SEARCHING FOR GAMMA-RAYS FROM NARROW-LINE SEYFERT 1 GALAXIES

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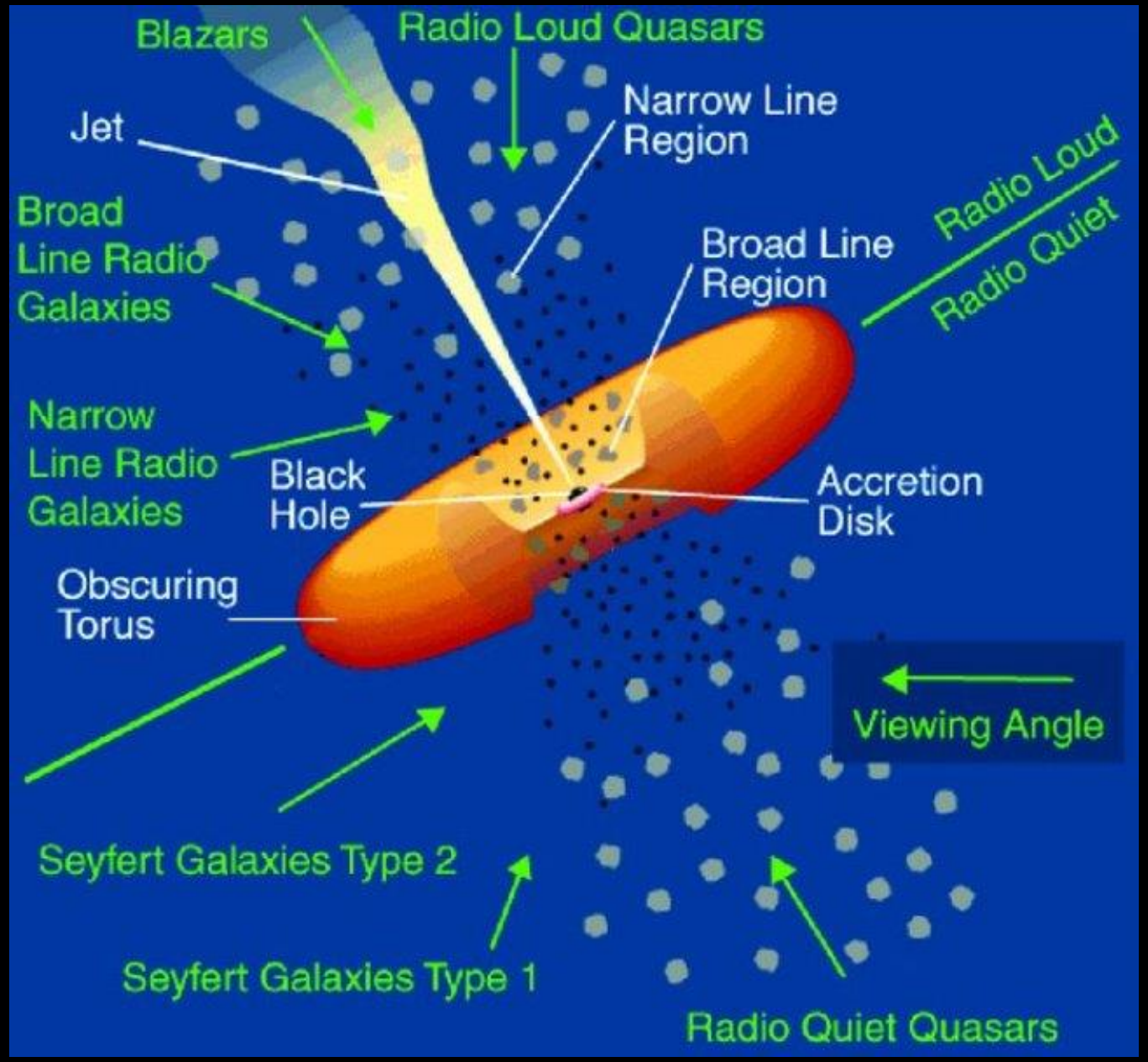
University of Oklahoma REU

