The Broadband Emission Properties of AGN Jets

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The MOJAVE Collaboration and the *Fermi* Collaboration

Active Galactic Nuclei

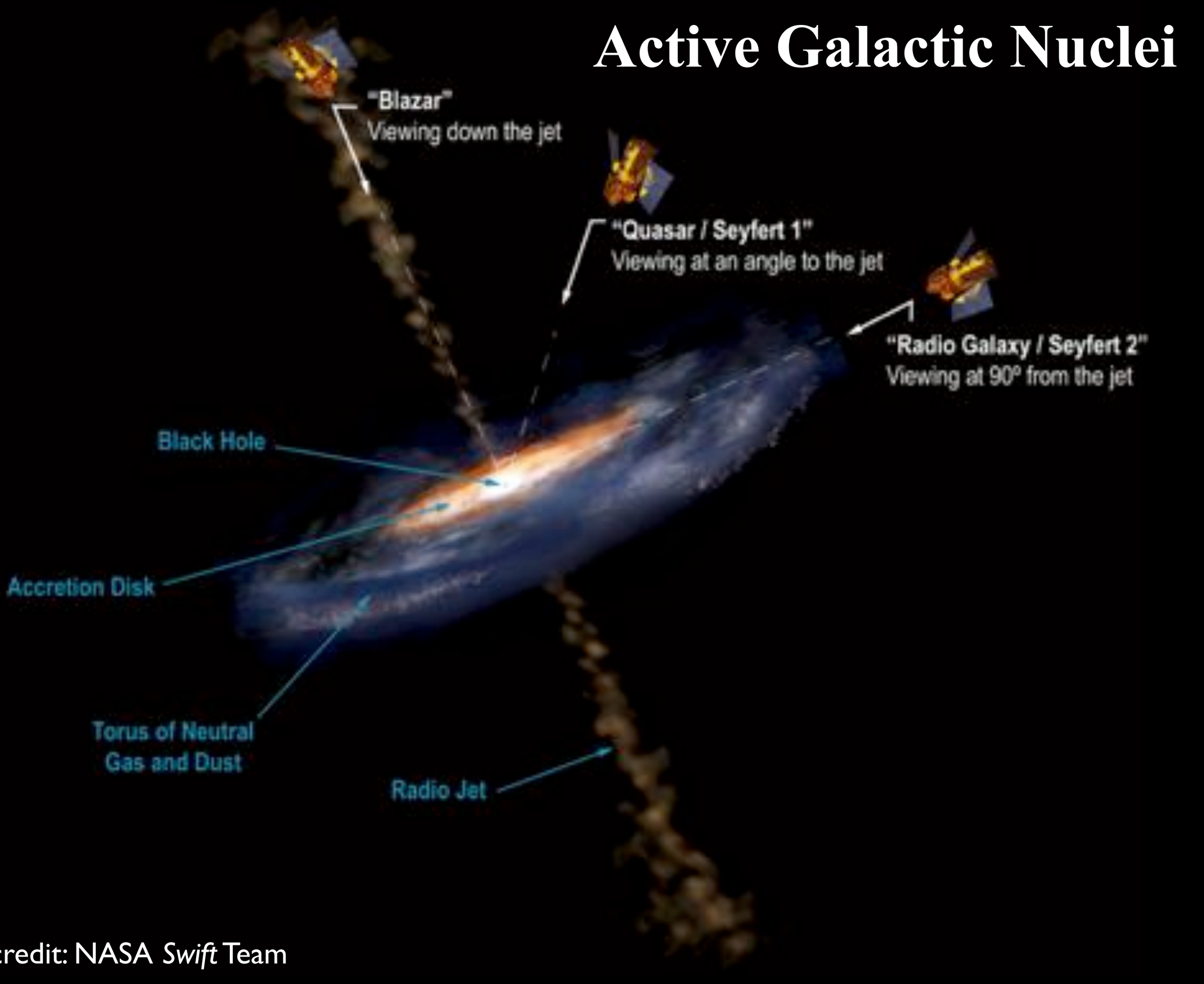
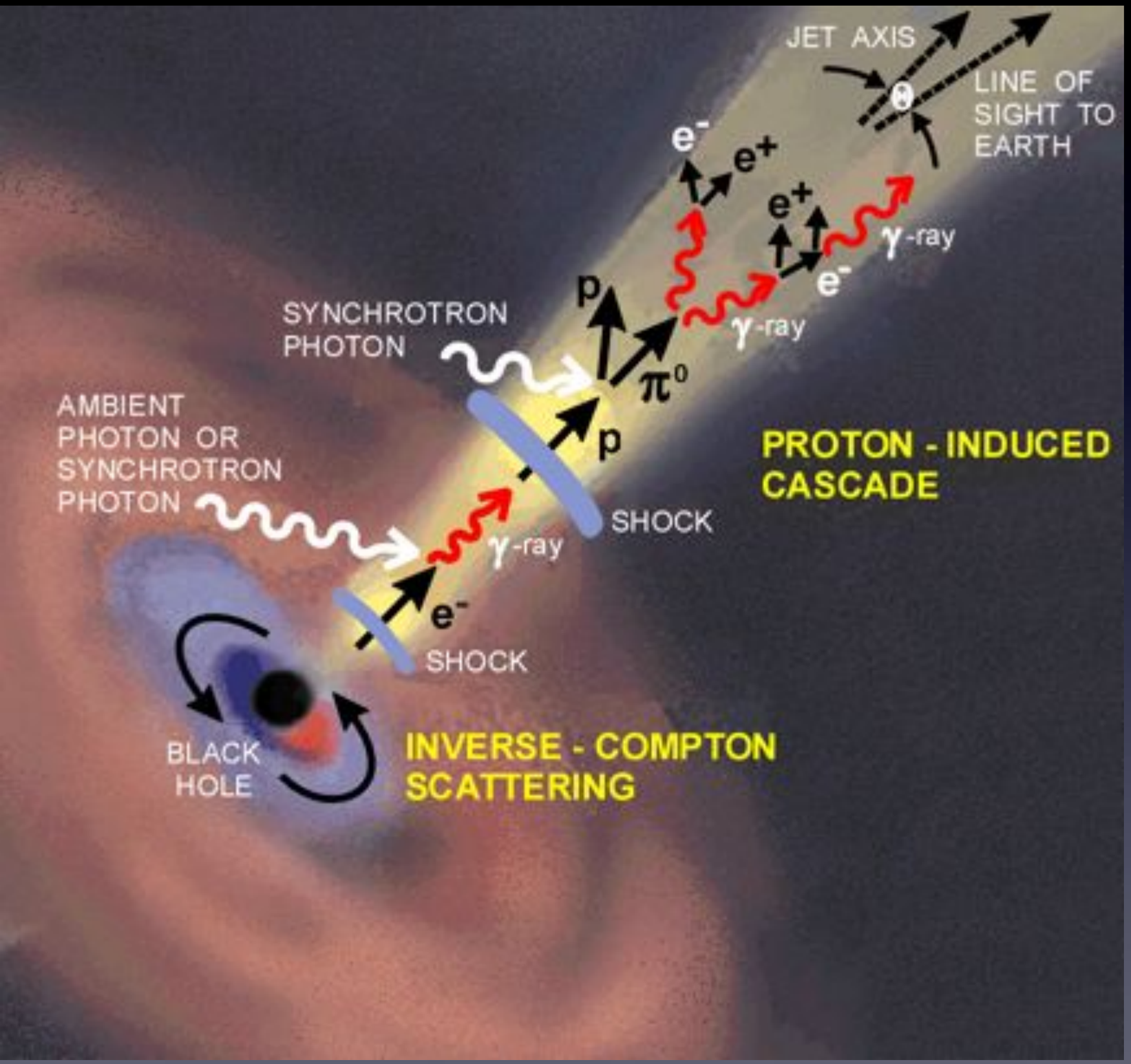
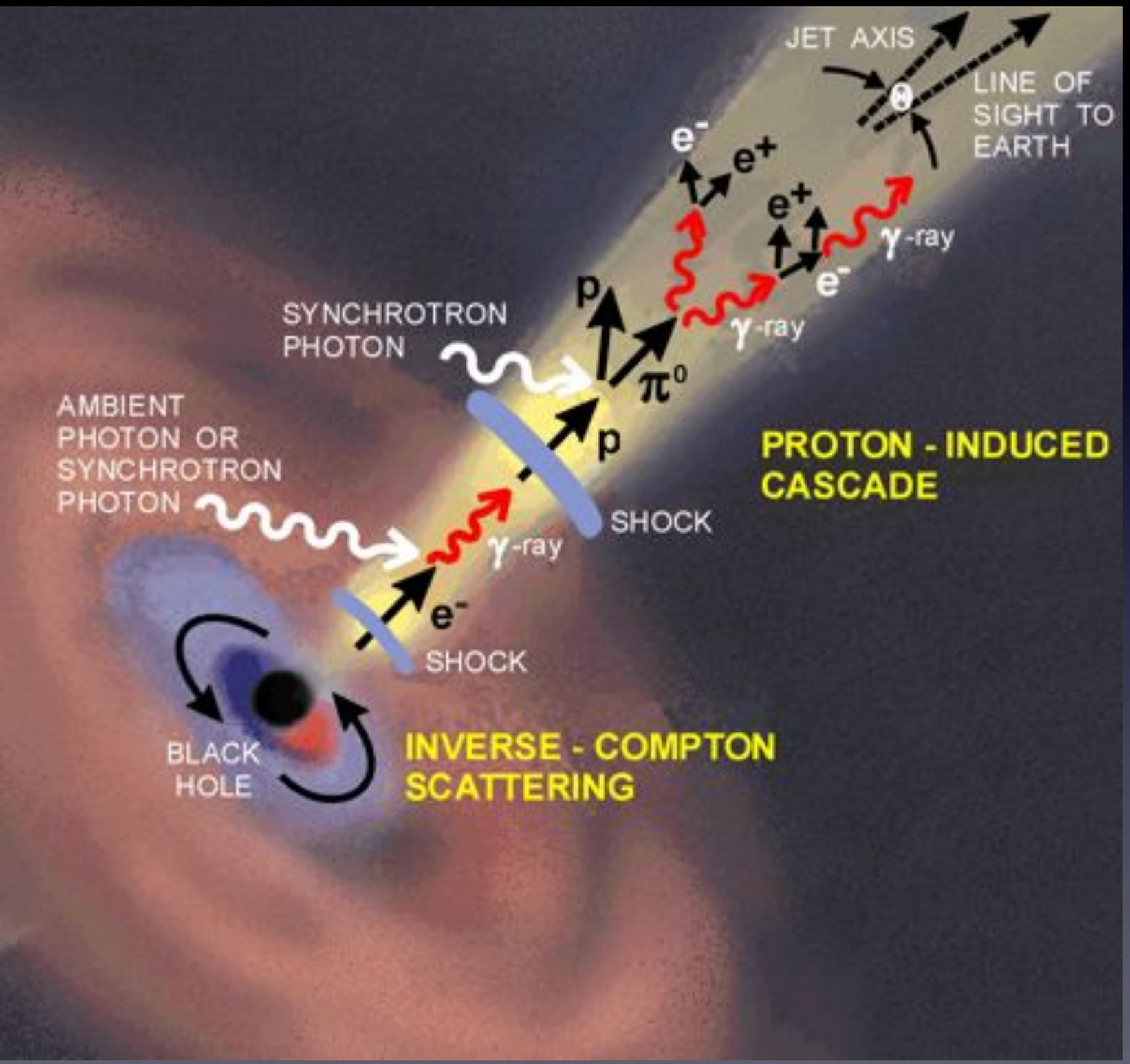


