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Dying young and Frustrated?

A low radio frequency view of young radio galaxies

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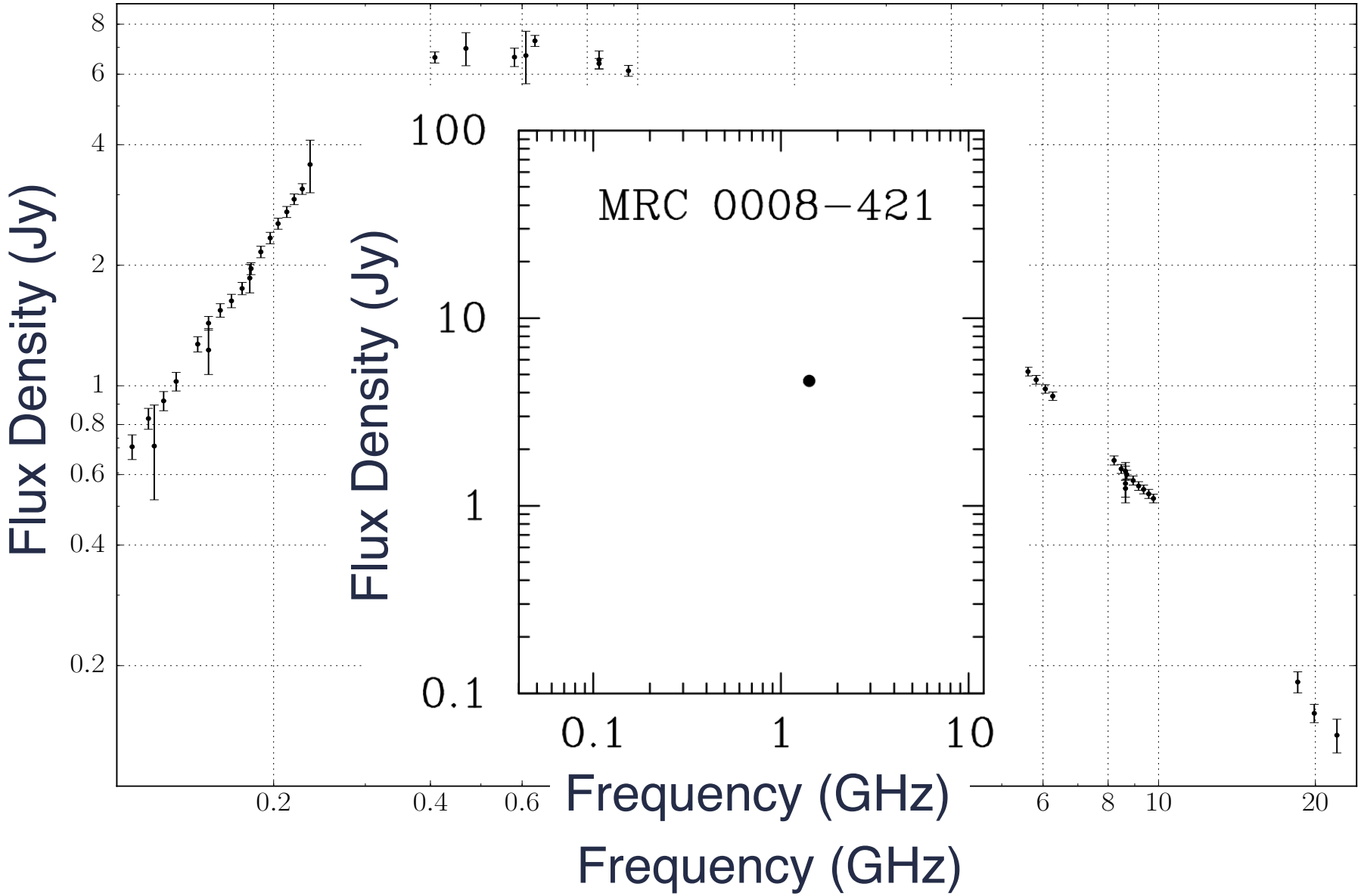
ASTRON Postdoctoral Fellow

The Broad Impact of Low Frequency Observing,
Bologna, Italy
22nd of June 2017

MWA MURCHISON WIDEFIELD ARRAY

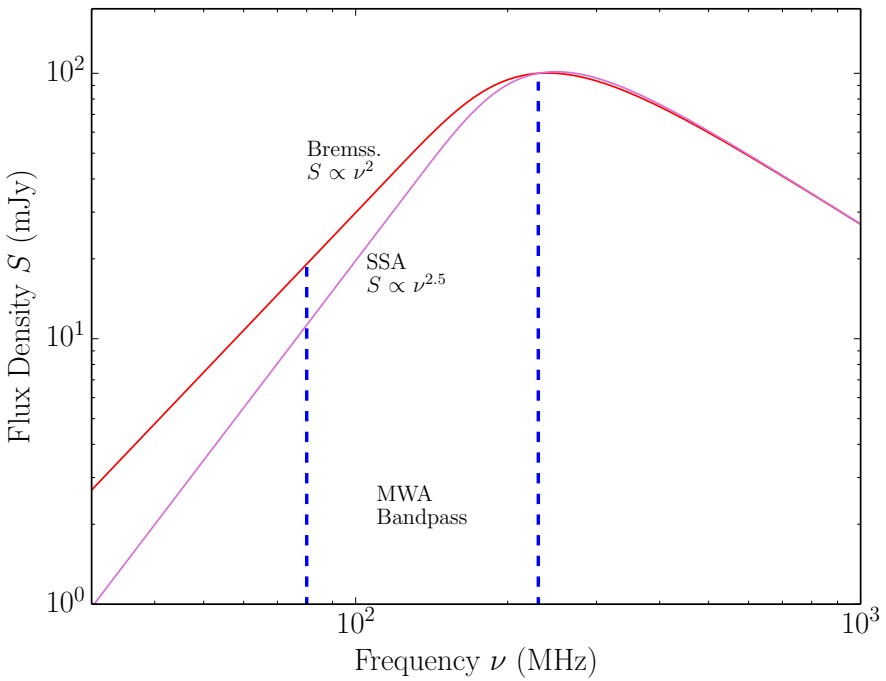
LOFAR

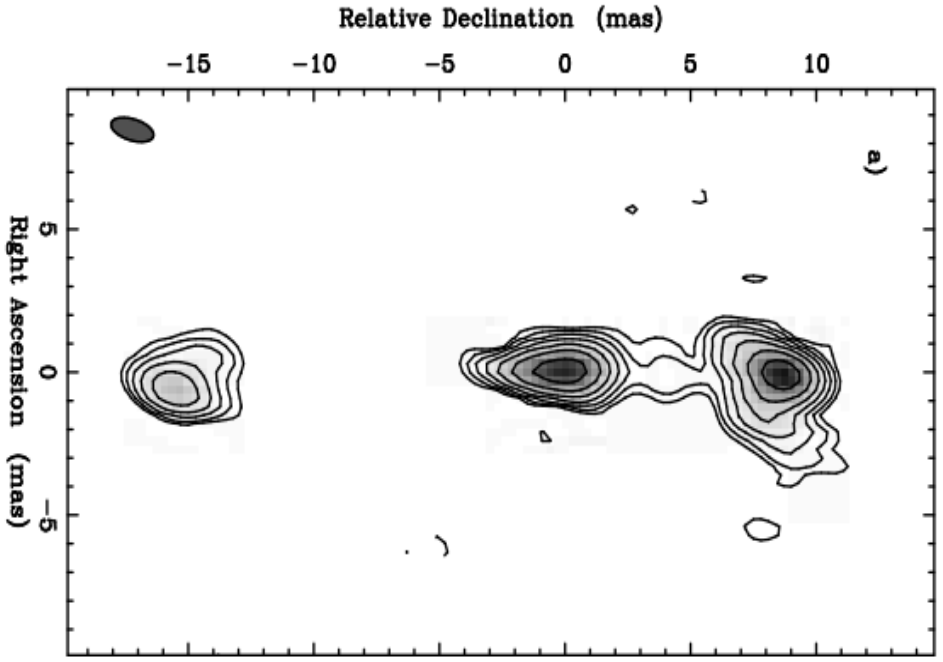
The spectral revolution has (re-)started!



What are GPS/CSS Sources?

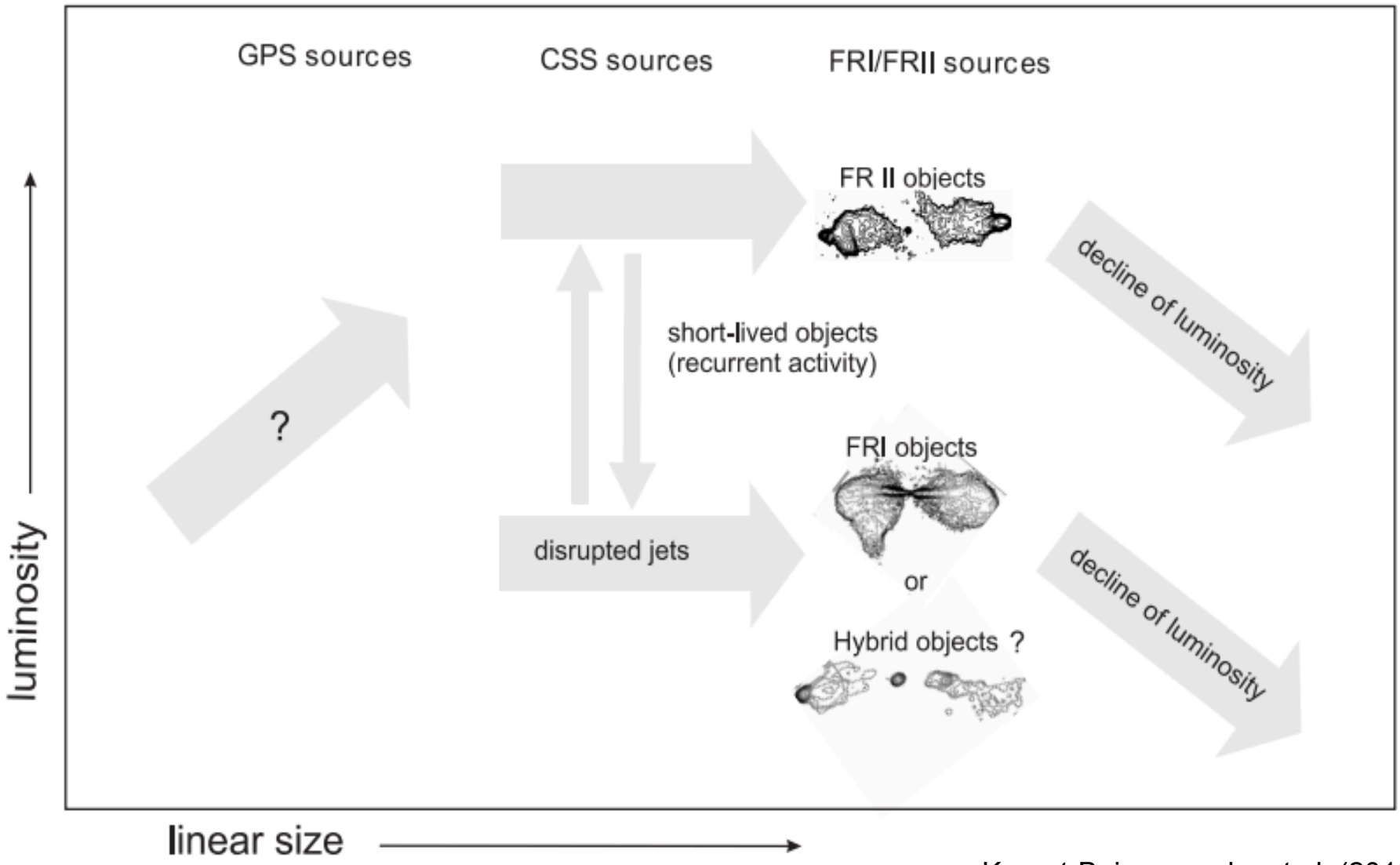
- GPS = gigahertz-peaked spectrum ; CSS = compact steep spectrum
  - powerful AGN with ***concave*** radio spectra
  - GPS turnover ~ 1 GHz ; CSS turnover ~ 150 MHz (?)
  - small physical sizes: GPS < 1 kpc, CSS ~ 1 – 10 kpc





0710+439 (Owsianik et al. 1998)

Possible Evolutionary Picture



Kunert-Bajraszewska et al. (2010)

Snellen et al. 2000

Why Study GPS/CSS Sources?