ACTIVE GALACTIC NUCLEI



Urry C. M. & Padovani P., 1995

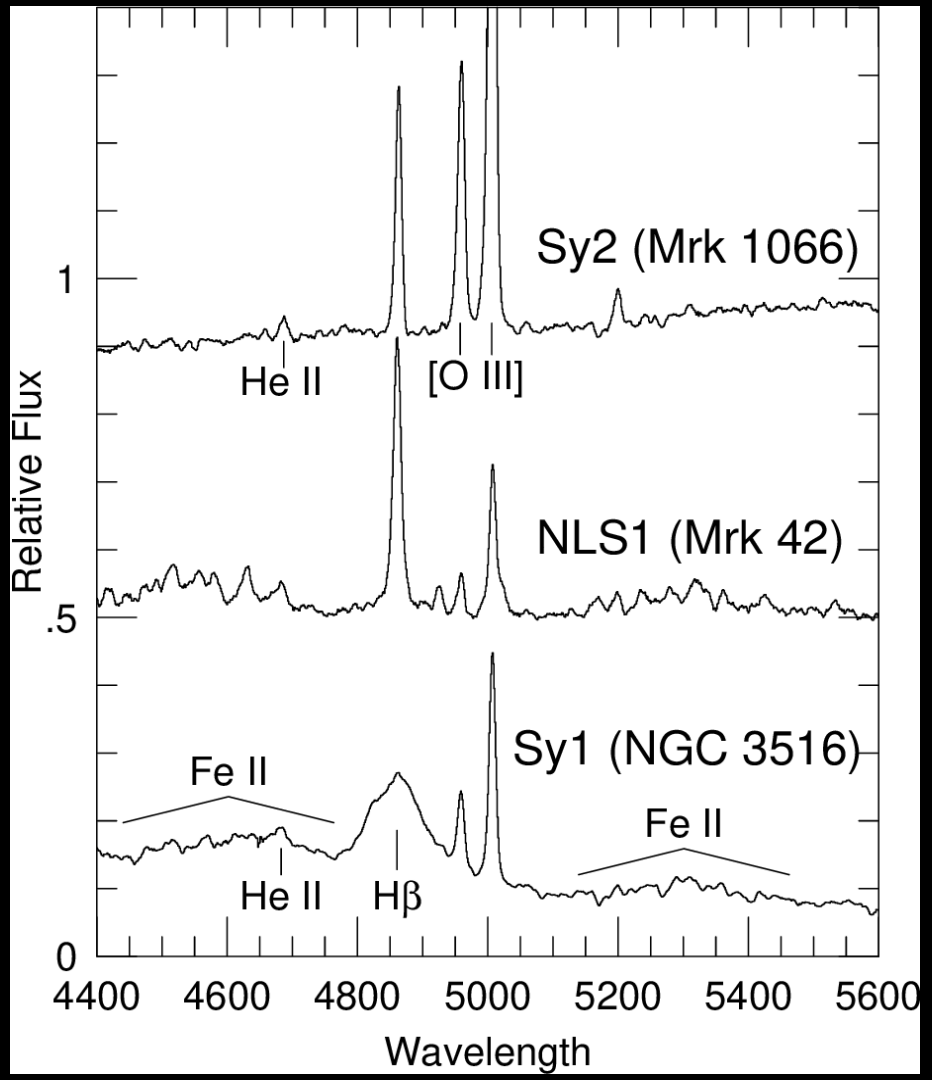
NLS1

Classification Criteria

- $FWHM$(Hβ) < 2000 km/s
- F([OIII])/ F(Hβ) < 3
- High F([FeII])

