The indefatigable power-law of radio sources? Ron Ekers curving the trend

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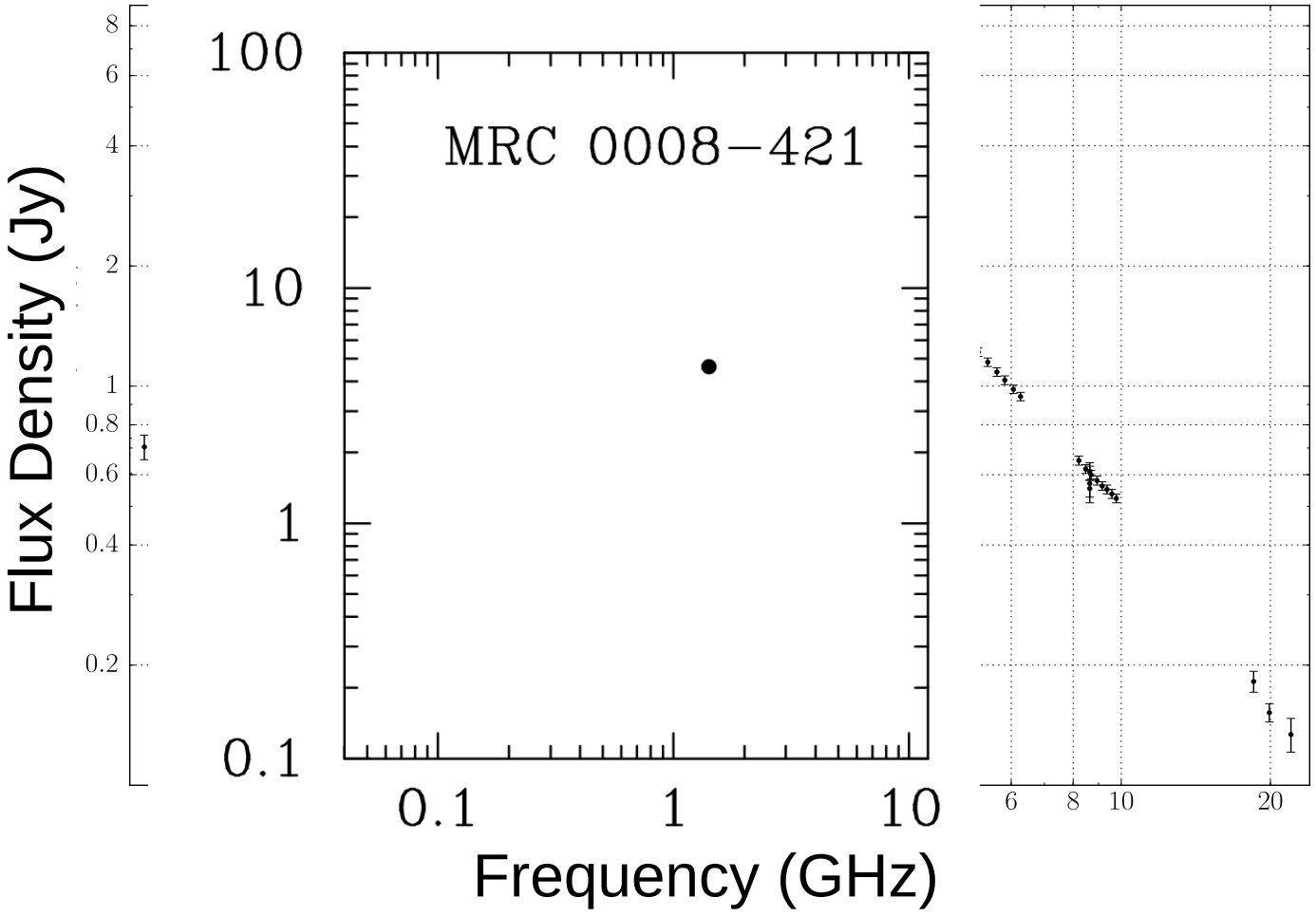
The University of Sydney / CASS

Innovation and discovery in radio astronomy

Queenstown, New Zealand

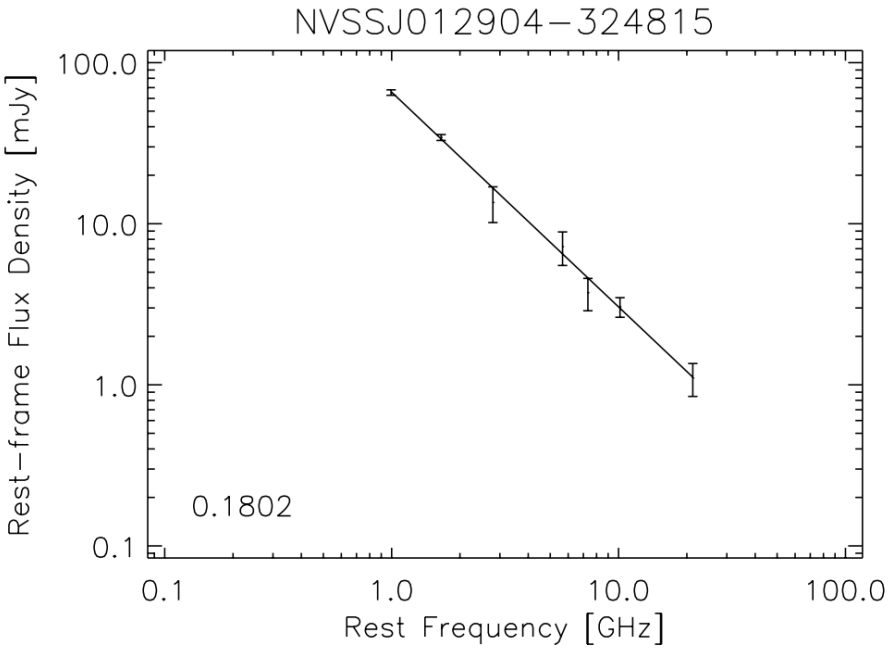
The spectral revolution has (re-)started!

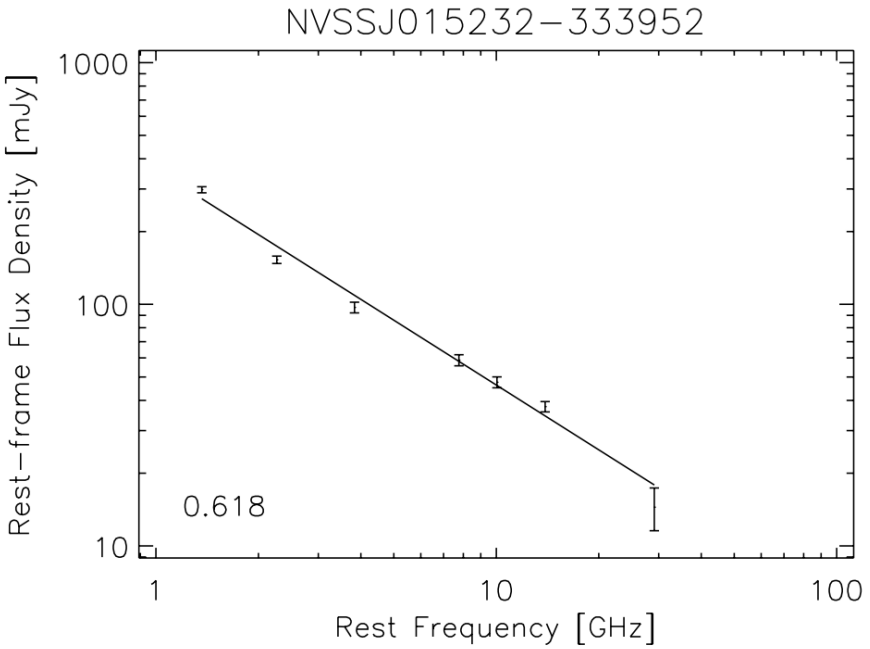
- Sampling the spectra above and below the turnover at an unprecedented level.
- New wide bandwidth backbends on the ATCA and VLA.
- MWA and LOFAR becoming operational.



The resilient power law

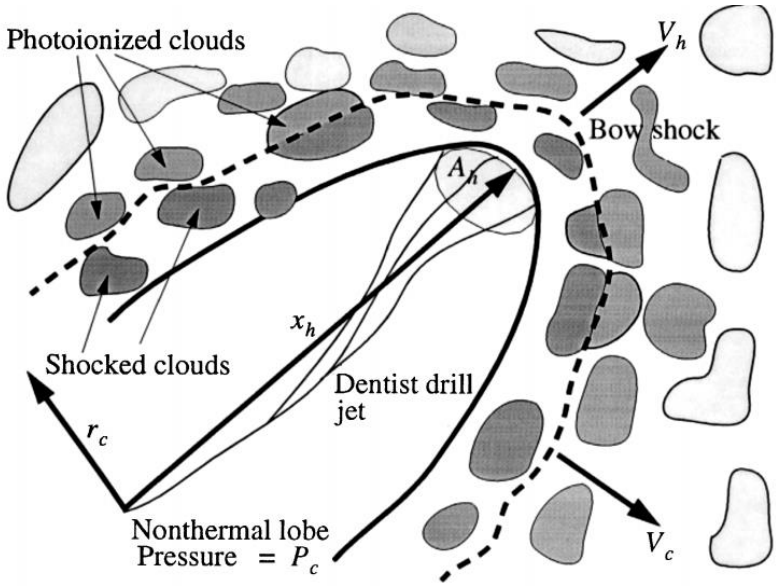
- Energy distribution of electrons is a power-law
- Some hints of it breaking down: Blundell et al. 1999, Marvil et al. 2014 etc
- Vital to understand for calculating energy density and magnetic field strength