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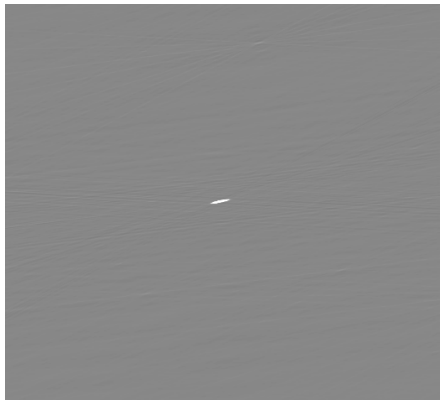
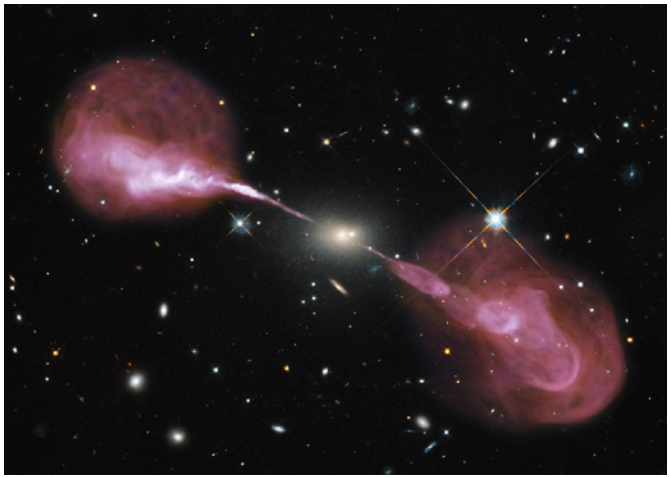


- Unique view of early AGN stages; probe of environment at scales of tens of pc
- Which radio galaxies evolve into "A team" sources (Cyg A, Her A, etc)?
- Are they confined to small spatial scales due to youth, frustration, or both?
- Cause of the turnover in spectrum? Free-free vs synchrotron self absorption

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



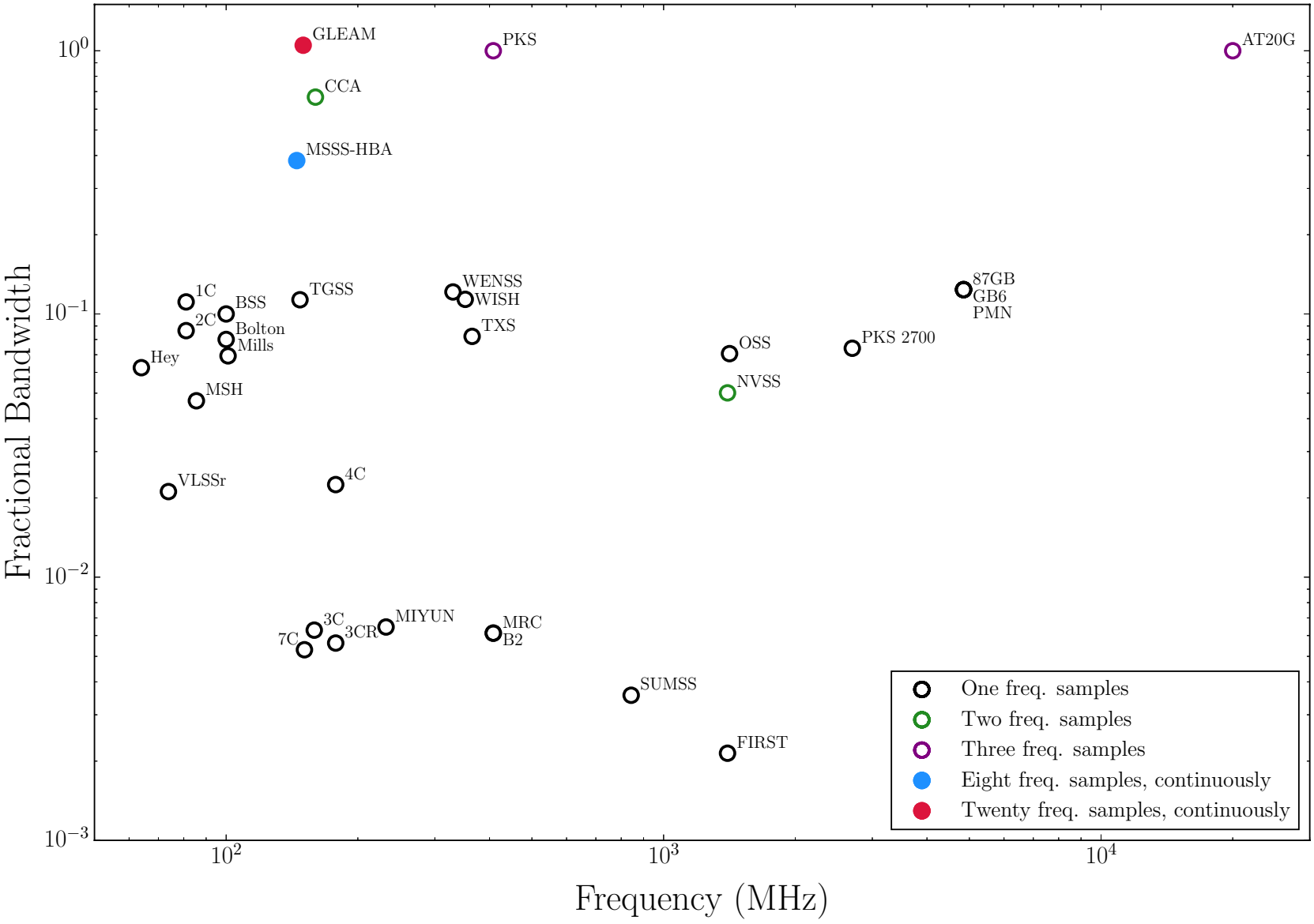
NASA, ESA, S. Baum and C. O'Dea (RIT), R. Perley and W. Cotton (NRAO/AUI/NSF), and the Hubble Heritage Team

The SED Revolution with GLEAM

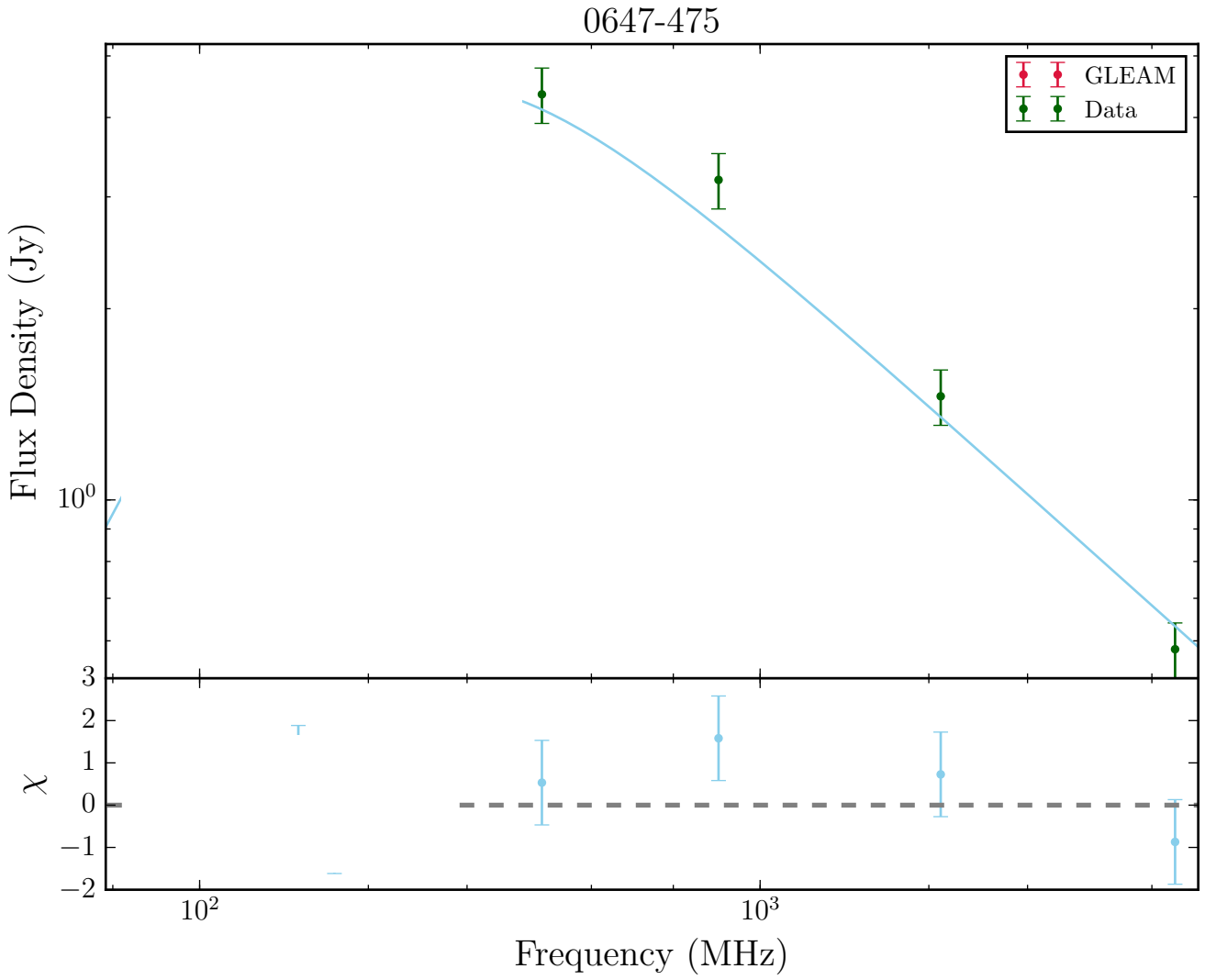
- MWA GLEAM (Hurley-Walker et al. 2017)
  - 305,615 sources over 59% of the sky at 2’ resolution, σ ~ 10 mJy
  - every source: 20 fluxes spanning 72 – 231 MHz

BBC Two Horizon

What survey parameters make GLEAM look good?

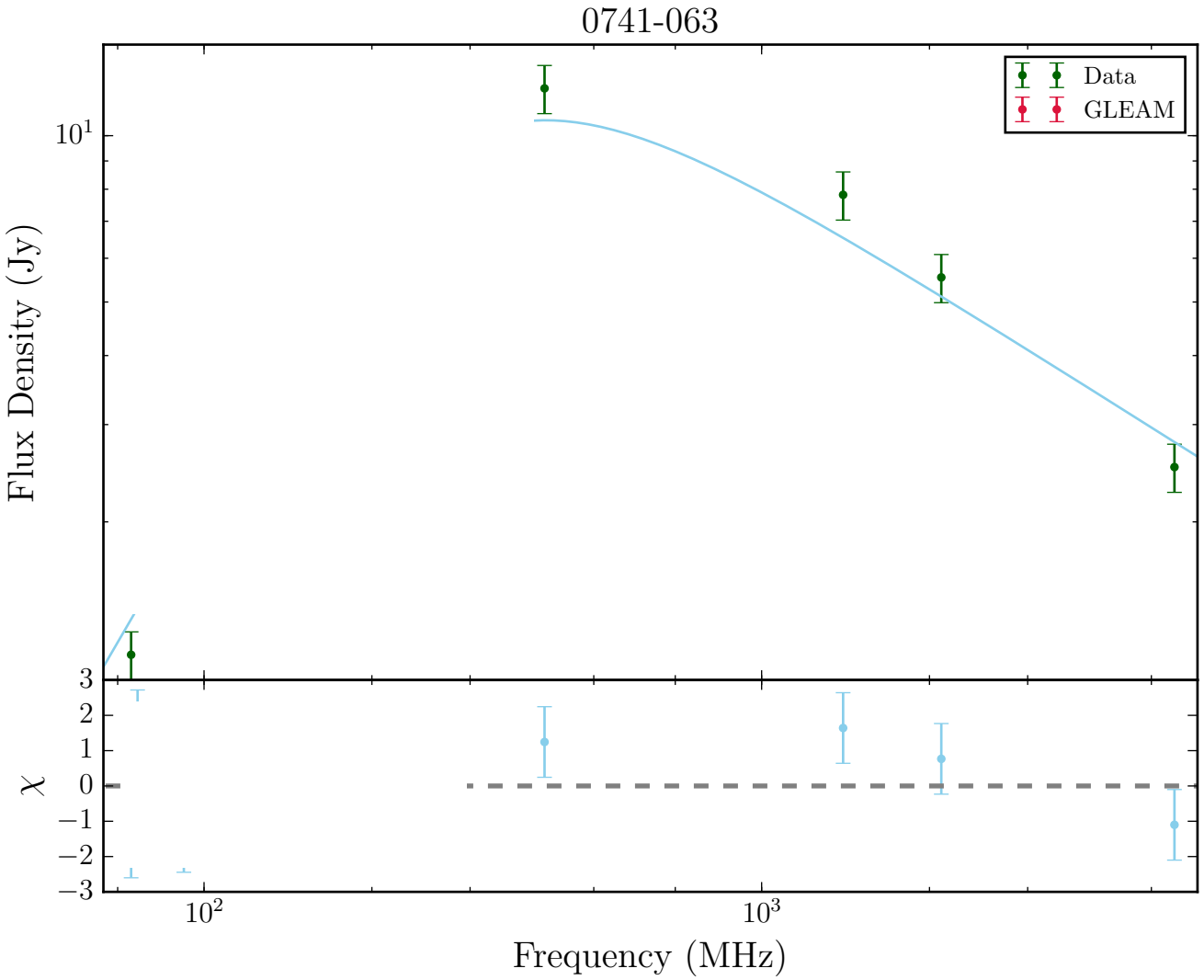


New Peaked-Spectrum Source (I)