Image credit: NASA *Swift* Team

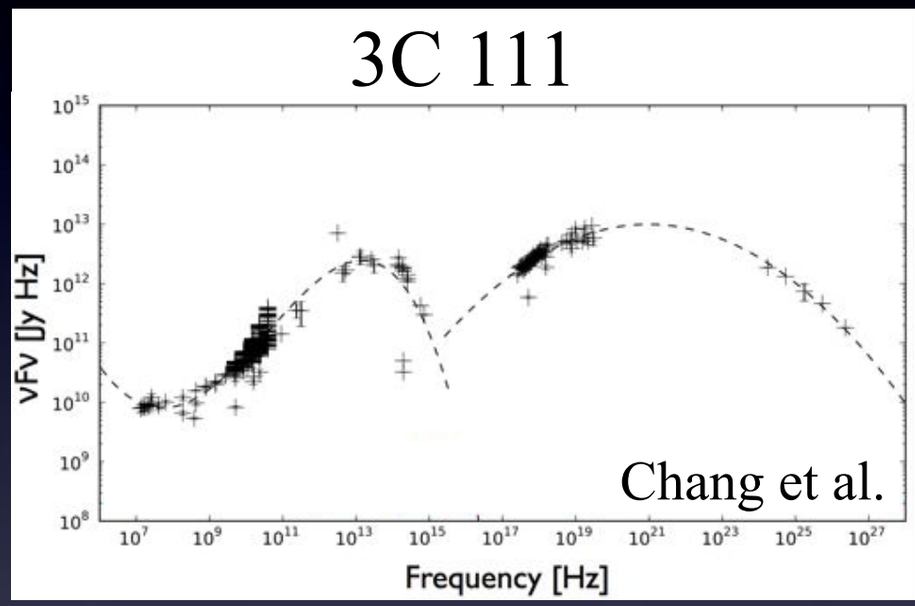
The Emission of AGN Jet



The Emission of AGN Jet

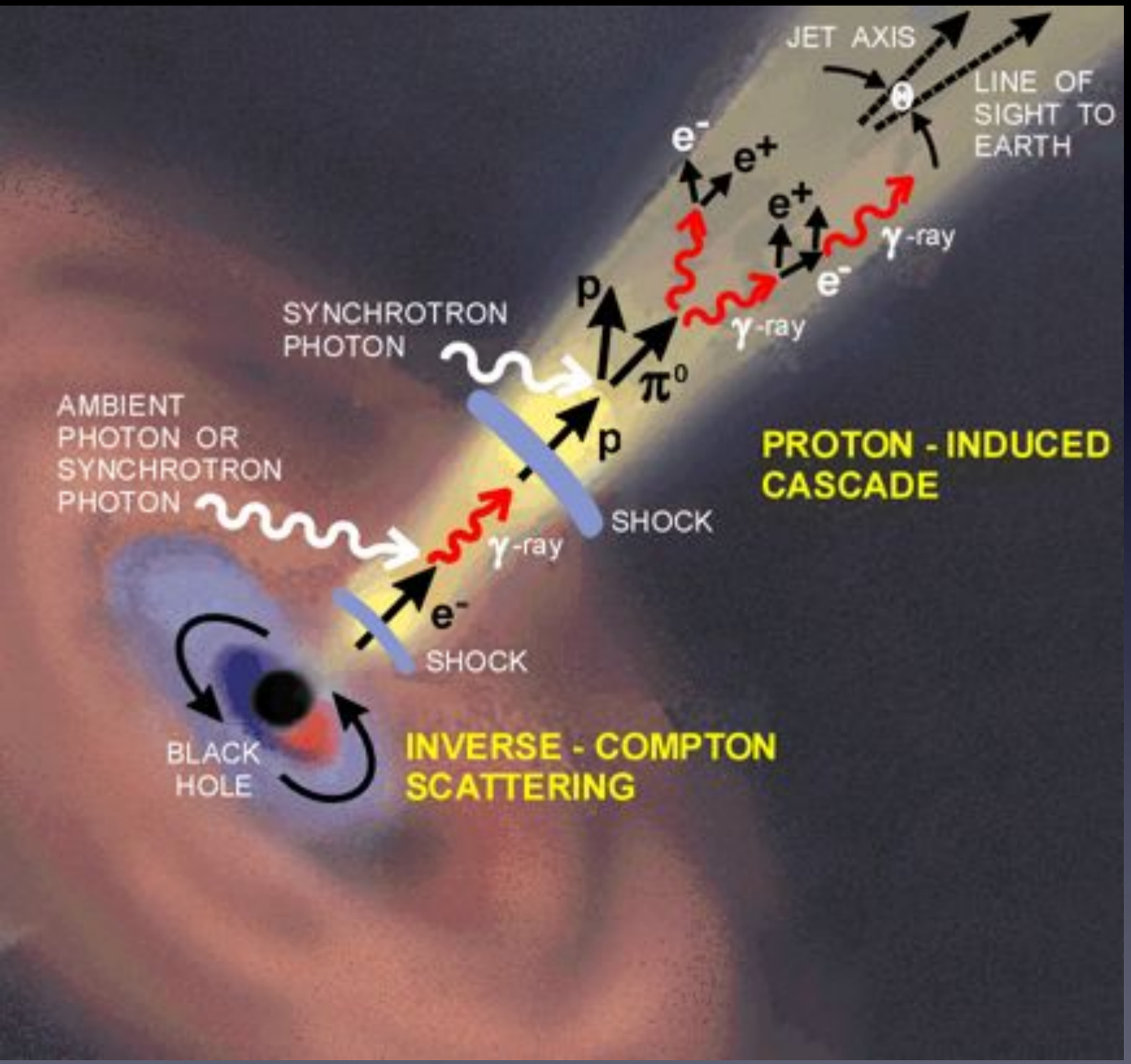


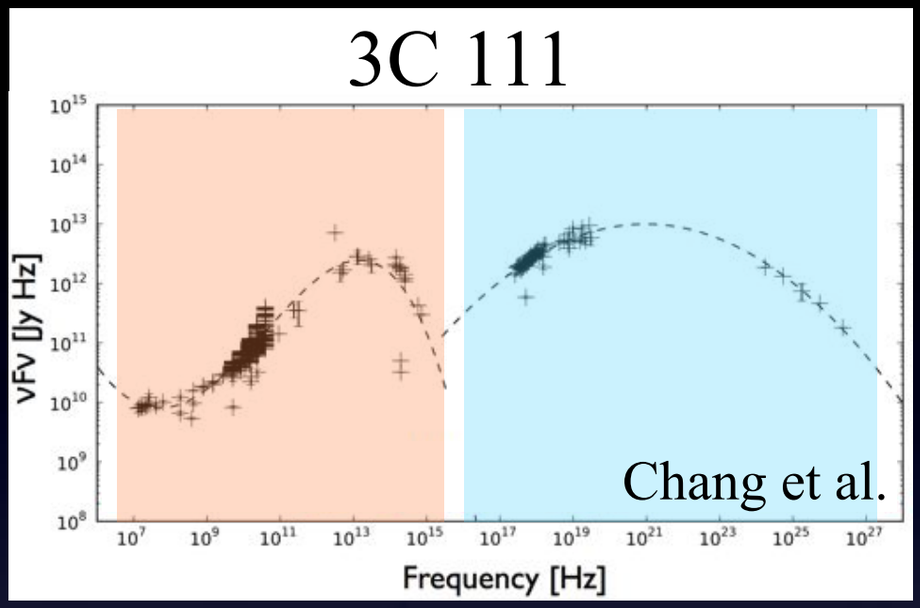
Spectral Energy Distribution (SED)



