CAMK- PAN
Warsaw

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with
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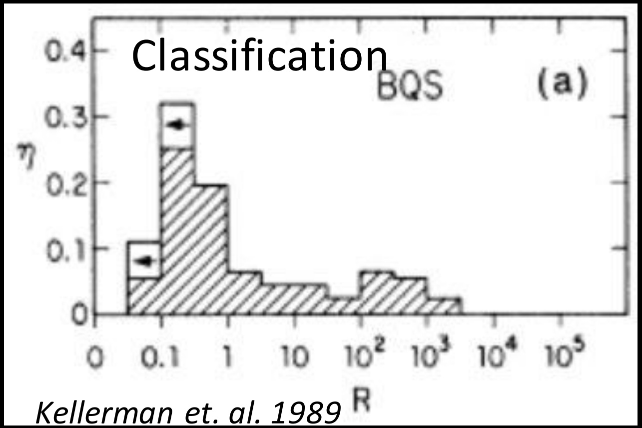
Katarzyna Rusinek

Comparing radio-loud Swift/BAT AGN with their radio-quiet counterparts


Cen A NASA


M77 NASA

Motivation

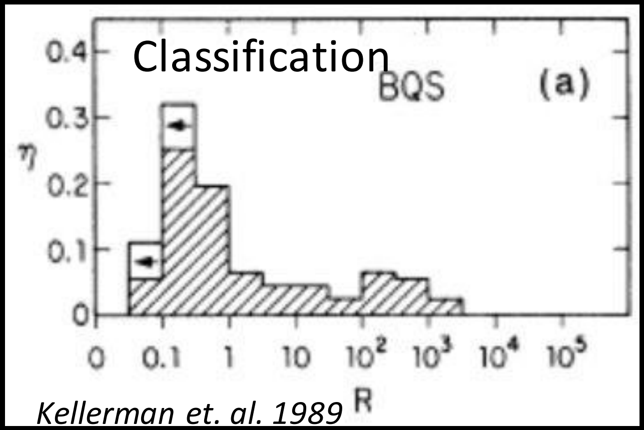


Kellerman et. al. 1989

- Why such large diversity in jet production efficiency in AGN
  - Relation Jet production efficiency and accretion modes
  - Compare radiative properties

Radio galaxy 3C98
Credit: NRAO

Motivation



- Why such large diversity in jet production efficiency in AGN
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- Radiative differences
  - Close to the BH (BZ mechanism)
  - Hot x-ray corona in the central portion of the accretion flow -> HX-rays.

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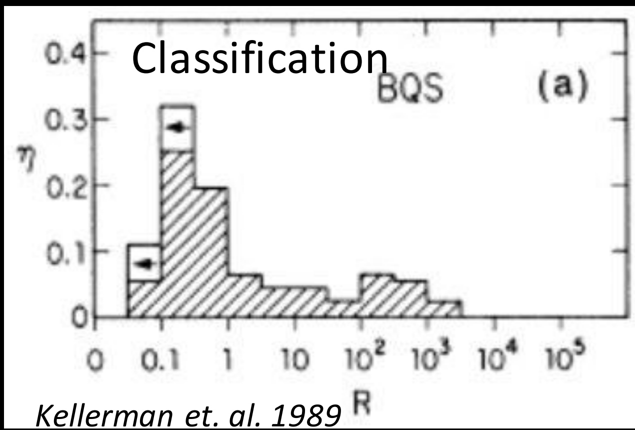

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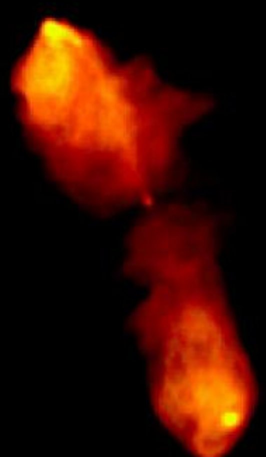
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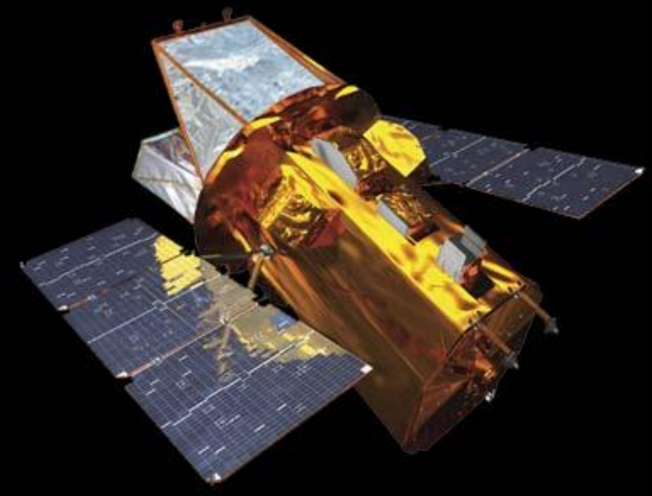
- Similar M_{BH} and λ_E:
  - To avoid biases since RL AGN have on average larger MBH and lower λ_E than RQ.

