A FLASH ON BLAZARS

CAPTURING THE RADIO REALM OF 4FGL BLAZARS

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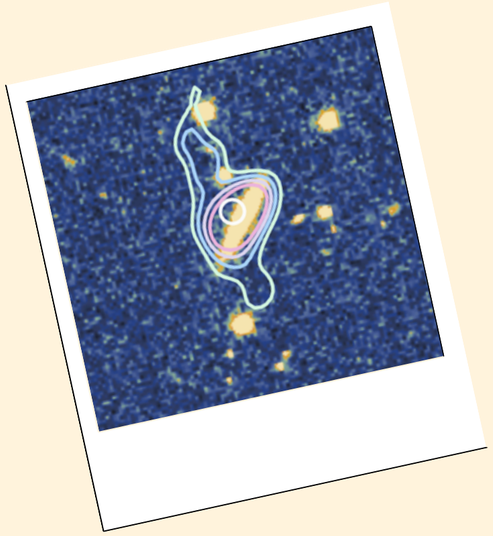
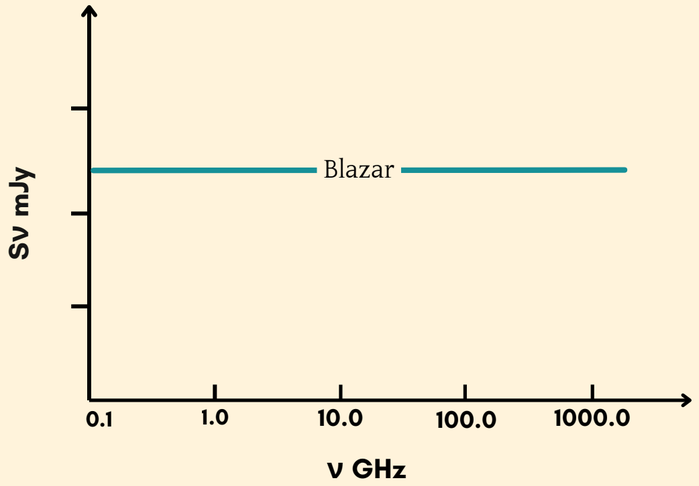
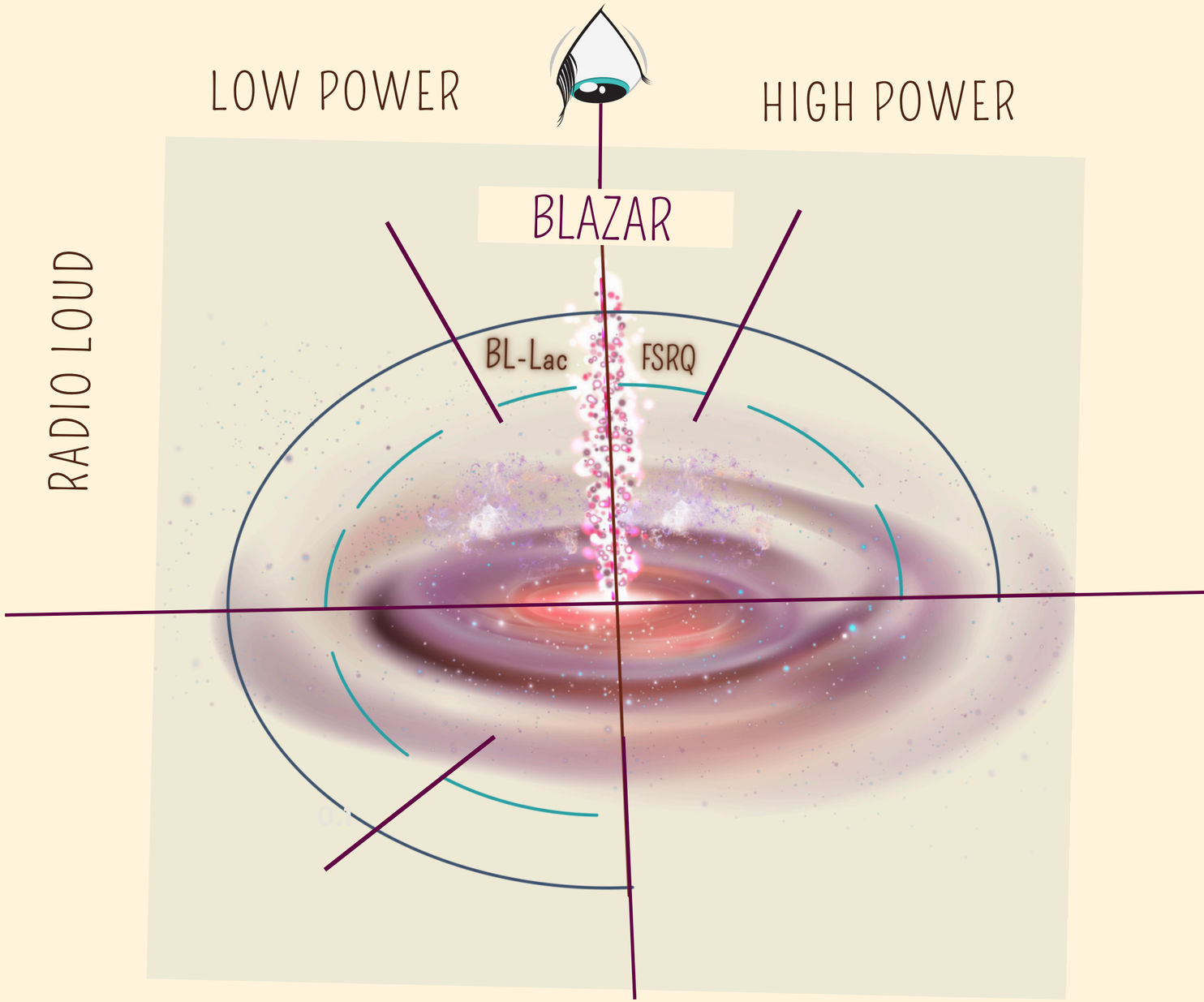


The Unified Model

Blazars:

- BL Lacs: weak/absent optical lines; γ-rays mainly SSC; often BH-spin-driven.
- FSRQs: strong optical lines; γ-rays mainly IC; accretion-driven, powerful, flat radio spectra.