Callingham et al. (2017)

New Peaked-Spectrum Source (II)



Callingham et al. (2017)

GLEAM Peaked-Spectrum Sample

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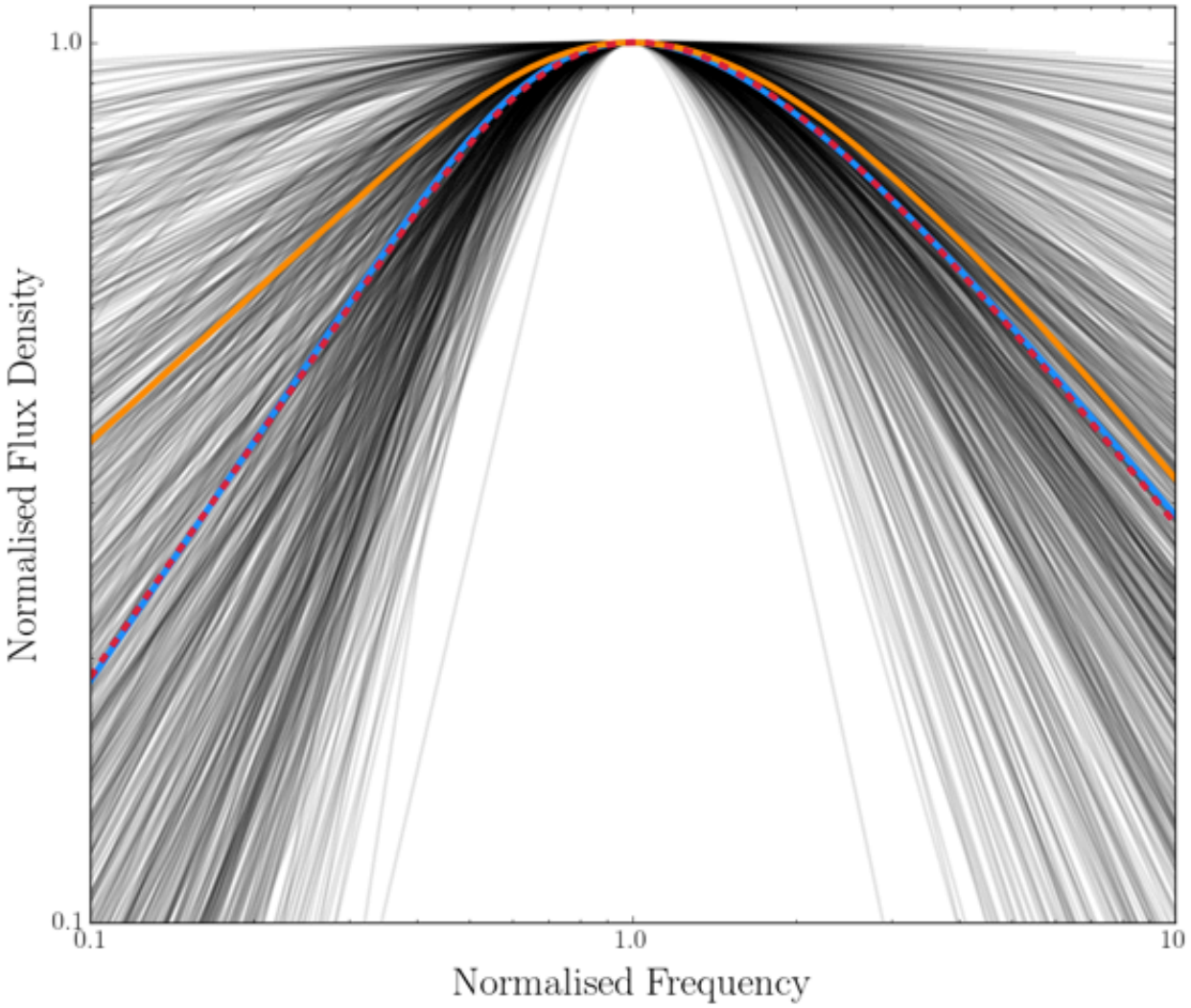
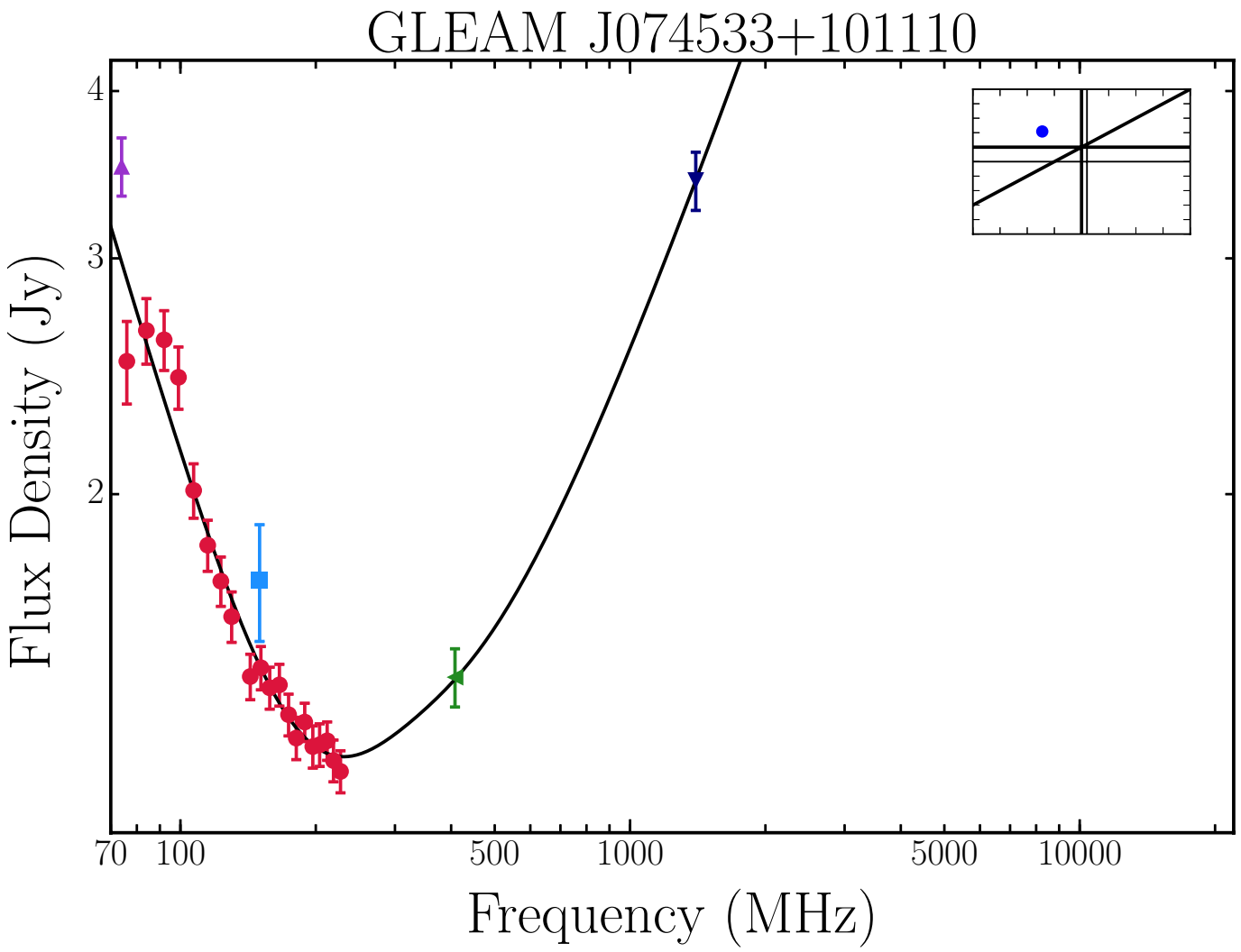
- 1483 peaked-spectrum sources from GLEAM
  - 4.5% of GLEAM sample
  - only 73 are previously known!
- Previous samples, e.g.:
  - O'Dea et al. (1998): 69
  - Snellen et al. (1998): 47



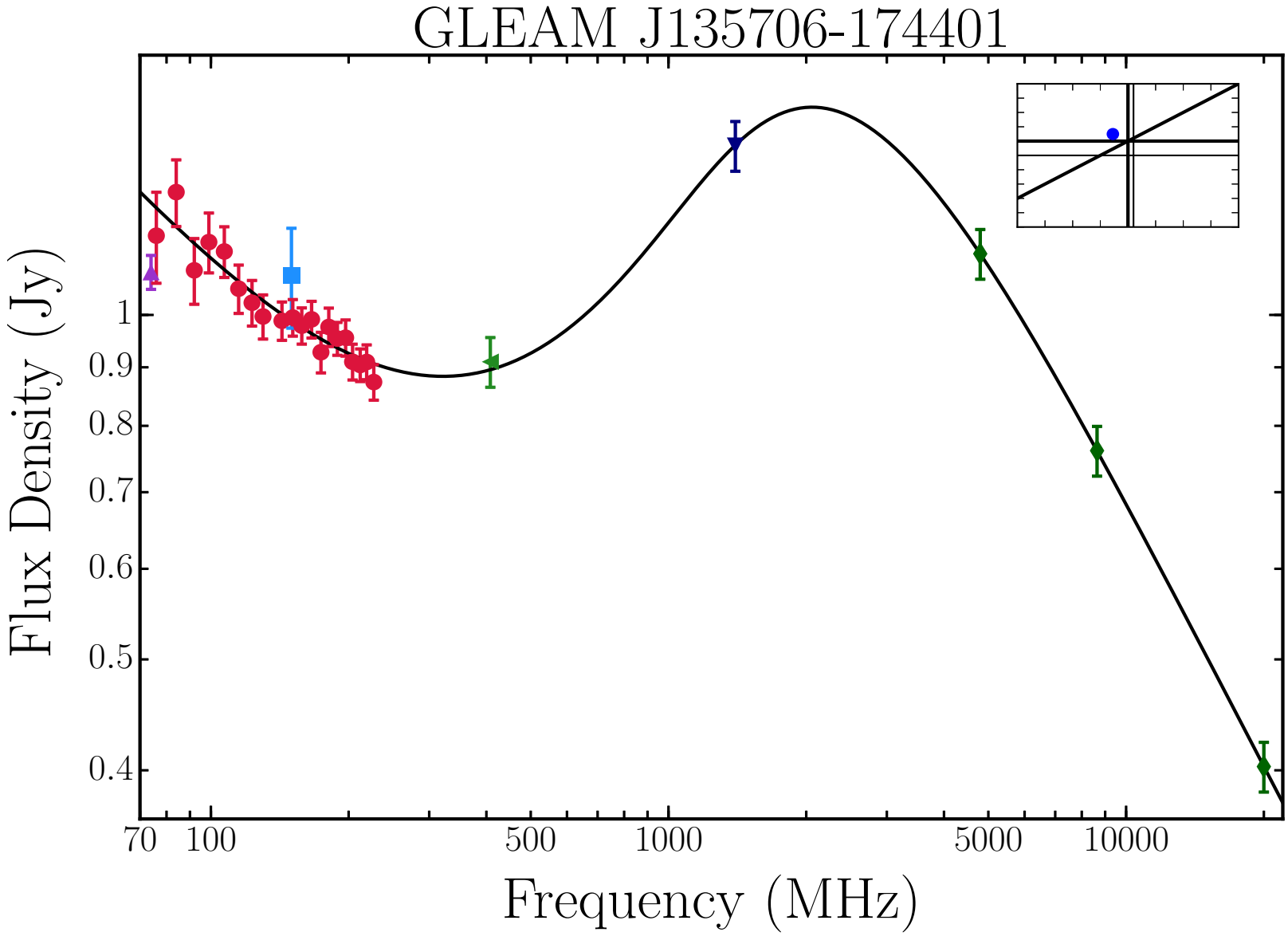
Callingham et al. (2017)

Sanity check

- All GPS sources with a turnover between 72 and 1.4 GHz are identified
- However, got convex sources?