Characteristics

- SMBH: <10^8 $M_\odot$
- Eddington ratio: 0.1-1



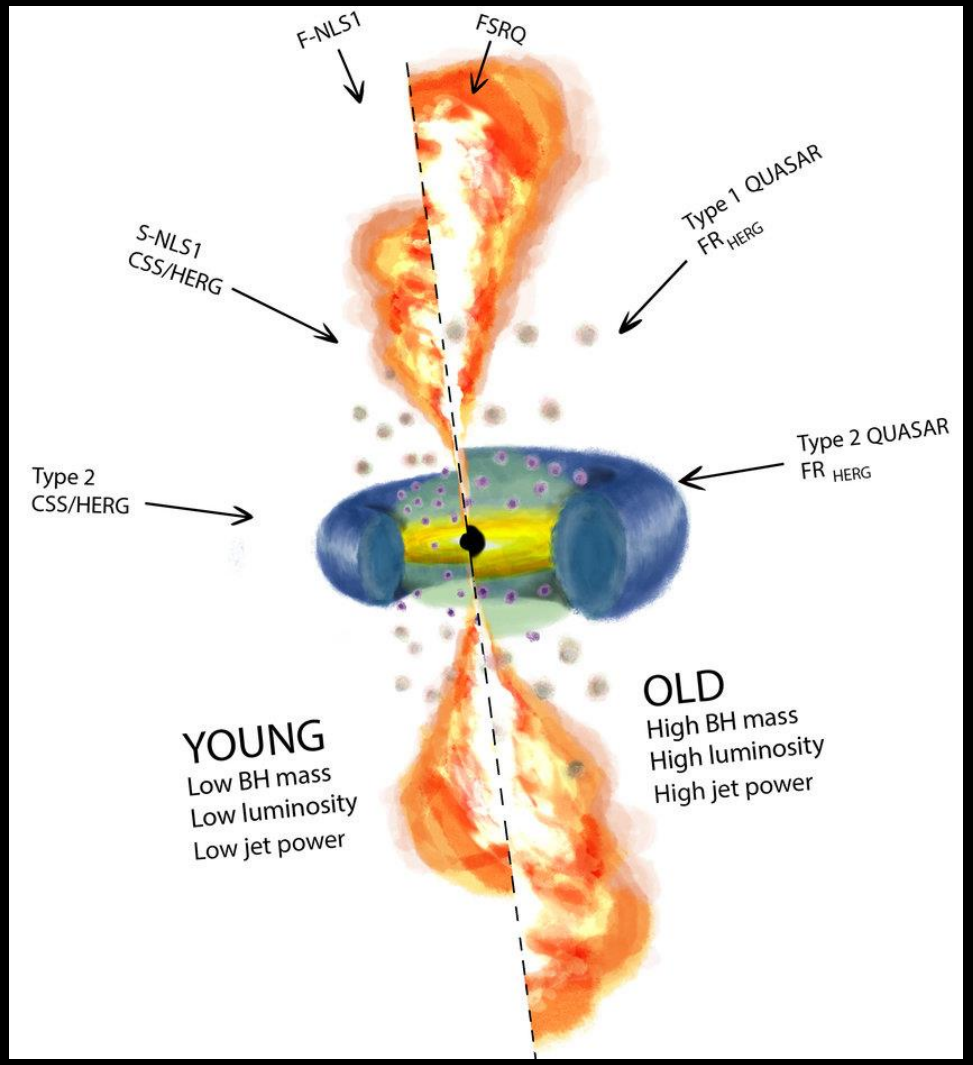
Pogge R. W., 2000

Osterbrock D. E. & Pogge R. W., 1985; Goodrich R. W., 1989; Peterson, B. M., et al. 2000; Boroson, T. A. & Green, R. F. 1992

NLS1

Early evolutionary stage

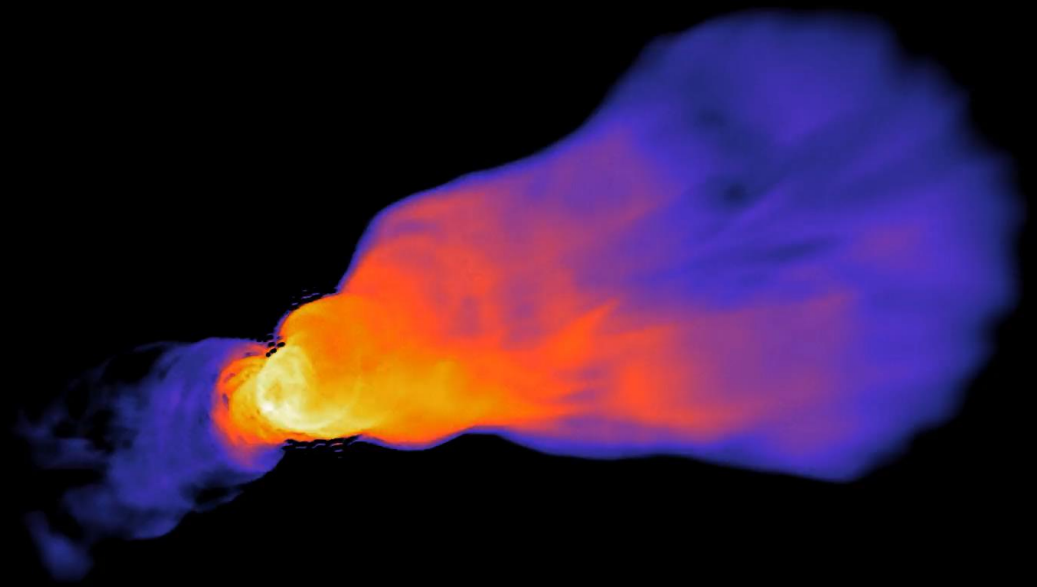
- Low SMBH mass
- High Accretion rate
- Spiral host galaxies
- Low $M_{\mathrm{BH}}/M_{\mathrm{bulge}}$