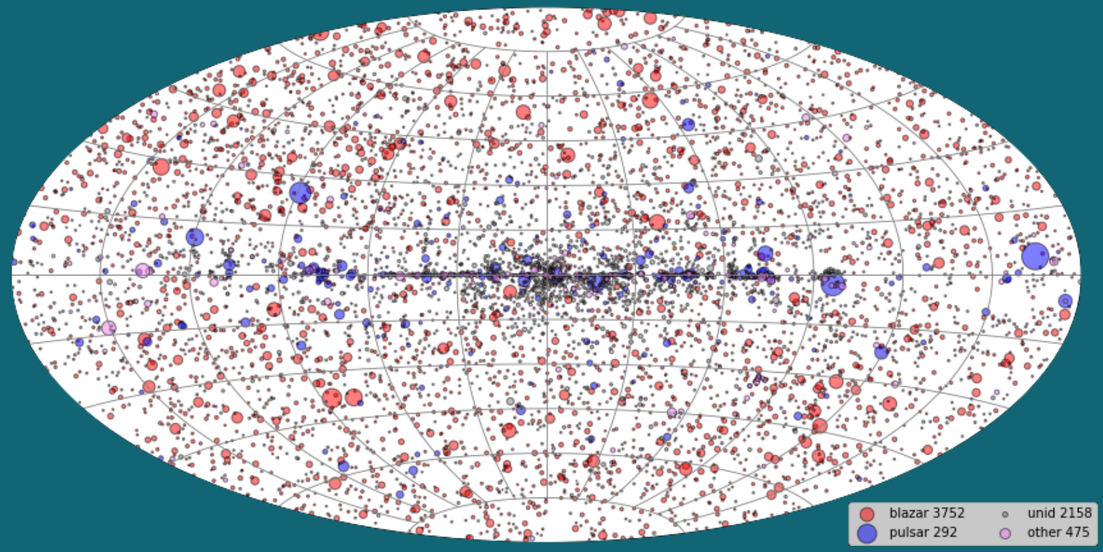


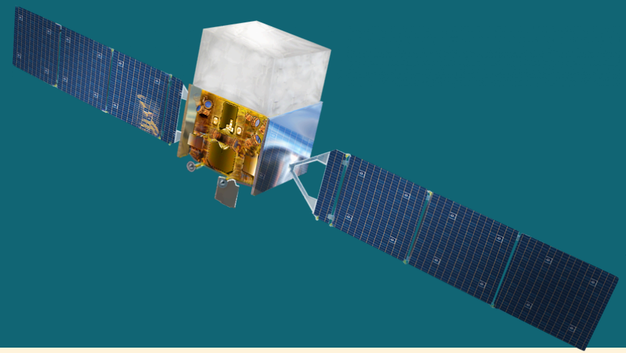
THE SURVEYS

4FGL

Fermi Large Area Telescope Fourth Source Catalogue

Instrument:	Fermi-Lat
Bands:	100 MeV-1 TeV
Area:	All sky
Resolution:	10.05-0.1 deg





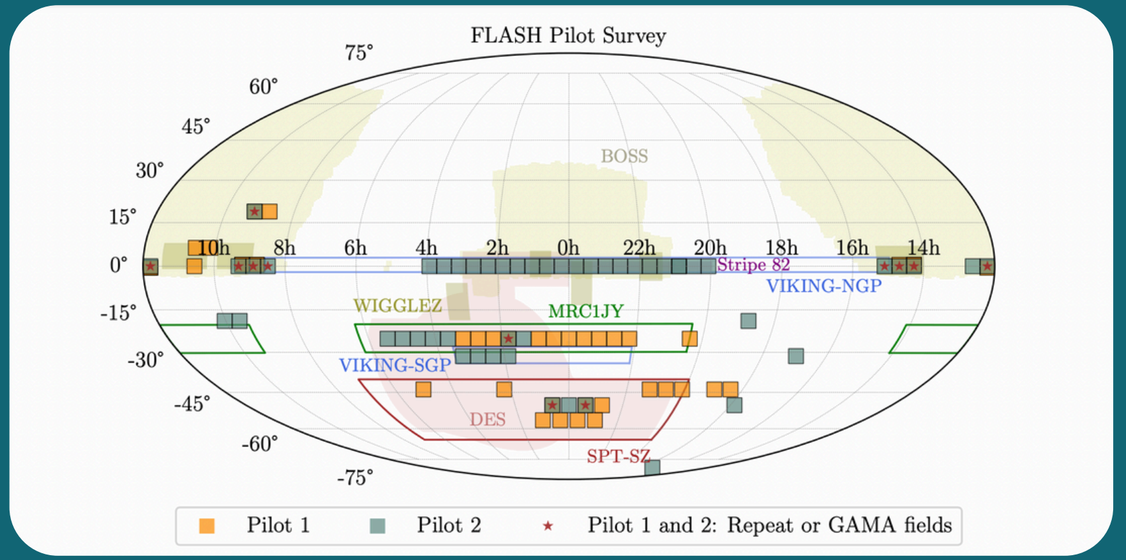
FERMI

THE SURVEYS

FLASH

First Large Absorption Survey in HI

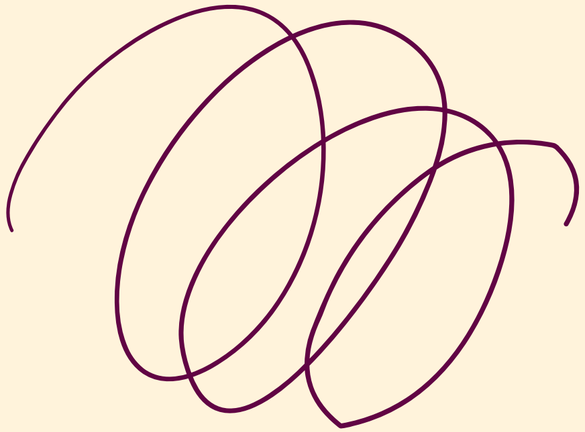
Instrument:	ASKAP
Bands:	711.5-999.5 MHz
Area:	100 sqdeg
Depth:	0.2 mJy/beam
Resolution:	15"