Insanity check



Insanity check

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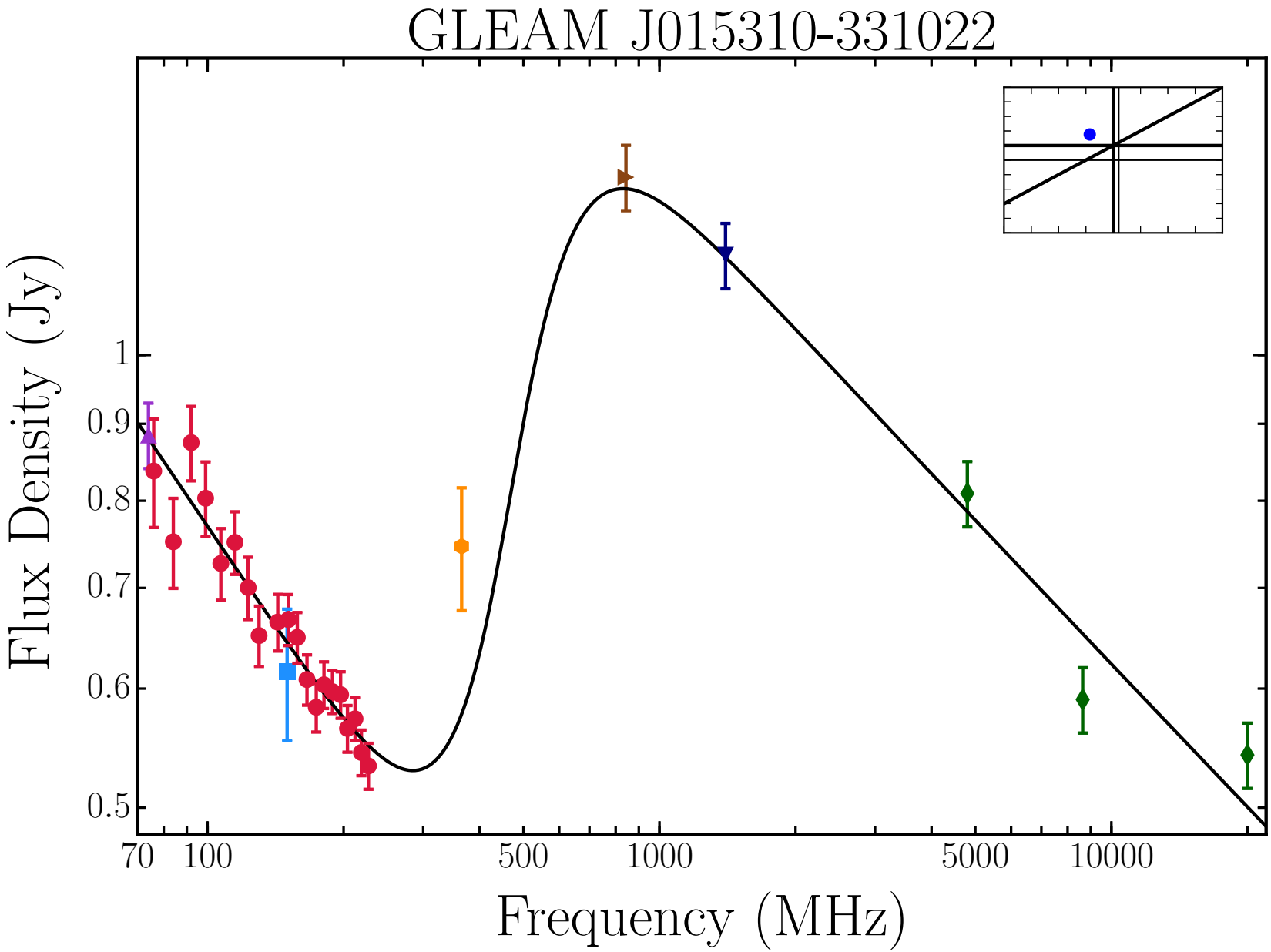
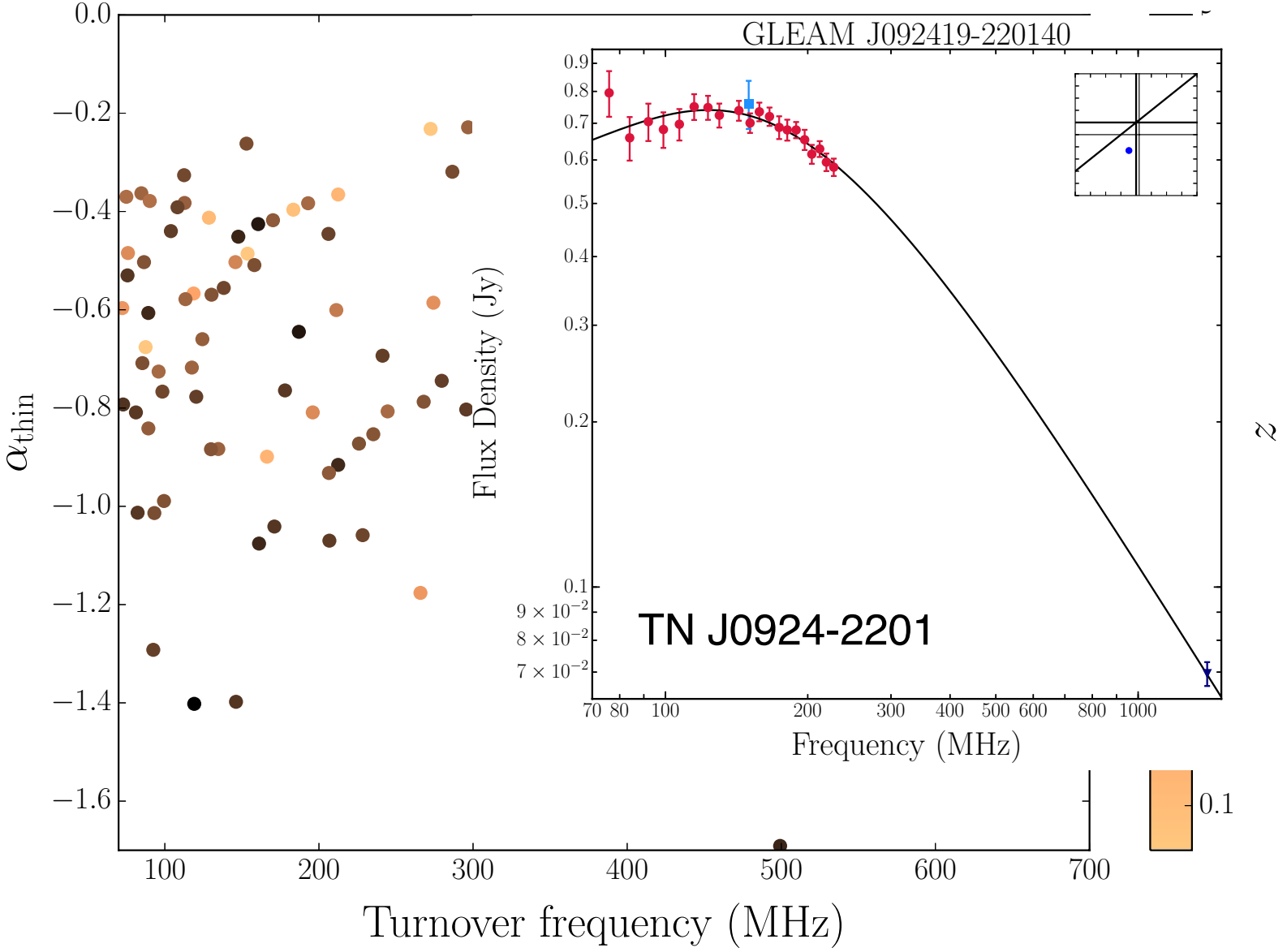
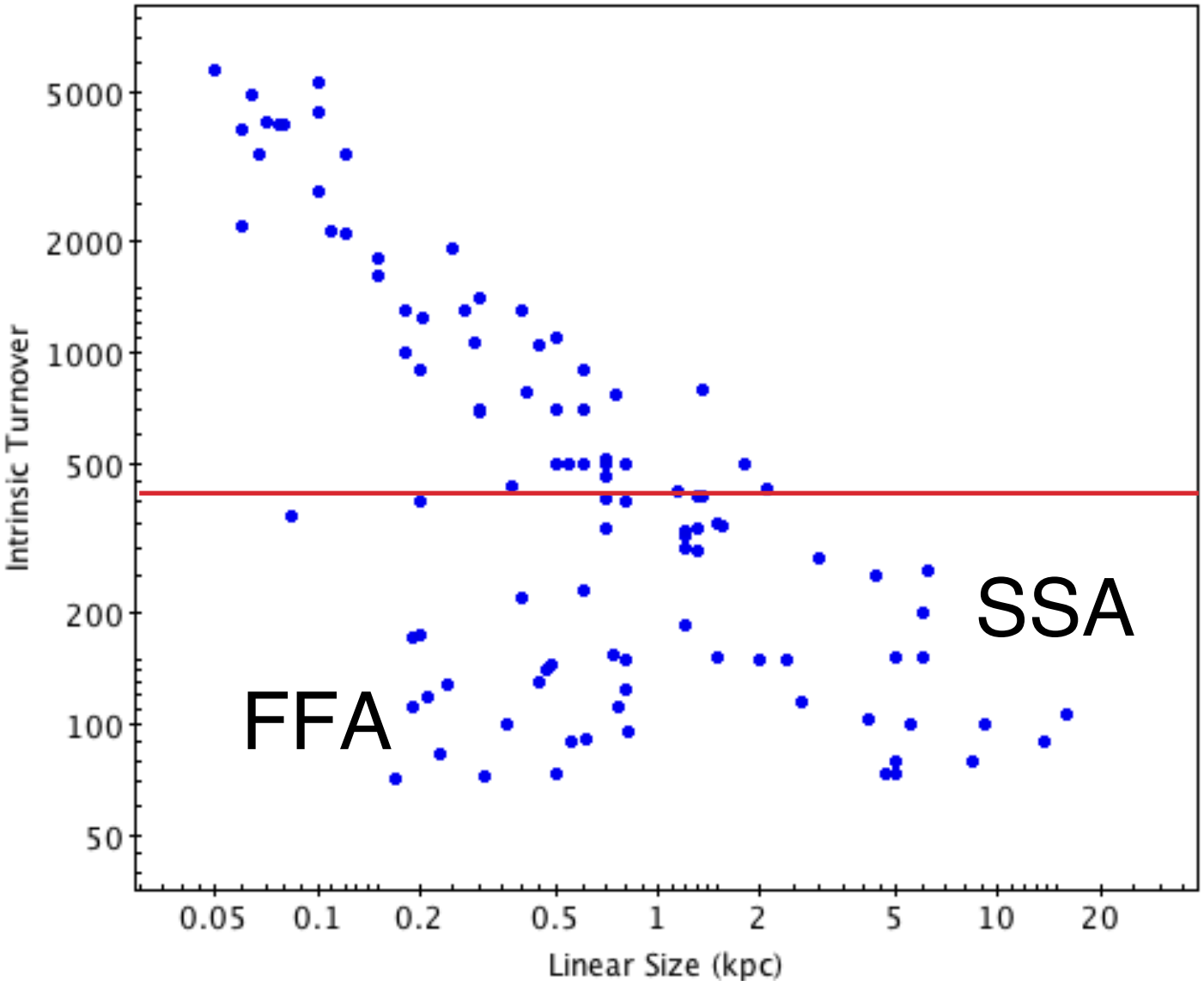


