The Broadband Emission Properties of AGN Jets

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The MOJAVE Collaboration and the Fermi Collaboration
The Emission of AGN Jet
The Emission of AGN Jet

Spectral Energy Distribution (SED)

3C 111

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Radio

γ-ray

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Synchrotron

Inverse Compton (Leptonic)

or

Proton-induced (Hadronic)
The Broadband Emission of AGN

Open questions:

- Where is the emission of AGN jets generated? Parsec-scale jet?
- How does apparent jet speed affect broadband emission properties?
- Does brightness temperature in parsec-scale jet play a role in generating broadband emission?
- What are the mechanisms to produce high-energy emission of blazars: leptonic (SSC, EIC), hadronic (photon-photon), or both?
The Broadband SED Catalog

- We constructed a broadband spectral energy distribution (SED) catalog of 135 MOJAVE sources, which is a radio-selected complete sample consisting of mostly blazars (AGN as seen jet-on)

- The MOJAVE sample has
  - 101 flat-spectrum radio quasars
  - 22 BL Lac objects
  - 8 radio galaxies, 4 unidentified objects

Continuously monitored in the radio band

- Use simultaneous datasets from radio to γ-ray bands
Broadband SED data


- *Swift* observations
  - **[X-ray/Optical]** XRT/UVOT: Dedicated program to observe MOJAVE sources, observations after August 2008


- **[Radio]** UMRAO monitoring (e.g., Aller et al. 2003, ApJ 586, 33)

- **[Radio]** FGAMMA monitoring (Fuhrmann et al. & Angelakis et al. 2010)
Broadband SED data


- Swift observations

- [X-ray/Optical] XRT/UVOT: Dedicated program to observe MOJAVE sources, observations after August 2008


- [Radio] FGAMMA monitoring (Fuhrmann et al. & Angelakis et al. 2010)
Data analysis

- A polynomial model is applied to both humps in all broadband SEDs (as a first approach)

- We estimated the peak positions of the synchrotron and high-energy humps
Distribution and Correlation Study

SED:
- $\nu_{\text{sync}, \text{peak}}$
- $\nu F_{\nu, \text{sync}, \text{peak}}$
- $\nu_{\text{IC}, \text{peak}}$
- $\nu F_{\nu, \text{IC}, \text{peak}}$

Radio (VLBI):
- Flux density
- Spectral index
- $\beta_{\text{app}}$
- Doppler factor
- Lorentz factor

X-ray:
- Flux
- Luminosity
- Photon index

$\gamma$-ray:
- Flux
- Luminosity
- Photon index
Distributions of Synchrotron Peak Values

\( \nu_{\text{sync}} \)  \hspace{1cm} \( \nu \nu_{\text{sync}} \)

Preliminary

<table>
<thead>
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<th>Number of Objects</th>
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Log \( \nu \) [Hz] (Synchrotron)
Distributions of IC Peak Values

$v IC$

$v Fv IC$

Preliminary

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Jet apparent speed & SED properties

$\beta_{\text{app}} - vFv_{\text{sync}}$

$\beta_{\text{app}} - v_{\text{IC}}$

Quasars ($N=95$)
- BL Lac Objects ($N=16$)
- Radio Galaxies ($N=6$)

Quasars ($N=84$)
- BL Lac Objects ($N=14$)
- Radio Galaxies ($N=5$)

Preliminary
Summary & Outlook

• We constructed the broadband SED catalog for the radio-selected, statistically-complete MOJAVE sample.

• We applied polynomial fits to the SED, and derived peak positions of the synchrotron and the IC humps.

• The distributions of the peak positions of the synchrotron and the IC humps show different behaviors, and further investigations are needed.

• We see possible relations between the apparent jet speed and $v Fv_{\text{sync}} / v_{\text{IC}}$, and we will confirm this with further detailed statistical analyses.
Summary & Outlook

• A complete study on the statistical properties between parameters of SED, VLBI, and X-rays is in progress.

• Physical modeling on the broadband SED is needed in order to understand the properties of each source.
Thank you
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