Radio ⟷ Υ-ray

The Emission of AGN Jet





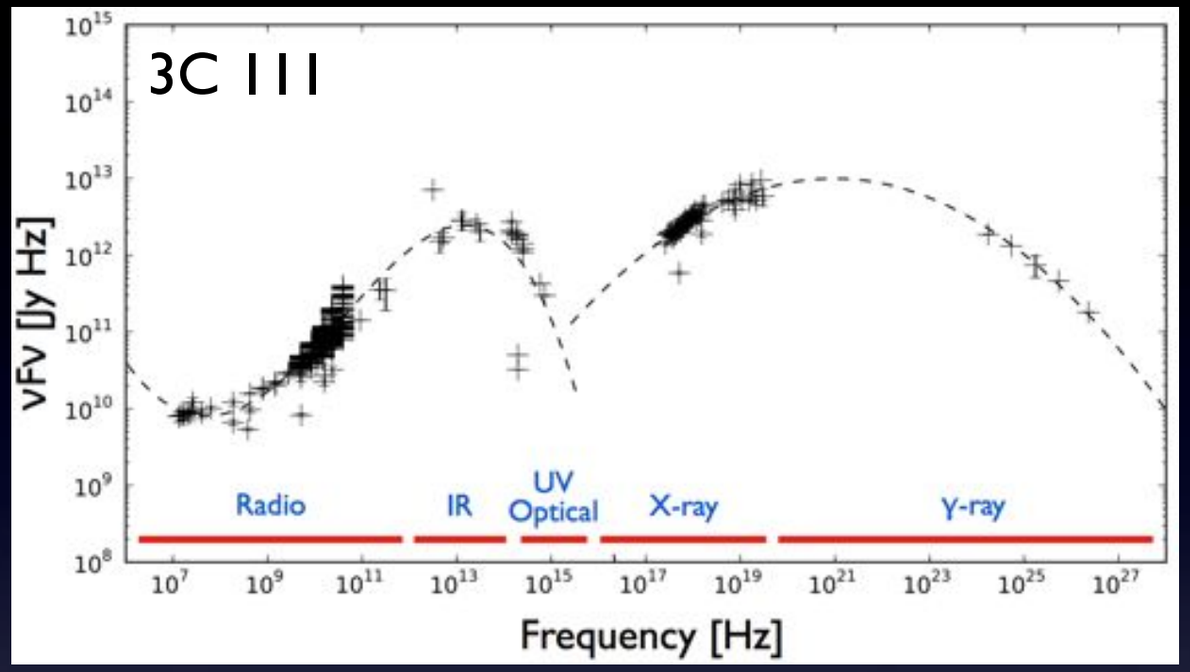
Synchrotron

Inverse Compton (Leptonic)

or

Proton-induced (Hadronic)

The Broadband Emission of AGN



Chang et al.
in prep

- **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?

http://www.physics.purdue.edu/MOJAVE/

MOJAVE

The Brightest Radio Galaxies in the Northern Sky

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

- [γ-ray] *Fermi* LAT 1yr catalog data (Abdo et al. 2010, ApJ 715, 429) for 85 sources; upper-limits for 50 sources (M. Böck et al.)
- *Swift* observations
  - [X-ray/Optical] XRT/UVOT: Dedicated program to observe MOJAVE sources, observations after August 2008
  - [Hard X-ray] BAT: 22-month catalog (J. Tueller et al. 2010, ApJS 186, 378)
- [Radio] MOJAVE program (Lister et al. 2009, ApJ 137, 3718)
- [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