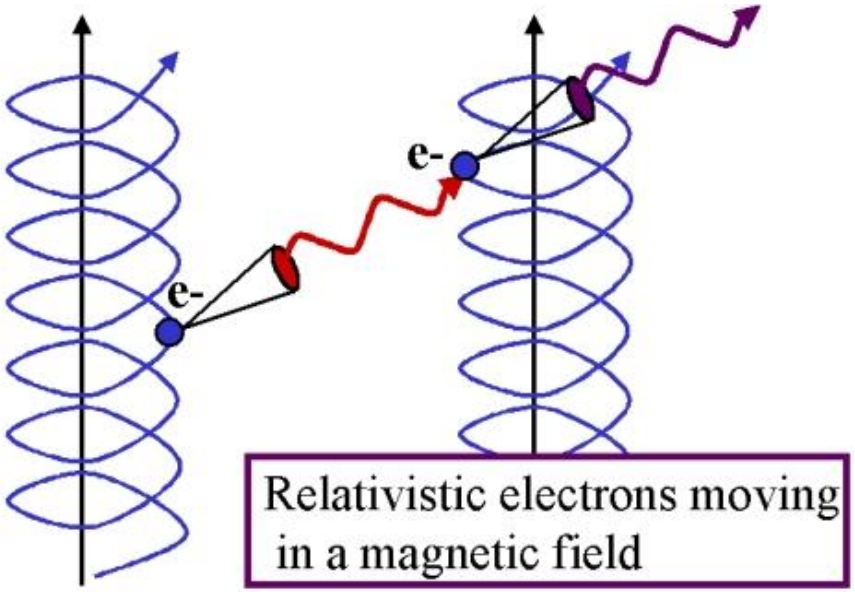


Klamer, Ekers et al. 2006

Absorption mechanisms



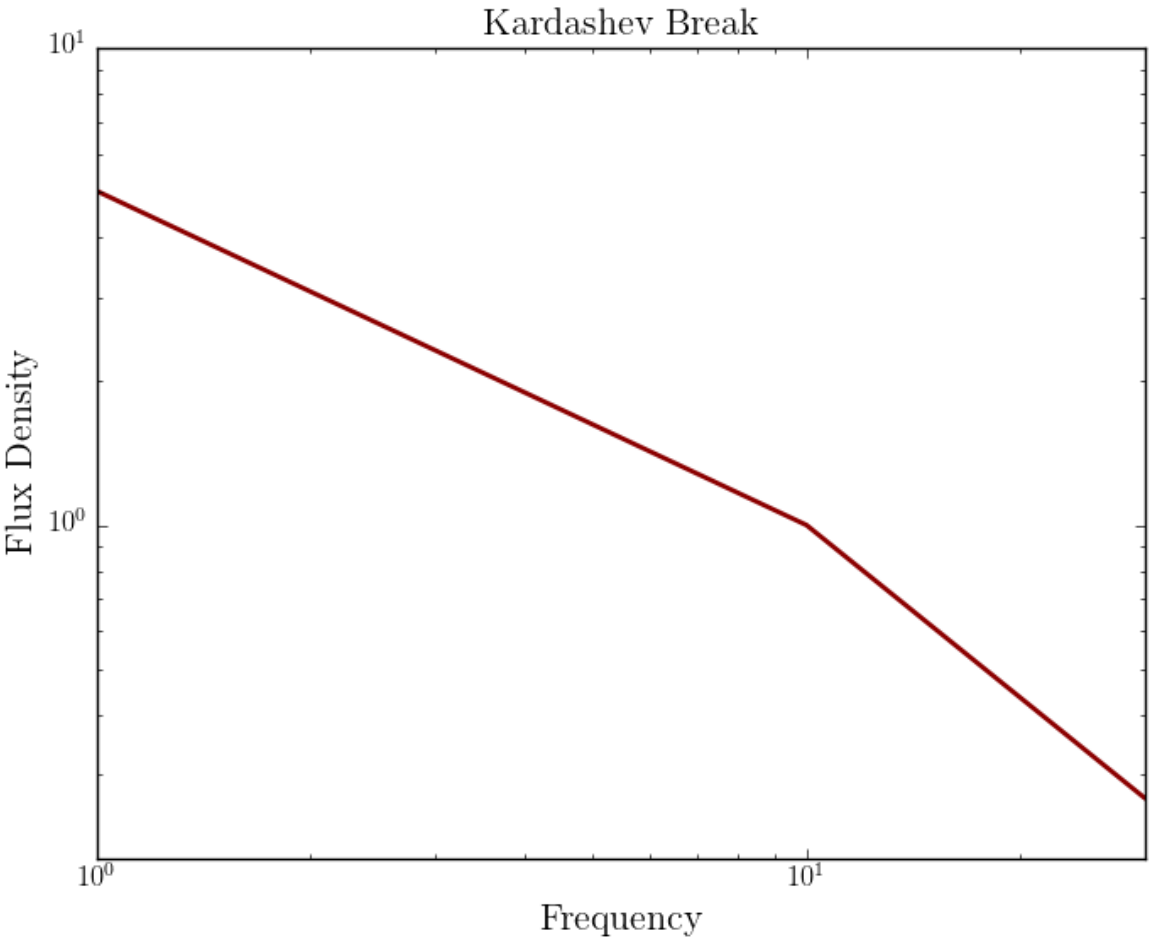
Bicknell et al. 1997

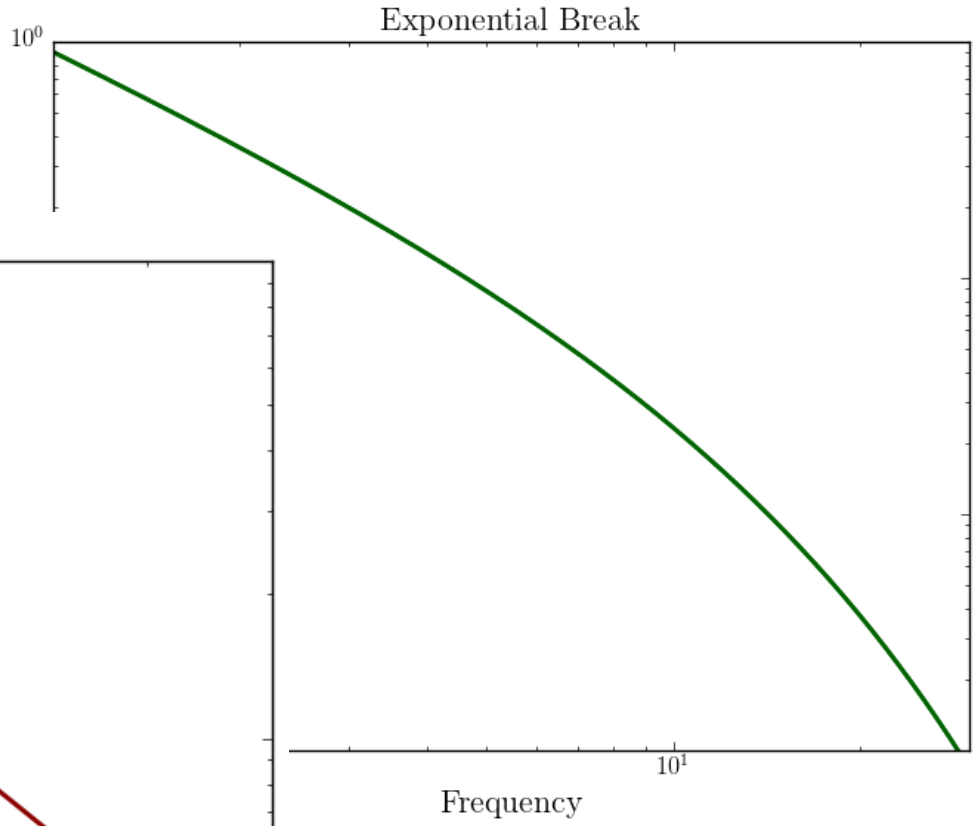


Kellermann 1966

Hate to break it to you

- Kardashev and exponential breaks etc





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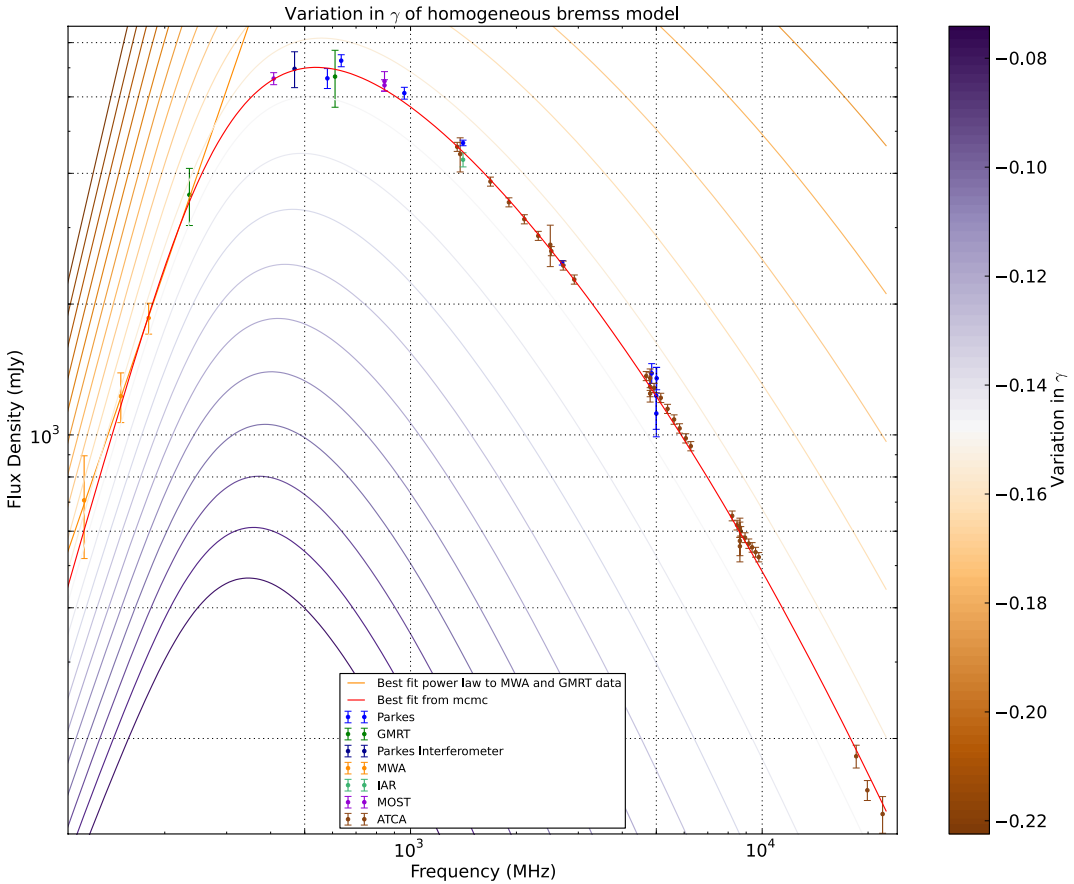
Adiabatic losses