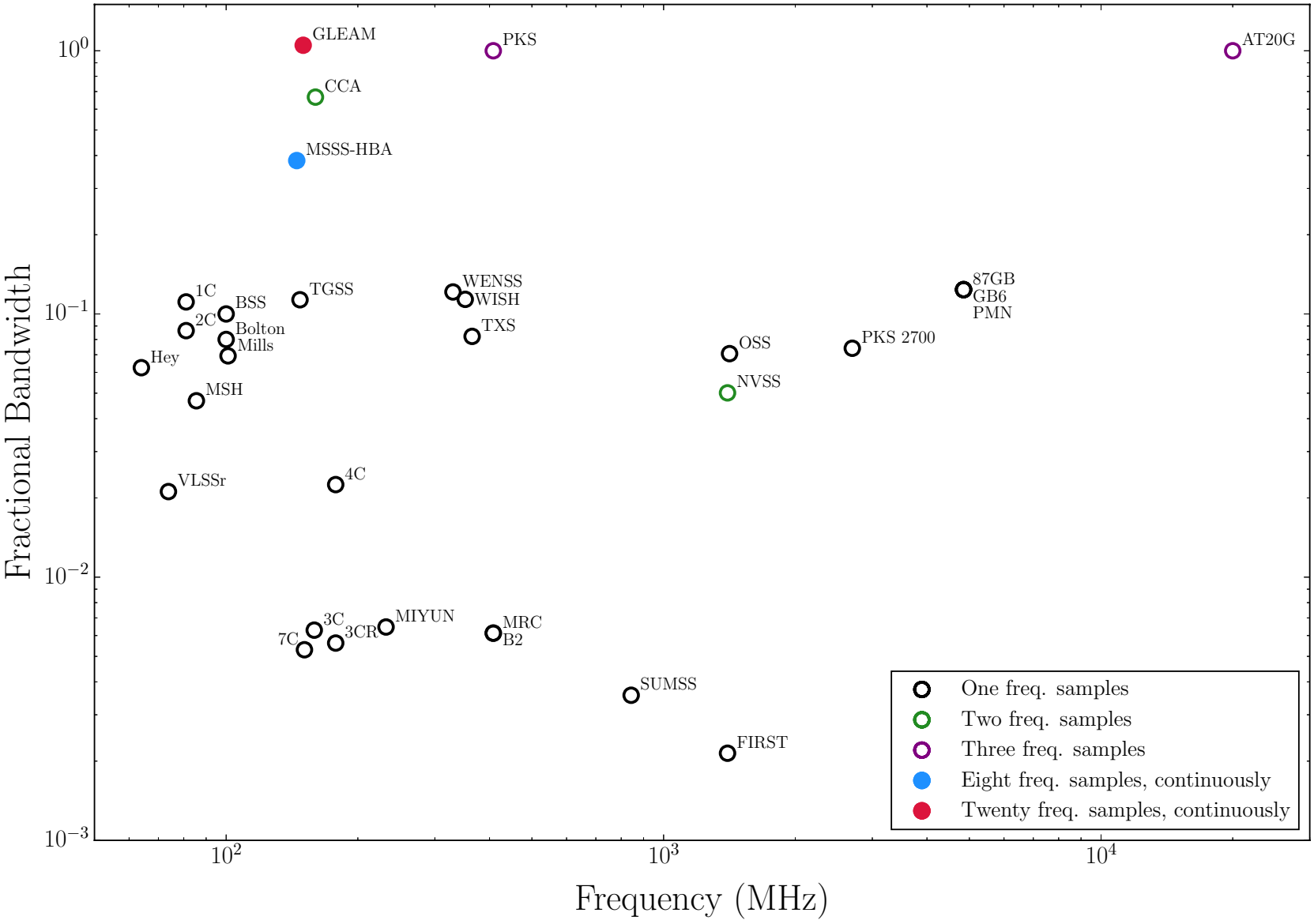
High Redshift Universe



Two populations?



What survey parameters make MSSS look good?



MSSS

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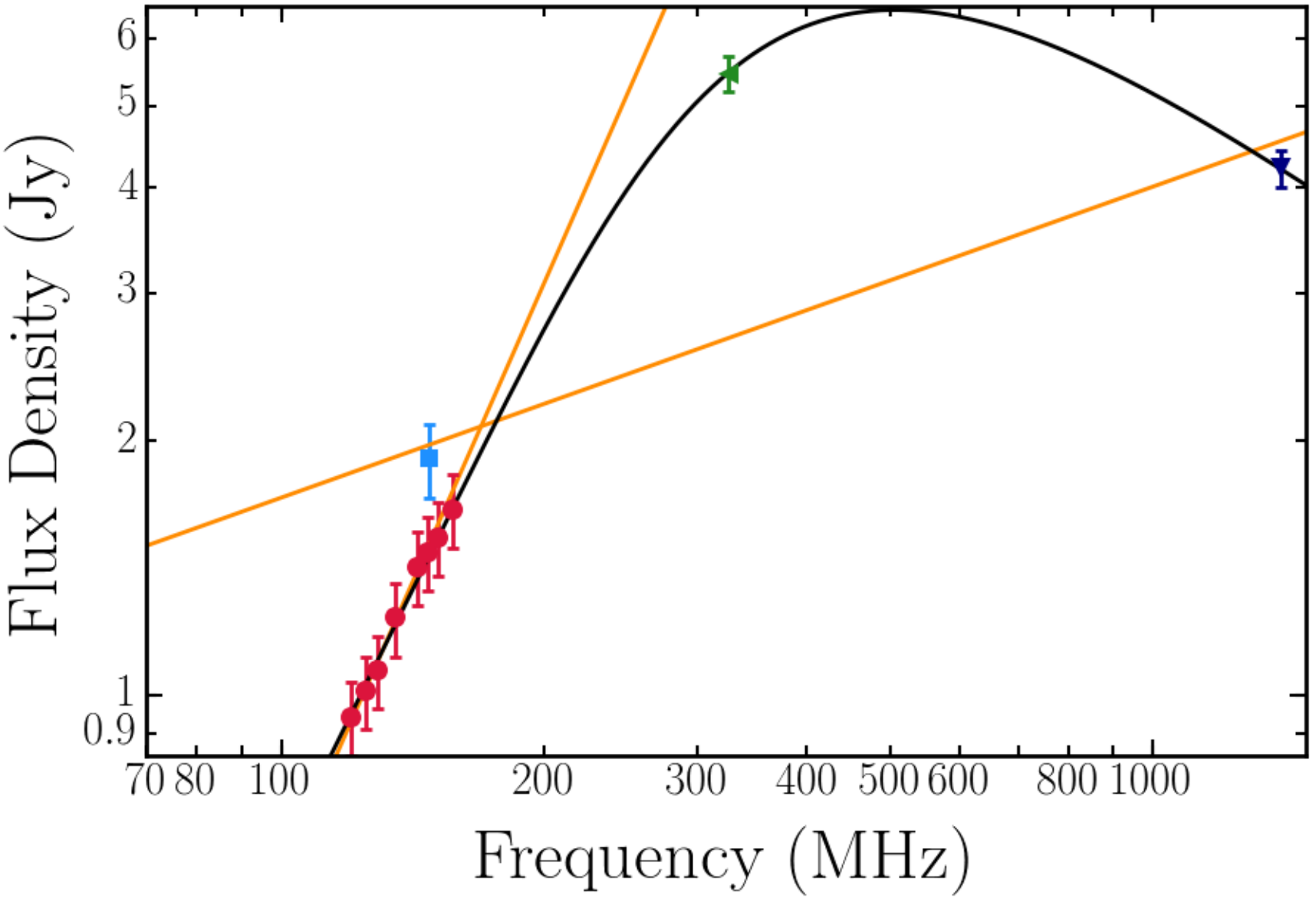
Flux Density (Jy)
6
5
4
3
2
1
0.9
70 80 100 200 300 400 500 600 800 1000
Frequency (MHz)

MSSS

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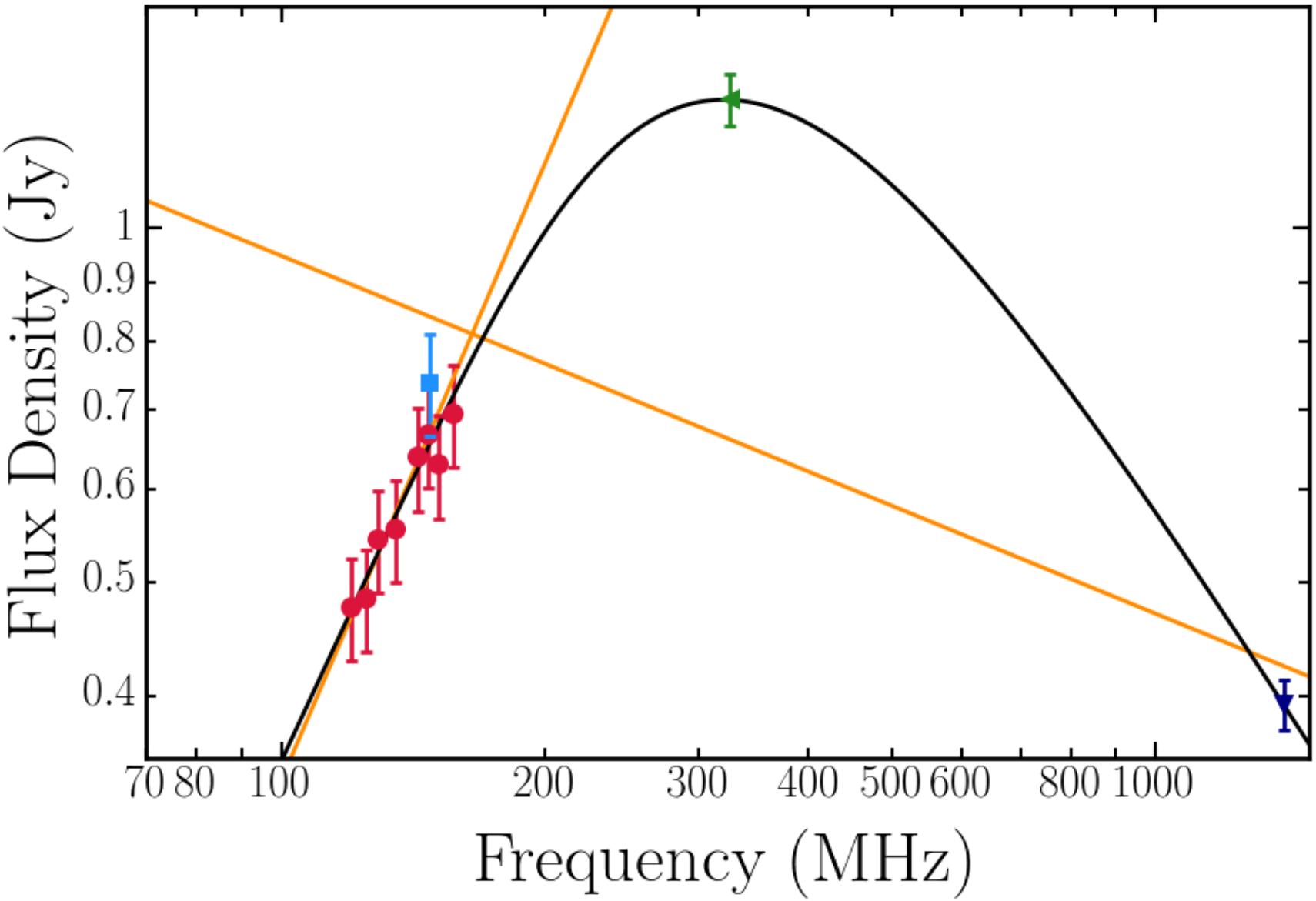
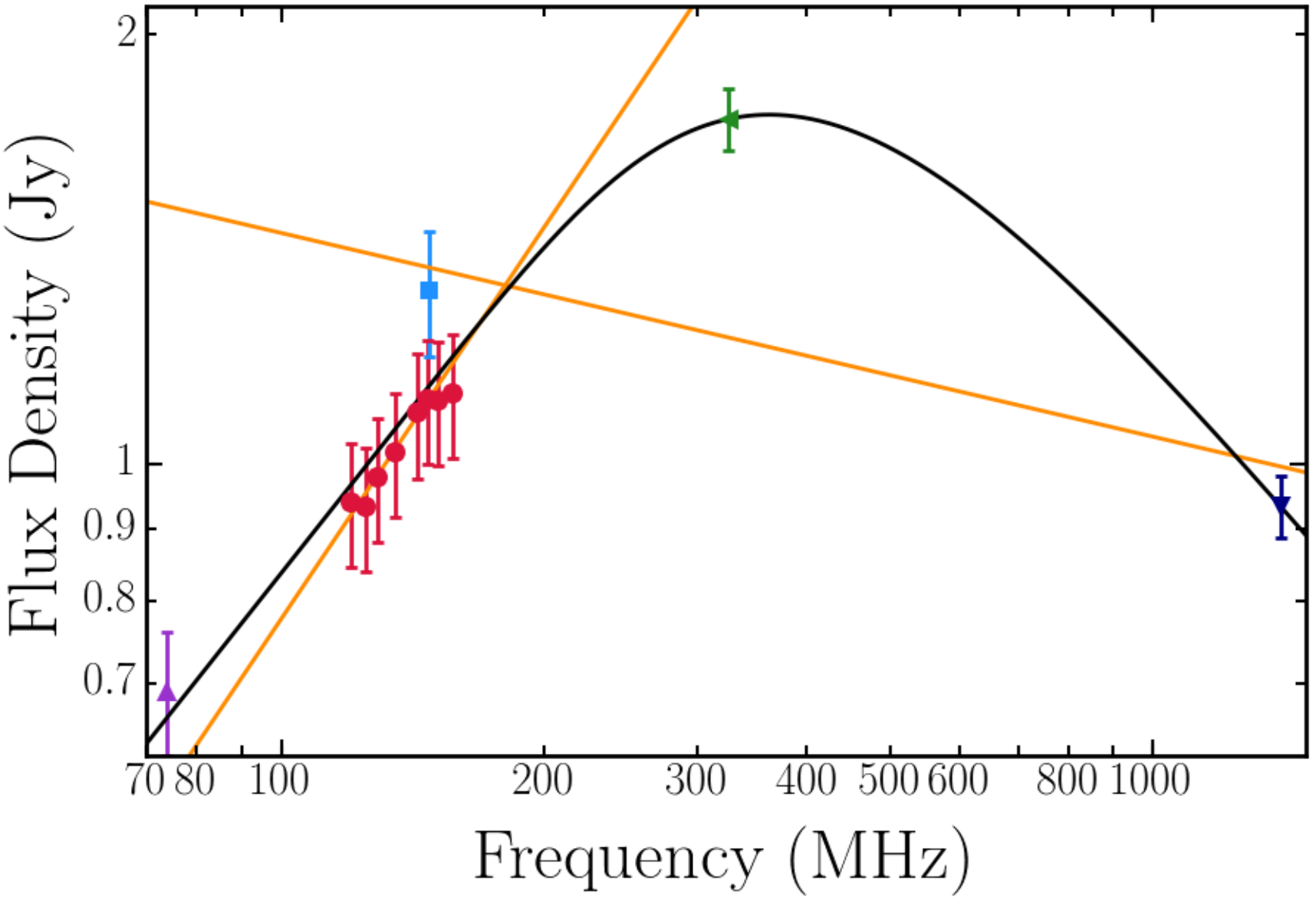