Primary Data Samples



SWIFT/BAT: Hard X-ray

WISE: Infrared

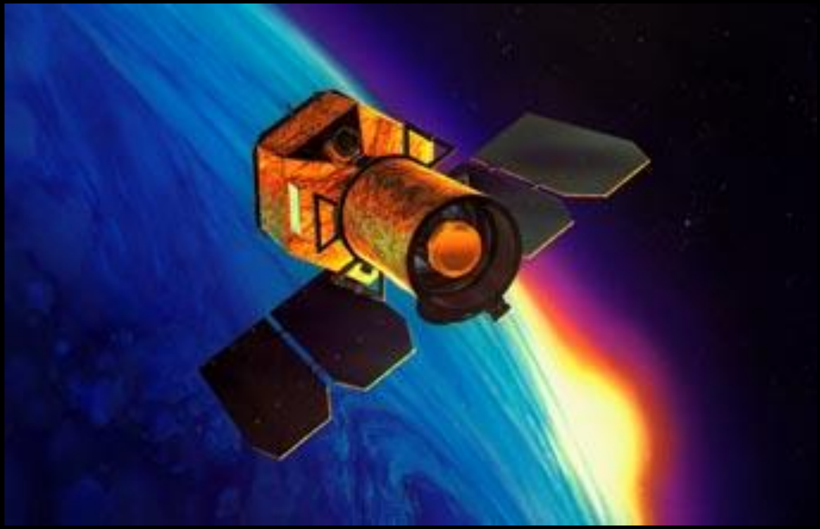
SUMSS: Radio

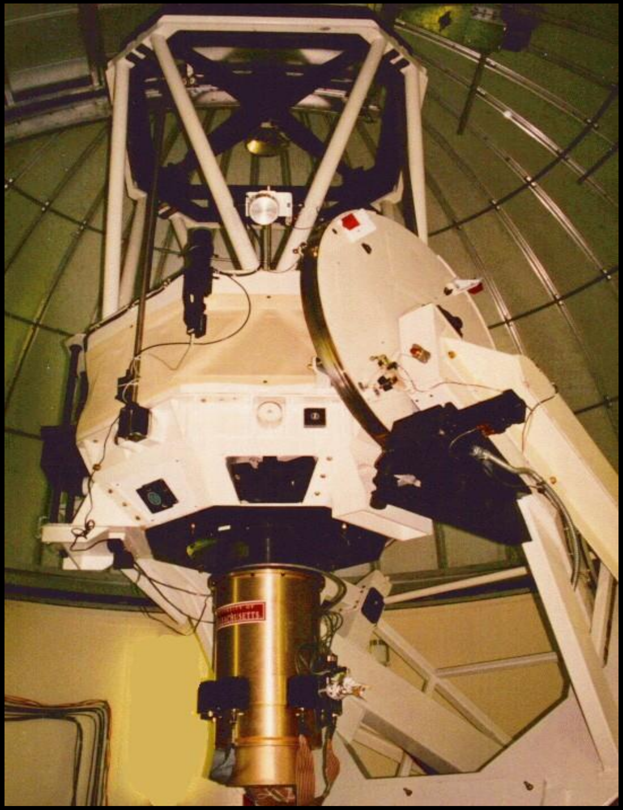
NVSS: Radio

Additional Data Samples

GALEX: UV

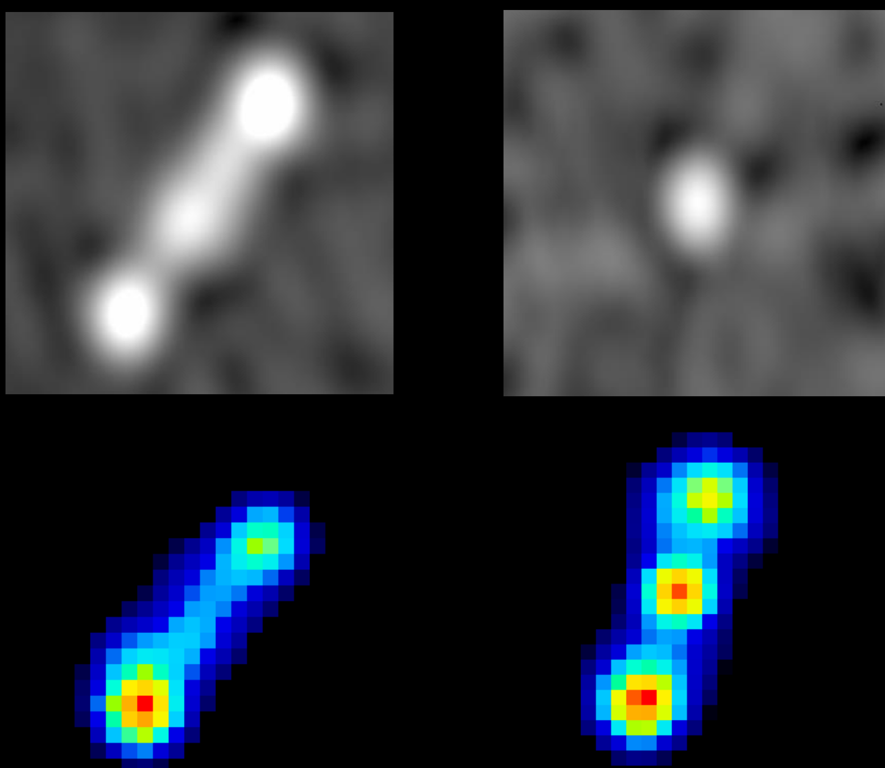
2MASS (Two-Micron-All-Sky-Survey) : Near Infrared