Berton, M., et al. 2017

Mathur S., et al. 2001

LAUNCHING RELATIVISTIC JETS



Andrew Chael. Simulation of M87 SMBH jet.

Blandford-Znajek (BZ)

- Kerr SMBH

Blandford-Payne (BP)

- Accretion disk

Blandford, R. D. & Znajek, R. L., 1977;
Blandford, R. D. & Payne, D. G., 1982

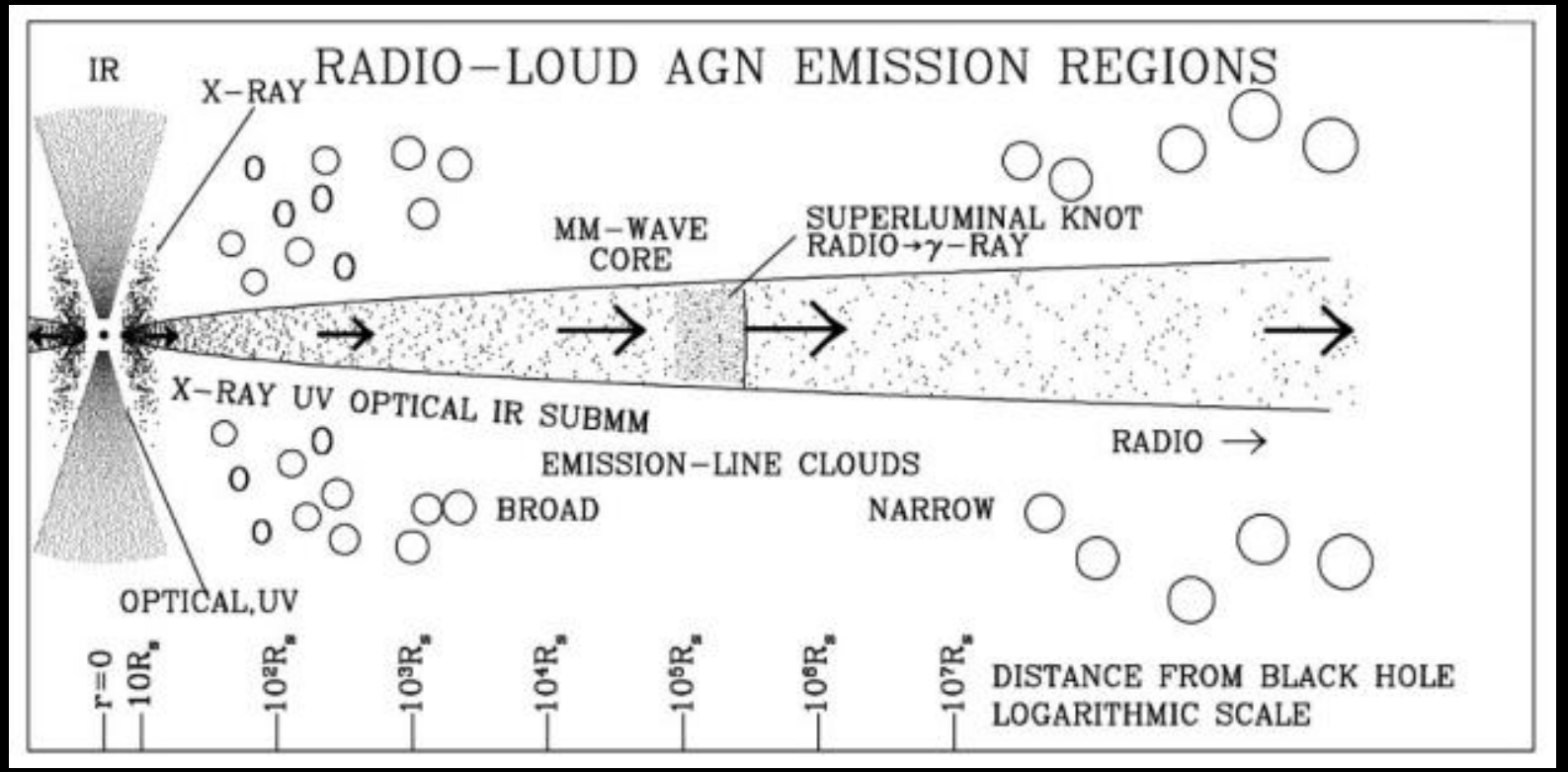
GAMMA-RAYS

External inverse Compton scattering

- Seed photons from around the jets

Synchrotron self Compton

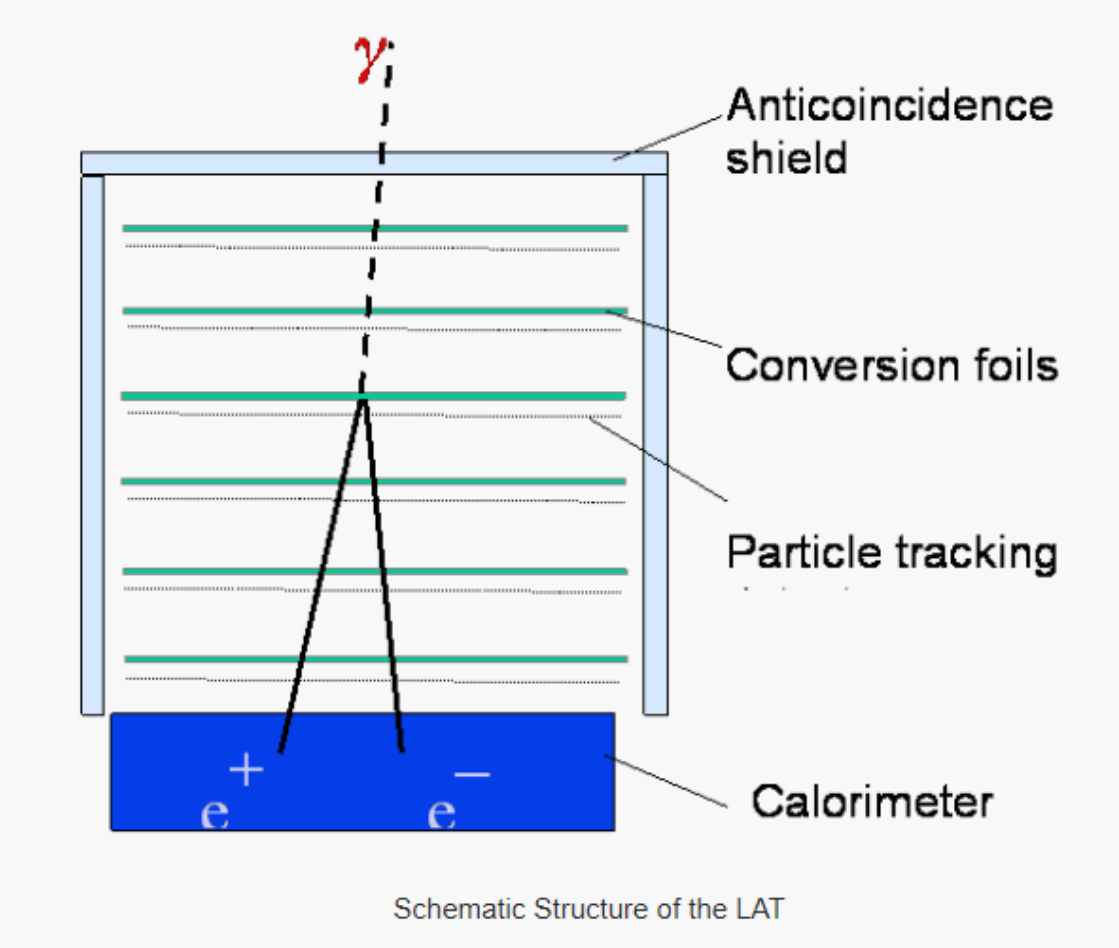
- Seed photons from the jets



Marschcer, A.P., 2005

Blandford, R., et al. 2019

GAMMA-RAY DETECTORS



Schematic Structure of the LAT

