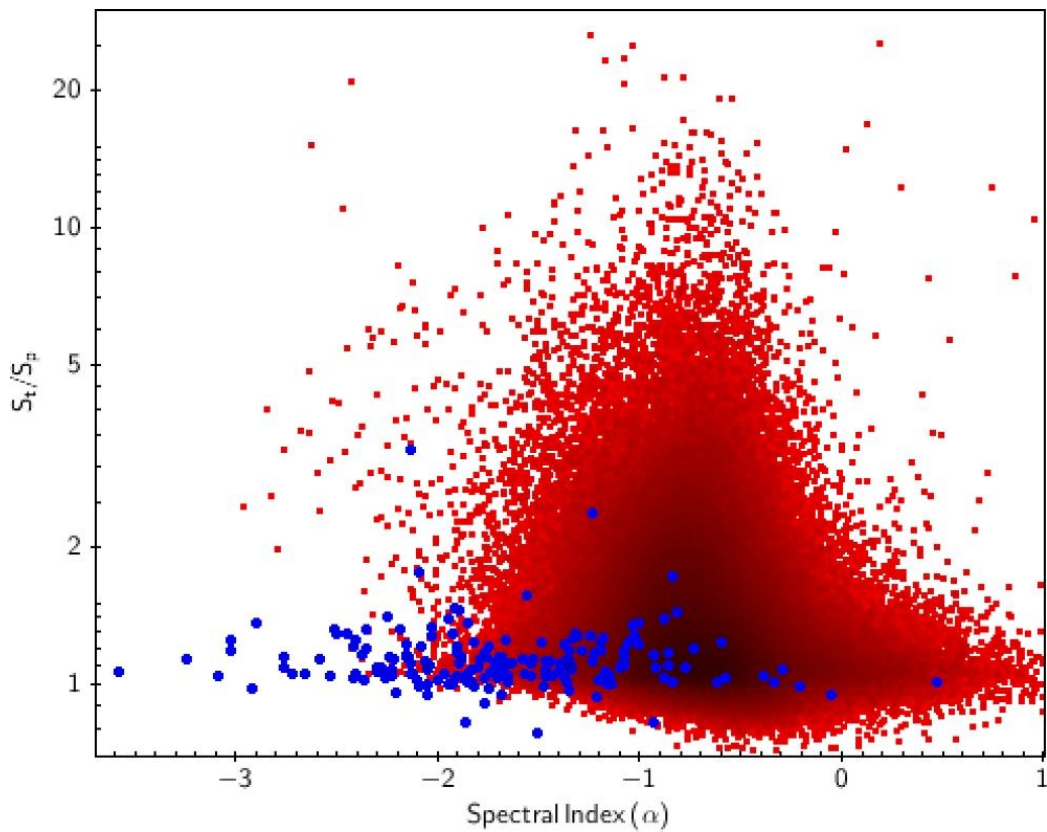
Bonus Slide: Frail 2018 Method

Bonus Slide: VLASS Statistics

Bonus Slide: SED Best Fit

Bonus Slide: Literally Just Cool Spacecraft Pictures