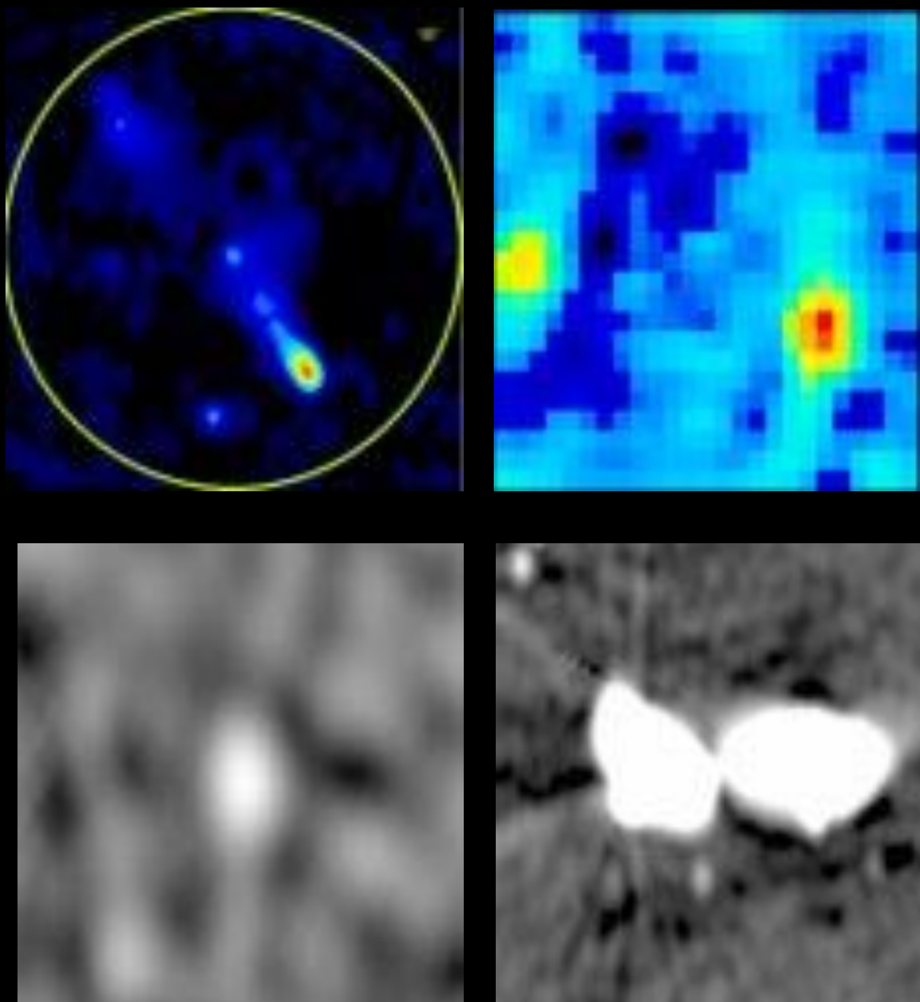




Radio selection

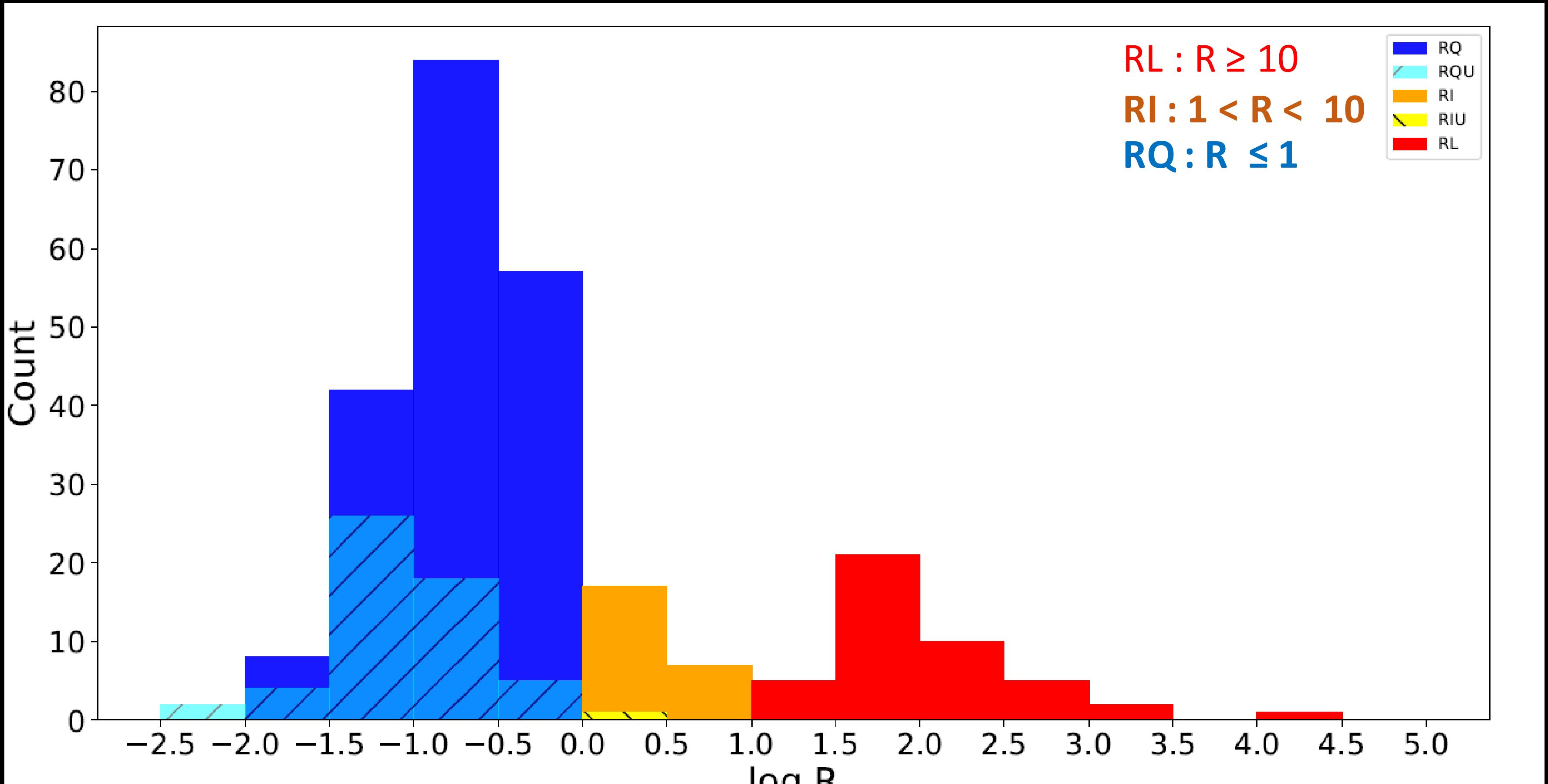
Code :
NVSS single, double, triple
SUMSS single, double, triple





Radio selection and radio loudness

- Radio-loudness : $R = F_{1.4}/F_{W3}$
- Kellerman et al. (1989) $R_K = F_5/F_B \sim 10*R$
- At moderate $\lambda_E < 0.03$ optical is contaminated by the host galaxy
- Clean samples



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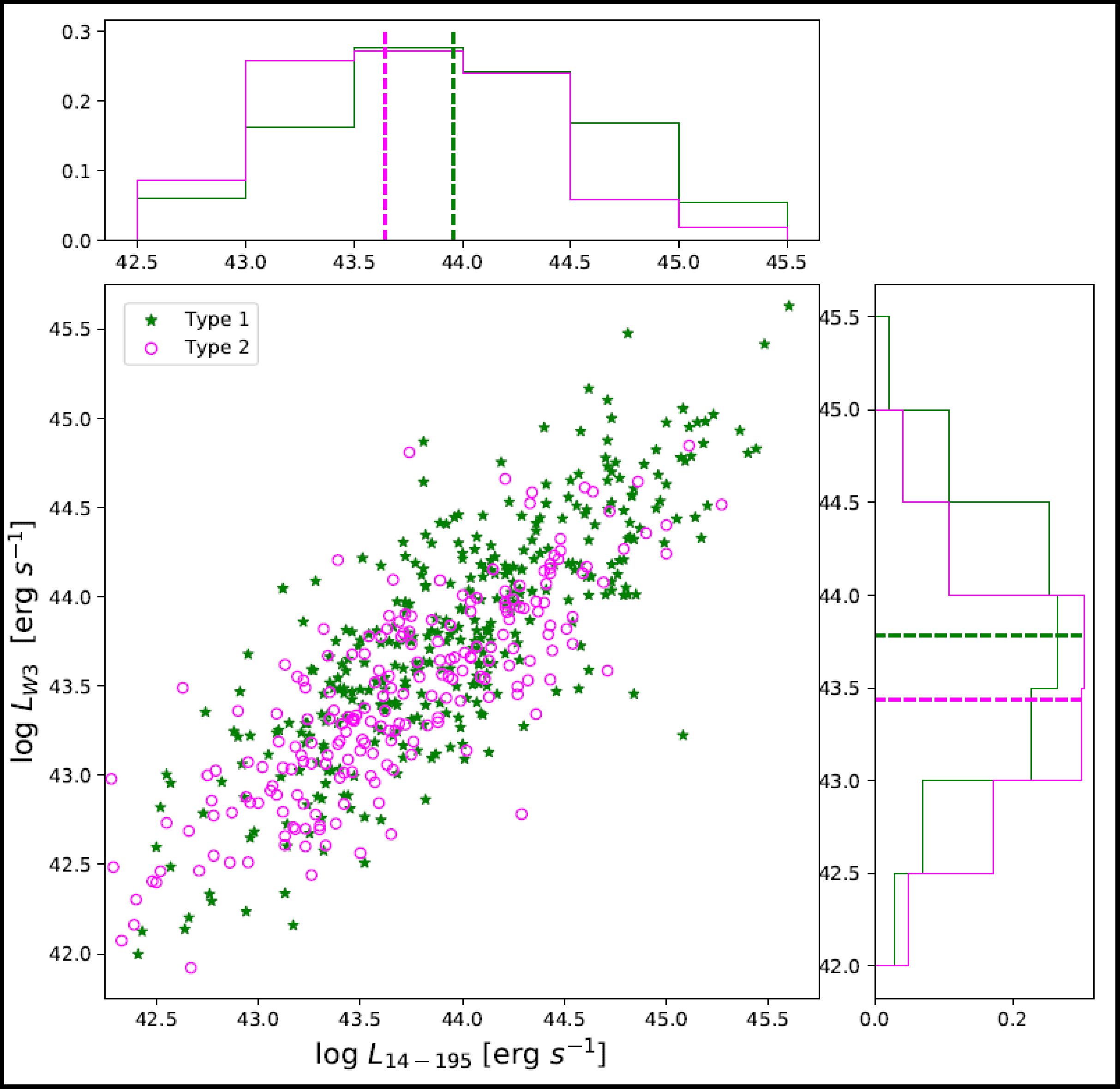
Type 1 and Type 2 AGN



