Maitrayee Gupta

Comparing Radio Loud Swift/BAT AGN with their Radio Quiet counterparts

Collaborators:
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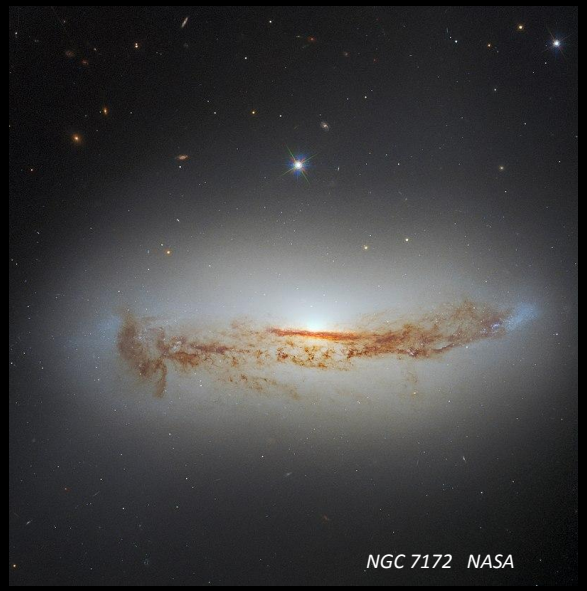
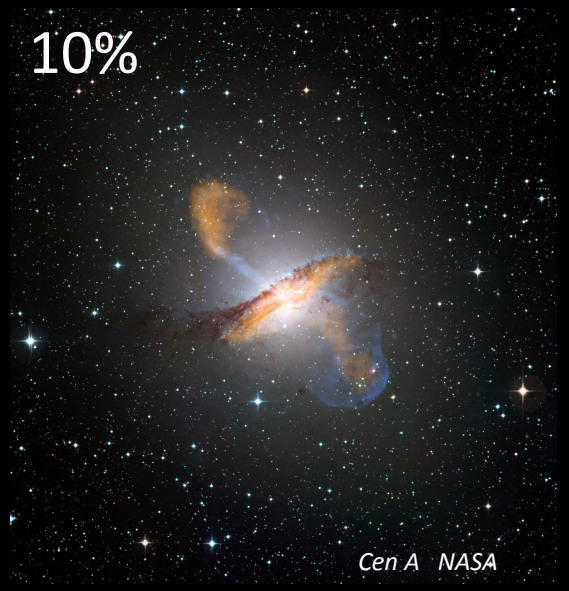
credit: NASA/JPL-Caltech