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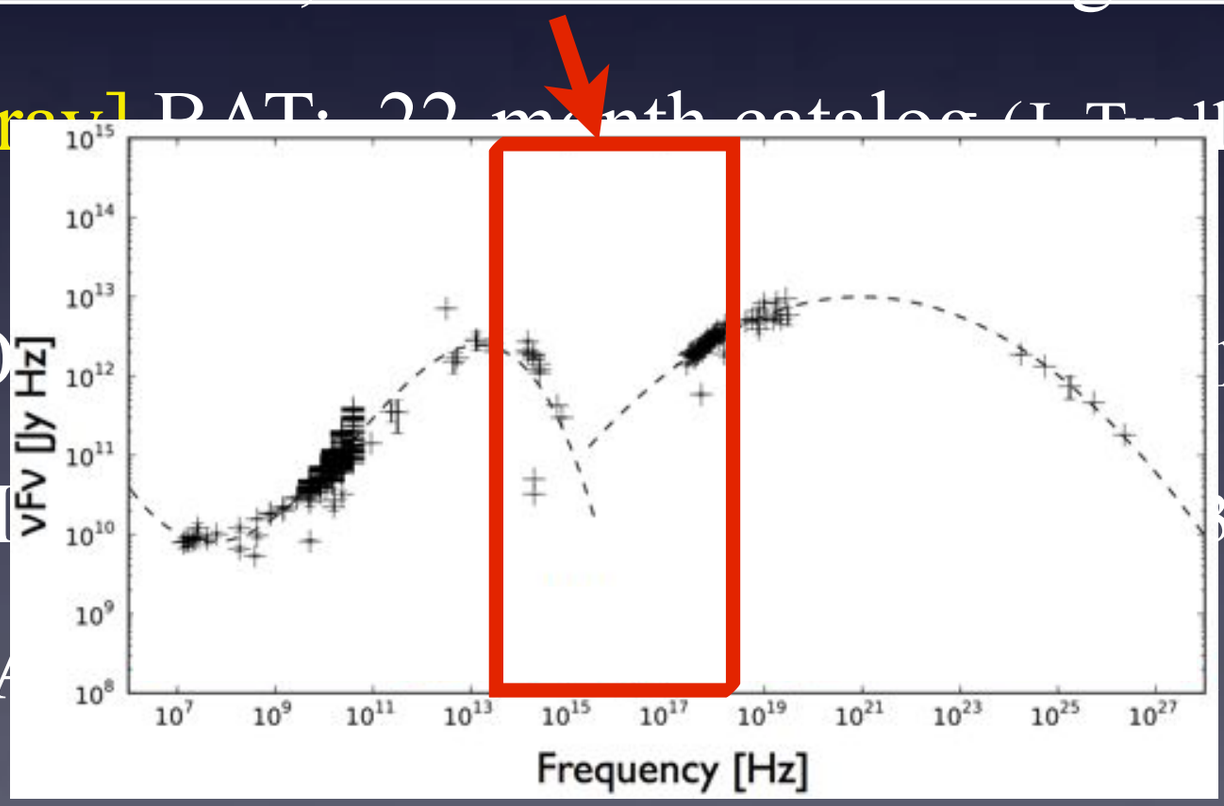
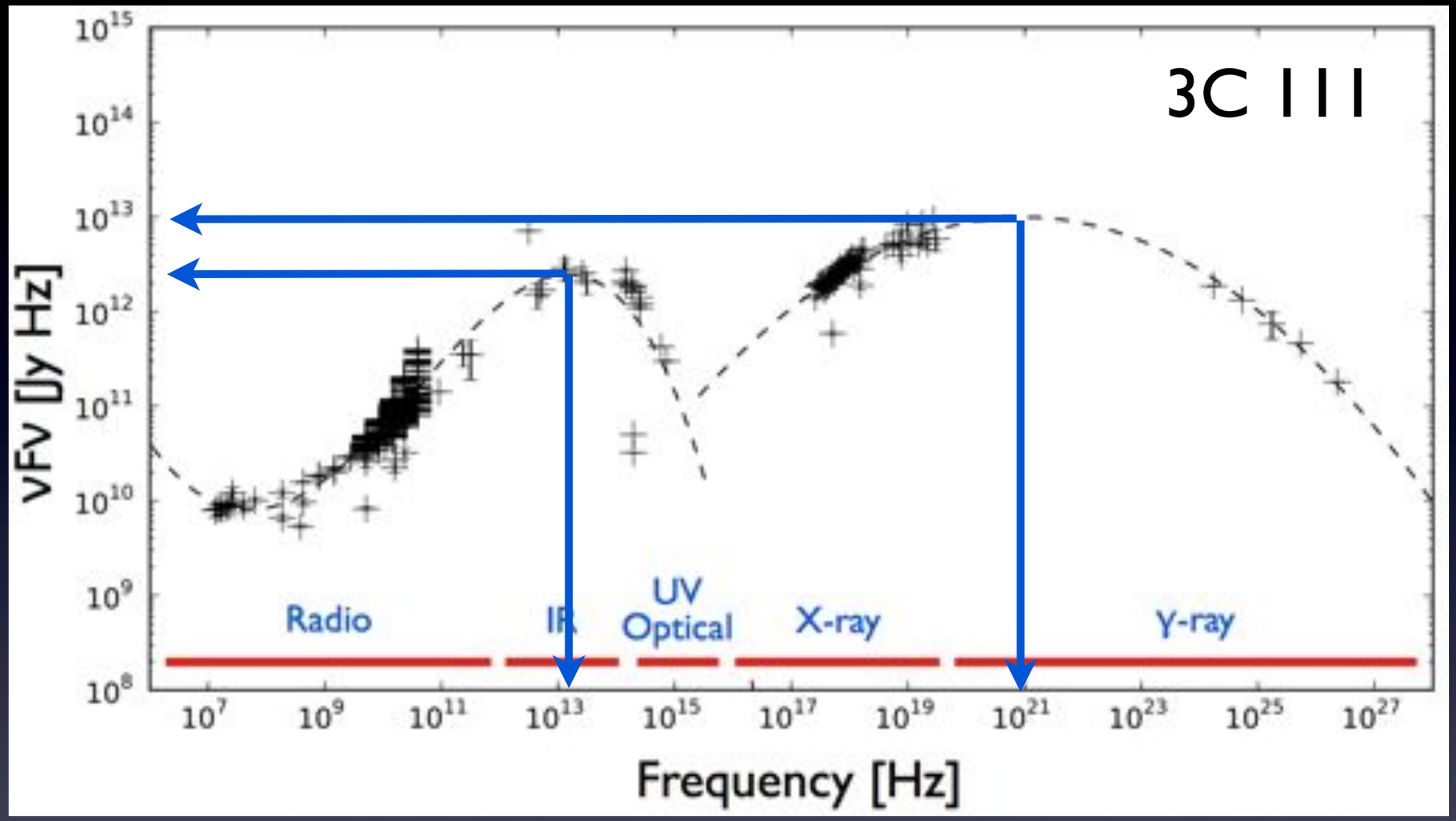
  - [Radio] UM , ApJ 586, 33)
  - [Radio] FGA Angelakis et al. 2010)



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:

$\nu_{sync,\ peak}$

νF_{ν} sync, peak

$\nu_{IC,\ peak}$

νF_{ν} IC, peak

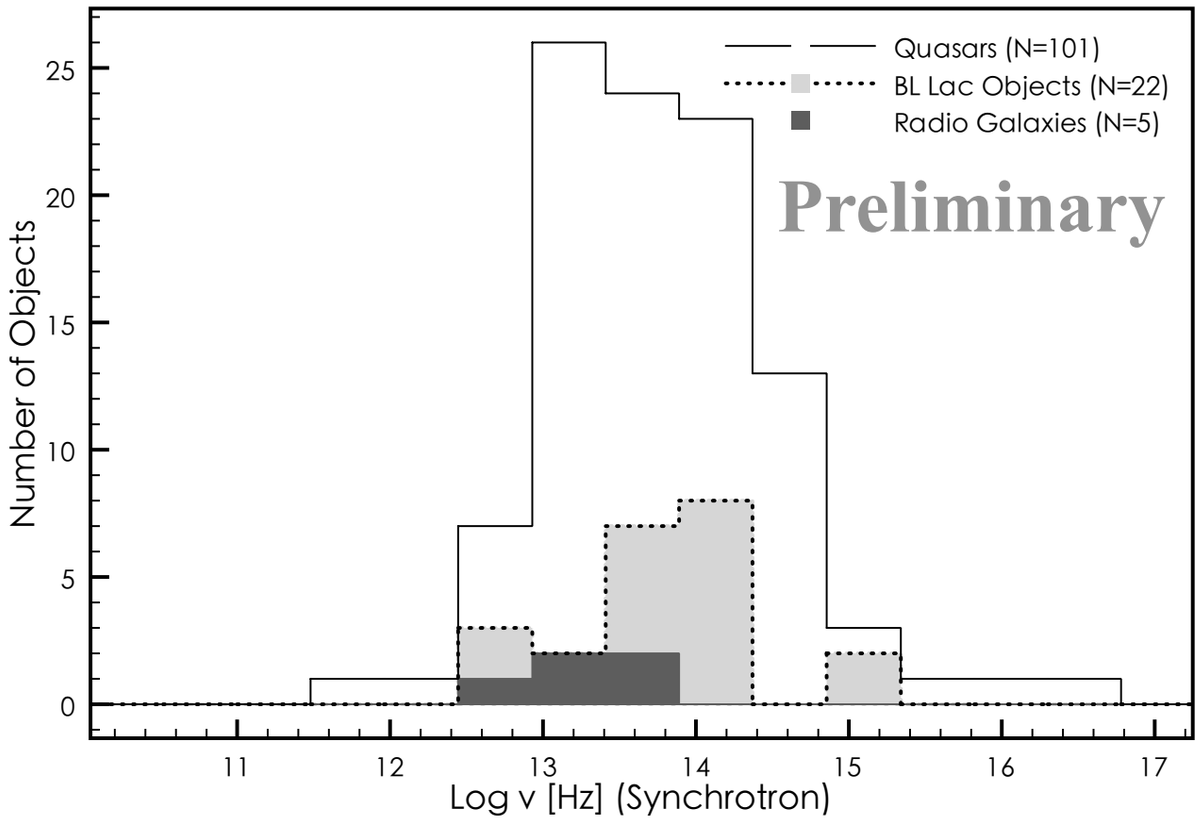
Radio (VLBI):
Flux density
Spectral index
β_{app}
Doppler factor
Lorentz factor