Adiabatic	Synchrotron	Compton

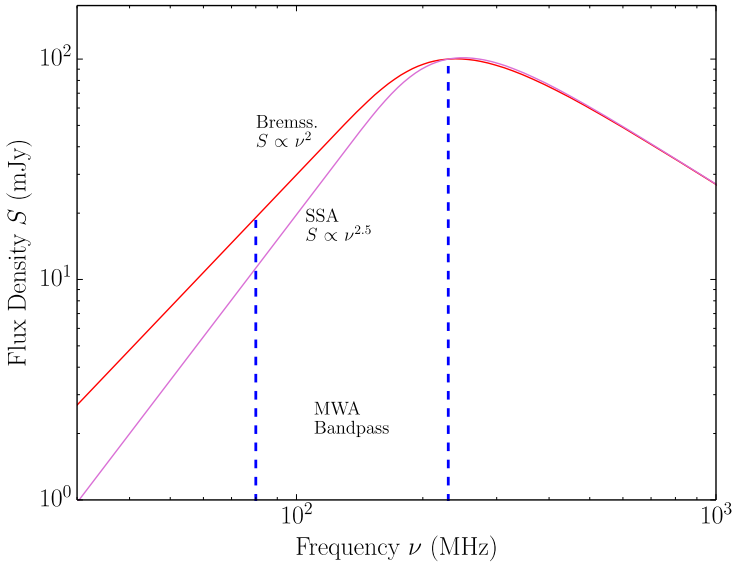
Subtly is the key

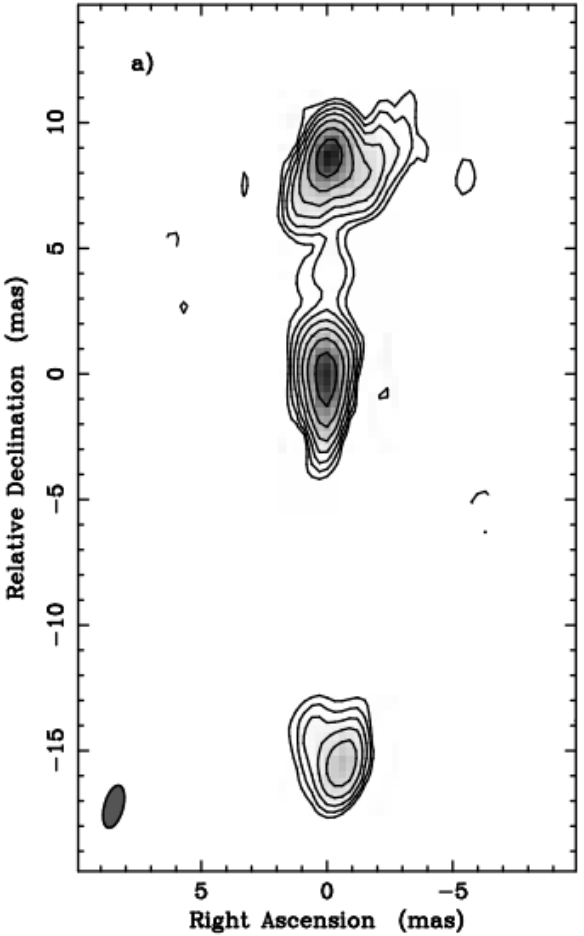
- Single power-law spectra of relativistic spectra is just a zero-order approximation
- Energy distribution of electrons is curved (Blundell & Rawlings 2000)



What are CSS/GPS sources?

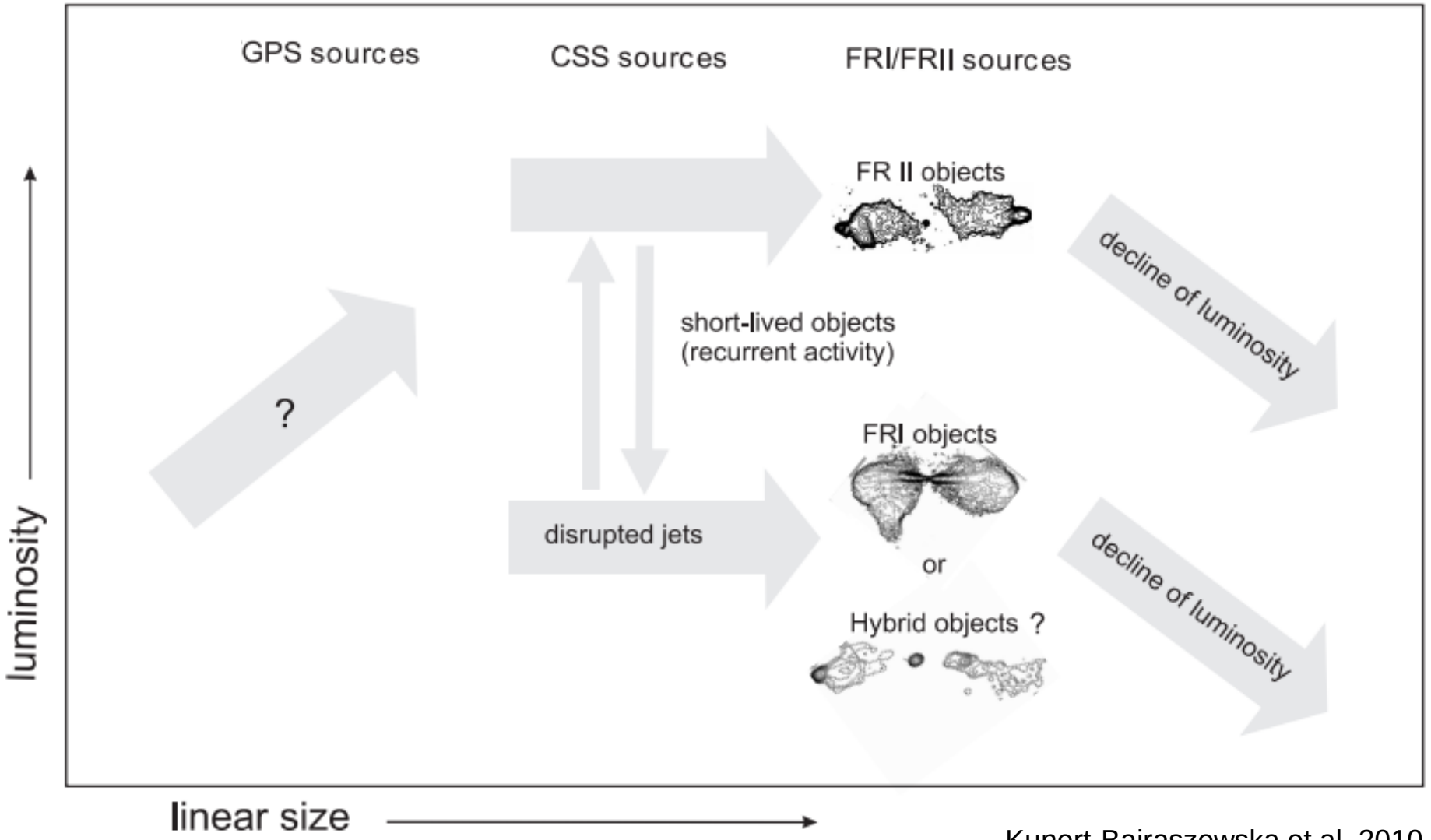
- Originally empirical classification:
  - Powerful AGN with concave spectra
  - GPS turnover ~ 1 GHz, CSS turnover ~ 150 MHz (?)
  - Small physical sizes. GPS < 1 kpc, CSS ~ 1 – 10 kpc
  - Hosts vary - quasars, radio galaxies and Seyferts





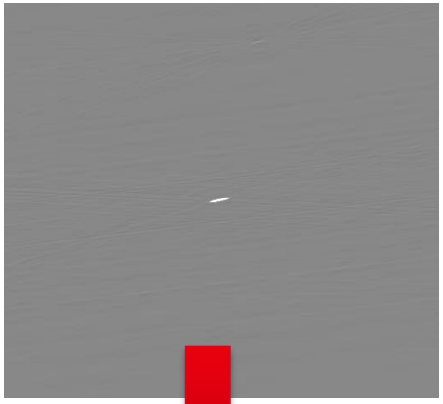
0710+439, Owsianik et al 1998

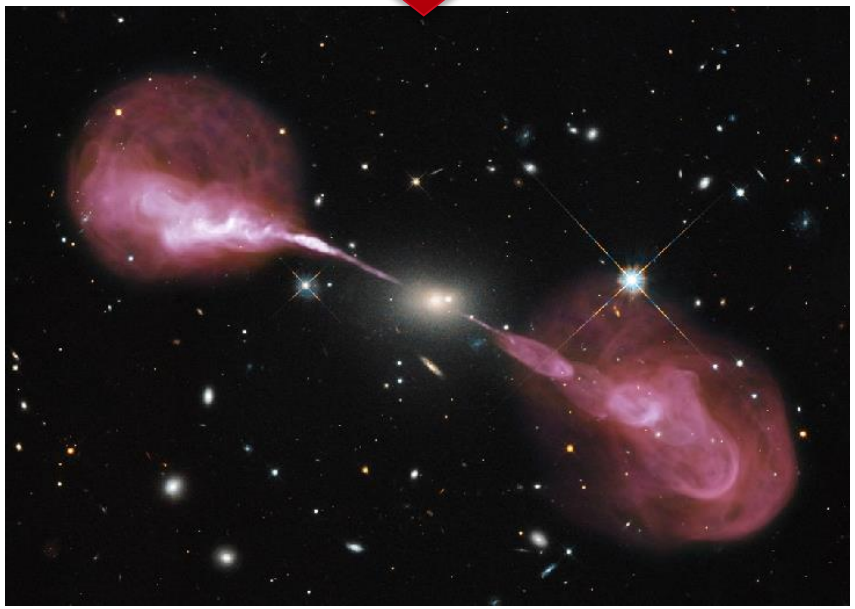
Acronym Spaghetti



Kunert-Bajraszewska et al. 2010

Why Study CSS/GPS Sources?





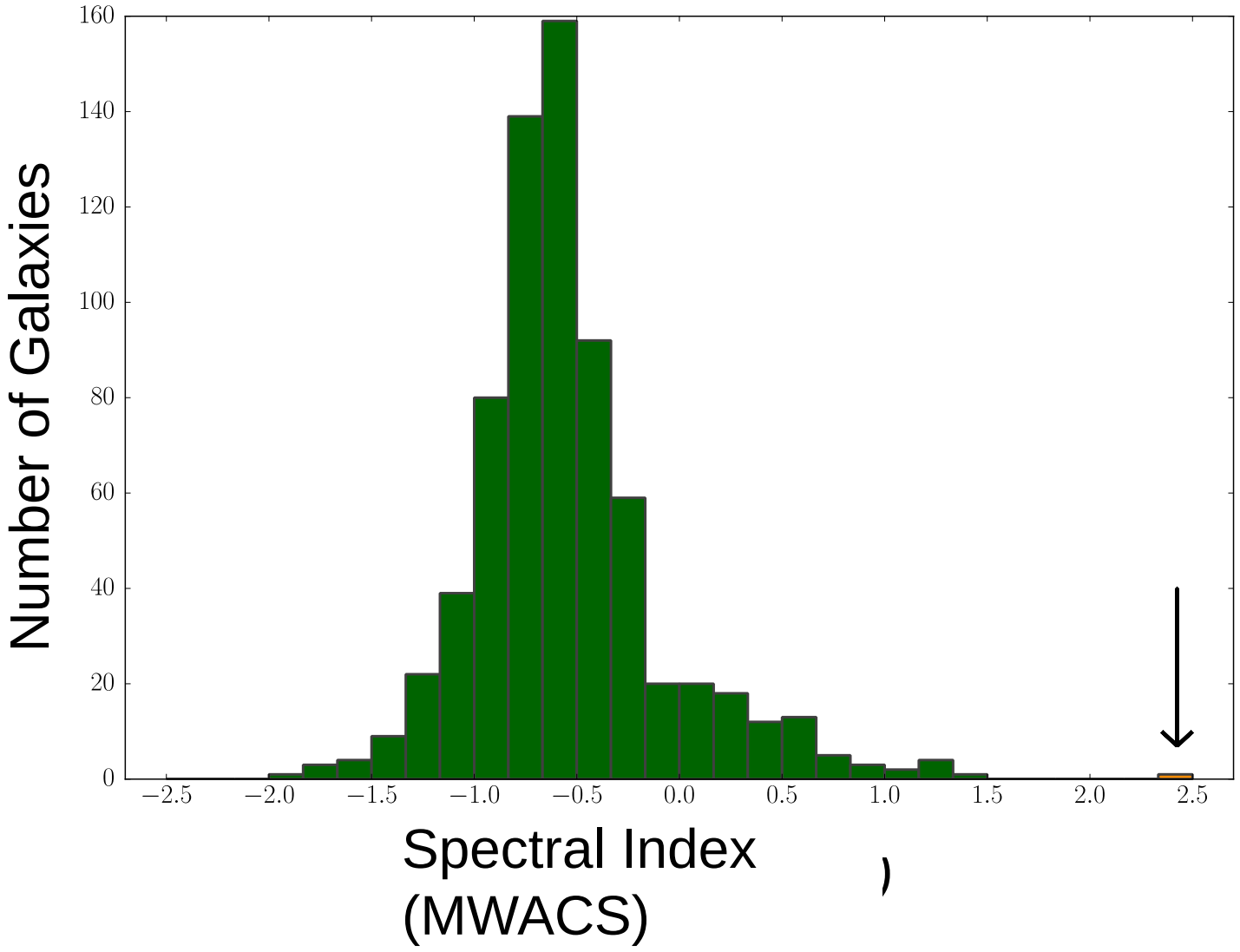
NASA, ESA, S. Baum and C. O'Dea (RIT), R. Perley and W. Cotton (NRAO/AUI/NSF), and the Hubble Heritage Team