Aim: Comparing RL AGN with RQ Counterparts



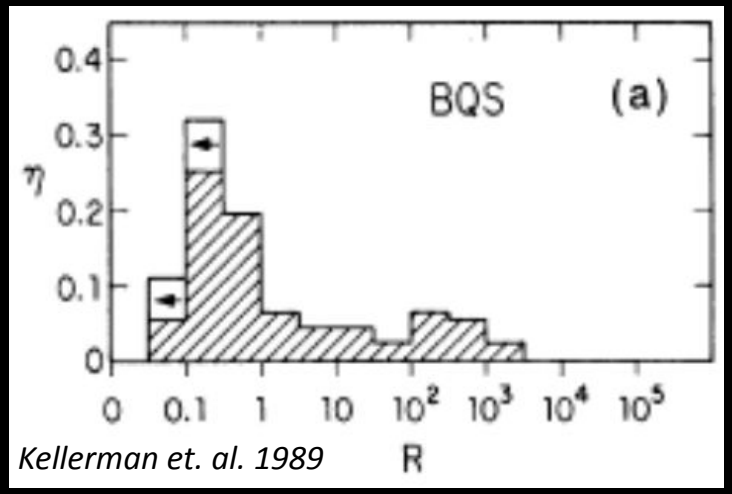


- Synchrotron

Motivation

Radio Loud

Cen A NASA



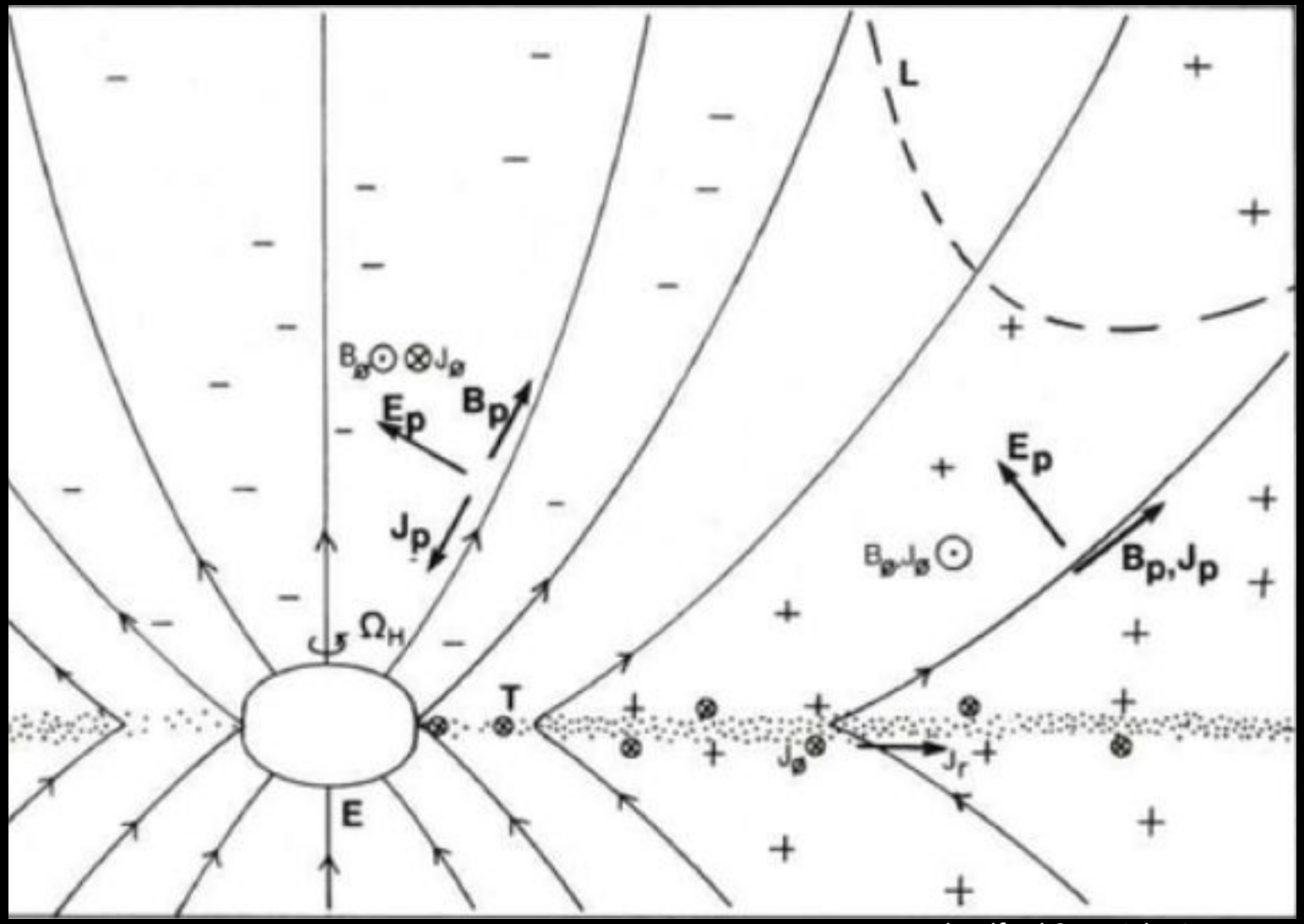
Kellerman et. al. 1989

- To investigate why large diversity in jet production efficiency in AGN?
  - Radiative properties
  - accretion modes or environment

M77 NASA

Radio Quiet

Probe scenario of Jet production



Blandford & Znajek 1977

- Blandford - Payne Mechanism
- Blandford - Znajek Mechanism
  - $P \propto B^2 a^2$

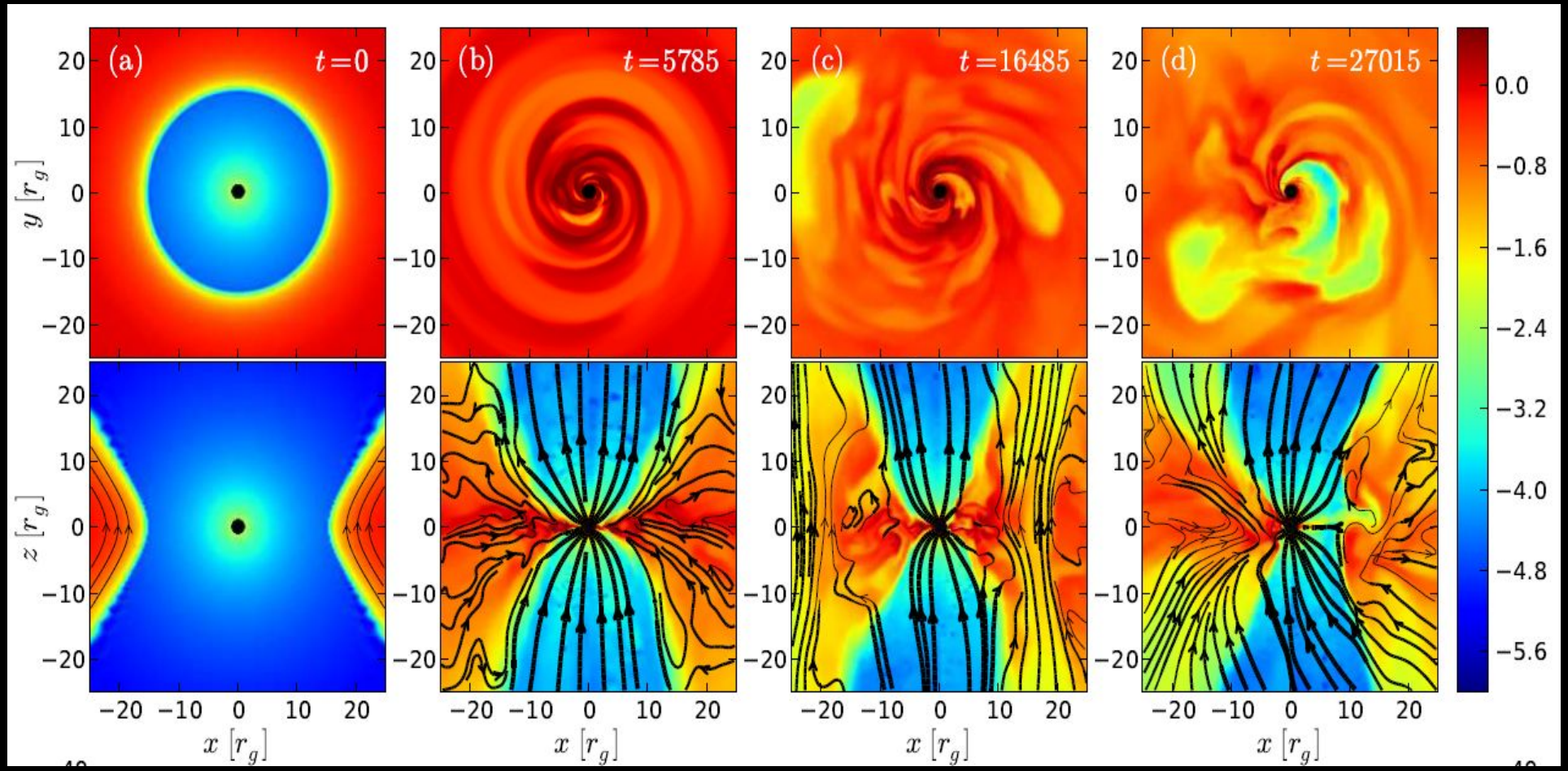
Theoretical and Numerical Studies

Fast rotating black hole immersed in very strong magnetic field

NS - no accretion disk

Mag field: Produced by current outside and confined by the pressure of matter accreting

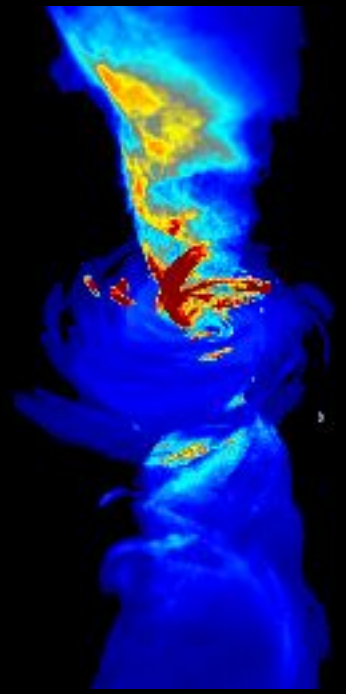
Maximal mag flux confined: Magnetically Arrested Disks - MAD