X-ray:
Flux
Luminosity
Photon index

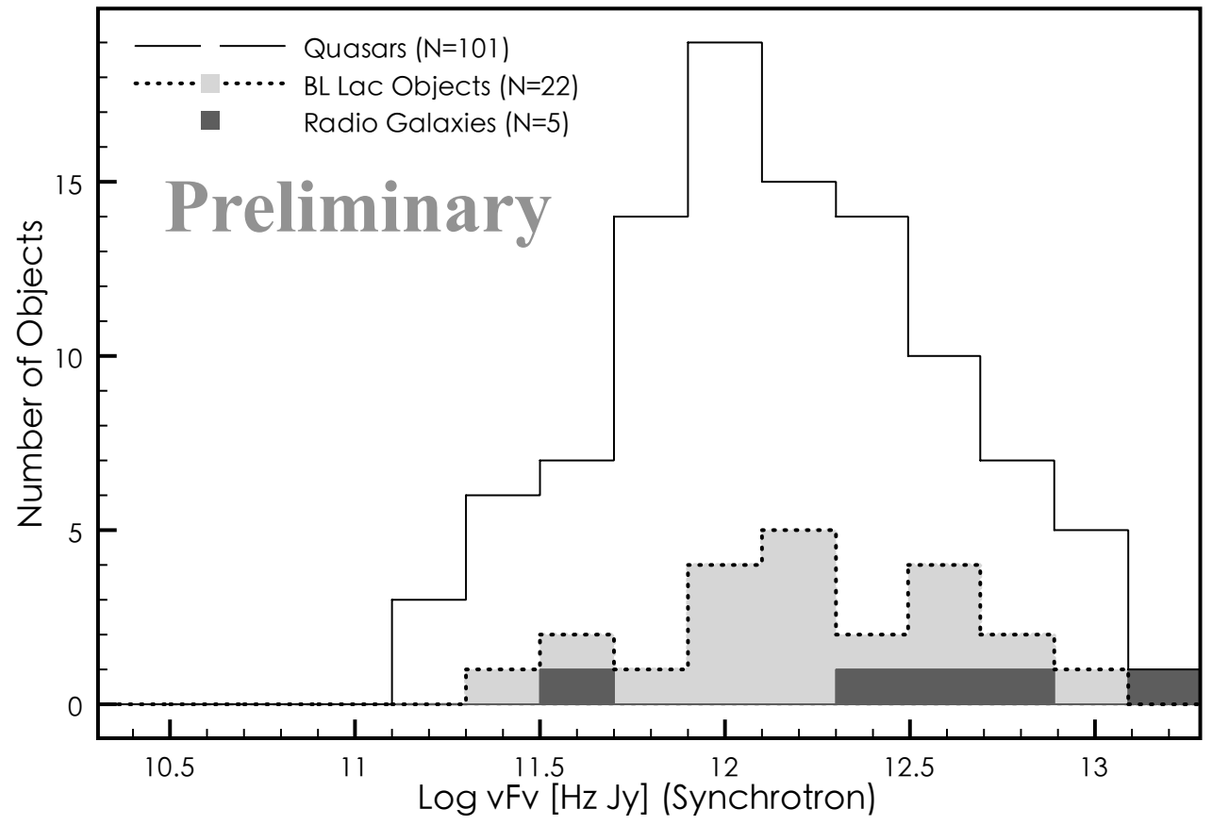
γ-ray:
Flux
Luminosity
Photon index

Distributions of Synchrotron Peak Values

ν_{sync}

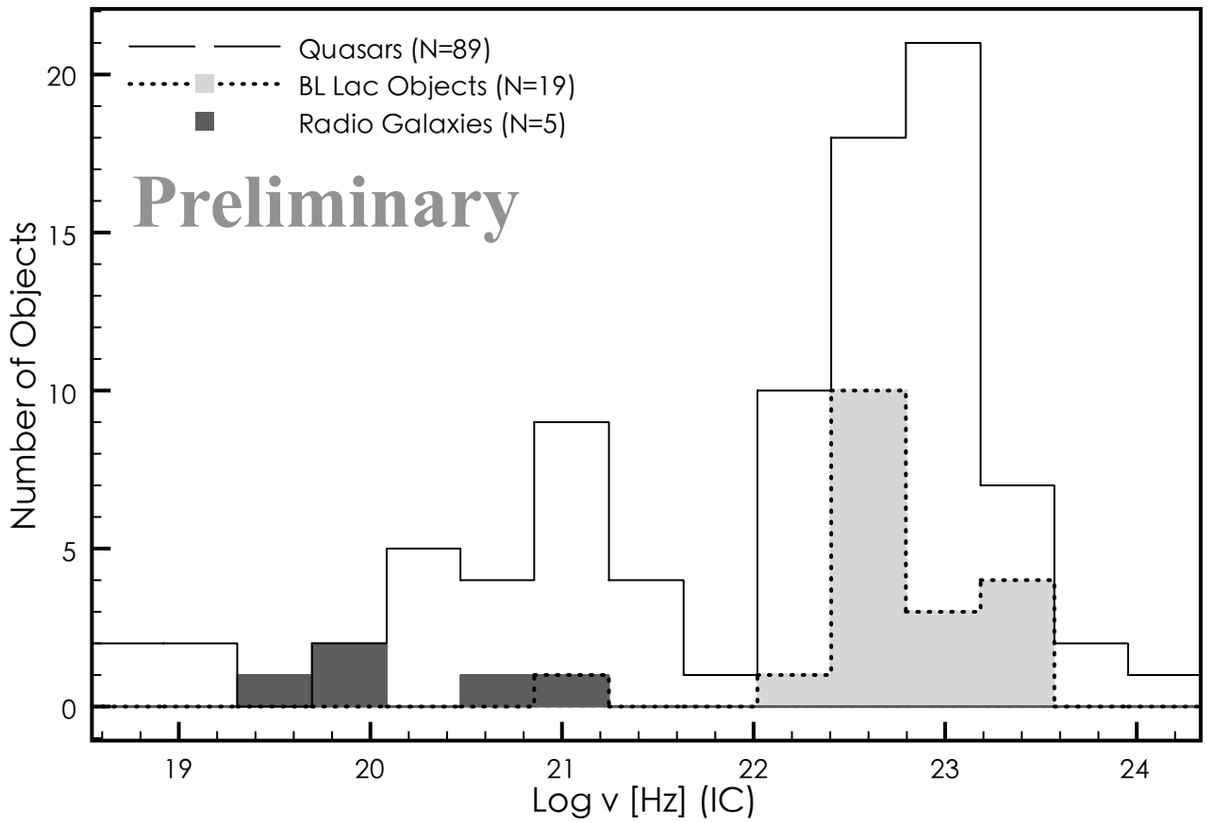


$\nu F_{\nu sync}$