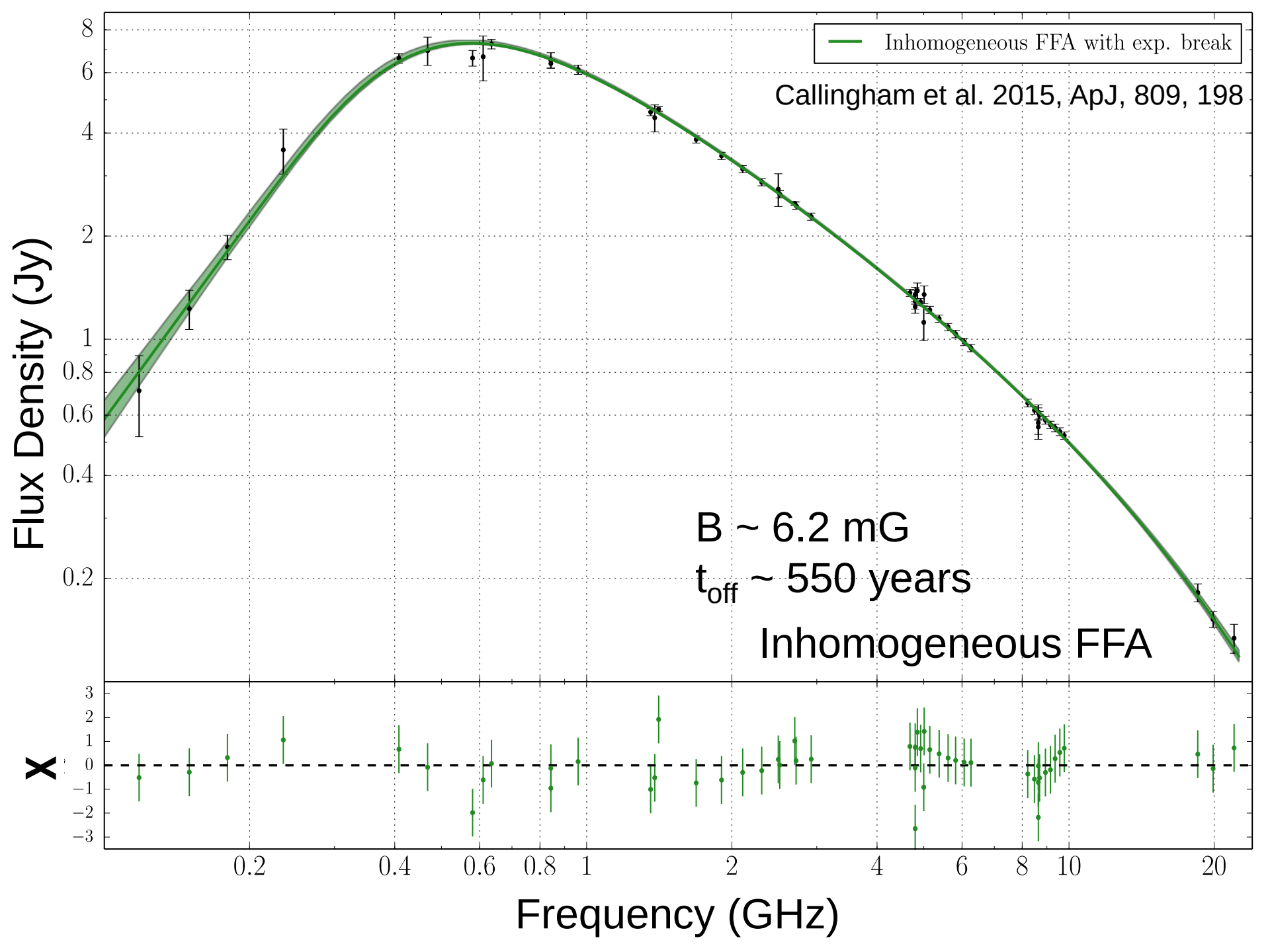
- Unique view of early stages of AGN activity. Probe of environment to tens pc scale.
- How many sources go from birth to A team sources (Cyg A, Her A etc)?
- Are they confined to small spatial scales due to 'youth' or 'frustrated' or **both**?
- Cause of the turnover in spectrum? Vital for accurate evolutionary models

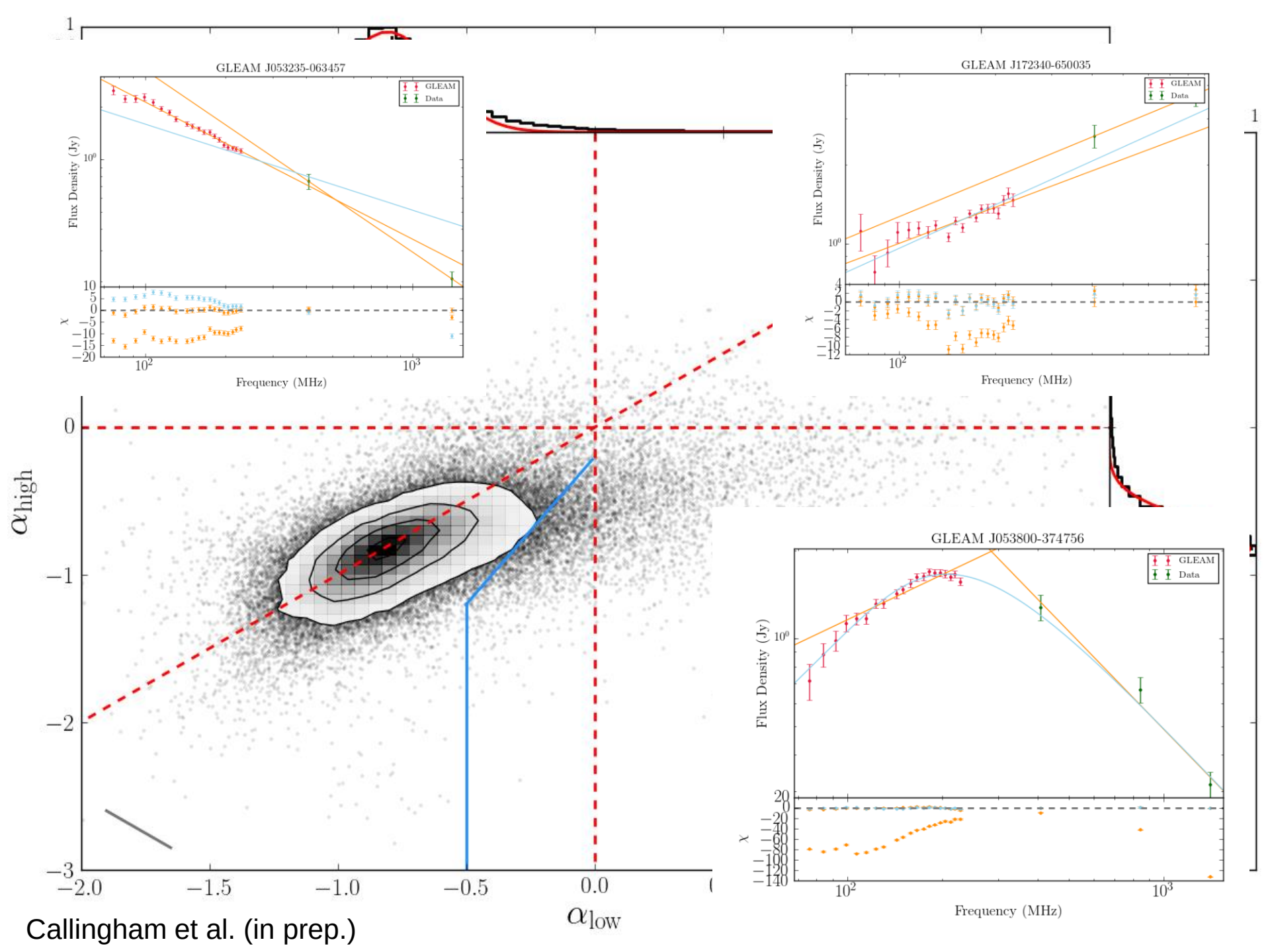
See Peck et al. 1999; Kameno et al. 2000; Marr et al. 2001; Orienti & Dallacasa 2008; Tremblay et al. 2008, Marr et al. 2014; Tingay et al. 2015, Callingham et al. 2015