Tchekhovskoy et. al. 2016

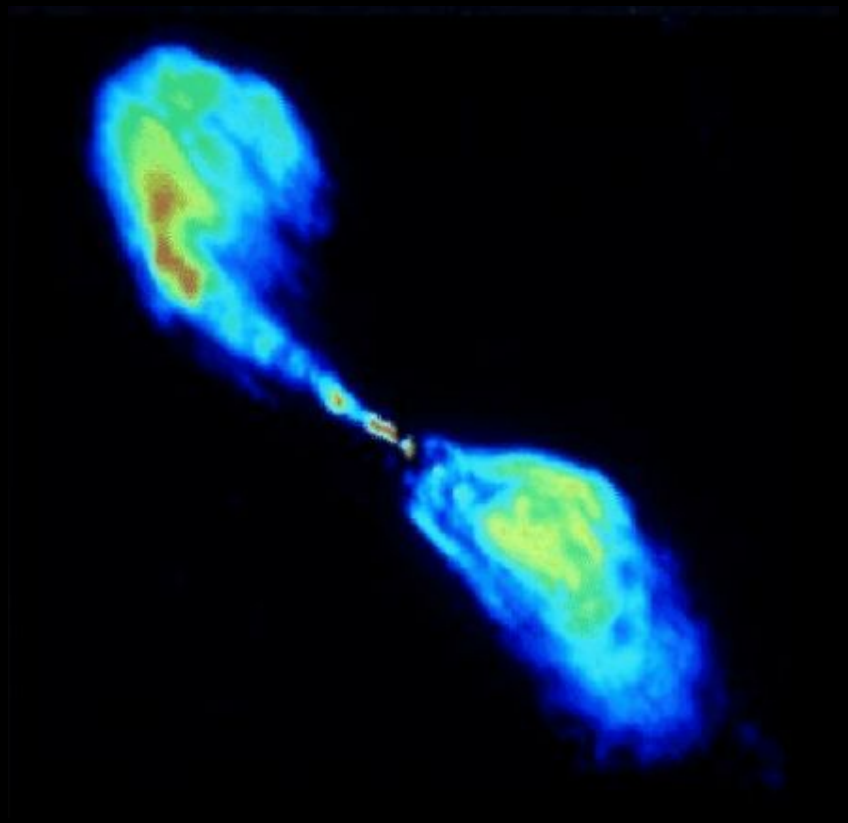
Better resolution - Where do jets start?

Theoretical simulation



Credit: Moscibrodzka et al.

Observed jets

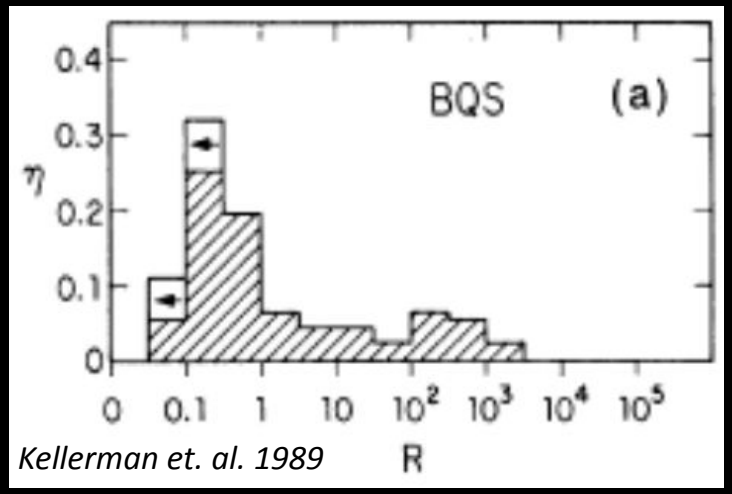


credit: Cen A Radio - VLA.

Motivation

Radio Loud

Cen A NASA



Kellerman et. al. 1989

- To investigate why large diversity in jet production efficiency in AGN?
  - Radiative properties
  - accretion modes or environment

- Because Jets are close to the BH:
  - Maximum radiative differences in the central portion of the accretion flow -> Hot x-ray corona -> HX-rays

- To avoid biases since RL AGN have larger M_{BH} and lower λ_E than RQ:
  - Similar M_{BH} and λ_E