Flux Density (Jy)
1
0.9
0.8
0.7
0.6
0.5
0.4
70 80 100 200 300 400 500 600 800 1000
Frequency (MHz)

MSSS

ASTRON


Flux Density (Jy)
2
1
0.9
0.8
0.7
70 80 100 200 300 400 500 600 800 1000
Frequency (MHz)

Summary

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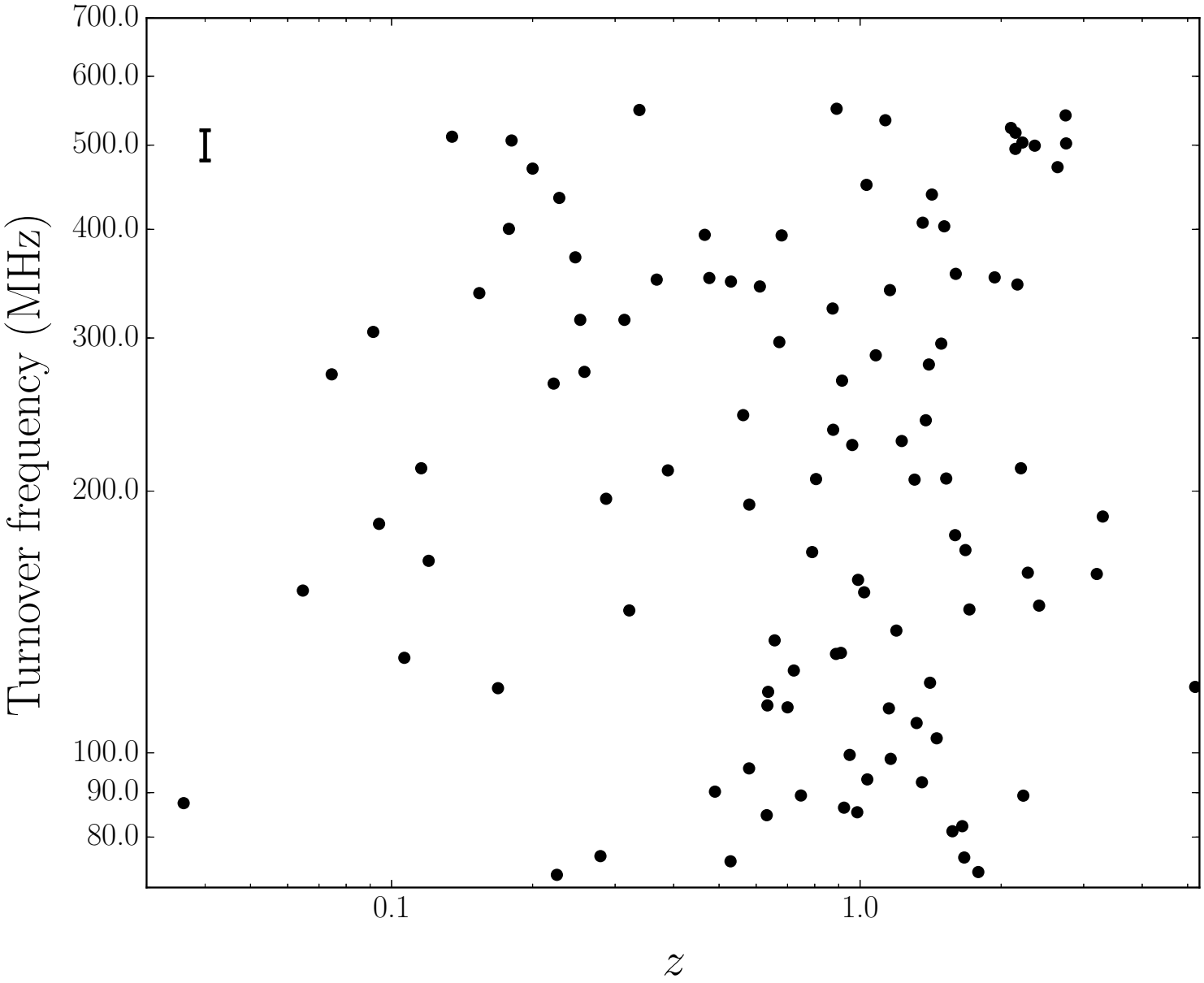
- GLEAM: widest ever fractional-bandwidth radio survey
  - ideal for finding peaked-spectrum sources
- New catalogue of 1483 peaked-spectrum sources
  - low-frequency analogues to GPS & CSS sources
  - 95% are new detections
  - more sources than all previous efforts combined
- Additional thoughts and future work
  - ***convex*** population: multiple epochs of AGN activity
  - low-freq turnover & high-freq steep spectrum: indicator of high-redshift ($z > 2$) galaxies?
  - MSSS and LoTSS
  - International baselines

MWA / Hurley-Walker

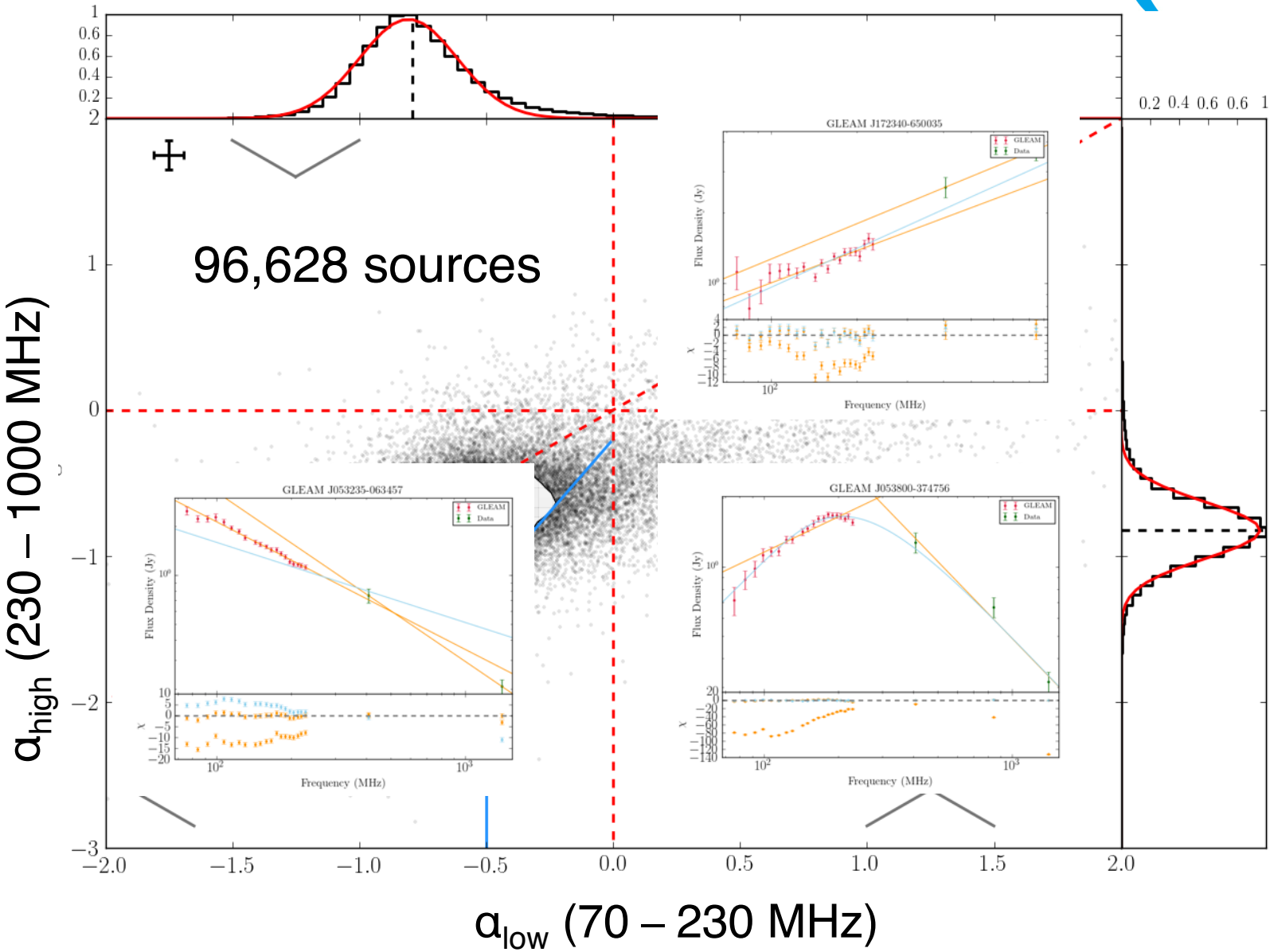
NASA, ESA, RIT, NRAO / AUI / NSF, Hubble Heritage