New Extreme GPS Source PKS B0008-421

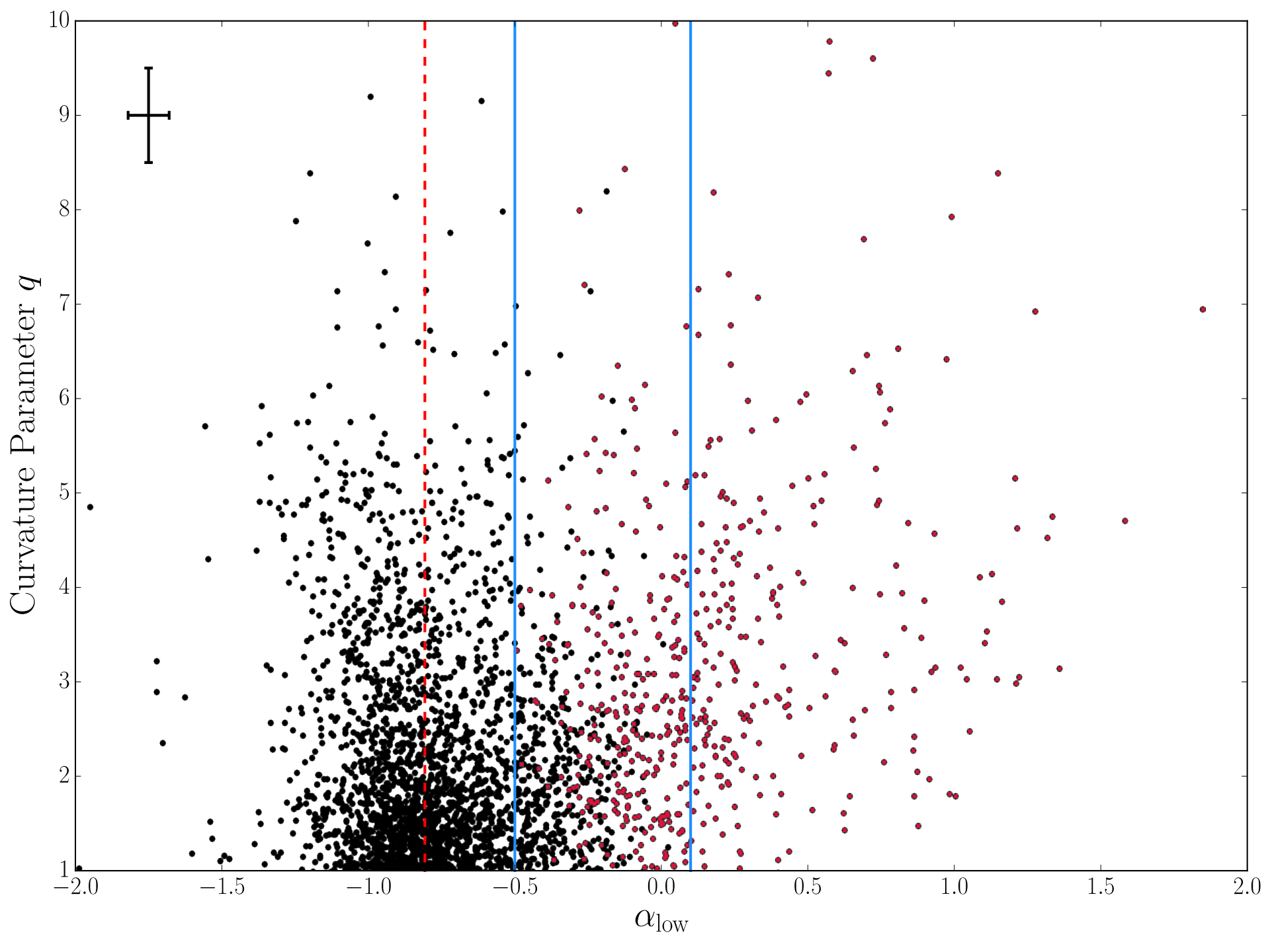
- Low frequency data has a gradient of ~2.5 – steepest known. Spectral width ~0.6 decade of freq. – smallest known.
- Test bed for models of GPS/CSS spectra
- ~120 mas scale, 1000 pc



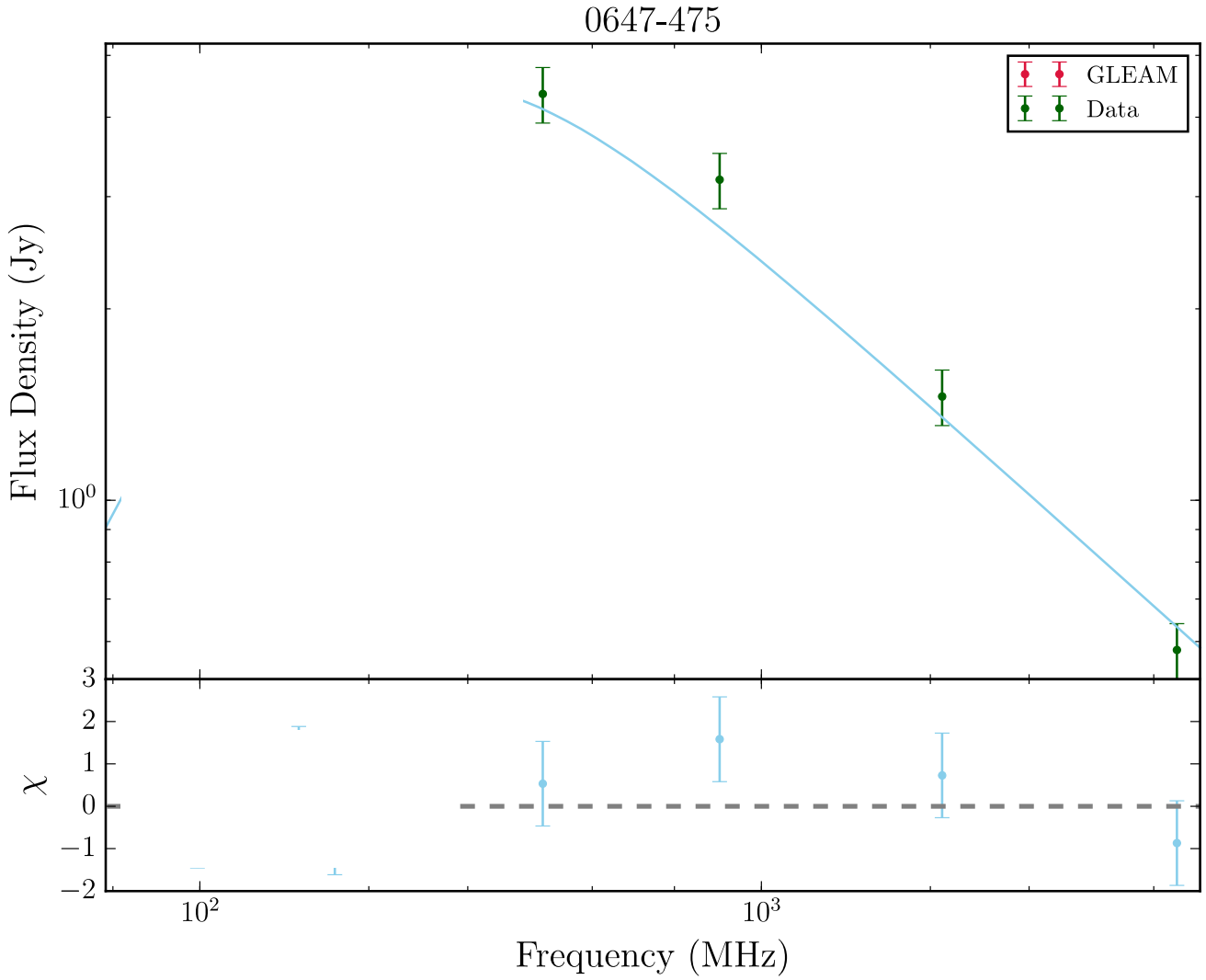

Inhomogeneous FFA with exp. break
Callingham et al. 2015, ApJ, 809, 198
B ~ 6.2 mG
t_{off} ~ 550 years
Inhomogeneous FFA
Flux Density (Jy)
Frequency (GHz)
X



Callingham et al. (in prep.)


Curvature Parameter q
$\alpha_{\rm low}$
10
9
8
7
6
5
4
3
2
1
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0

New GPS (MPS?) Sources



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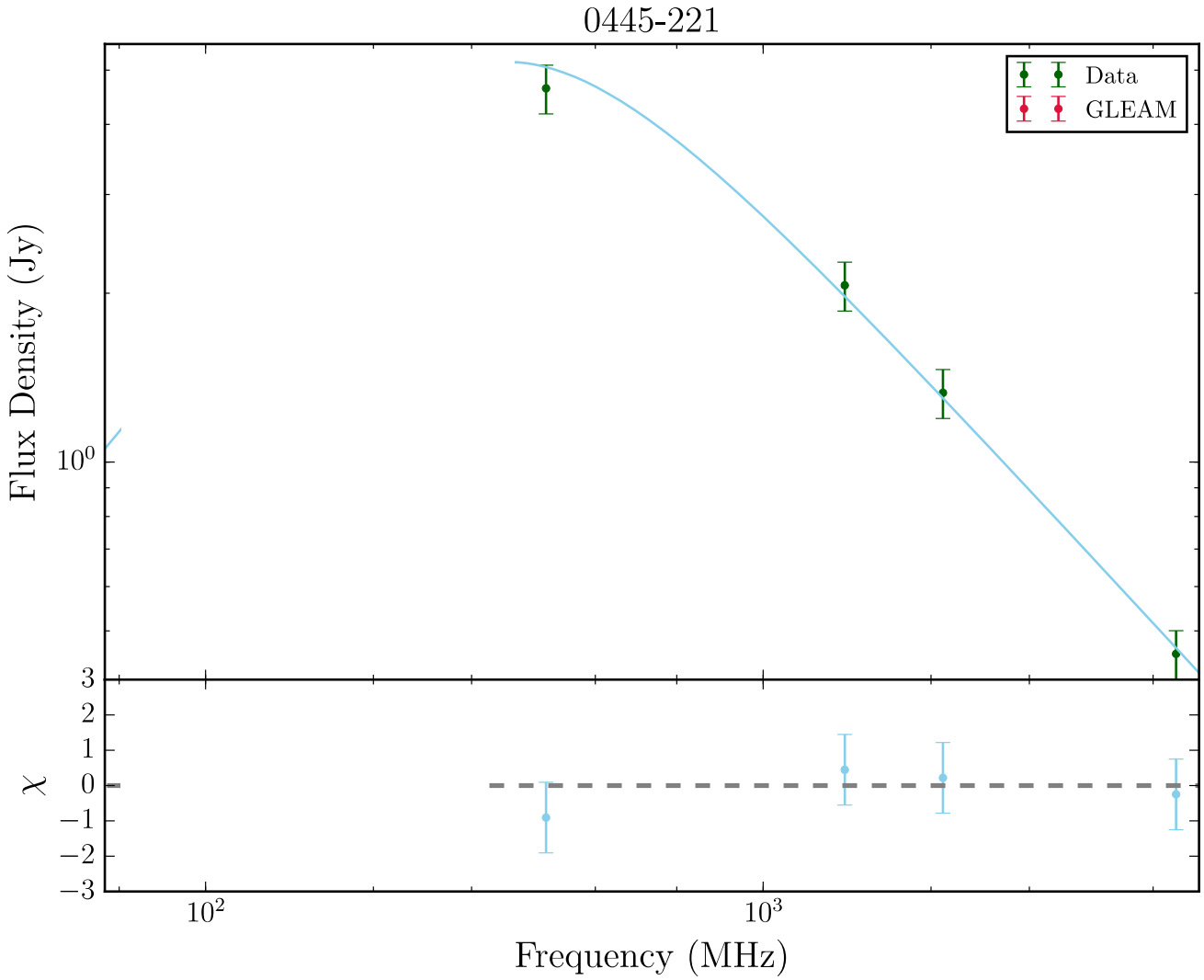