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Selection Summary

Sample Ricci et al. (2017) X-ray spectral parameters for 838 BASS AGN

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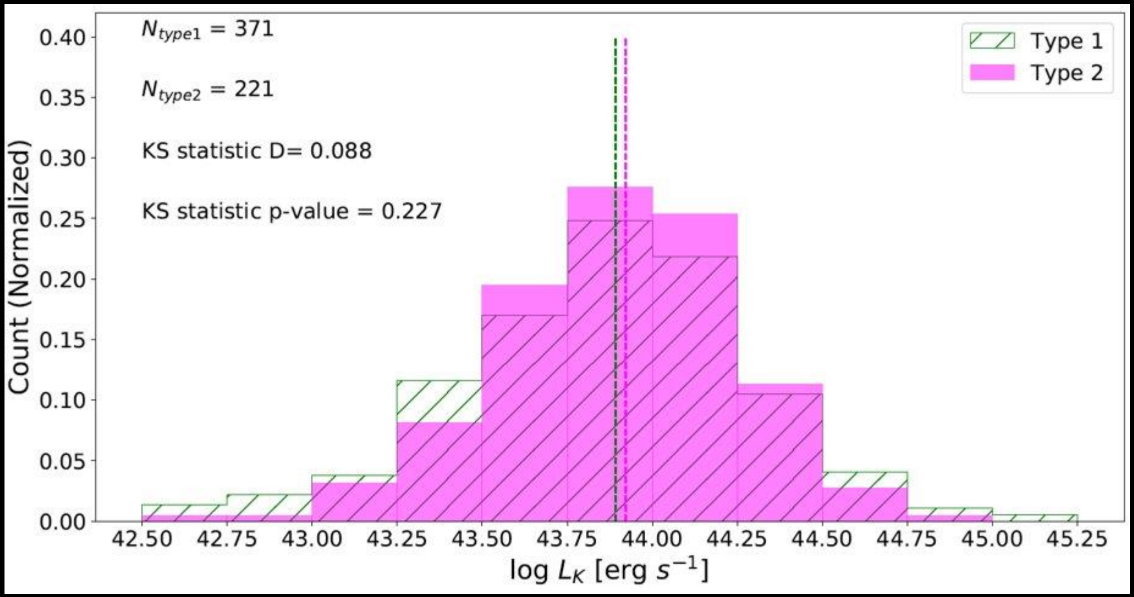
Next step is determining the MBH

M_{BH} determination

- Lack of M_{BH} data in literature
  ~ 50% objects
- Luminosity of galaxy in NIR to calculate M_{BH}
- $\log(M_{BH}/M_{\odot}) = -0.37\ (\pm 0.04)\ (M_K + 24) + 8.29\ (\pm 0.08)$
  - Graham (2007)
  - M_K – absolute K band magnitude



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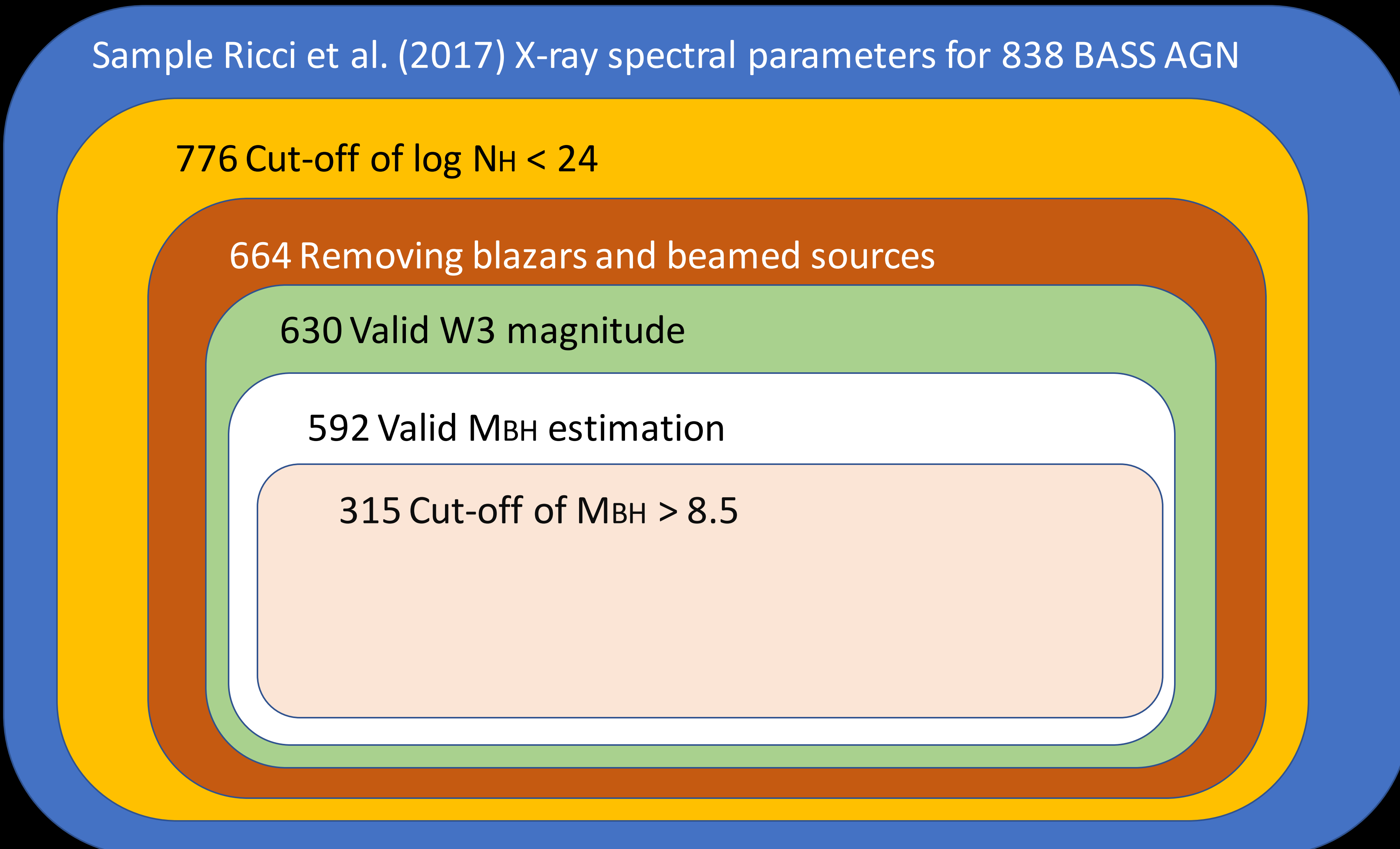