LOFAR / ASTRON

Mix and Match

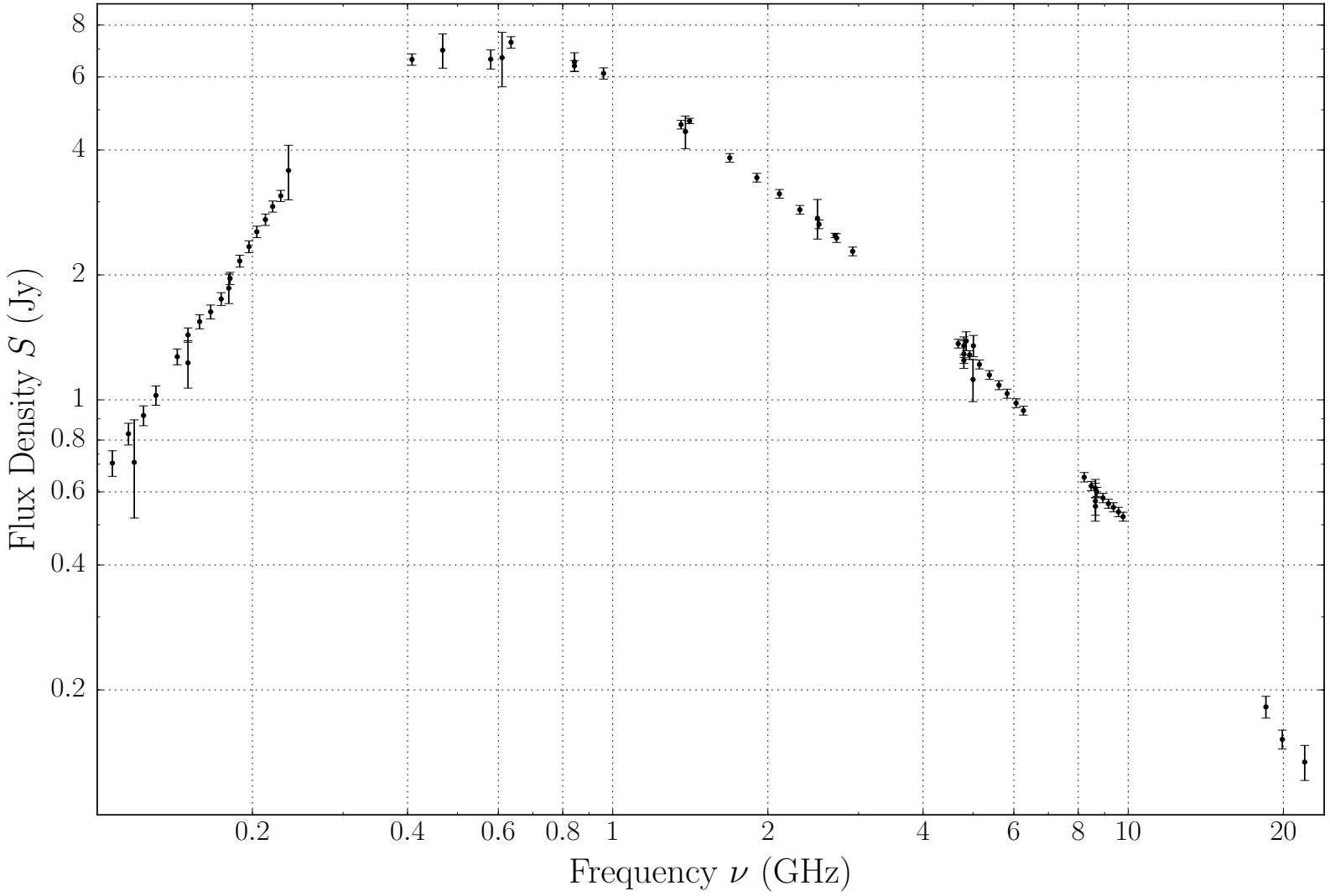


GLEAM Colour-Colour Diagram



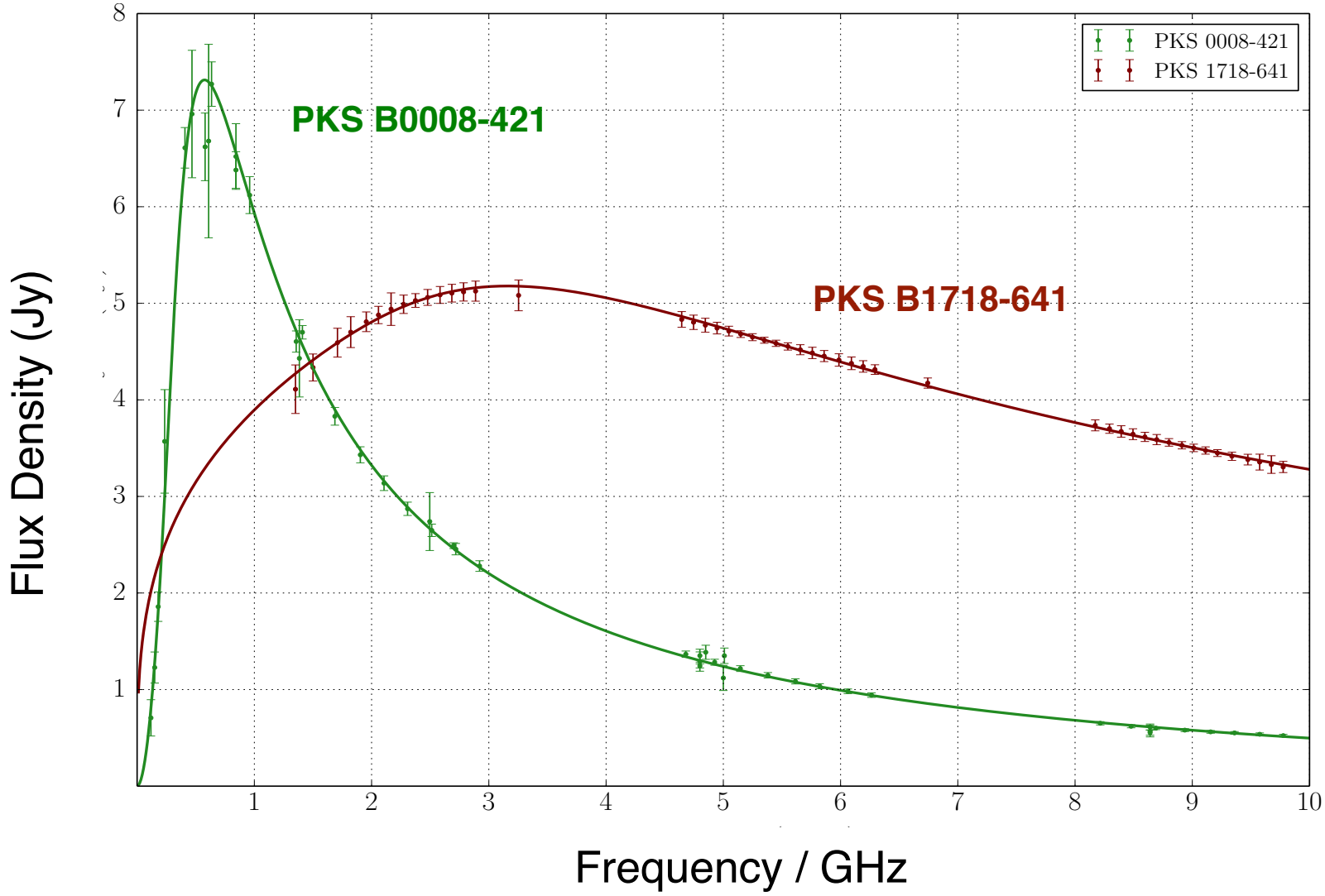
Callingham et al. (2017)

Extreme GPS Source PKS B0008-421 (II)



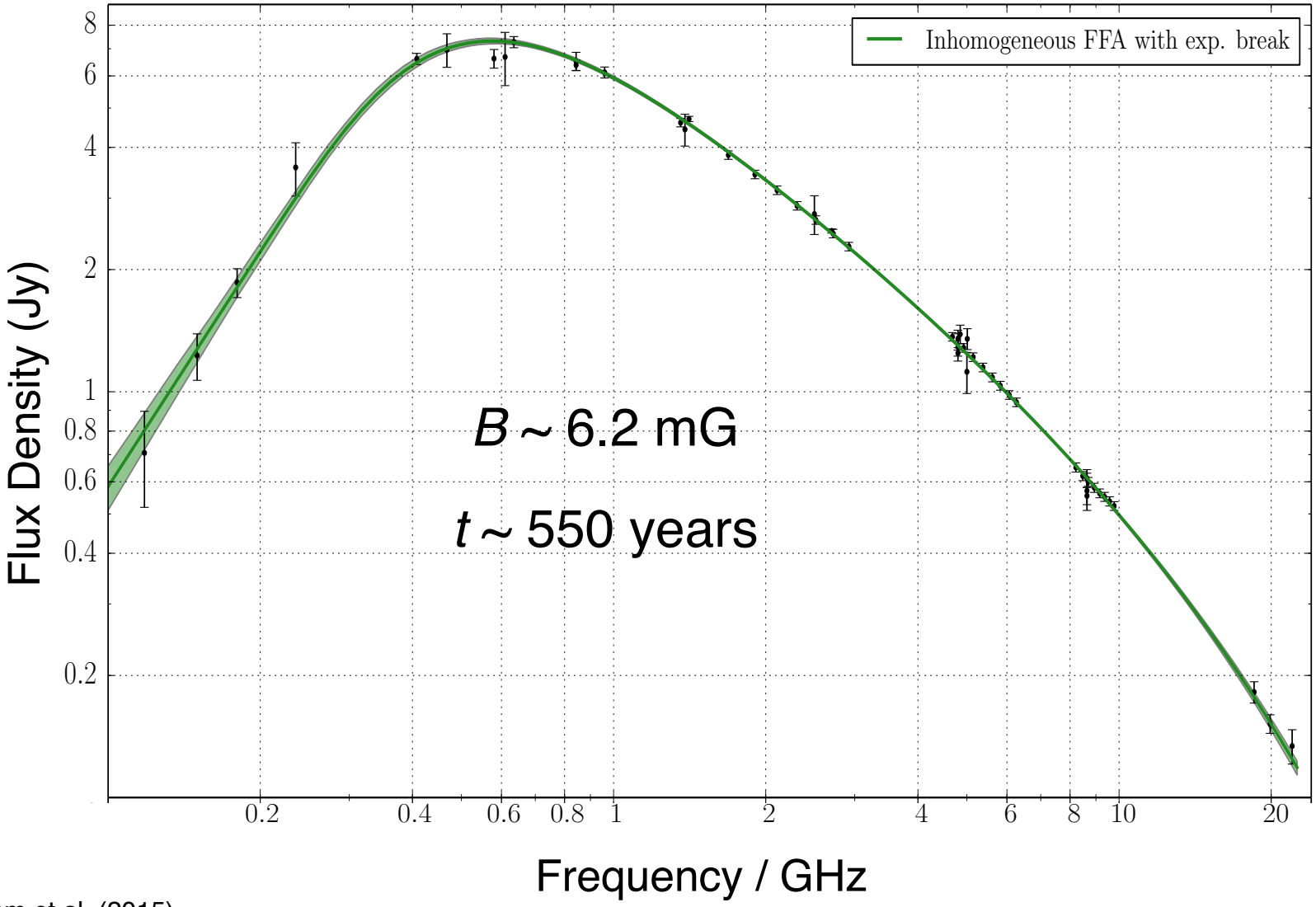
Callingham et al. (2015)

Extreme GPS Source PKS B0008-421 (III)



Callingham et al. (2015)

Extreme GPS Source PKS B0008-421 (IV)



Callingham et al. (2015)

Possible Absorption Mechanisms

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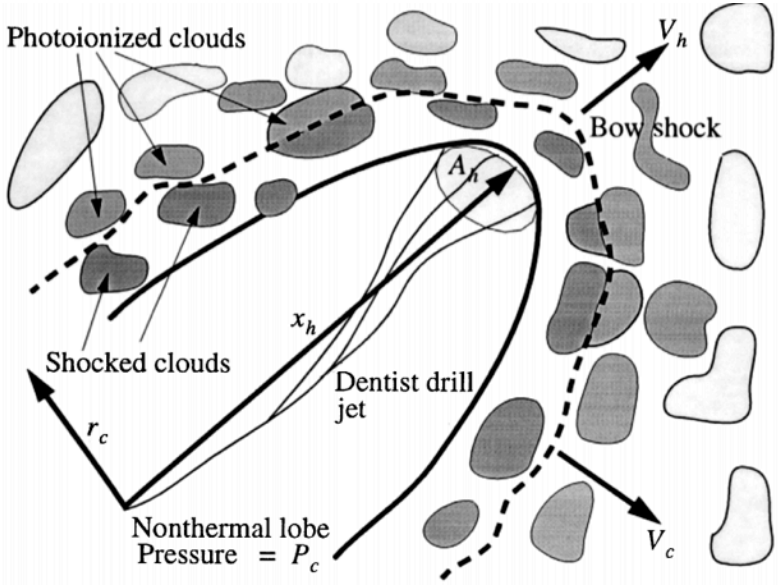
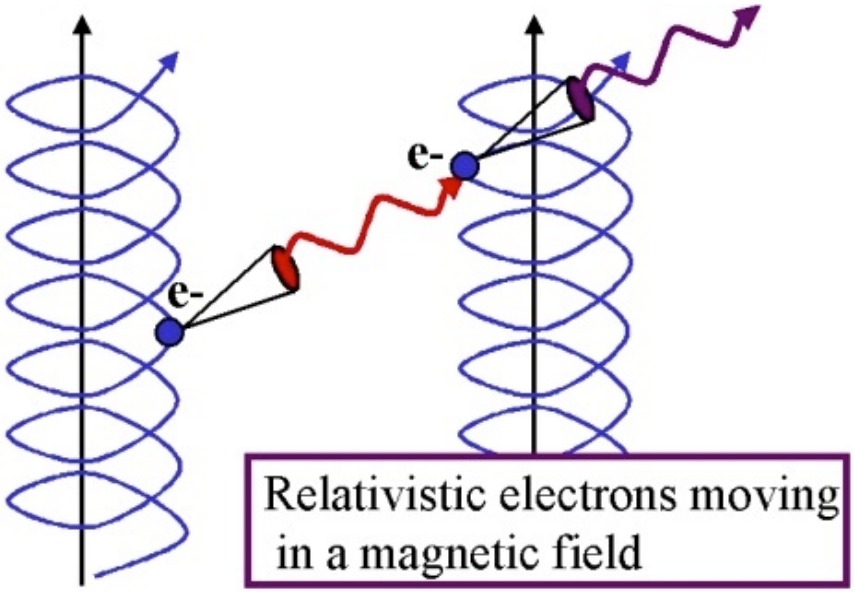
Astronomy & Astrophysics
UNIVERSITY OF TORONTO