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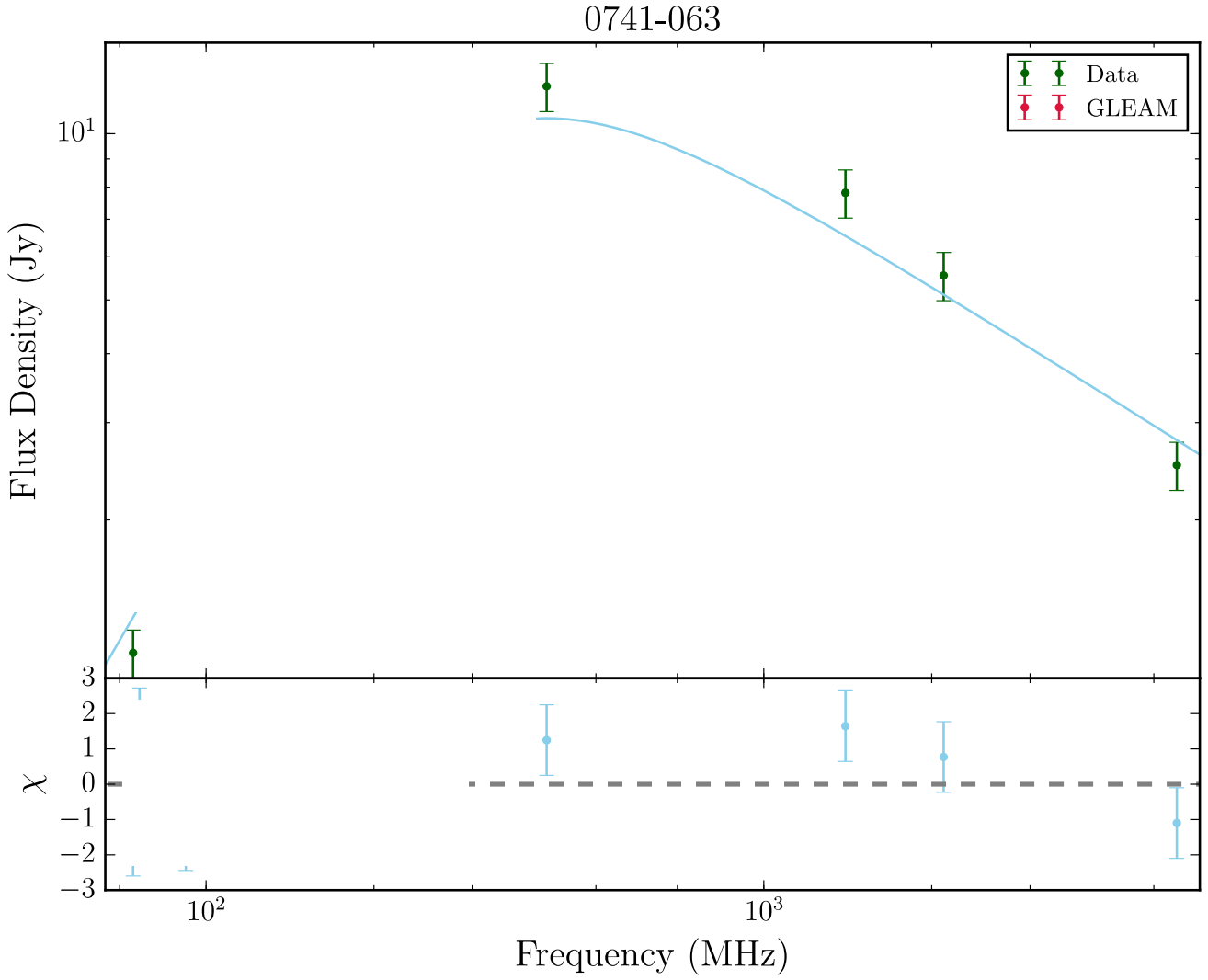

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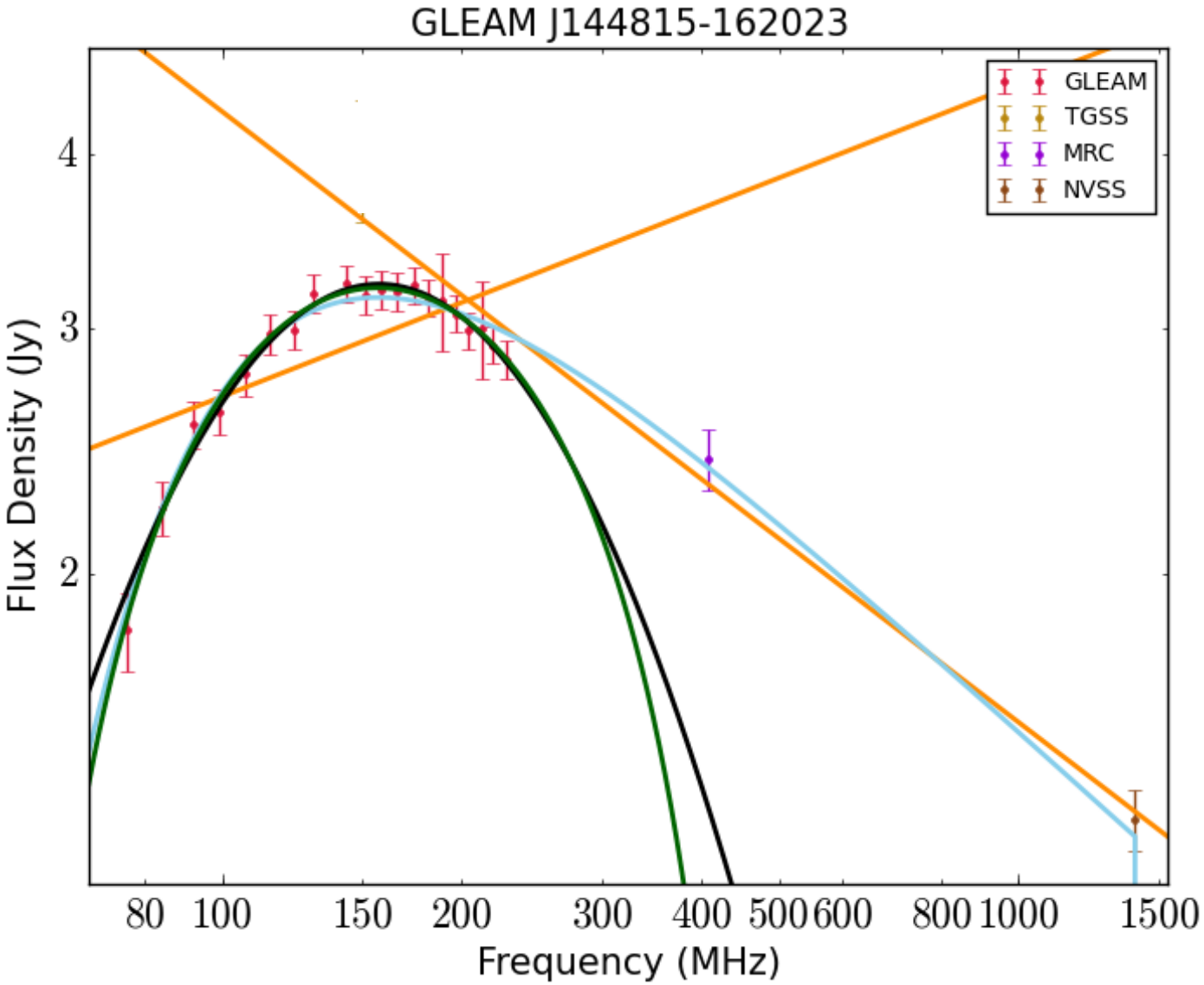
New GPS (MPS?) Sources



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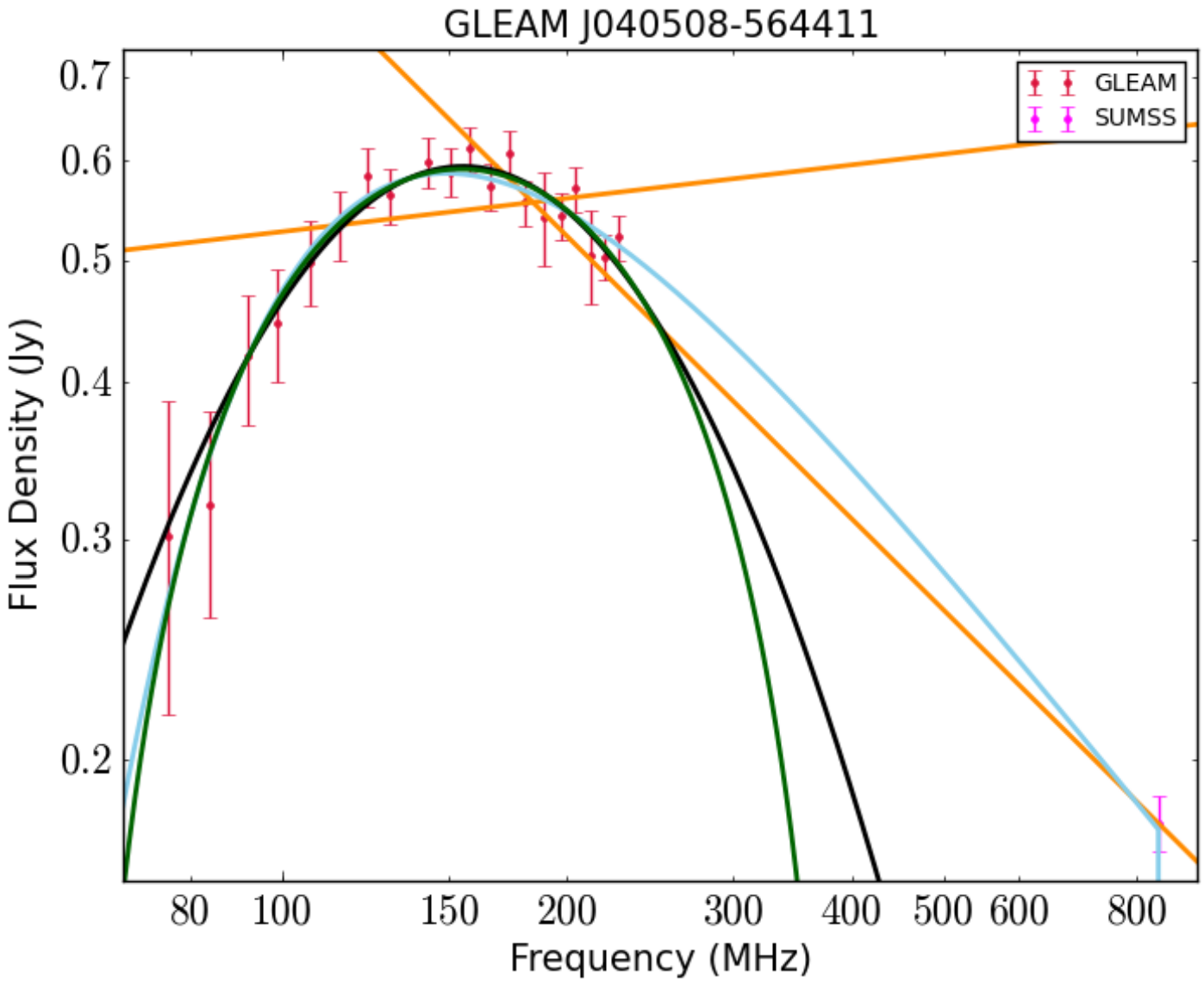

