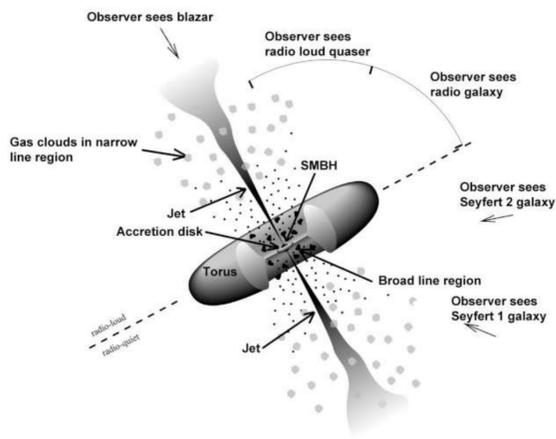


Gamma-ray Emission in Narrow-Line Seyfert 1 galaxies: A Fermi LAT study

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INTRODUCTION & AIM



AGN Classification Context:

- **Seyfert 1:** Has a board (2000km/s)+narrow emission lines.
- Unobscured view of BLR.
- **Seyfert 2:** Only narrow lines; it has an obscured view by the dusty torus.
- **NLS1:** FWHM(H β) < 2000 km/s; subset of seyfert 1s with narrower BLR.

Defining Characteristics:

- Low black hole mass(MBH < 10⁸ M \odot)
- High Eddington ratio(L/LEDD~0.1-1)
- Strong FE II emission relative to H β .
- Weak[OIII] λ 5007 emisson

- **NLS1:** Narrow Line Seyfert 1 galaxies are a type of subclass of Type 1 AGN characterized by unusually narrow permitted emission lines.

Objective

Research Question: How many NLS1 galaxies are detectable in gamma-rays And what are their Test Statistical Properties?

THE ISSUE:

- NLS1 galaxies have low black hole masses \rightarrow weak jets \rightarrow hard to detect in gamma-rays
- Only ~10% are radio-loud, but not all host jets.
- Current studies miss weaker sources and flaring events.
- The fraction of NLS1s with jets is poorly constrained.

RESEARCH OBJECTIVE:

Goal: Investigate gamma-ray emission properties of a large NLS1 sample (~4000 sources) using Fermi-LAT data

Specific Aims:

- Determine detectability rates in gamma-rays.
- Identify the frequency of gamma-ray flaring events.
- Find sources overlooked by conventional methods.
- Characterize the jet-hosting NLS1 population.

METHOD

Data Reduction

Statistical Analysis

Automate Likelihood Analysis

Combine Undetected NLS1

Publication

- **Selection:** H β FWHM < 2000 km/s
- **Data:** ~4000 NLS1 sources (Fermi-LAT + catalogs)
- **Tools:** Python · Fermi Science Tools · HPCC
- **Method:** Automated unbinned likelihood analysis
- **Threshold:** TS > 25 (strong detection)

RESULTS & DISCUSSION

Confirmed Detections (Osman et al. 2025 - Binned Analysis):

Source	TS Value	Flux ($\times 10^{-8}$ ph cm $^{-2}$ s $^{-1}$)	log MBH (M \odot)	Method
J120014-004	41.857	67.73 $273.49 \pm$	7.4	1-week binned
J121826+294846	32.045	137.16 \pm 35.87	6.43	1-week binned

Preliminary Unbinned Analysis (In Progress):

- Pipeline successfully implemented and tested
- Currently processing sources J121826+294846 and J120014-004
- Results pending - analysis running

New Results (Unbinned Analysis):

- Source: J0324+3410
- TS Value: ~0 (non-detection)
- Status: Confirms weak source

Binned vs Unbinned

Binned Analysis

- Divide the data into bins based on spatial pixels and energy ranges.
- Count the number of photons observed for each bin.
- Get the expected number of photons in each bin by making a prediction.
- Compare observed vs expected counts across all bins to calculate likelihood.

Unbinned Analysis

- Evaluate the likelihood of the model for each photon event.
- Consider its energy direction and time.
- The probability density function from the model is directly compared to each photon.

Our Choice:[Unbinned Analysis] Best for faint NLS1 γ -ray detection and for short flares

FUTURE WORK

- The pipeline is currently being deployed across the full sample, with the primary objective of determining the detectability of gamma-ray emission that conventional catalog methods may overlook. Once detections are collected, the results will be published, expanding the known census of NLS1 galaxies hosting relativistic jets and contributing to a broader understanding of jet formation in low-mass AGN systems.

References

1. **Abdo, A. A., et al. (Fermi/LAT Collaboration) 2009** - The landmark Fermi/LAT discovery paper
2. **Osman, Rana. 2025-Gamma-Ray Detection in Narrow-Line Seyfert 1 Galaxies: Tracing Transient Emission and Expanding the jetted AGN Population.** Apr.2025.



SCAN ME