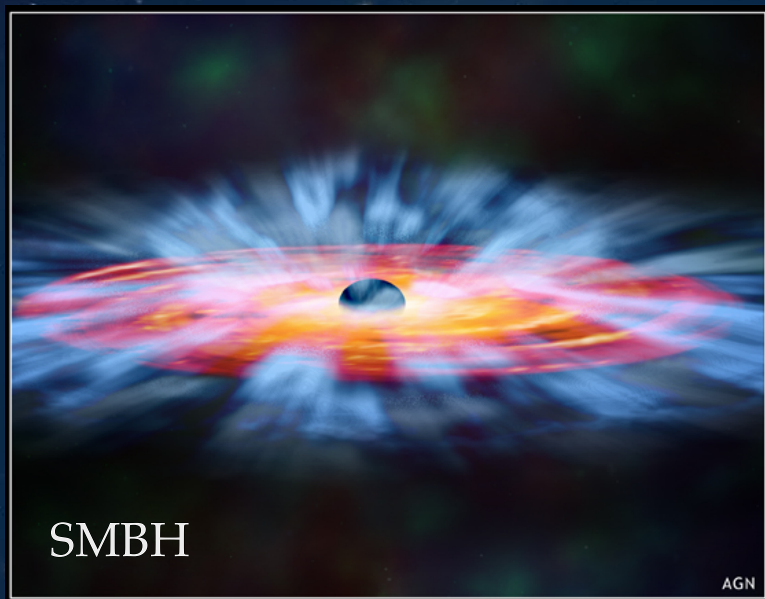
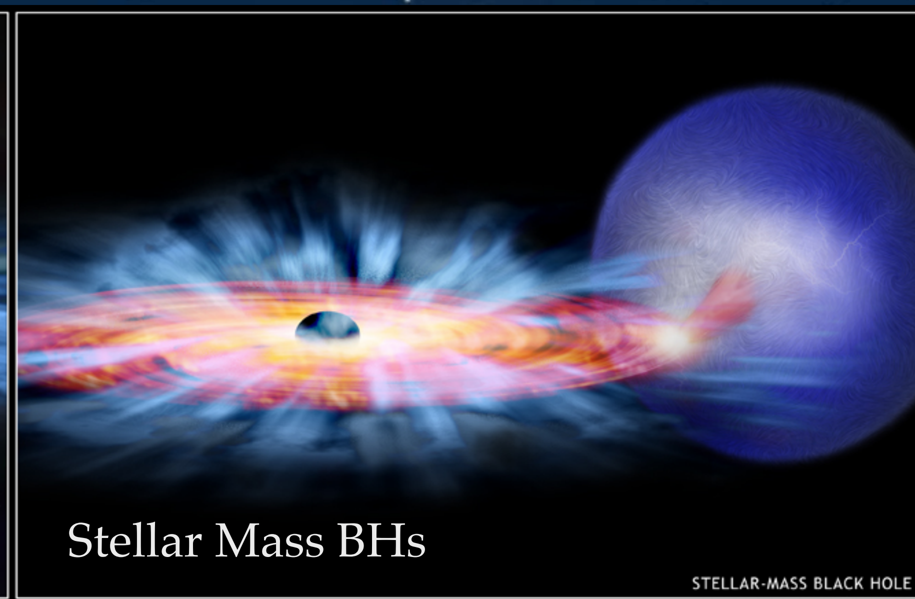
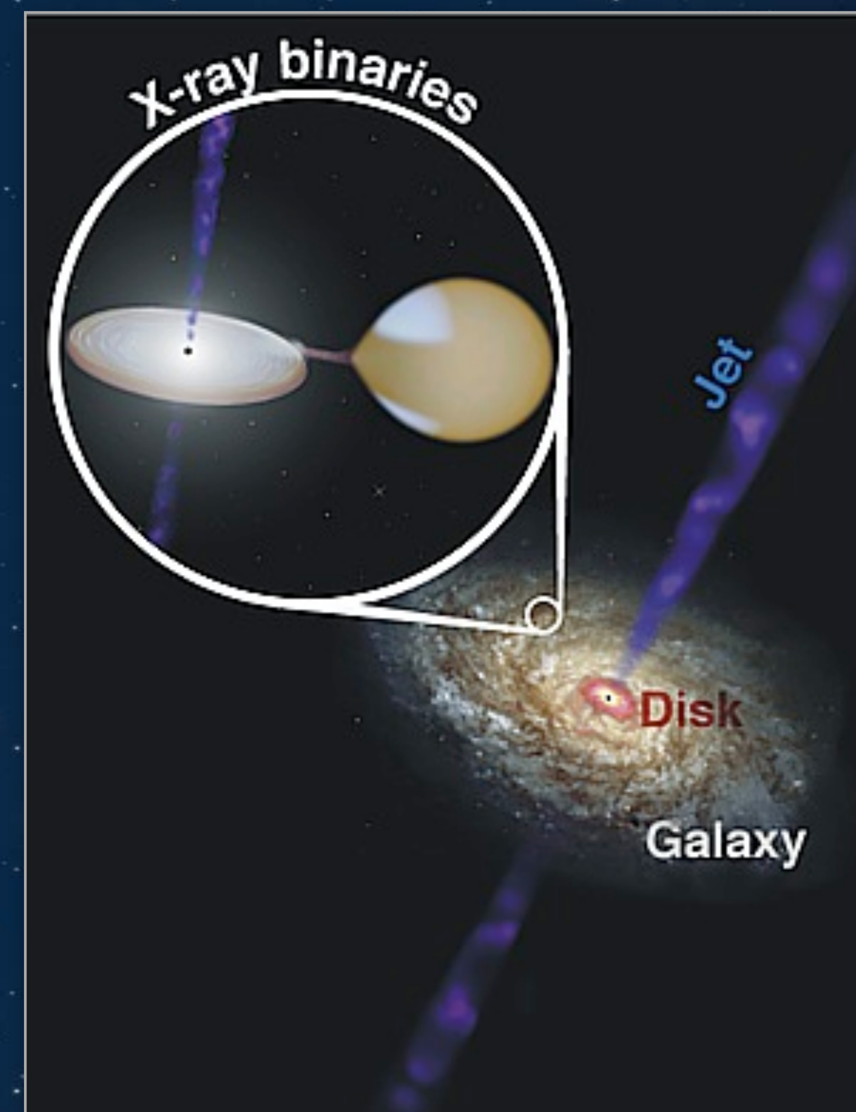
Observational Signatures of Accretion Disk Evolution