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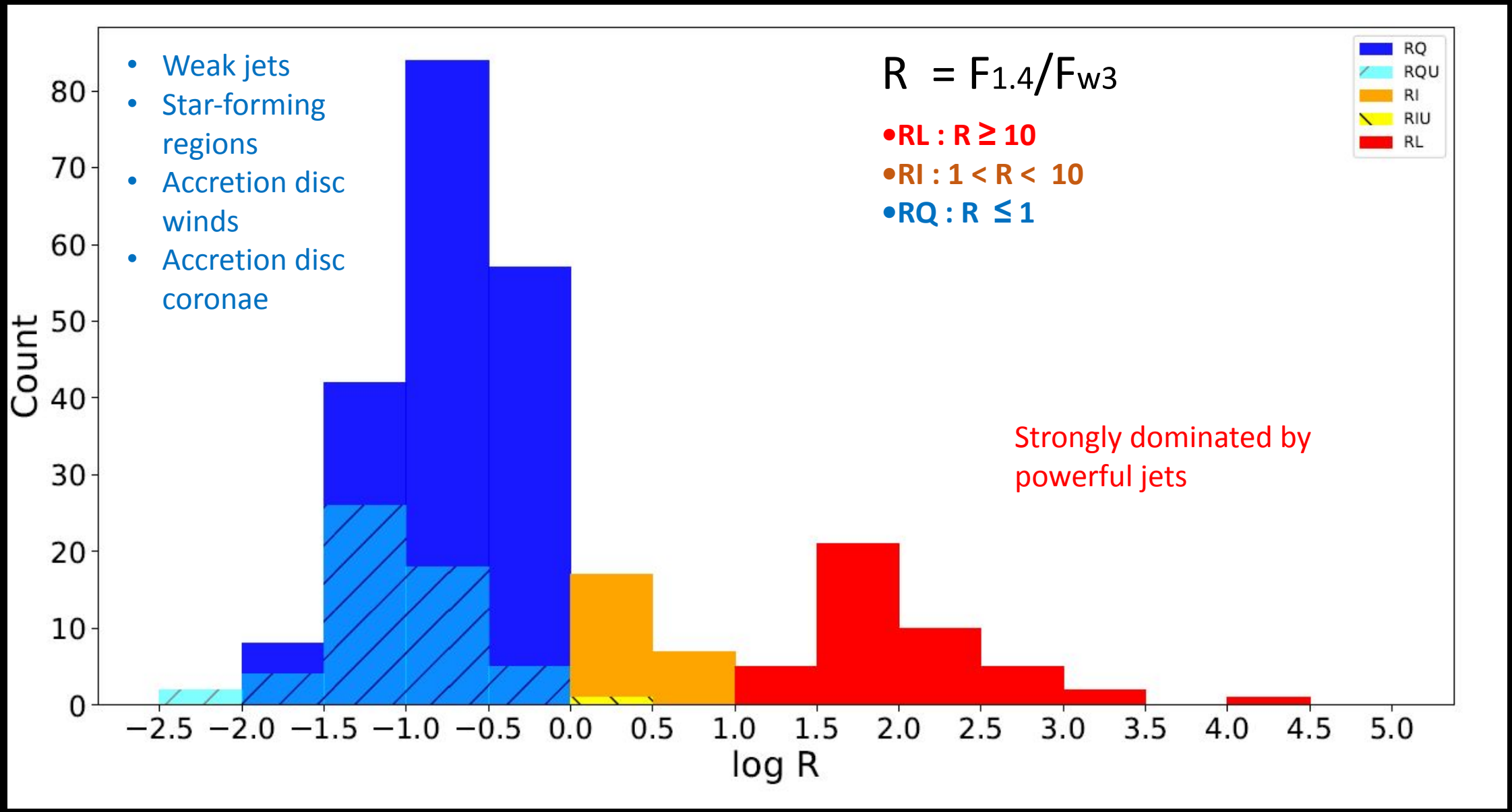
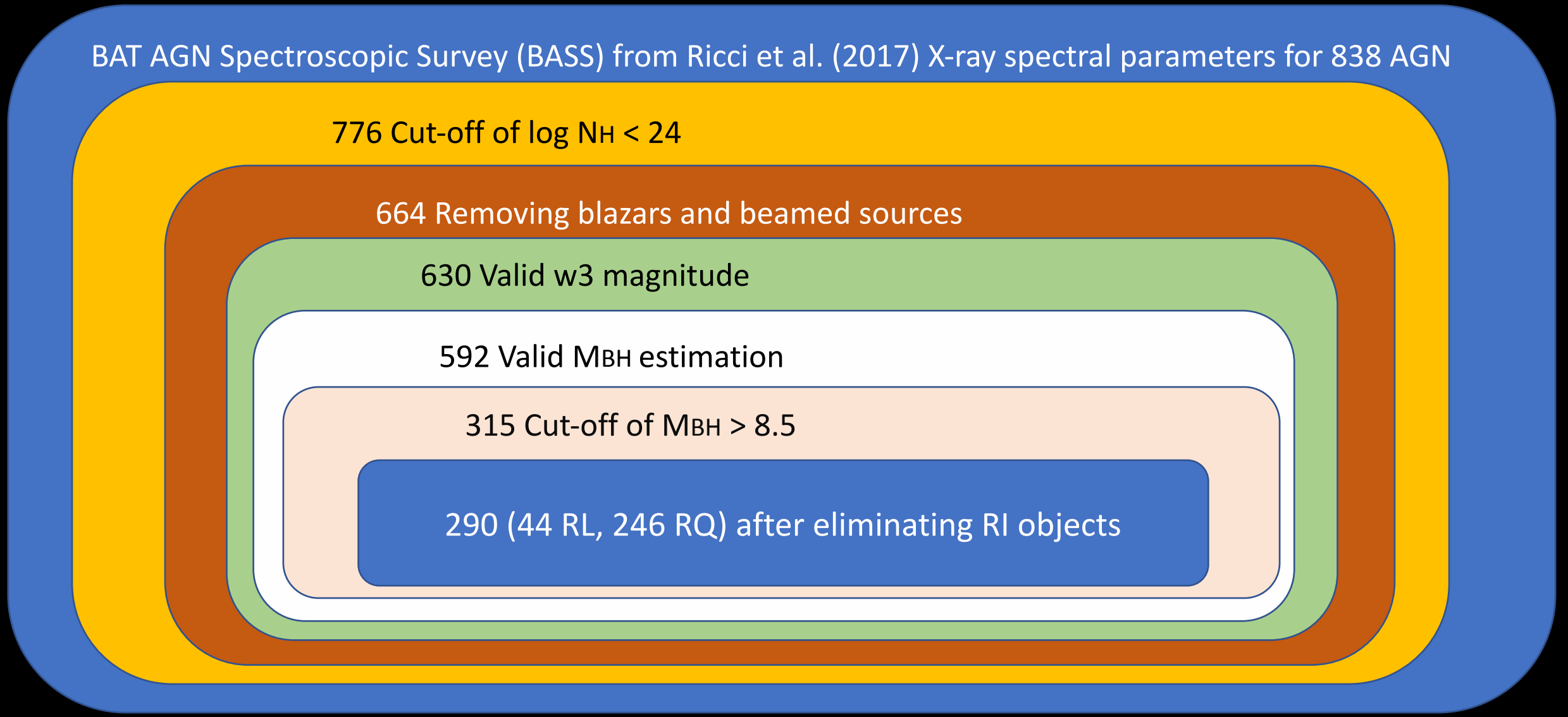
Radio Quiet