NASA/DOE/Fermi LAT Collaboration

FERMI OBSERVATIONS

Fermi GST

- Launched 2008
- 10 keV to 300 GeV

Fermi LAT

- 2.4 st FOV
- 0.8 m^2 effective area

NASA/DOE/Fermi LAT Collaboration

FERMI OBSERVATIONS

4FGL-DR3

- 14-year catalog
- 1 year+ binning
- Data reduction required for NLS1 detection

NASA/DOE/Fermi LAT Collaboration

DATA REDUCTION

Maximum Likelihood Estimation

- Maximize likelihood function $L(\gamma)$
- $TS = -2\log\left(\frac{L(\gamma_0)}{L(\gamma_1)}\right) = 2(l(\gamma_1) - l(\gamma_0))$
- $TS > 25$: detection ; $TS > 9$: candidate

Binning

- 1 year
- 2 months
- 1 week

THE 7

Selection Criteria

- Radio silent or radio quiet
- Dense large-scale environments
- Estimated 37GHz flux density or high X-ray/optical

2018 candidates/detections:

- SDSS J090113.23 + 465734.7 (TS=10)
- SDSS J122844.81 + 501751.2 (TS=20)
- SDSS J123220.11 + 495721.8 (TS=16)
- SDSS J164100.10 + 345452.7 (TS=39)

Lähteenmäki A., 2018; Järvelä E., 2023

THE 4000

Previous ‘NLS1’ sample

- 11,001
- Highly contaminated

After cleaning signal-to-noise and remodeling Hβ

- 36% remain

Varglund I. *Submitted;* Berton M. 2021

GOALS

Short term

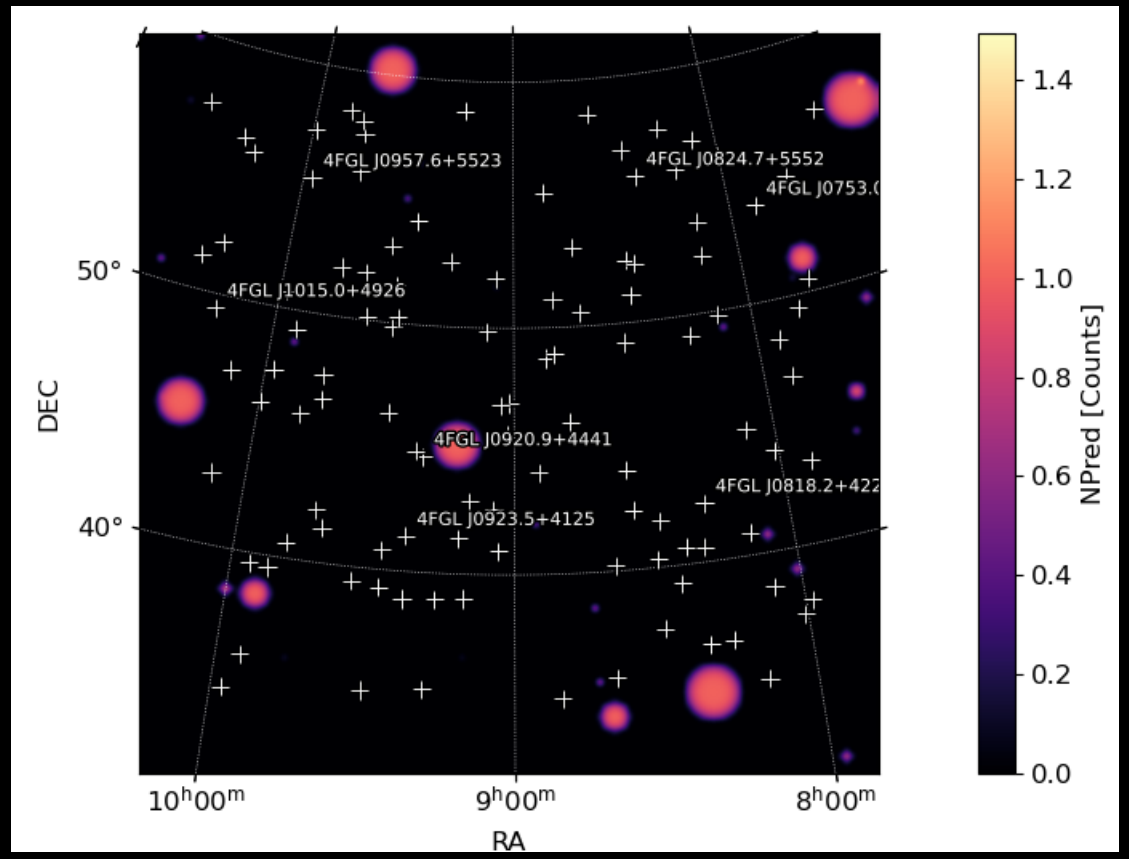
- The 7: NLS1s (mostly) with extreme radio variability