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630 Valid W3 magnitude

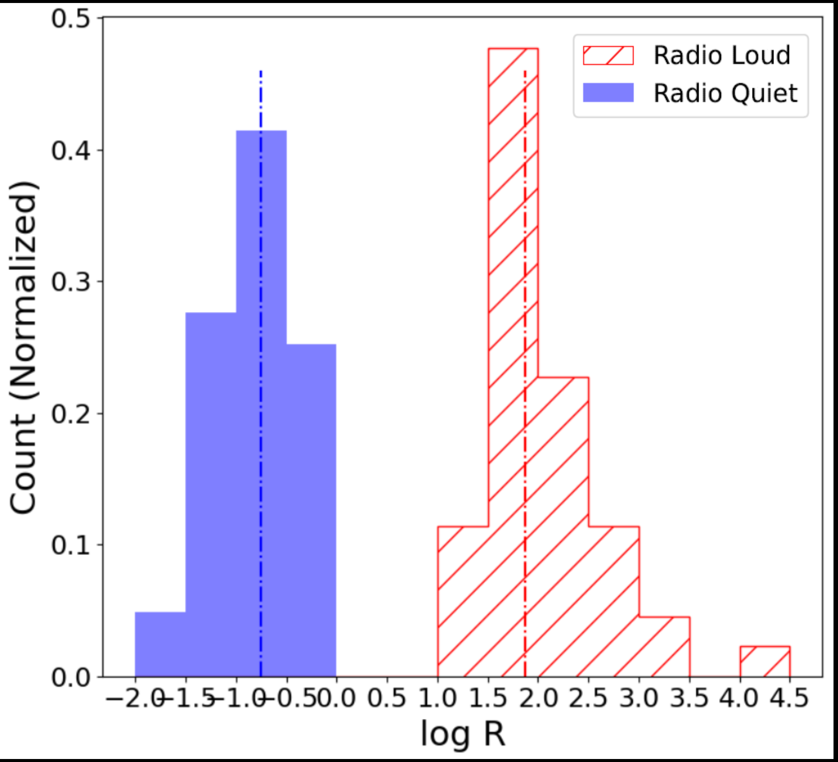
592 Valid M_{BH} estimation

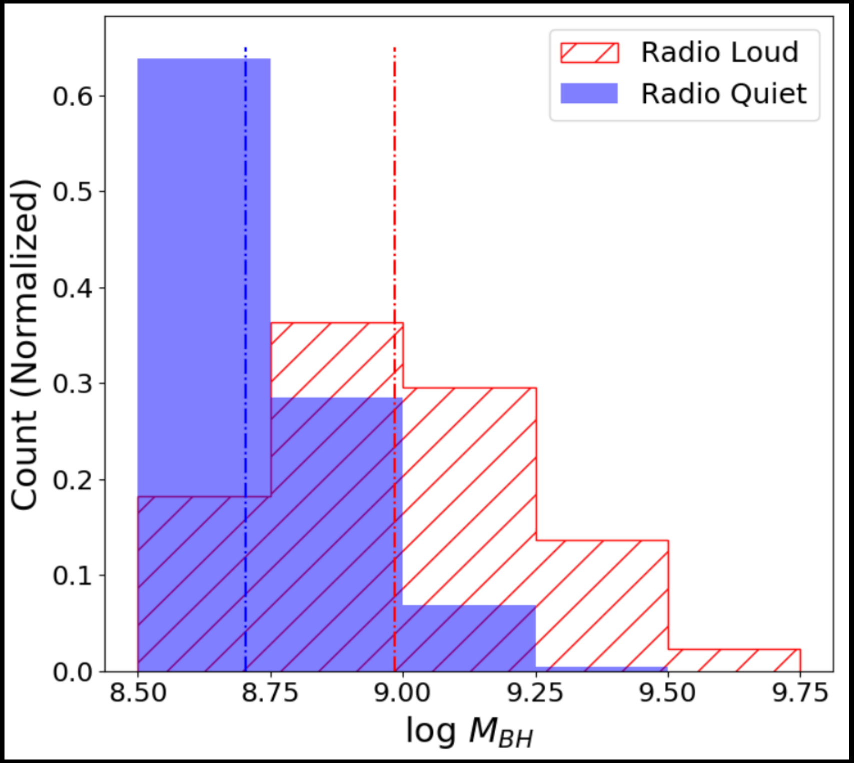
315 Cut-off of M_{BH} > 8.5

290 (44 RL, 246 RQ) after eliminating RI objects

Final Subsample

- 44 RL & 246 RQ
- Population ratio : 1:5





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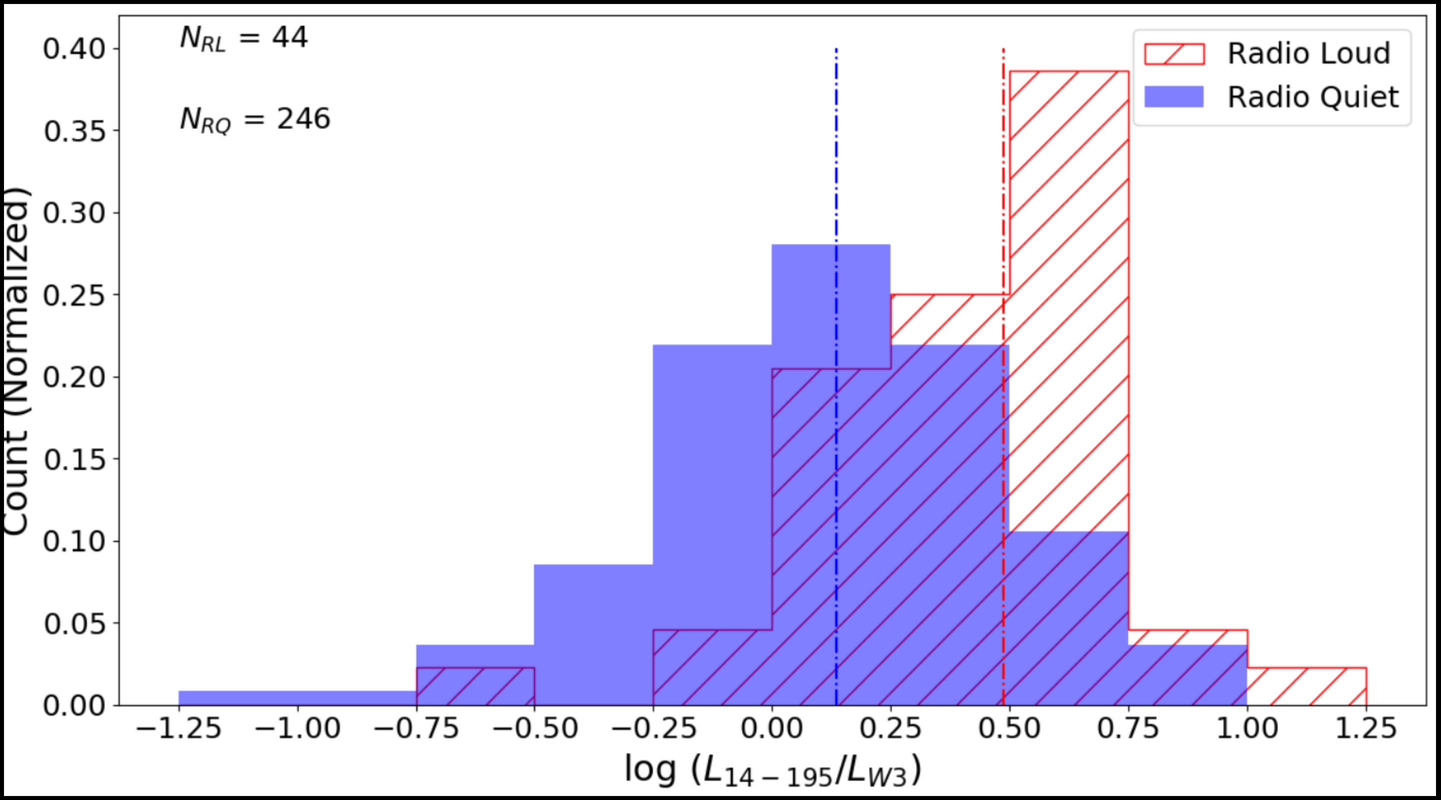
X-Ray Properties Study- X ray Loudness