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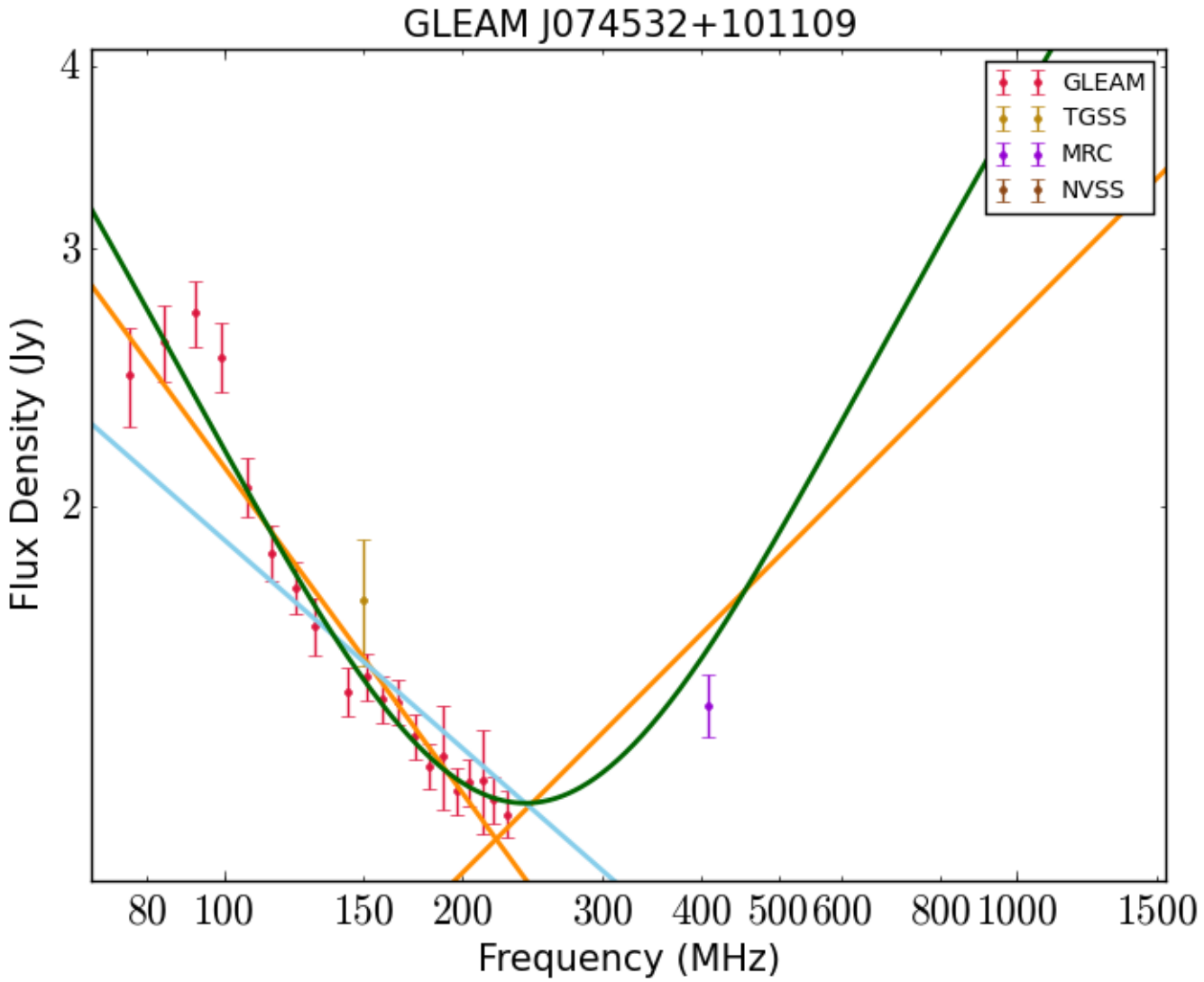
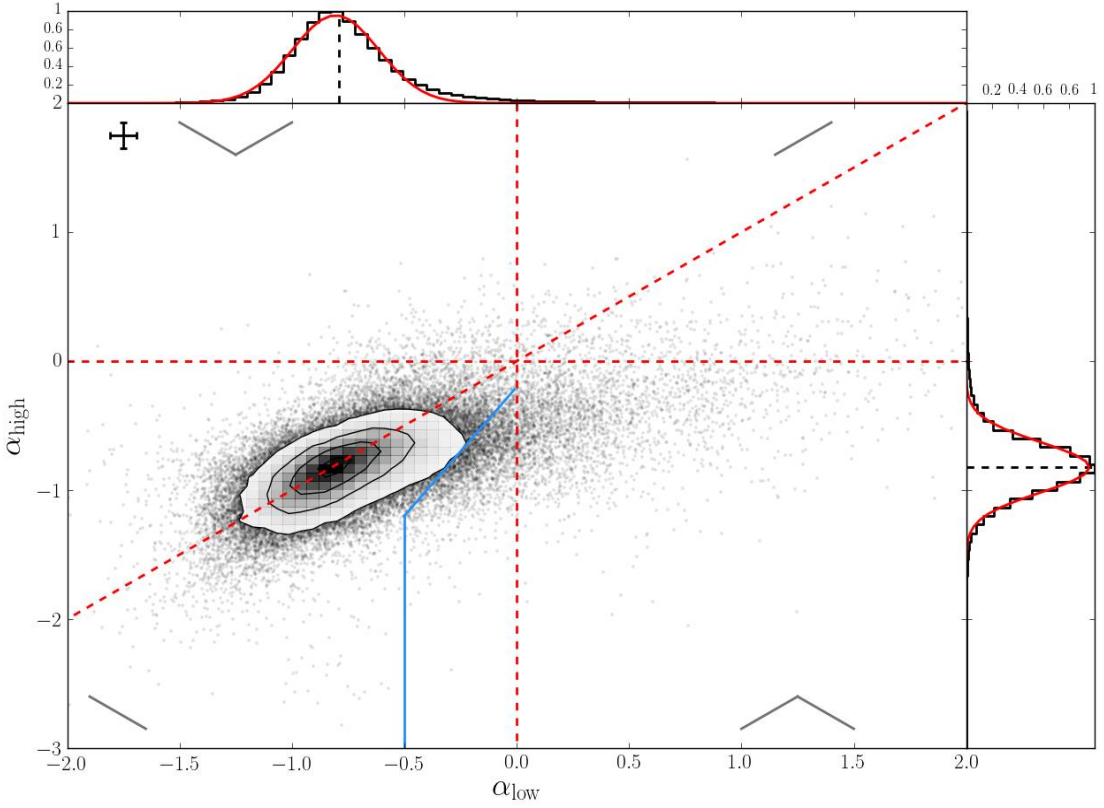
WTF?



Number of sources

- 1,471 GPS candidates
- ~230 have spectroscopic redshifts
- ~430 have VLBI information