Radio selection and radio loudness



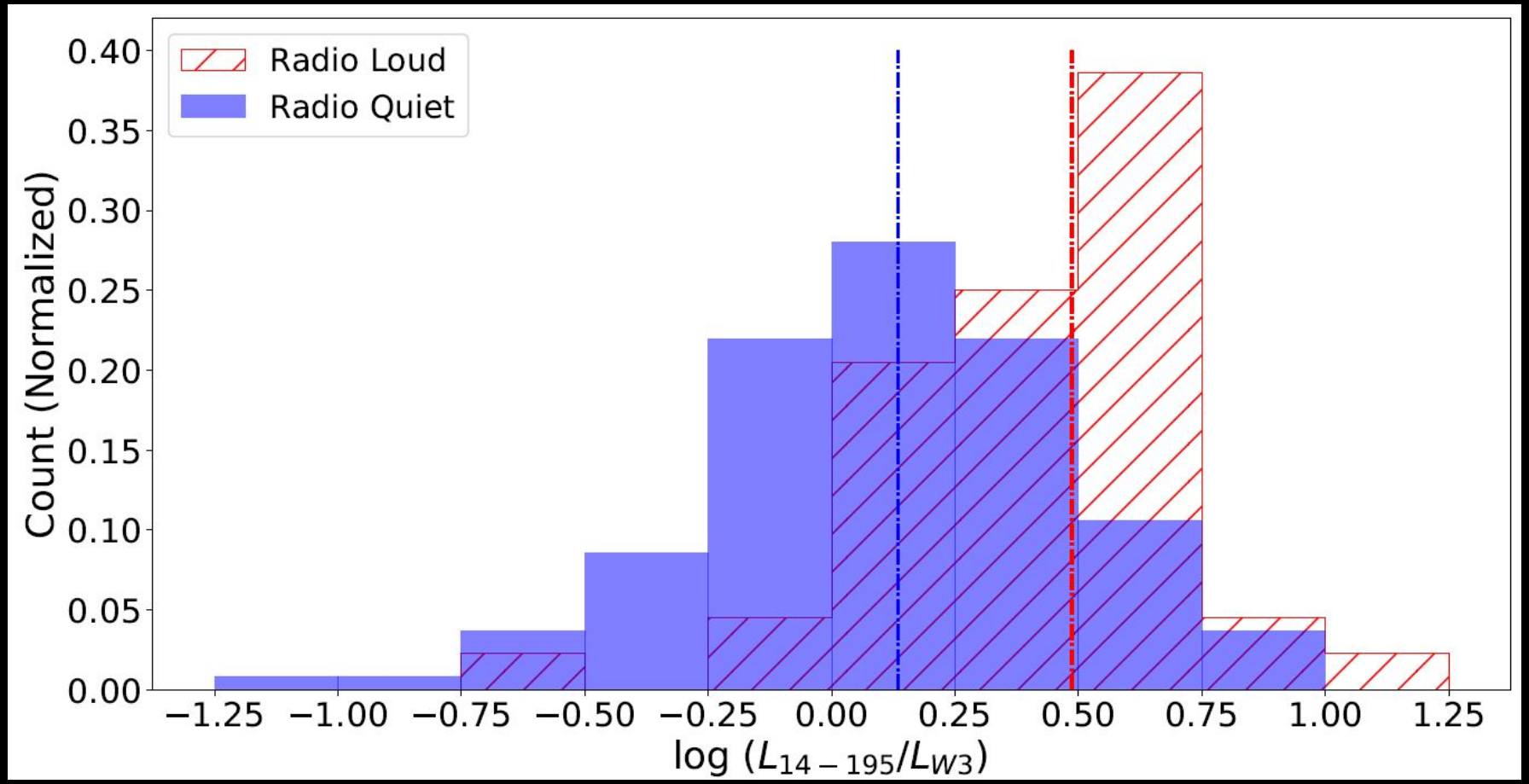
Gupta et. al. 2020

Selection Summary



X-Ray Properties Study- X ray Loudness

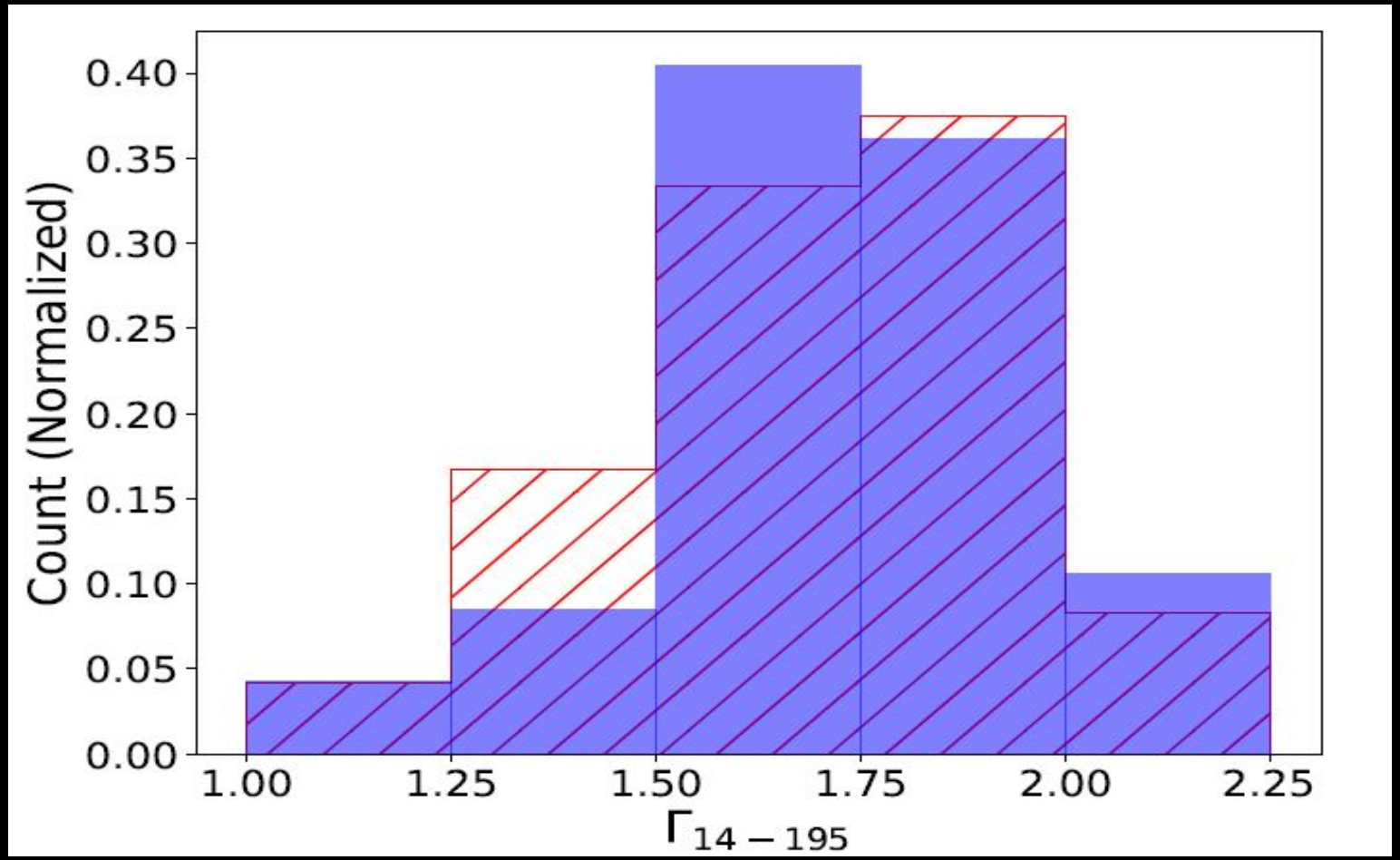
- X-ray loudness - Similar but shifted
- RL 2 times X-ray-louder