ASKAP

01

Select Blazars from the 4FGL catalogue

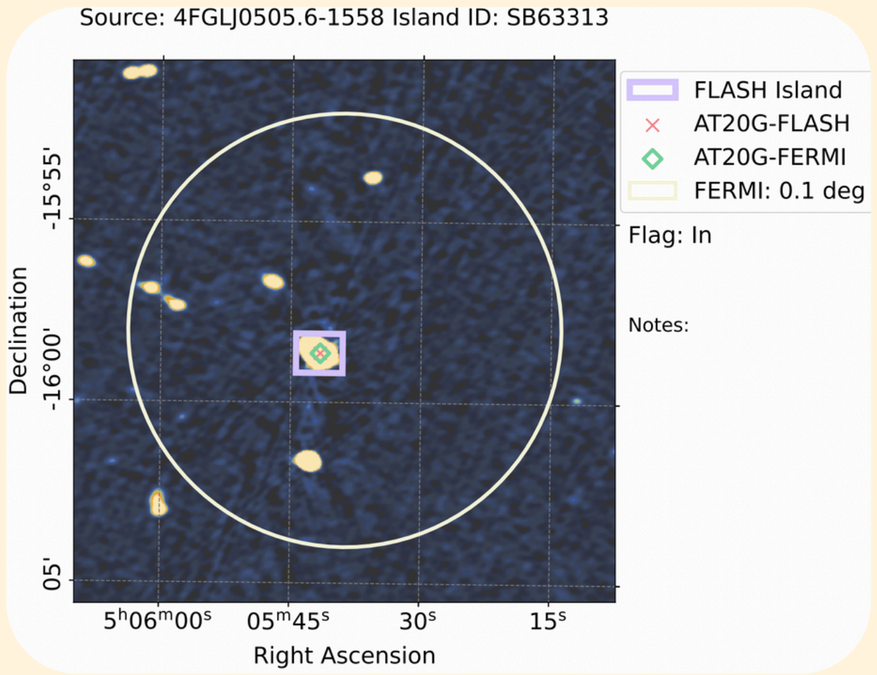


The sample selection

02

Find the counterparts in the FLASH continuum

0.1 deg

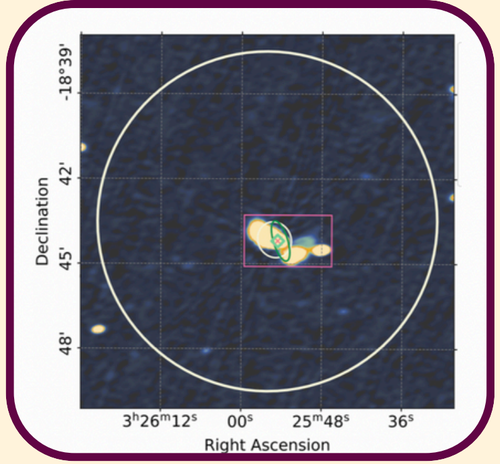


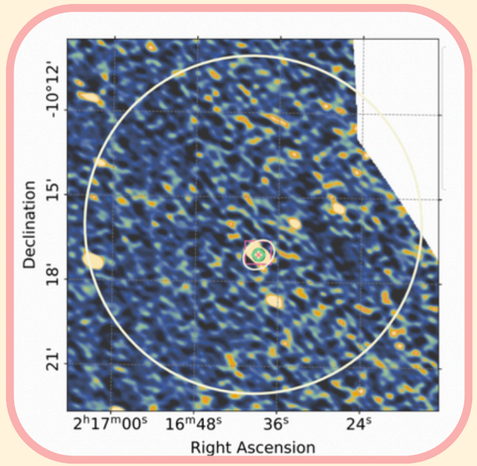
The sample selection

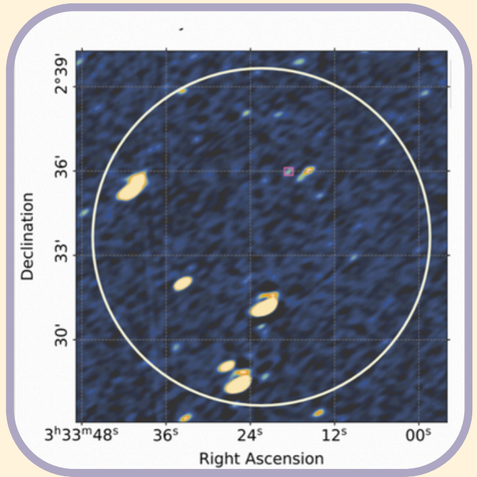
The sample selection

03

Select only the good ones







SAMPLE SELECTION

01

Select Blazars from the 4FGL catalogue

+

02

Find the counterparts in the FLASH continuum