Free-Free Absorption



Bicknell et al. (1997)

Synchrotron Self-Absorption



Kellermann (1966)

Possible Evolutionary Picture

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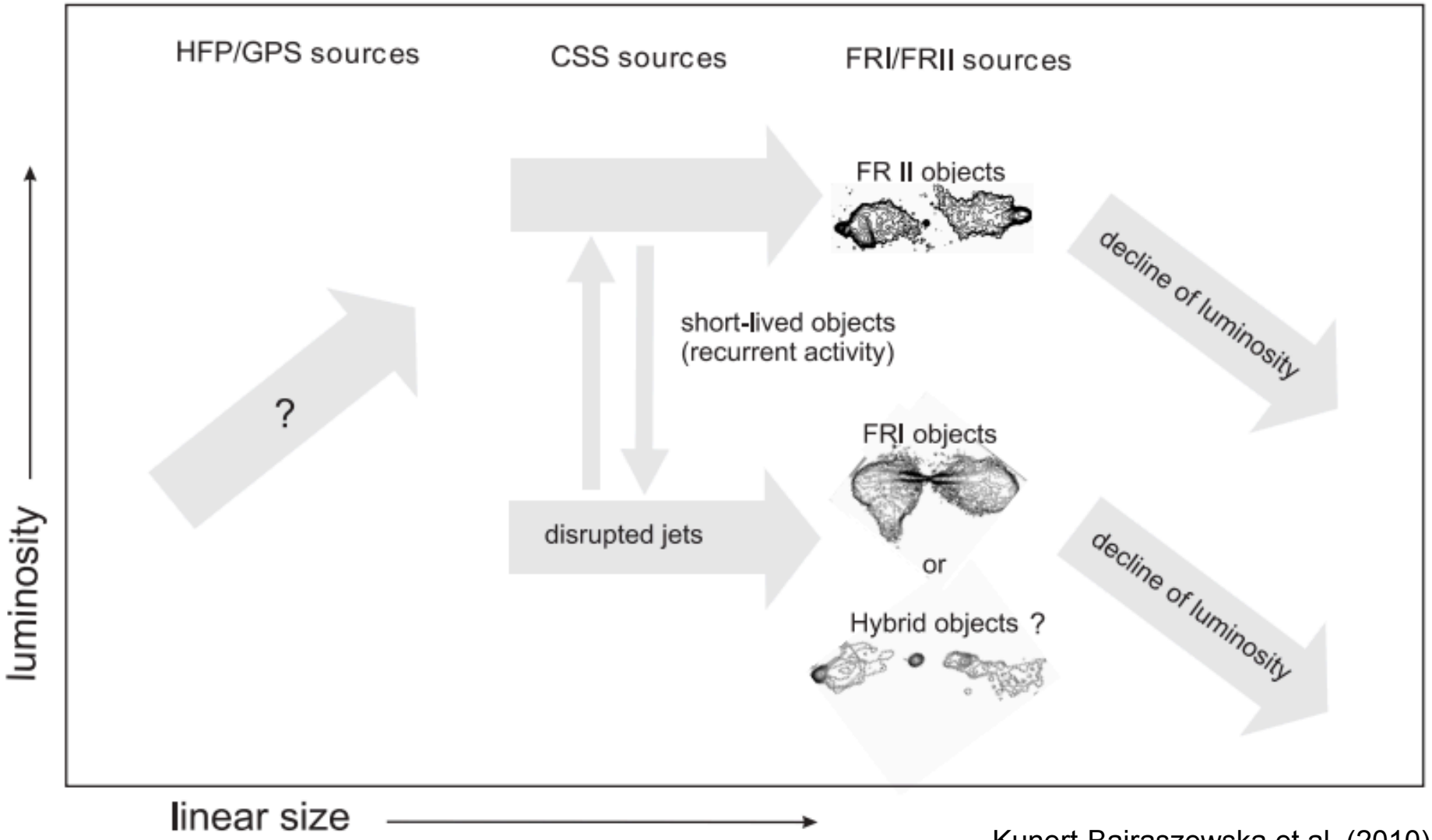
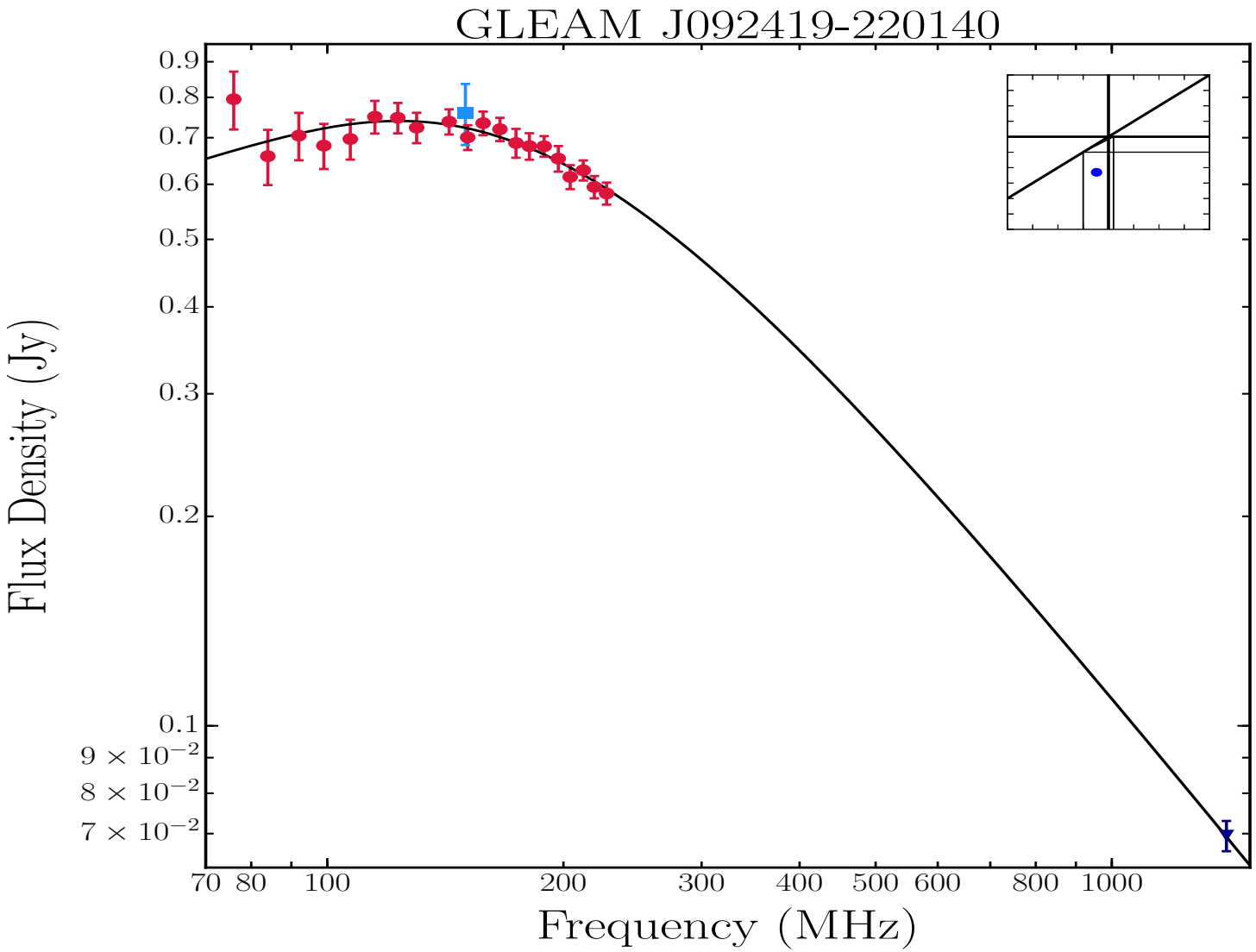


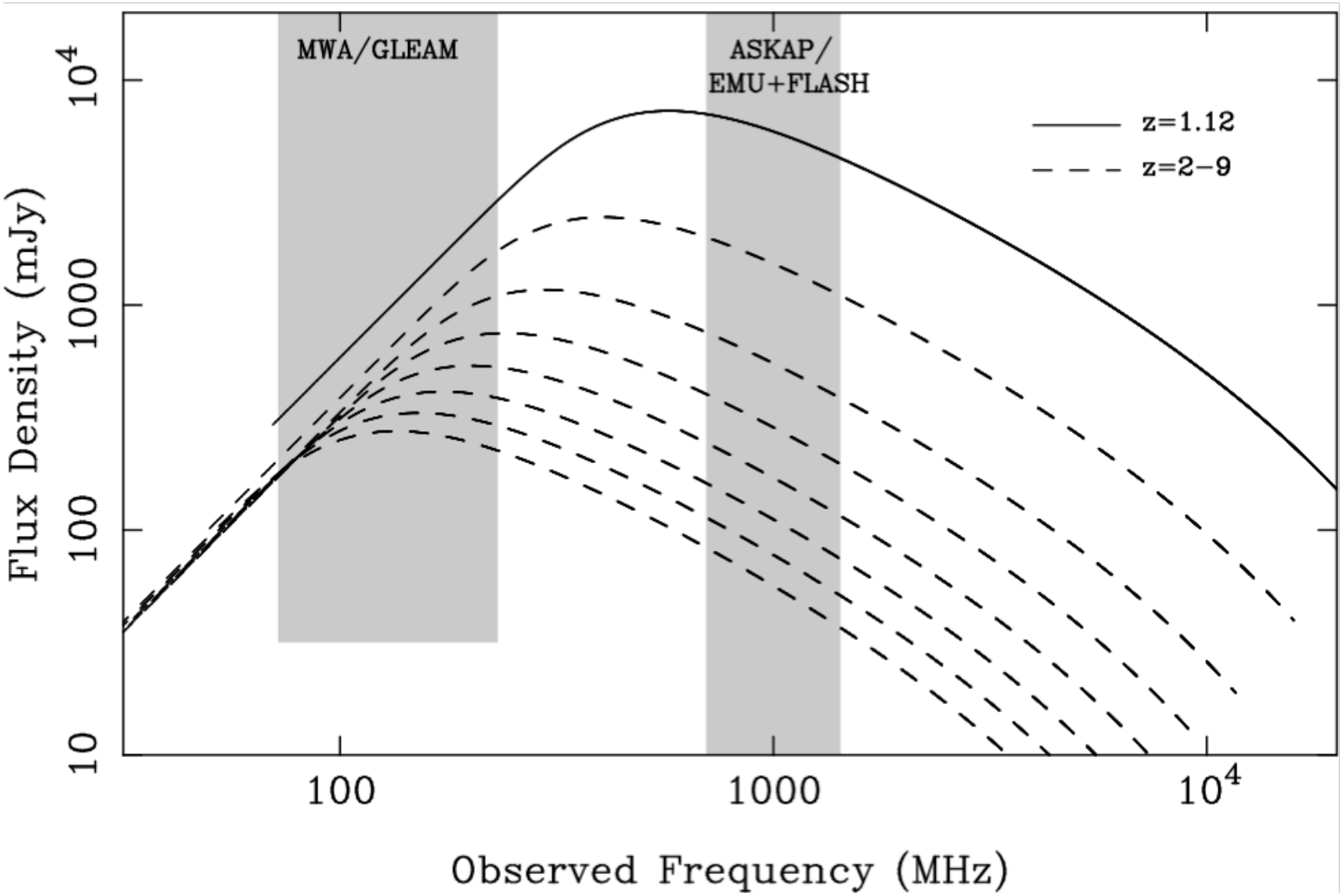
Kunert-Bajraszewska et al. (2010)

Ultra-Steep Spectrum Source



Callingham et al. (2017)

High Redshift Candidates



Nick Seymour