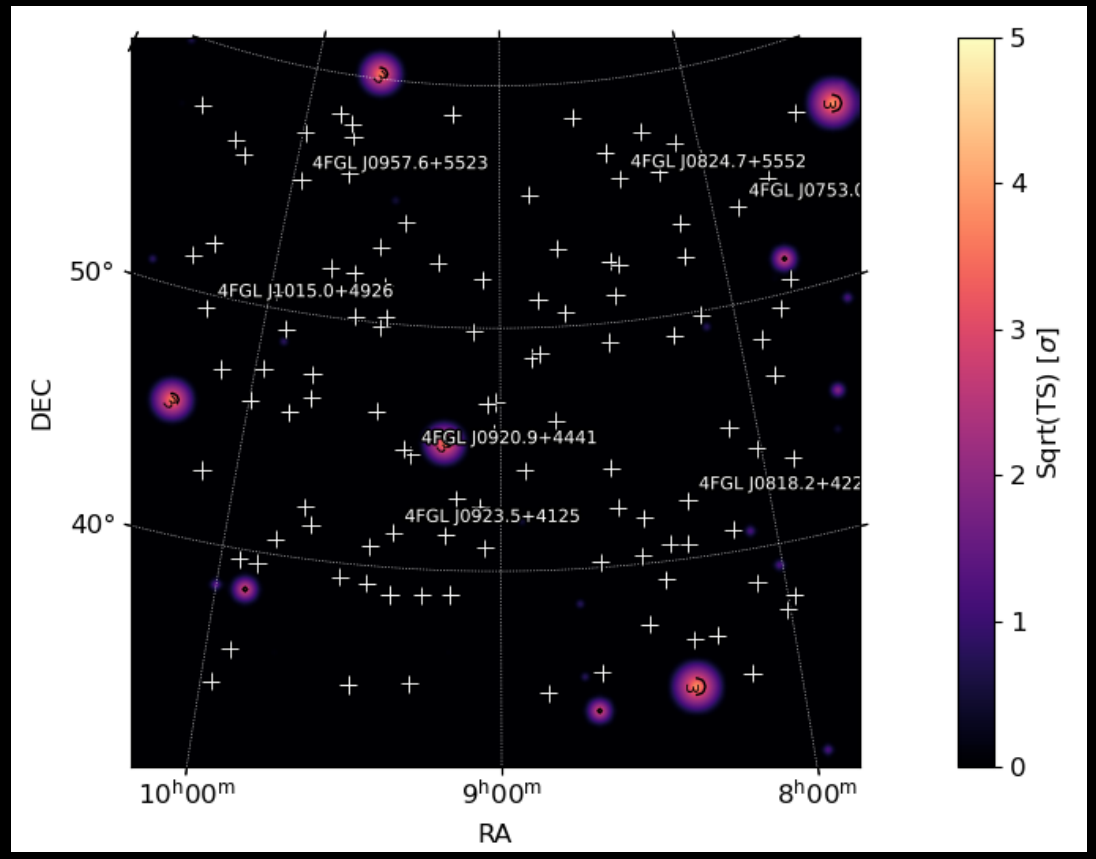
Long term

- NLS1s that have jets based on radio data
- Largest existing sample of 4000

Lähteenmäki A., 2018; Järvelä E., 2023; Varglund I. *Submitted*

PROGRESS (SO FAR)





QUESTIONS

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