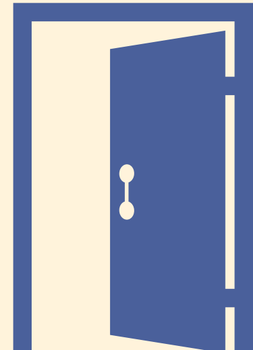
+

03

Select only the good matches

=

165 sources



SAMPLE SELECTION

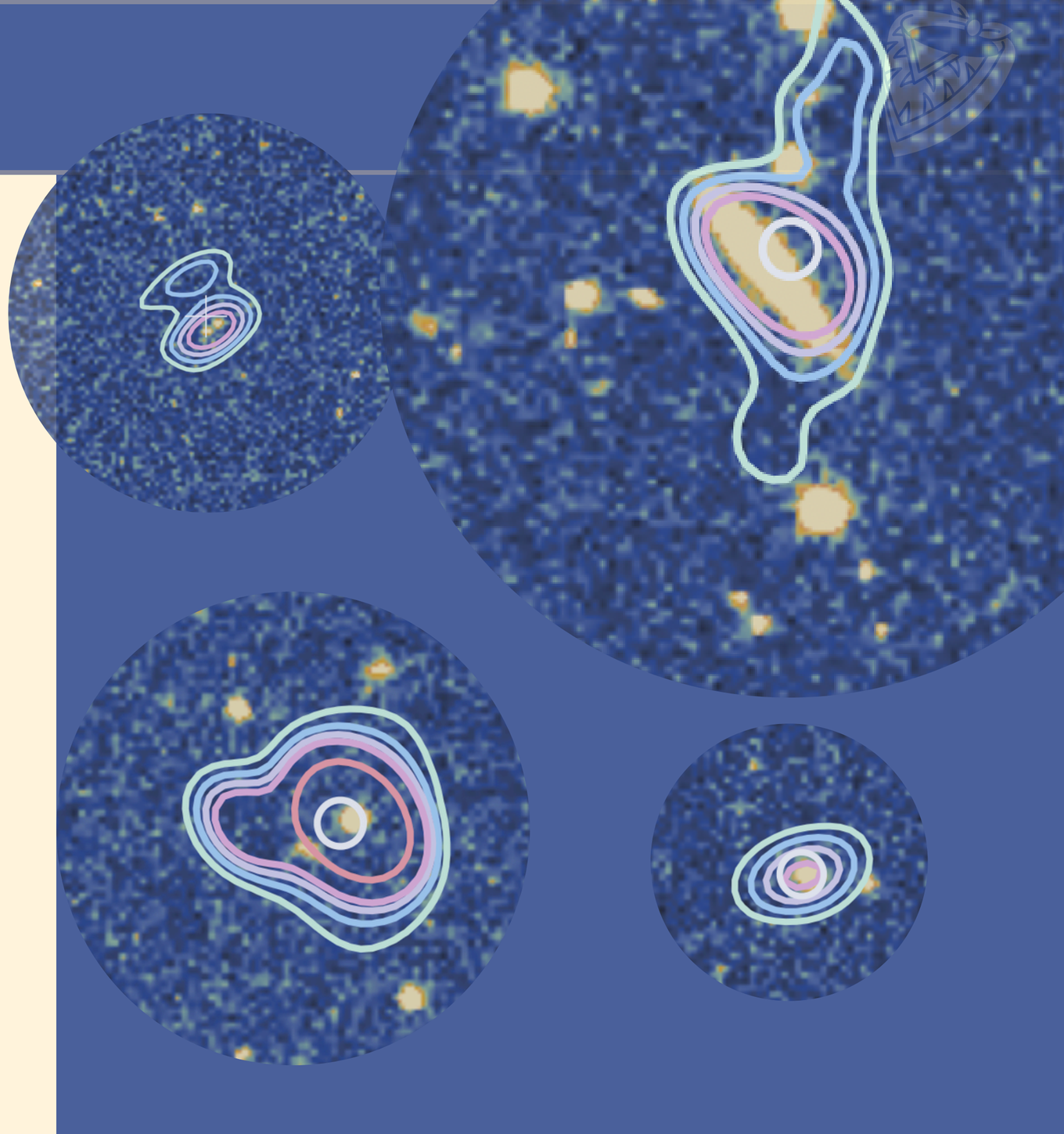
The spectroscopic sub-sample

Cross-match with the SDSS DR17 survey and QUAIA.

We achieved a total of 77 spectroscopically confirmed objects.

The median redshift of these sources is 0.77, consistent with the FLASH catalogue .

For these sources, we computed di intrinsic luminosities and turnover frequencies.