- Comparing with previous studies
- RL 2 times X-ray-louder



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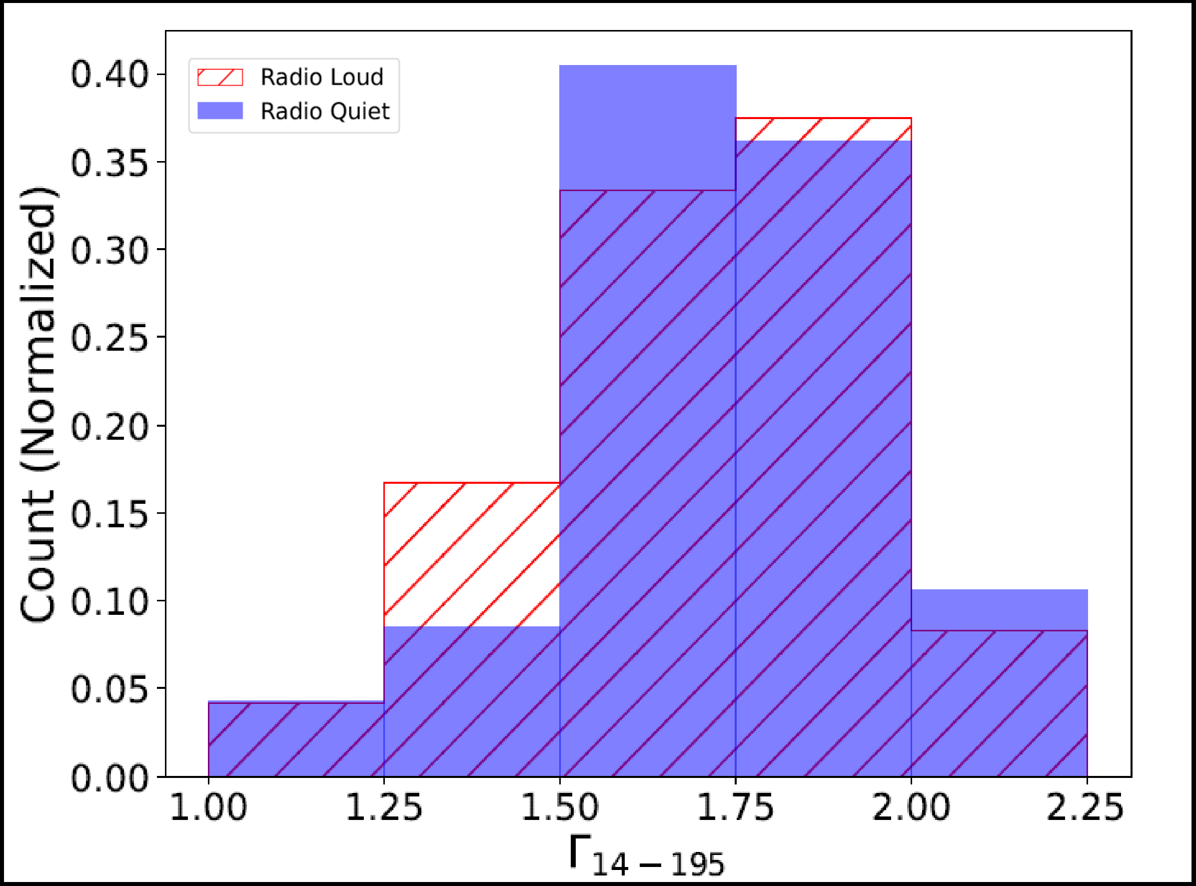
X-Ray Properties Study – Spectral Slope

- Comparing with previous studies
- Significant overlap
- Similar underlying mechanism in the production of X-rays independent of the radio loudness value.



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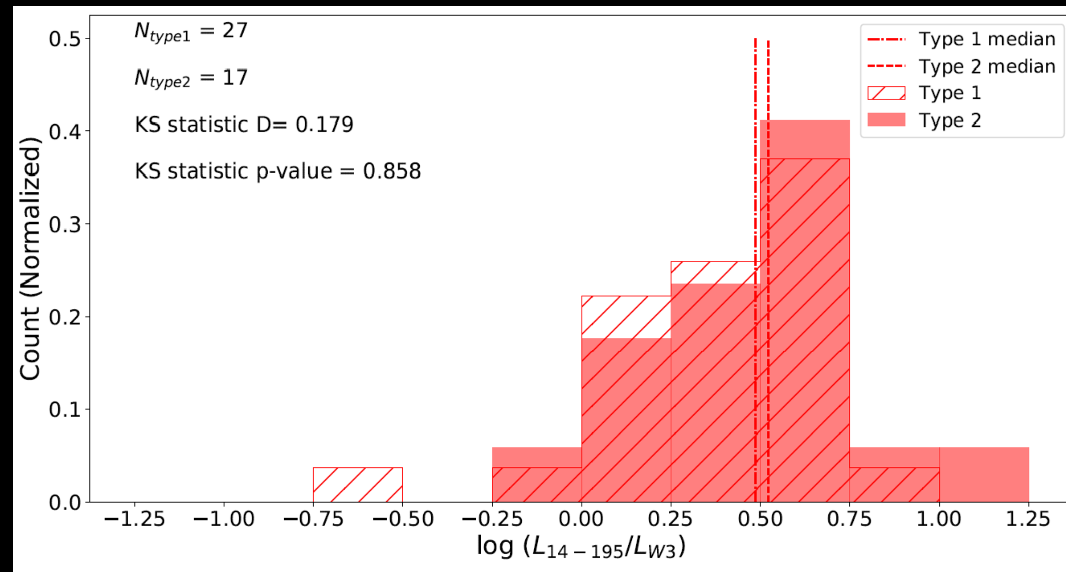
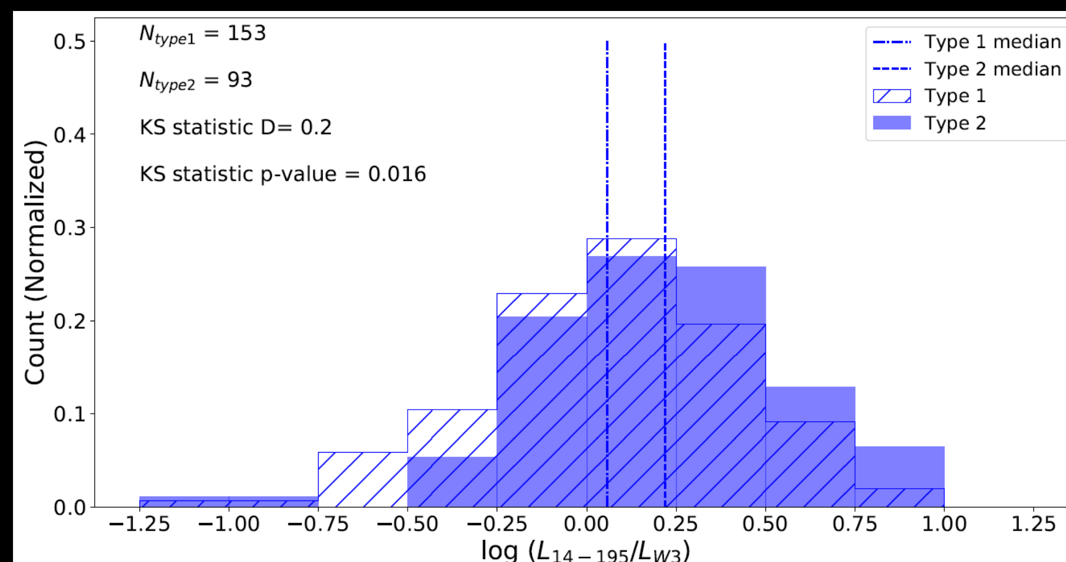
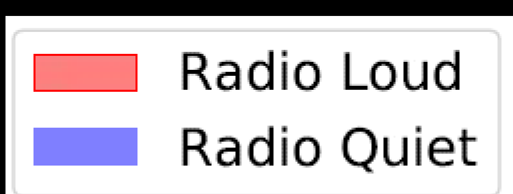
Isotropy of X rays

- Type 1 and Type 2
- No gravitational lensing
- No relativistic boosting
- Isotropic







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Results & Conclusions
The origin of hard X-rays in RQ and RL AGN

We compare X-ray properties of RL AGN with RQ counterparts with similar range of M_{BH} ($10^{8.5} \leq M_{BH} \leq 10^{9.5}$) and λ_E ($0.003 \leq \lambda_E \leq 0.03$)

- X-ray luminosities : RL 2x stronger in HX-ray than RQ. Larger radiative efficiencies of the innermost portions of the accretion flows around faster rotating BHs.

