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imma-ray Space Telescope



Search for binary SMBHs in Gamma-ray Blazars



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Introduction





- AGN: variability in the overall electromagnetic spectrum
- Pattern → **Periodicity**
- Different strategies in the literature:
 - one object by means of a few (two) analysis algorithms
 - cross-correlation with other data of different wavelength







- *Fermi*-LAT (launched 11th July 2008)
- Fast Orbit (95 min) Large field of view (2 sr)

Monitoring Sources (scanning the sky each 3 hours)

Detect γ rays by producing an electron-positron pair in the detector
Energies ranging: ≈ 20 MeV - ≥ 300 GeV





- \approx 2000 AGN (3FGL+2FHL+3FHL catalogs)
- 21st August 2008 7th September 2017
- Light-curve monthly binned: 28 days
- Data processing:
 - Integral Energy Flux above 1 GeV
 - Energy Flux Upper limits for TS<4 $\approx 2\sigma$



















REDFIT

Schulz and Mudelsee, 2002



















- All of them have drawbacks and advantages VanderPlas J., 2018 Goyal, A., et al. 2017
- Potential results comparison

















- 4 methods with a same period peak with $\geq 4\sigma$
- 11 AGN as candidates to have periodic gamma-ray emission (our "Golden list"):
 - 2 previously reported (PG 1553+113 & PKS 2155-304)
 - 9 new candidates

TXS 0518+211

 $2.8 (> 3\sigma)$

Results (I): Candidates in the Literature

- 13 low-significance candidates
 - \sim 3 methods with a same period peak with $\geq 4\sigma$
- False-Detection Periodicity Rate: ≈ 1 fake detection
- 5σ exposure estimation: range 2-4 years
- The impact of upper limits in LCs:
 - significance: 10%-40%
 - period: 5%-30%
- Multiwavelength Analysis:
 - KAIT, SMARTS, OVRO..
 - Cross-Correlation
 - Periodicity Study

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- Characterization of the candidates:
 - \circ prediction of high-activity states \rightarrow monitoring
 - SED

- Candidates observables with 45° over zenit:
 - \circ 4 only from the North
 - 3 only from the South
 - 4 from both hemispheres

- Separation parsec scales:
 - FMgII/FCIV up to one order of magnitude smaller than single black holes.
 - \circ F_{MgII}/F_H may be significantly reduced only at the shortest separations

- Systematic search of gamma-ray periodicity in ≈2000 *Fermi*-LAT AGNs studied over a period of 9 years
- 11 gamma-ray periodicity candidates
 - 9 new candidates
 - 2 previously reported in the literature
- 13 low-significance candidates
 - 10 new candidates
 - 3 previously reported in the literature
- On-going:
 - Multi-Wavelength study
- Sinergy:
 - IACTs: monitoring and characterization of the candidates
 - GTC: spectroscopy study in the optical/IR range