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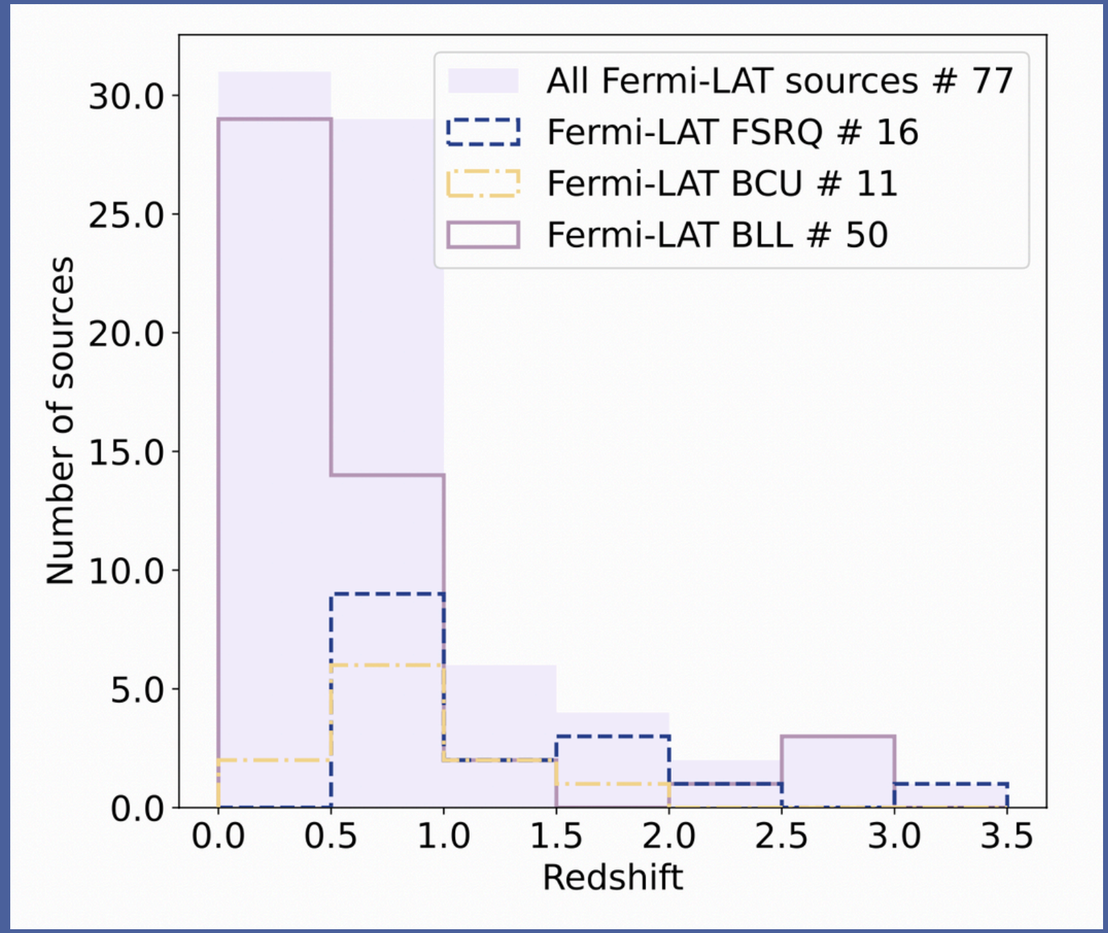
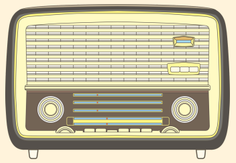
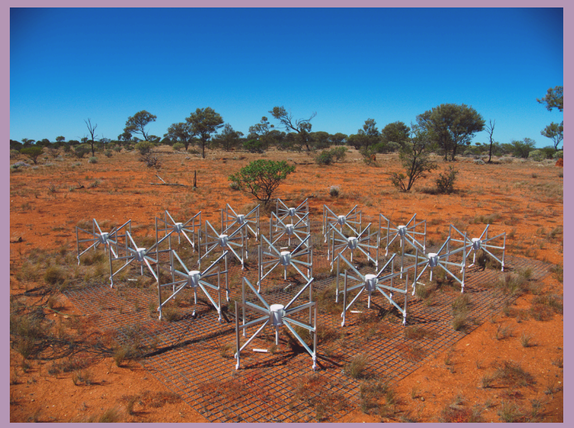
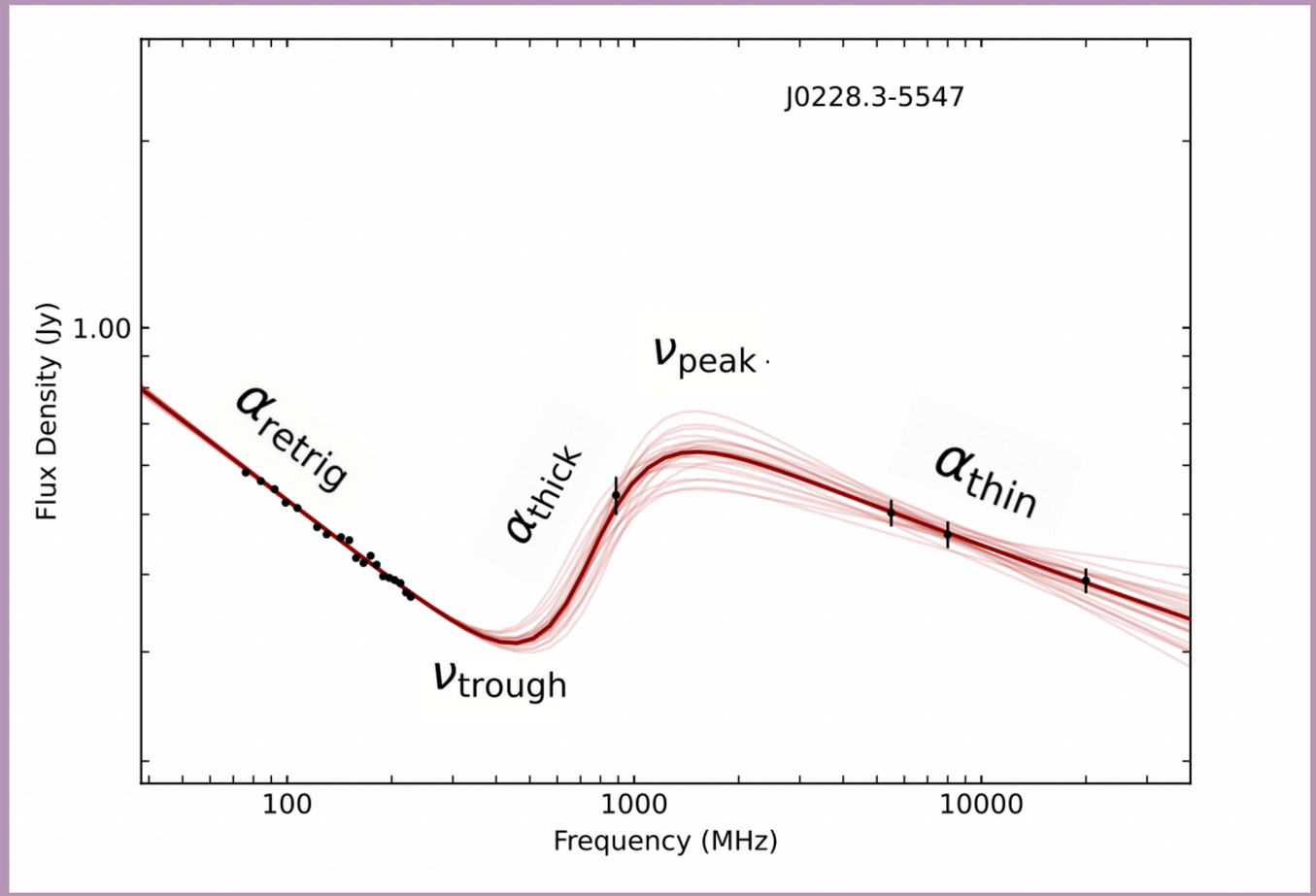


Radio Properties

Photometric coverage across radio frequencies, ranging from 72 MHz (GLEAM-X) to 20GHz (AT20G) and 30 GHz (ALMACAL).







Radio SED-fitting

We performed the SED-fitting using RADIOSED (Kerrison+24)

Each model is fitted independently, and the best-fit model is determined through Bayesian model selection.

RadioSED computes the Bayes factor to compare the likelihoods of different models.