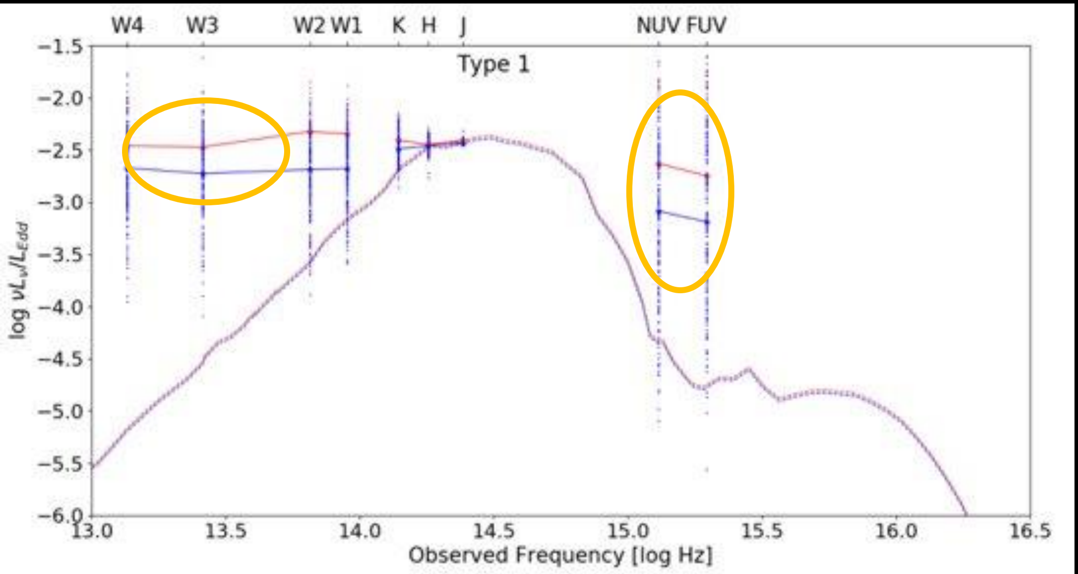
- Similar spectral slopes, high energy breaks and reflection features : similar mechanism and location of production of the HX-rays. Production of very powerful jets does not significantly affect radiative properties of accretion flow, even in the HX-ray band believed to be produced in the innermost portions of accretion flows.

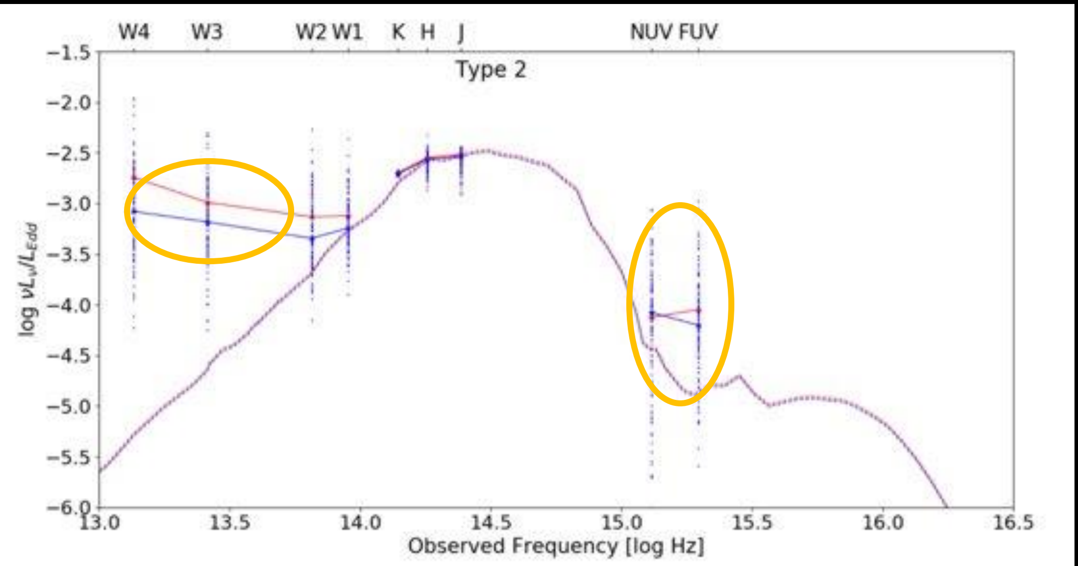
- Isotropy of X-rays : in RL and RQ indicates that HX-ray emission is not very compact. No boosting or gravitational lensing.

- Mechanism : Dominated by comptonization of optical / UV radiation of truncated ‘cold’ accretion disc by hot electrons.

- Region : Central hot and geometrically thick portion of the accretion flow.

UV Luminosity – Polar Dust





- L_{UV} in Type 1 >> Type 2
  - Type 1 AGN - strongly dominated by AGN accretion disks but also have some contribution by hot stars.
  - Type 2 objects – only by hot stars.
- UV radiation of accretion disk reprocessed -> MIR radiation in the tori. One expects L_{MIR} / $L_{O\text{-}UV}$ of the order $CF \approx N_{Type2}/(N_{Type1}+N_{Type2})$ but integrated L_{MIR} exceeds L_{UV} for Type 1 AGN.

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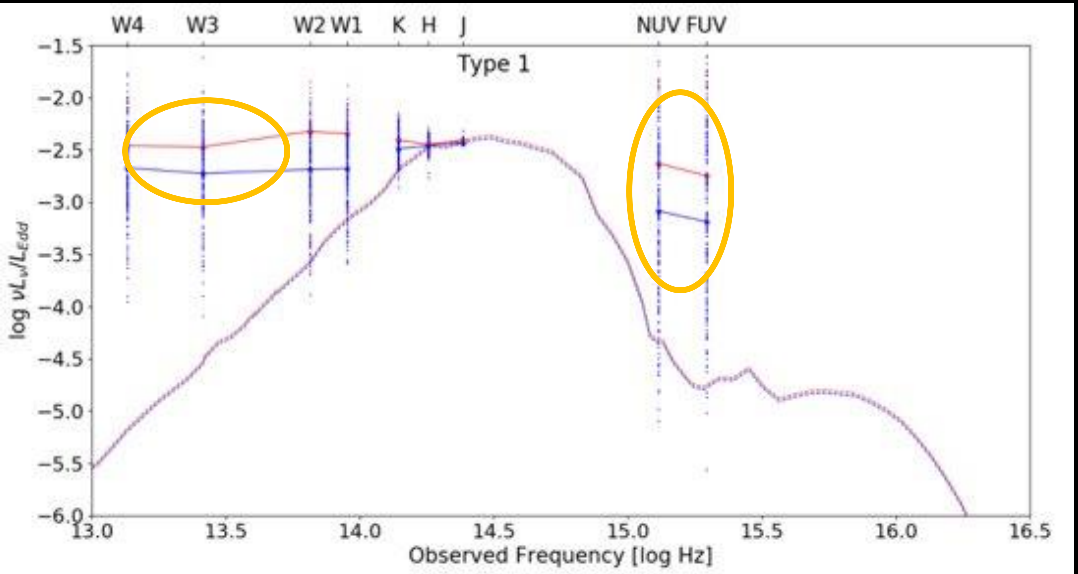
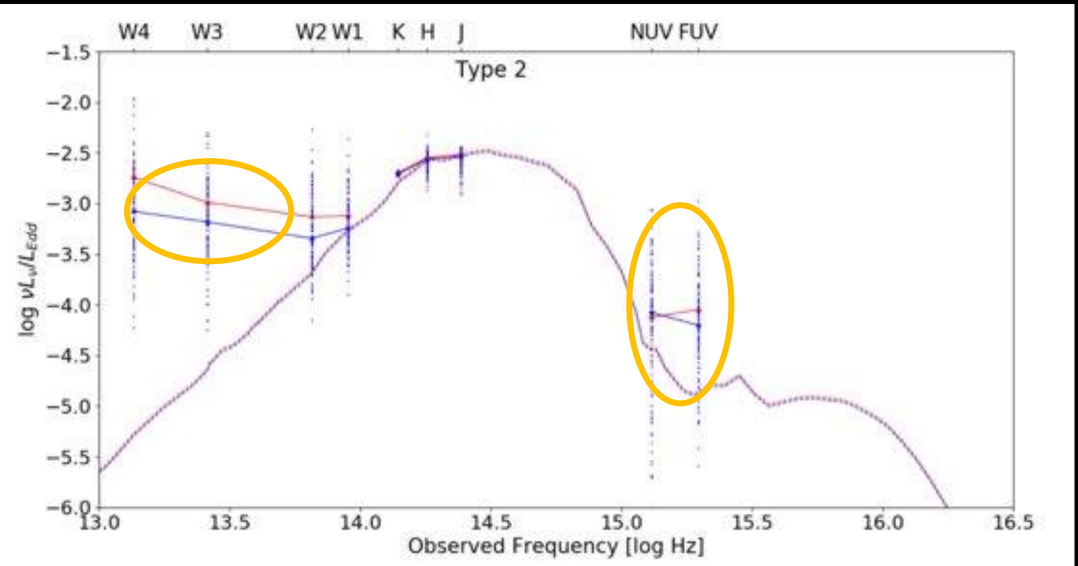