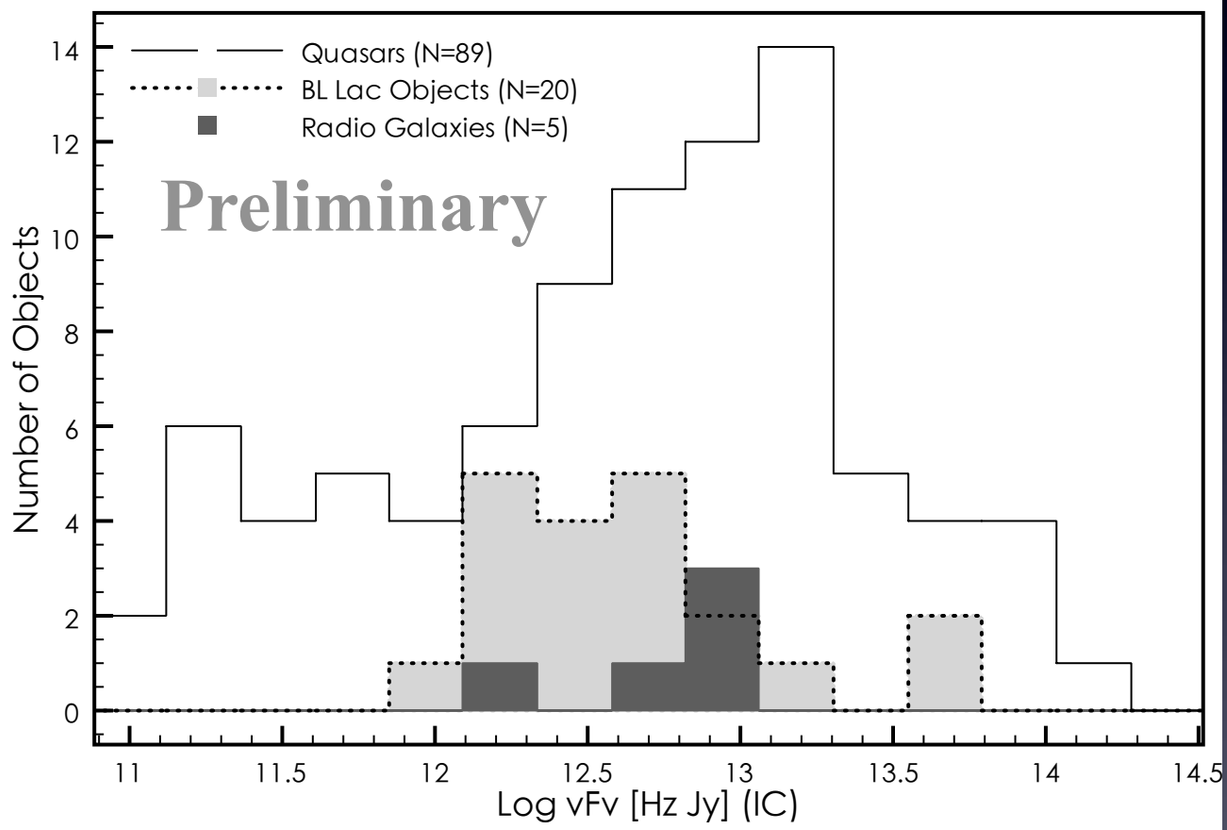


Distributions of IC Peak Values

ν_{IC}

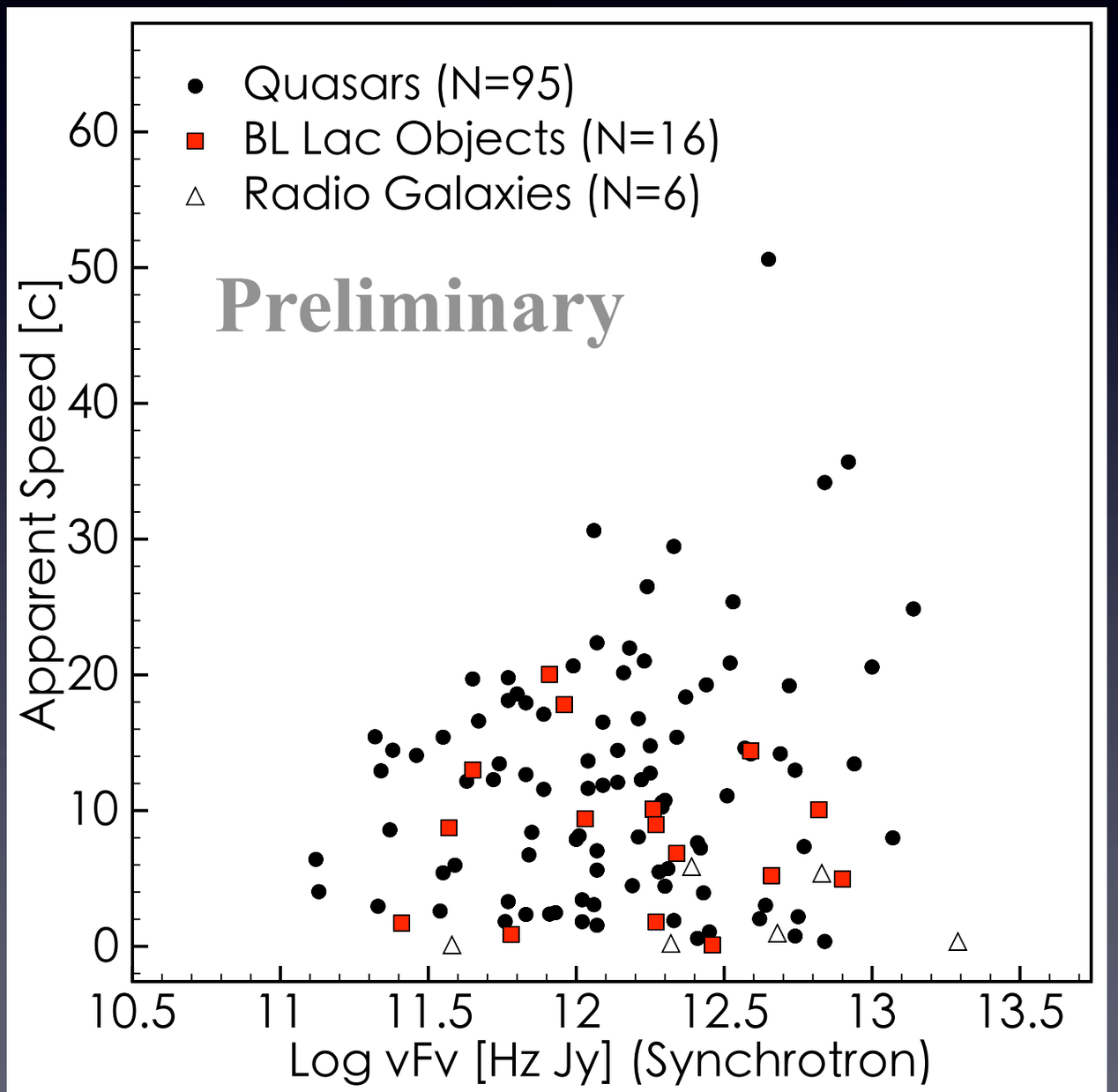


$\nu F_{\nu IC}$

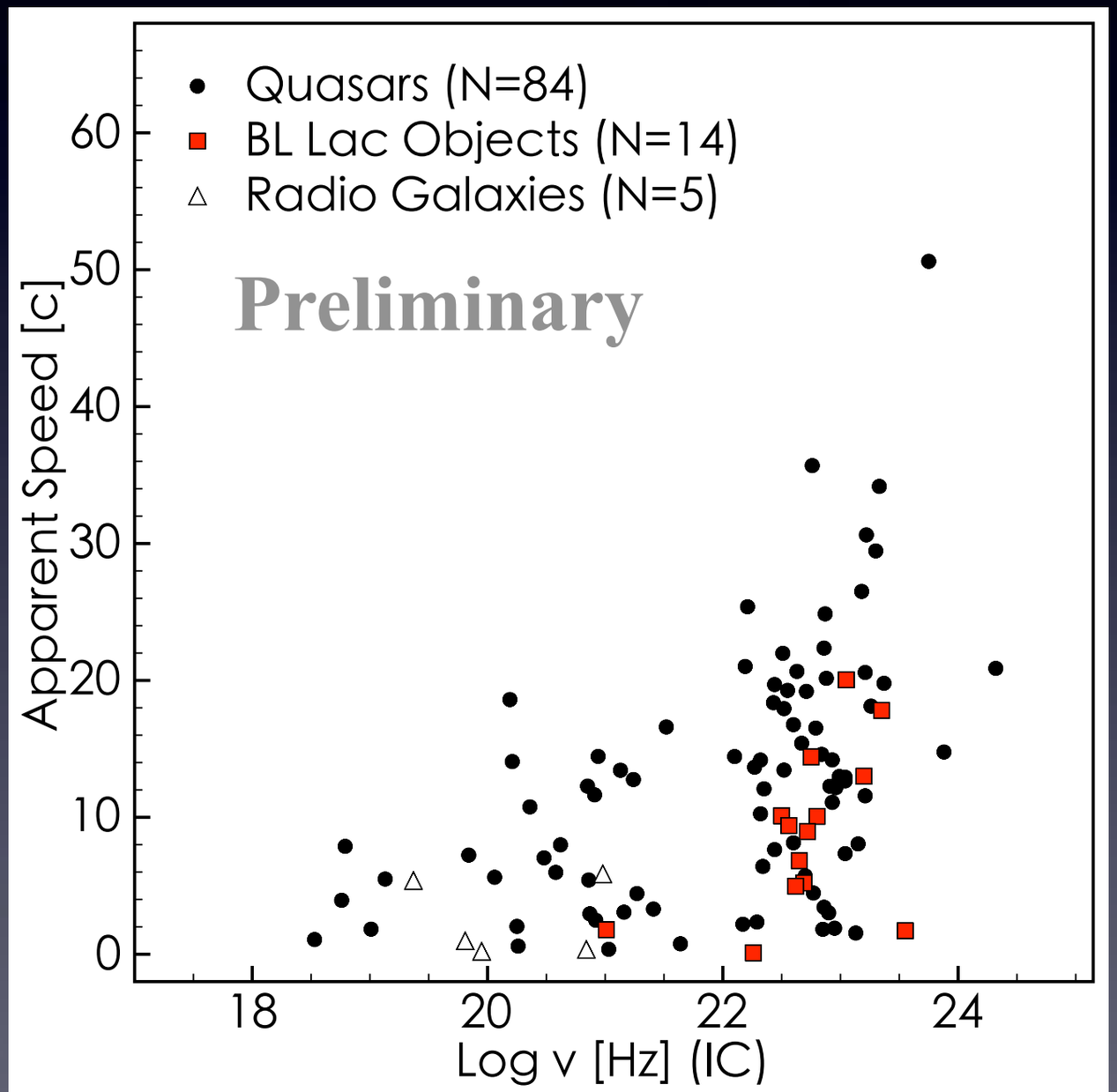


Jet apparent speed & SED properties

β_{app} - $\nu F\nu_{sync}$



β_{app} - ν_{IC}



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 $\nu F\nu_{sync}/\nu_{IC}$, 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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