RADIO PROPERTIES

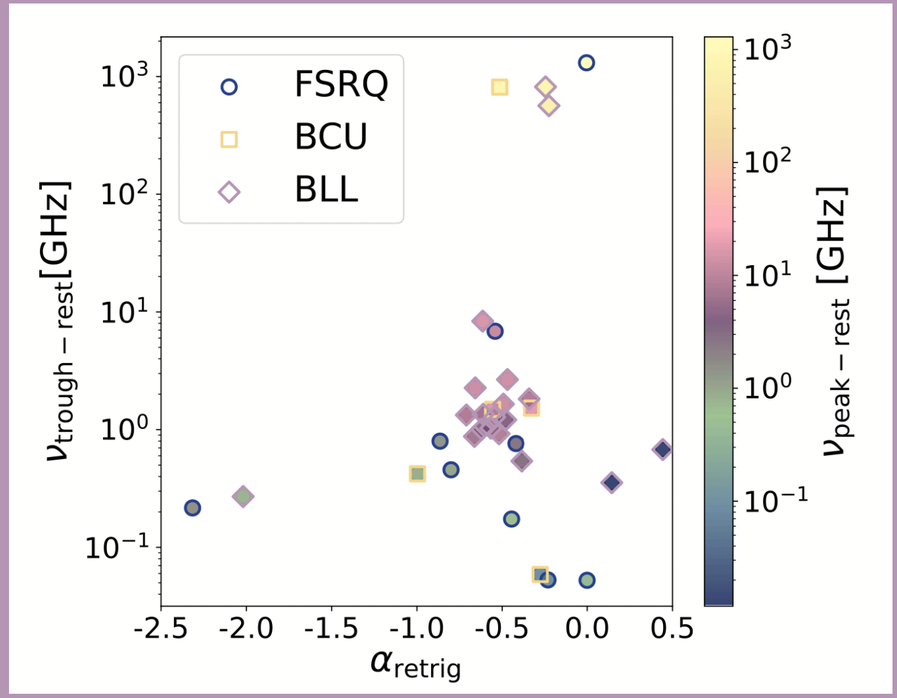
Before the minimum

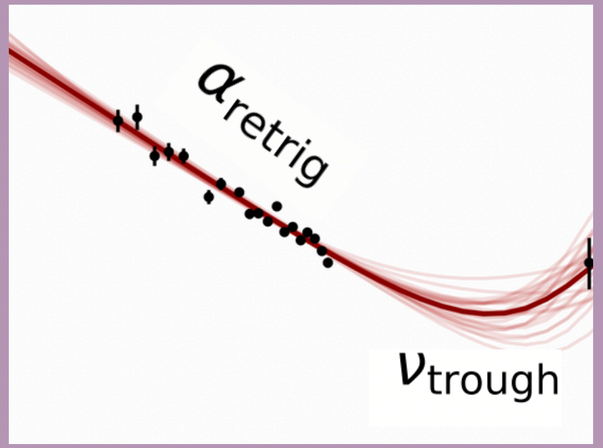
Using the advanced surveys employed in this study, we conclude that at GLEAM-X wavelengths the spectral behaviour is not completely flat (α -0.54).

This finding opens the path to an additional extended, steep-spectrum emission, previously missed due to the lack of high-resolution and deep low-frequency data.

Young sources turn up at higher frequencies with a steady index, while older ones break near 100 MHz and loosen up spectrally.

This hints that only the young still have a core efficiently refurnishing the jet with energetic electrons.