- Strongly implies significant fraction of UV radiation is extincted and reprocessed -> IR radiation by the dust located within the ionization cone.



- Polar dust is theoretically predicted to be common in the AGN accreting at moderate rates, because at such rates the pressure of UV radiation is too small to protect the ionization zone against the dust.

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Take-Home Results

- Hard X-rays are isotropic and are produced in hot central portions of accretion flows. The larger on average X-ray luminosities in RL AGN can be associated with having faster rotating BHs and larger magnetic fluxes in these objects.

- Dominant fraction of UV radiation is extincted and reprocessed into IR radiation by the dust located within the ionization cone.

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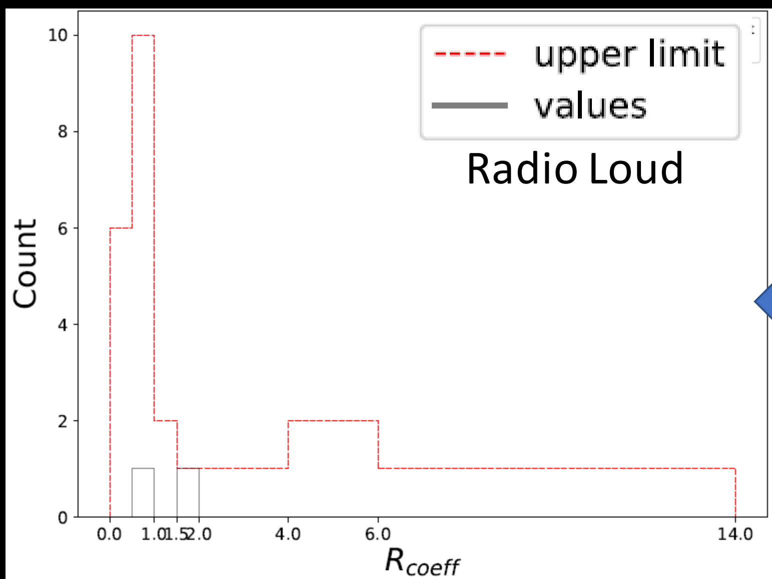
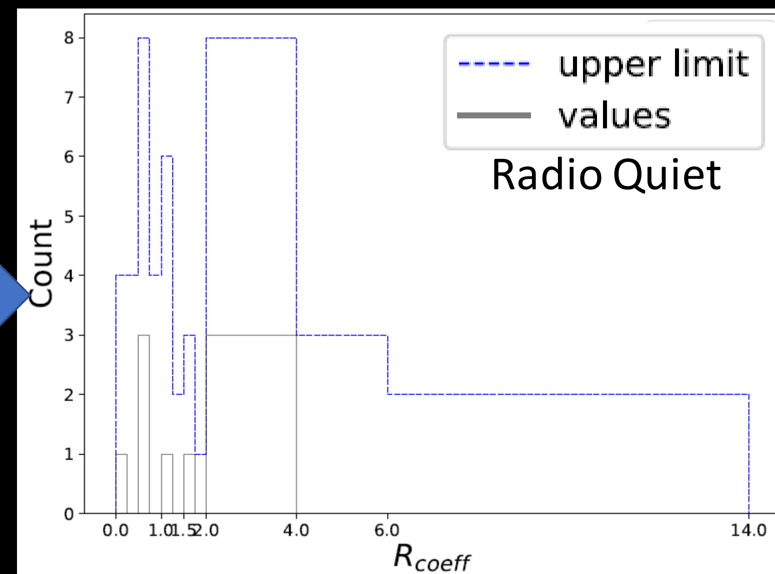
Thank you!

X-Ray Properties Study- Reflection coefficient

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



Similar trend



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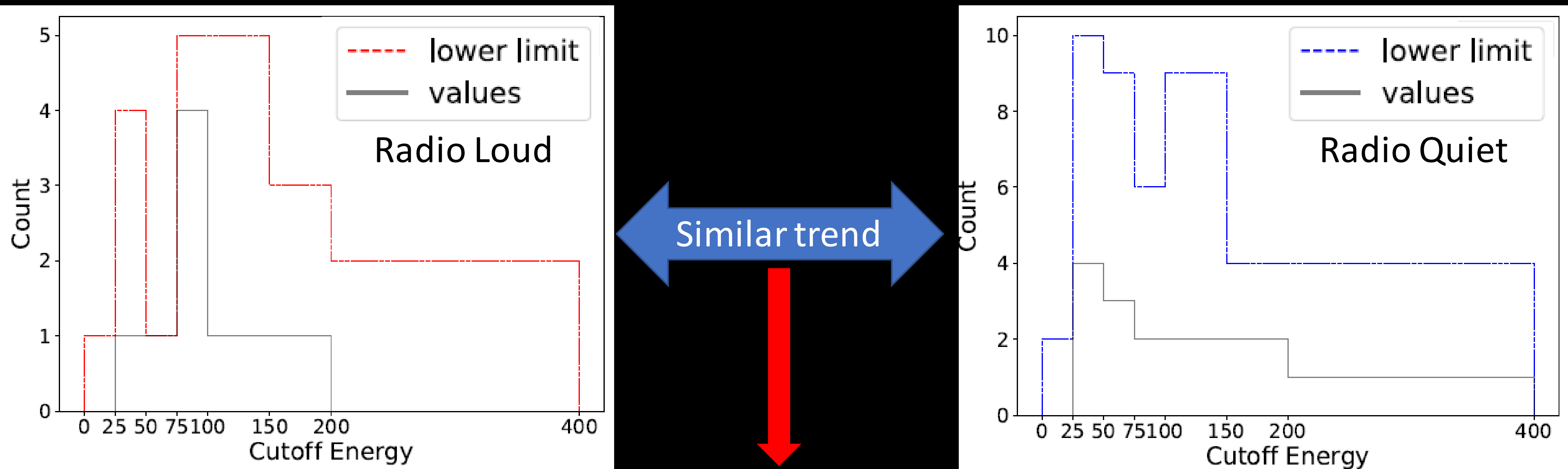
The fraction of hard X-ray intercepted by the cold accretion disk is similar.

X-Ray Properties Study- High Energy Cutoff



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

Mechanism and location of Hard X-ray emission is similar.