Gupta et. al. 2020

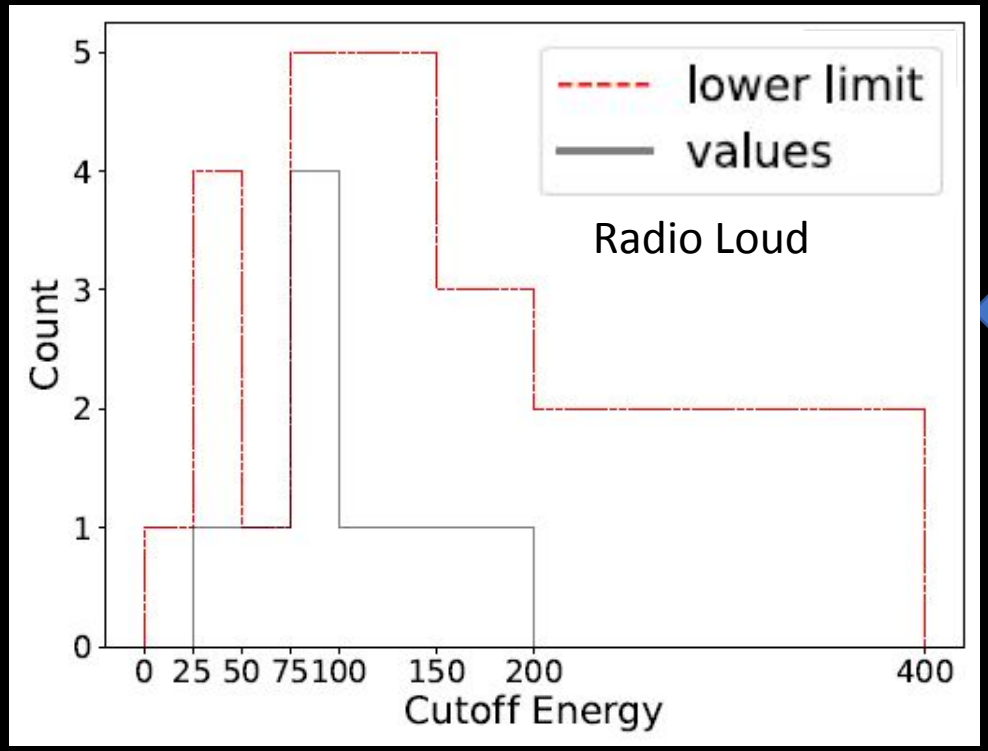
X-Ray Properties Study – Spectral Slope

- Gamma - Significant overlap and similar median.
- Previous studies had found RL have harder X-ray spectra than RQ.
- Similar underlying mechanism in the production of X-rays independent of the radio loudness value.

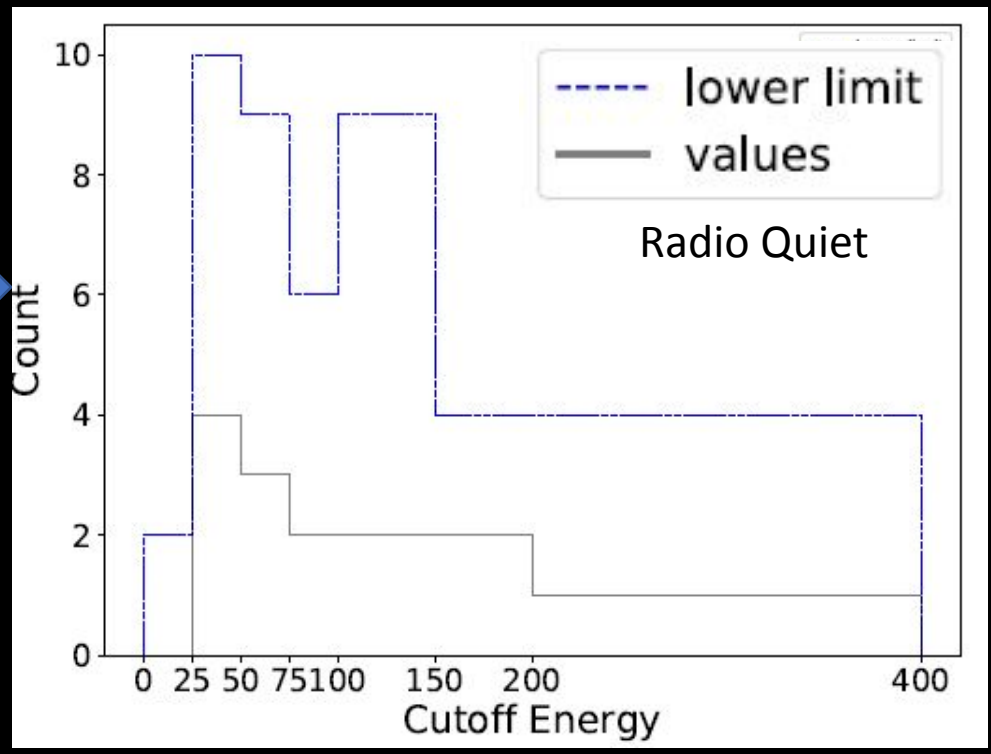


Gupta et. al. 2018

X-Ray Properties Study- High Energy Cutoff



Similar trend



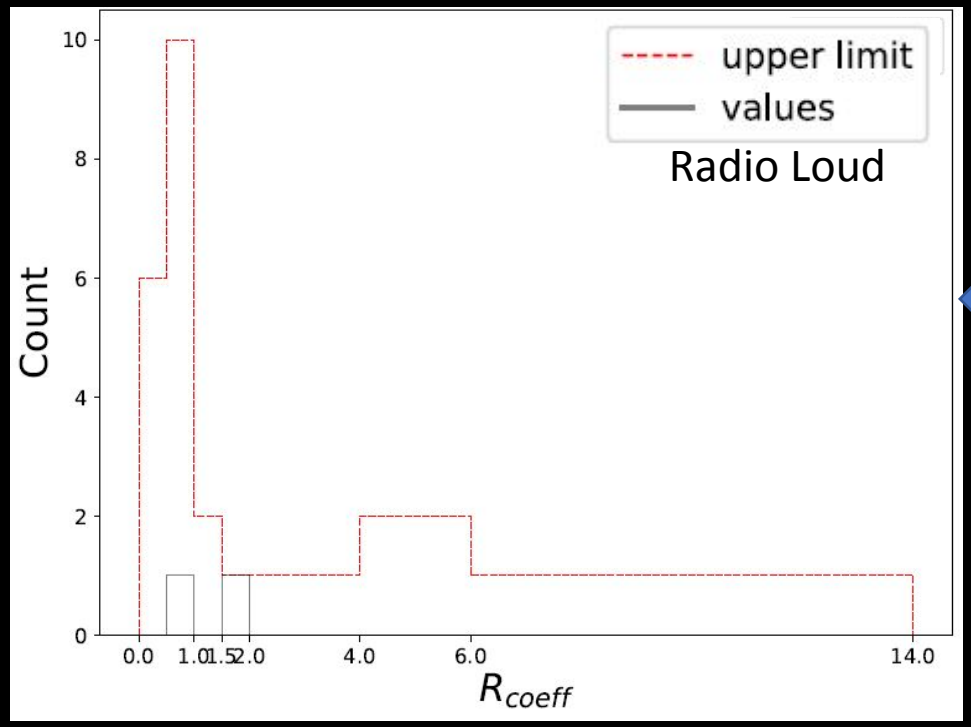
Gupta et. al. 2018

High energy break for RL and RQ AGN around the same place

Mechanism that produces the X-rays is similar.