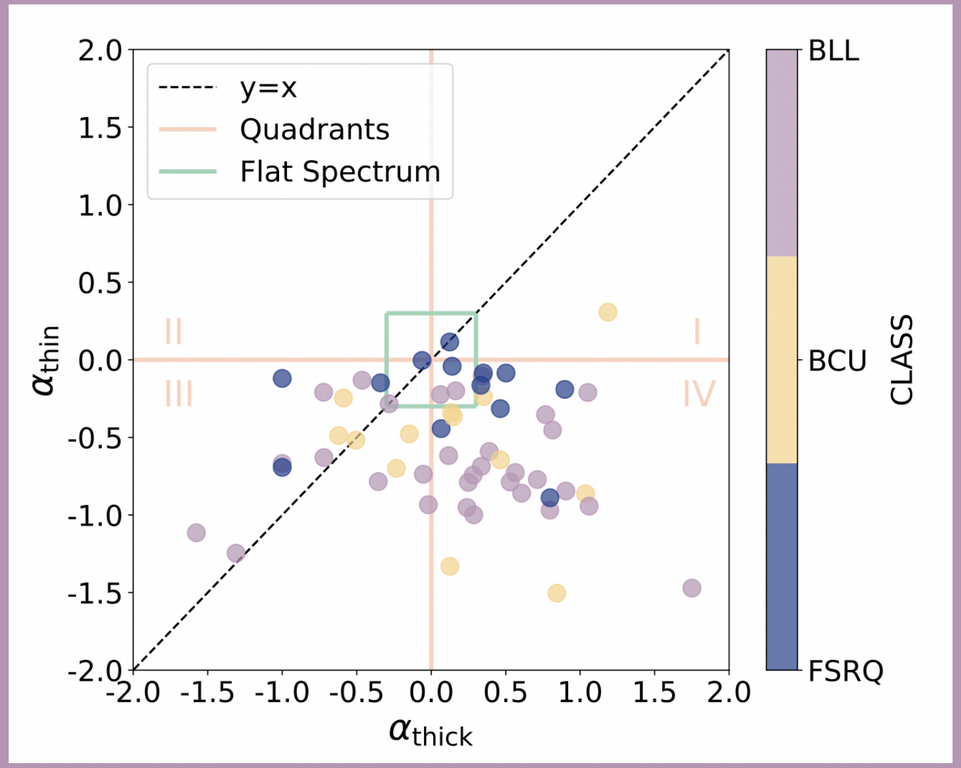
RADIO PROPERTIES

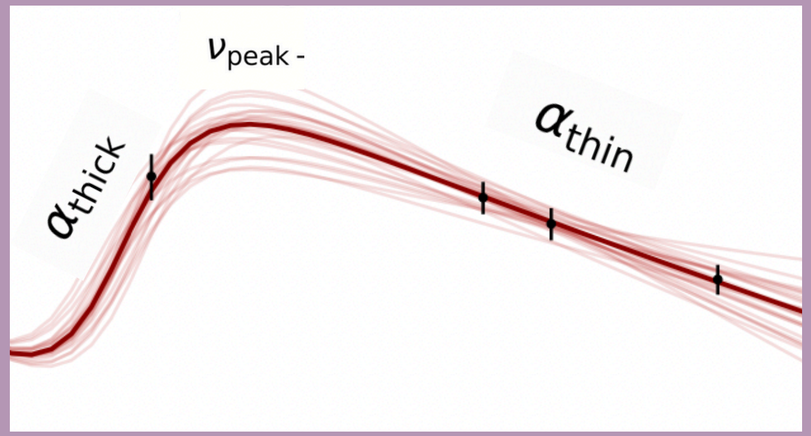
After the minumum

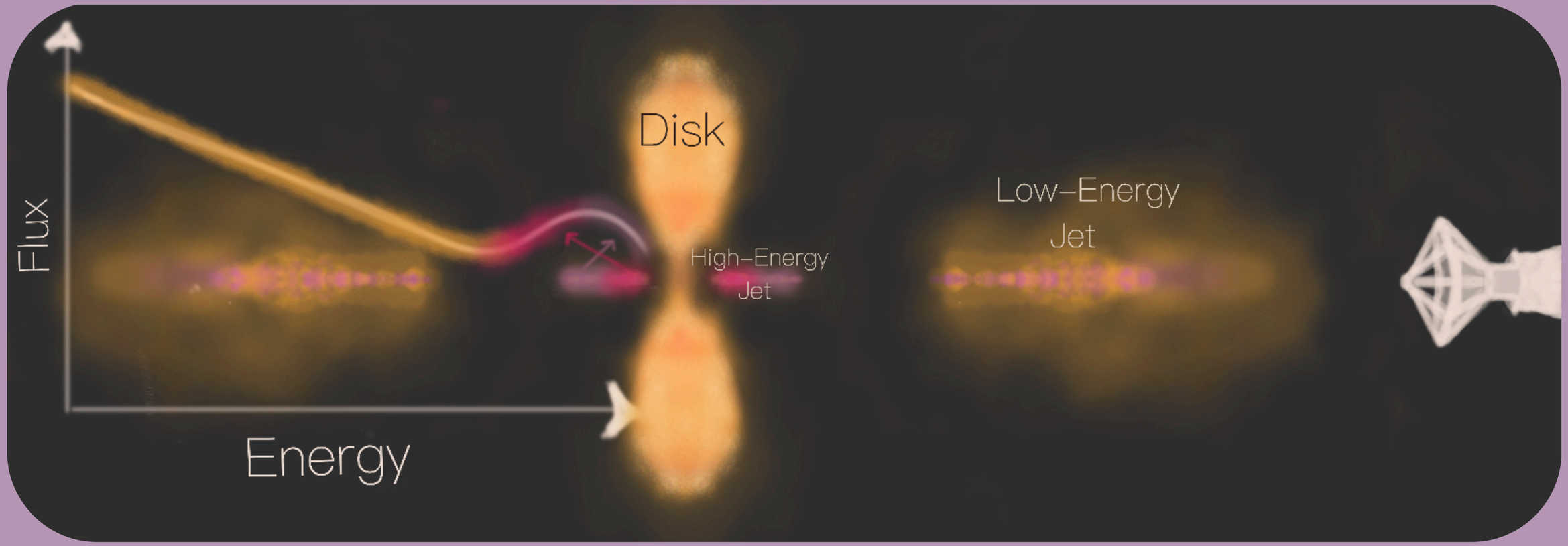
57.6 % are in the fourth quadrant, i.e. have a hint of a peaked spectrum

10.2% have a flat spectrum, after νtrough.

In the GHz domain as well we would expect a single emitting region, rather than the superposition of a number of compact regions of different sizes, self-absorbed at different frequencies