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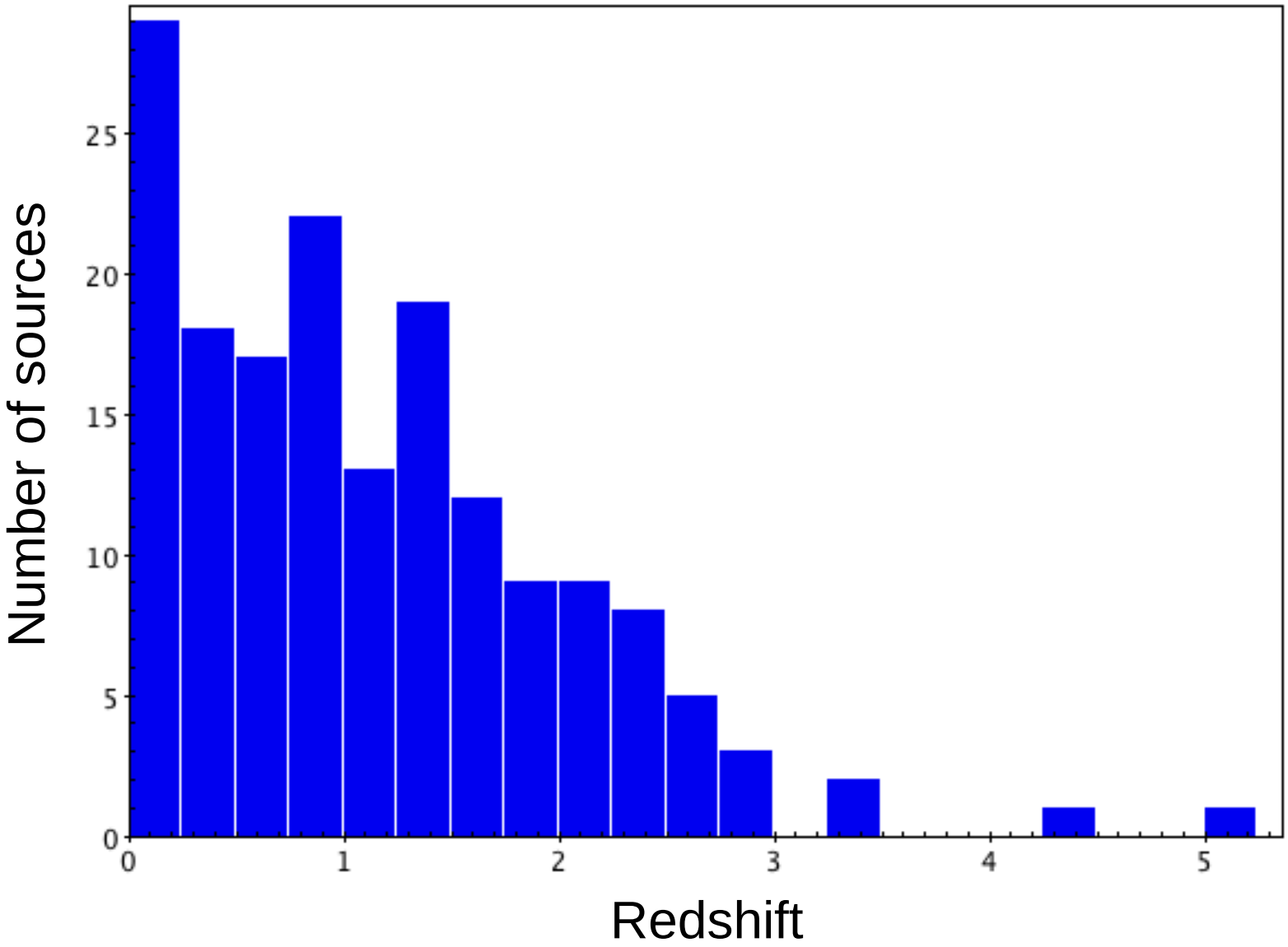
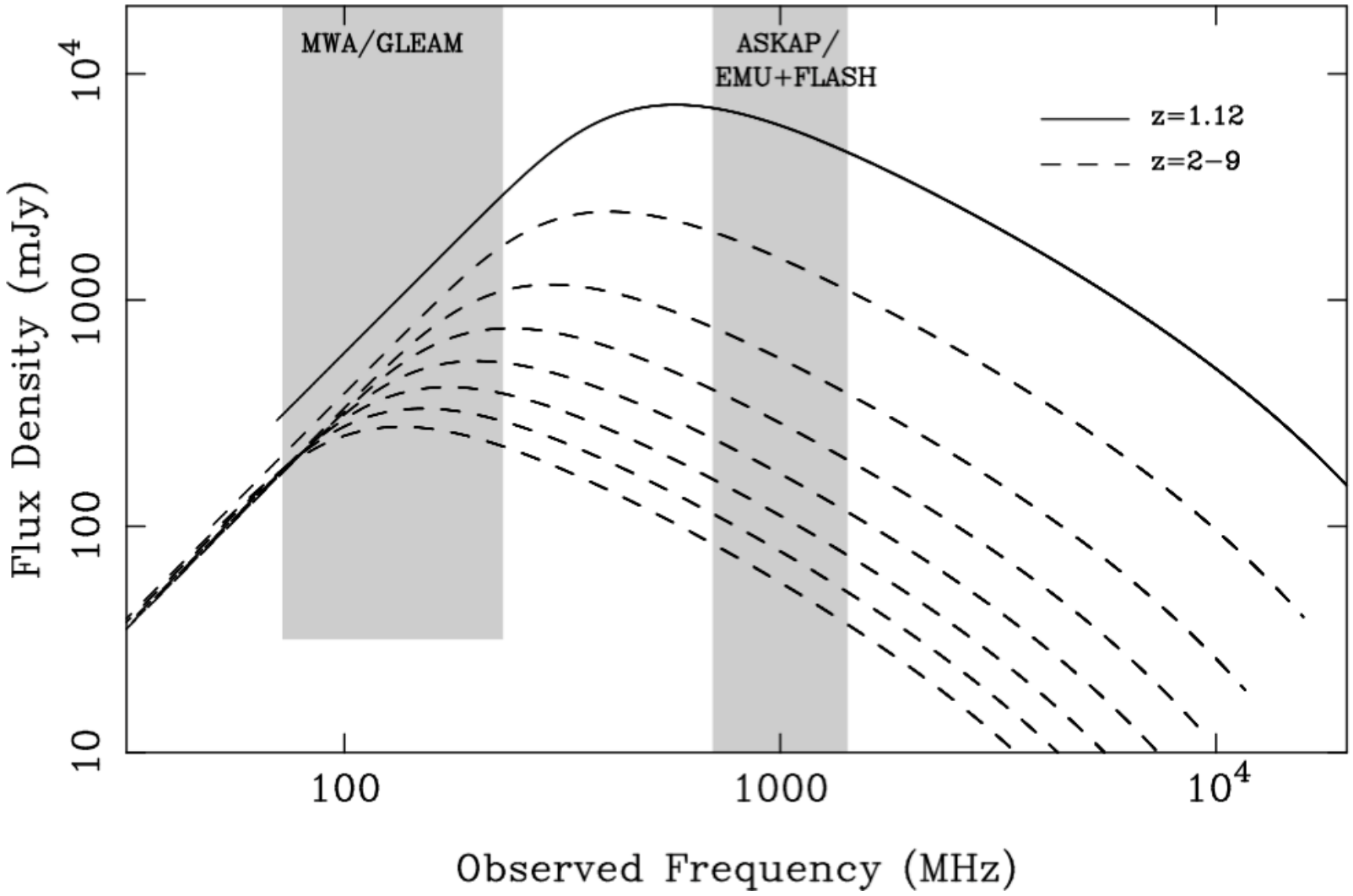
Redshift Distribution



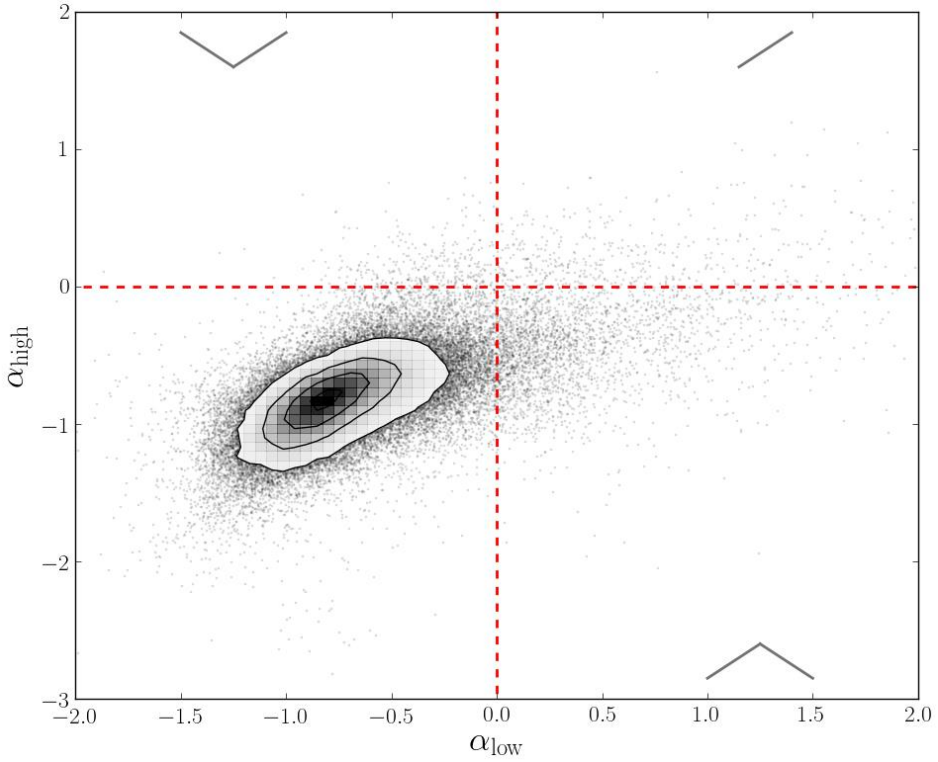
High Redshift Candidates



Nick Seymour

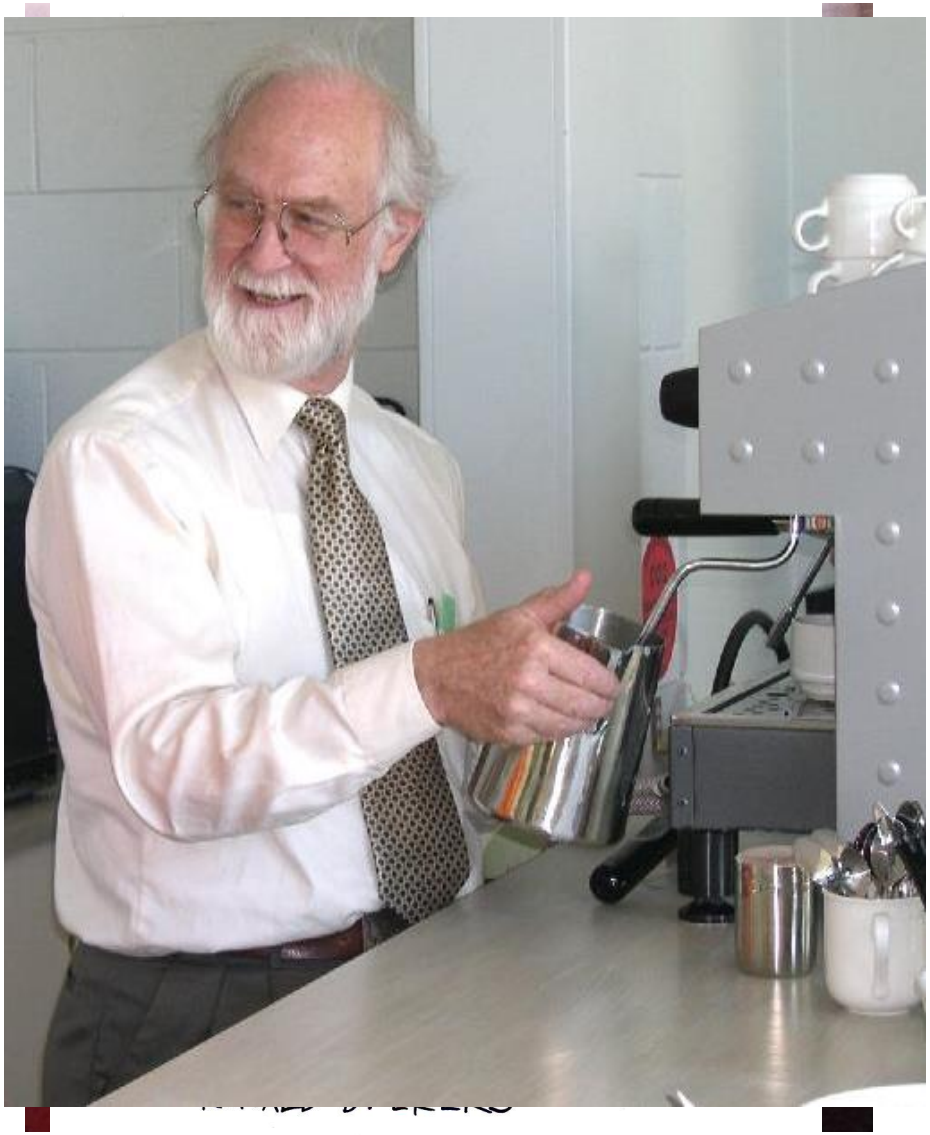
Conclusions

- Spectra become very interesting when you add well-sampled low radio frequency data.
- Appears the GPS/CSS population is defined by two distinct populations.
- About to triple the number of known GPS/CSS candidates



My time with Ron

- Question everything
  - Thousands of questions
- Know when you have asked a good question
- Know the people that can possibly answer those questions (or at least help!)
- Make predictions
- Have a good coffee habit
- Have a nap when necessary ;)



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Geoff's plots