X-Ray Properties Study- Reflection coefficient

Swift/XRT, XMM-*Newton*, ASCA, *Chandra*, and Suzaku, data below 10 keV. by Ricci et. al.



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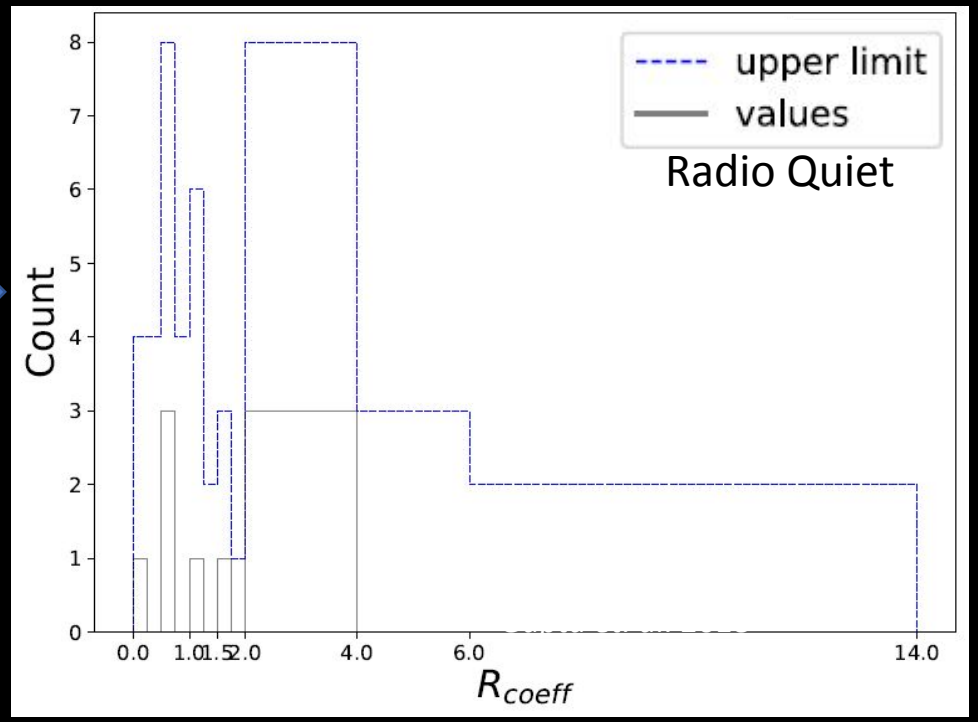


Gupta et. al. 2018

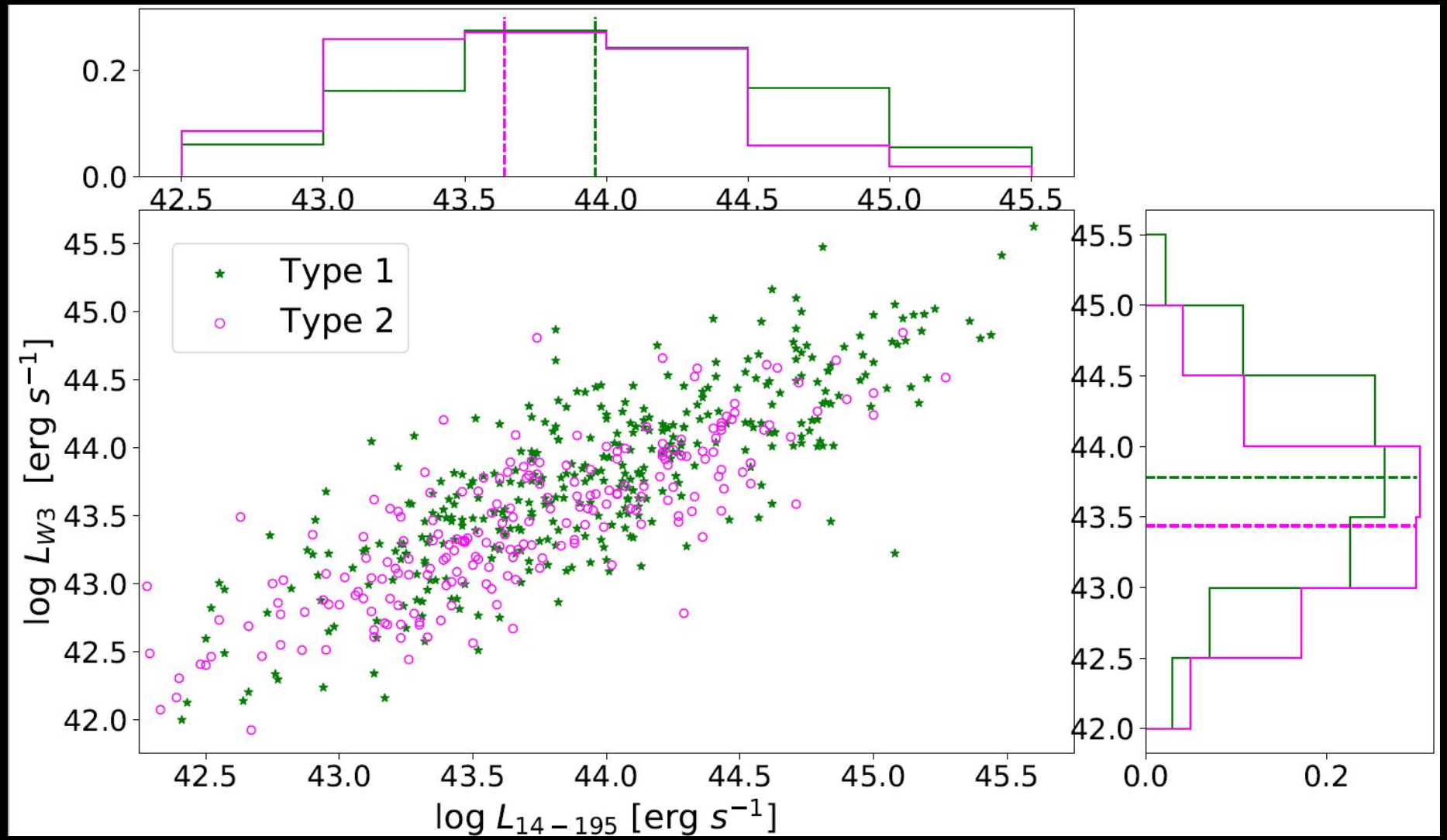
The fraction of hard X-ray intercepted by the cold accretion disk is similar.