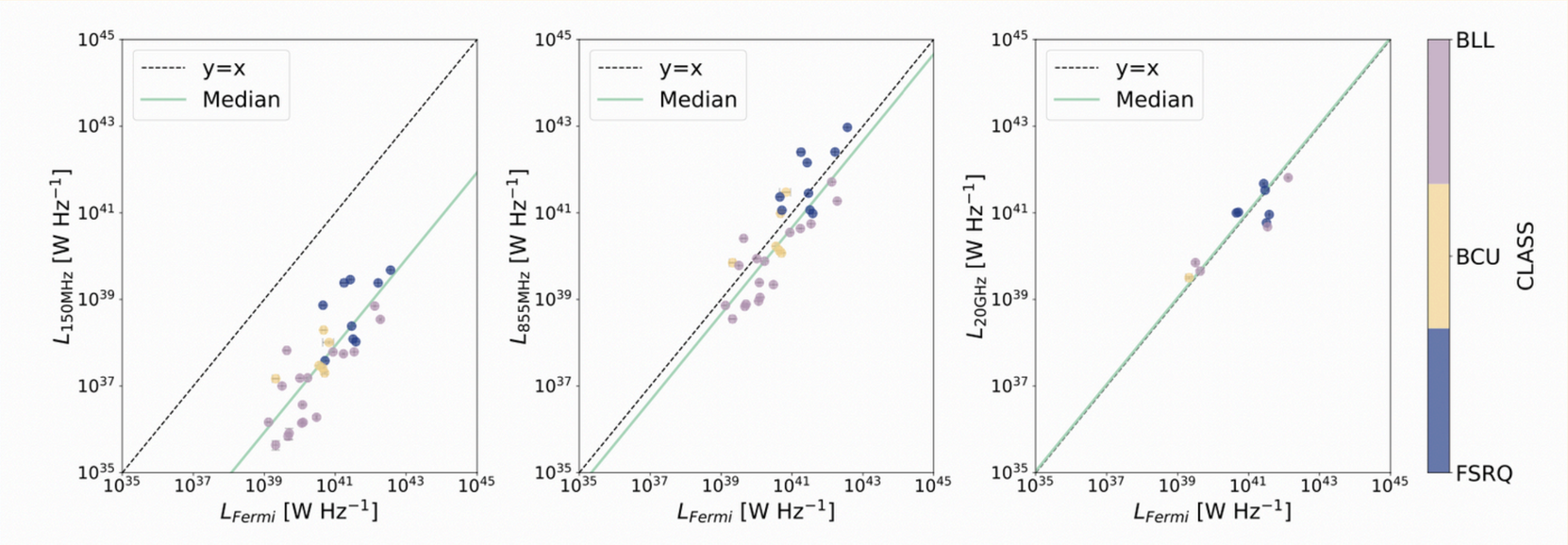




Physical interpretation

The interplay between compact self-absorbed components and extended steep-spectrum emission may indicate episodic jet activity or restarted AGN cycles.

HIGH ENERGY CORRELATIONS

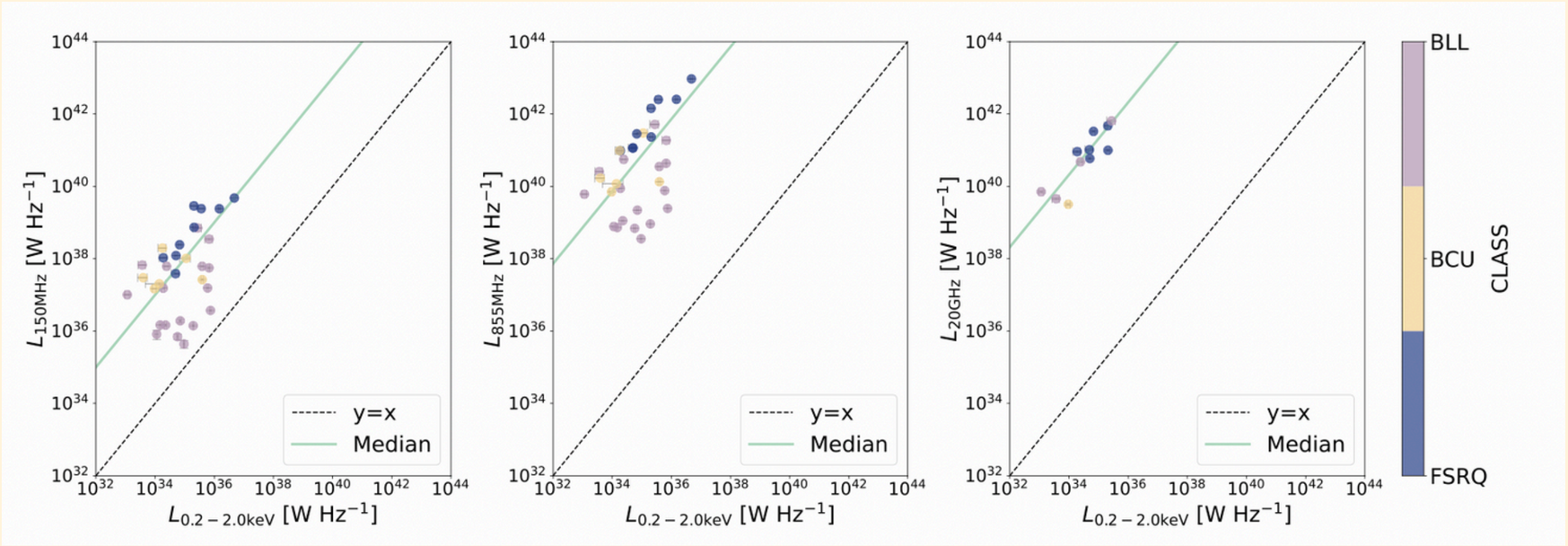


		All	FSRQ	BL-Lac
$\log\left(\frac{L_{150MHz}}{L_{0.2-2.0keV}}\right)$	Median	3.00	3.55	2.09
	Correlation	0.80	0.81	0.28
$\log\left(\frac{L_{855MHz}}{L_{0.2-2.0keV}}\right)$	Median	5.86	6.62	6.62
	Correlation	0.32	0.97	0.02
$\log\left(\frac{L_{20GHz}}{L_{0.2-2.0keV}}\right)$	Median	6.32	6.34	6.33
	Correlation	0.82	0.48	0.99

A strong correlation between radio and gamma-ray luminosities was identified, particularly at 855 MHz, emphasizing the dominant contribution of relativistic jets to the observed multi-wavelength emission. .

FSRQs might generally exhibit more effective high-energy pumping across various scales and reflects the presence of a flat spectrum at ν > νtrough, i.e. the emitting mechanism at 885 and 20 GHz is almost the same.

HIGH ENERGY CORRELATIONS



		All	FSRQ	BL-Lac
$\log\left(\frac{L_{150MHz}}{L_\gamma}\right)$	Median	-3.07	-2.82	-3.25
	Correlation	0.70	0.77	0.93
$\log\left(\frac{L_{855MHz}}{L_\gamma}\right)$	Median	0.34	0.38	-0.48
	Correlation	0.70	0.92	0.85
$\log\left(\frac{L_{20GHz}}{L_\gamma}\right)$	Median	0.06	0.15	-0.14
	Correlation	0.78	0.20	0.98

The X-ray luminosity (0.2–2.0 keV) is tightly correlated with radio luminosity for FSRQs, reflecting their accretion-driven nature, while BL Lacs show a more scattered relationship, consistent with their jet-driven dynamics.

Future perspectives

Spectroscopic Analysis

FLASH absorption lines
XMM spectra
SDSS-GAIA spectra for BLR, NLR etc., to estimate the SMBH mass

Inclusion of ALMA observations

34 sources in the sample have archival ALMA observations.

Polarization studies with POSSUM

To probe the magnetic field structure in the jets and their interaction with the surrounding environment

Collecting VLBI data

17 sources have been observed using the VLBI. This could offer a direct proof of the scenario.