X-Ray Properties Study

- Recap: Similar mechanism and location in RL and RQ.
- The larger X-ray loudness of RL may not be contribution of jets but larger efficiency of Hard X-ray production in accretion flows.
- Since the MIR is isotropic, this can be verified by checking whether X-ray loudness depends on angle of view.

Type 1 and Type 2 AGN

- Taking advantage Our sample has both Type 1 and Type 2 & having W3 data which is isotropic.
- We can use this to study the isotropy of Hard X-ray if any.



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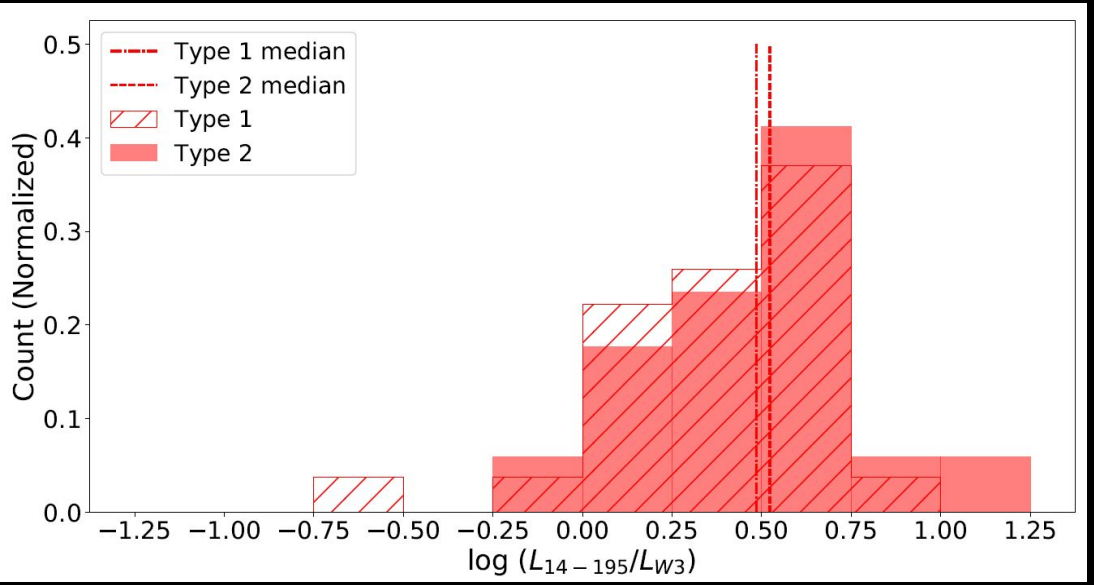
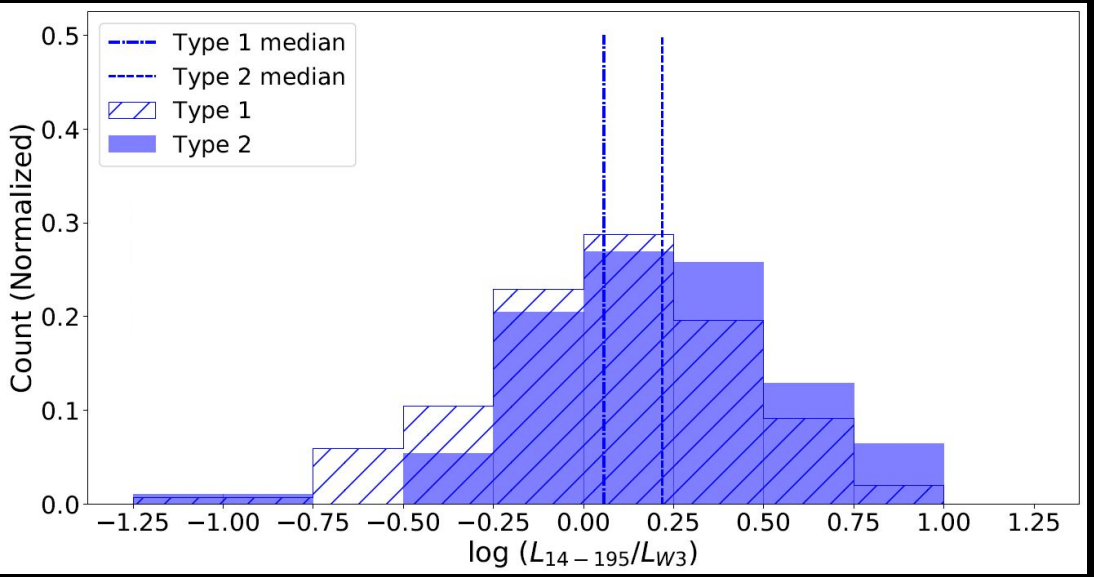
Isotropy of X rays





- X-ray loudness - similar - dominated by accretion flow & quasi isotropic
- The isotropy -> X-ray sources in both cannot be too compact -> gravitational lensing.
- Production of X-rays by a slow jet with similar luminosity as by accretion flow would imply that most of the jet energy required to efficiently power the radio lobes is dissipated and radiatively lost already at the base.
- Hot coronae associated with central portions of accretion flows.

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The origin of hard X rays in RQ and RL AGN

- Key observations:
  1. RL AGN are X-ray louder
  2. RL & RQ have similar X-ray slope & cut off energies
  3. Isotropy of hard X-rays

- Same location and same emission mechanism of hard X-ray sources in RL and RQ AGN.

  Location : the hot corona in the innermost portions of accretion flow.
  Mechanism : Compton up-scattering of lower energy disk photons.

The origin of hard X rays in RQ and RL AGN

- More efficient X-ray production in RL AGN result from larger magnetization of innermost portions of accretion flows and from larger BH spins.

- These are required to afford efficient jet production in the MAD scenario involving the Blandford-Znajek mechanism.

Thank you!