Laura Trouille, Ryan Hickox, Dave Alexander
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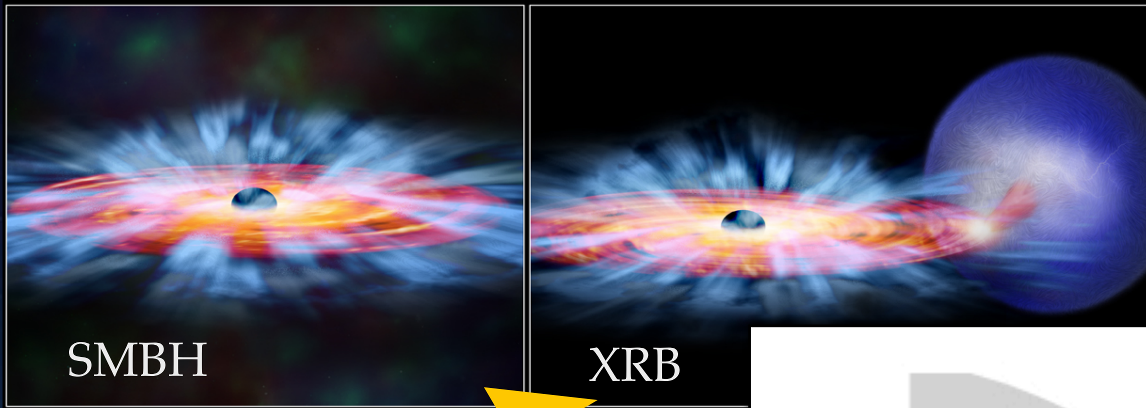
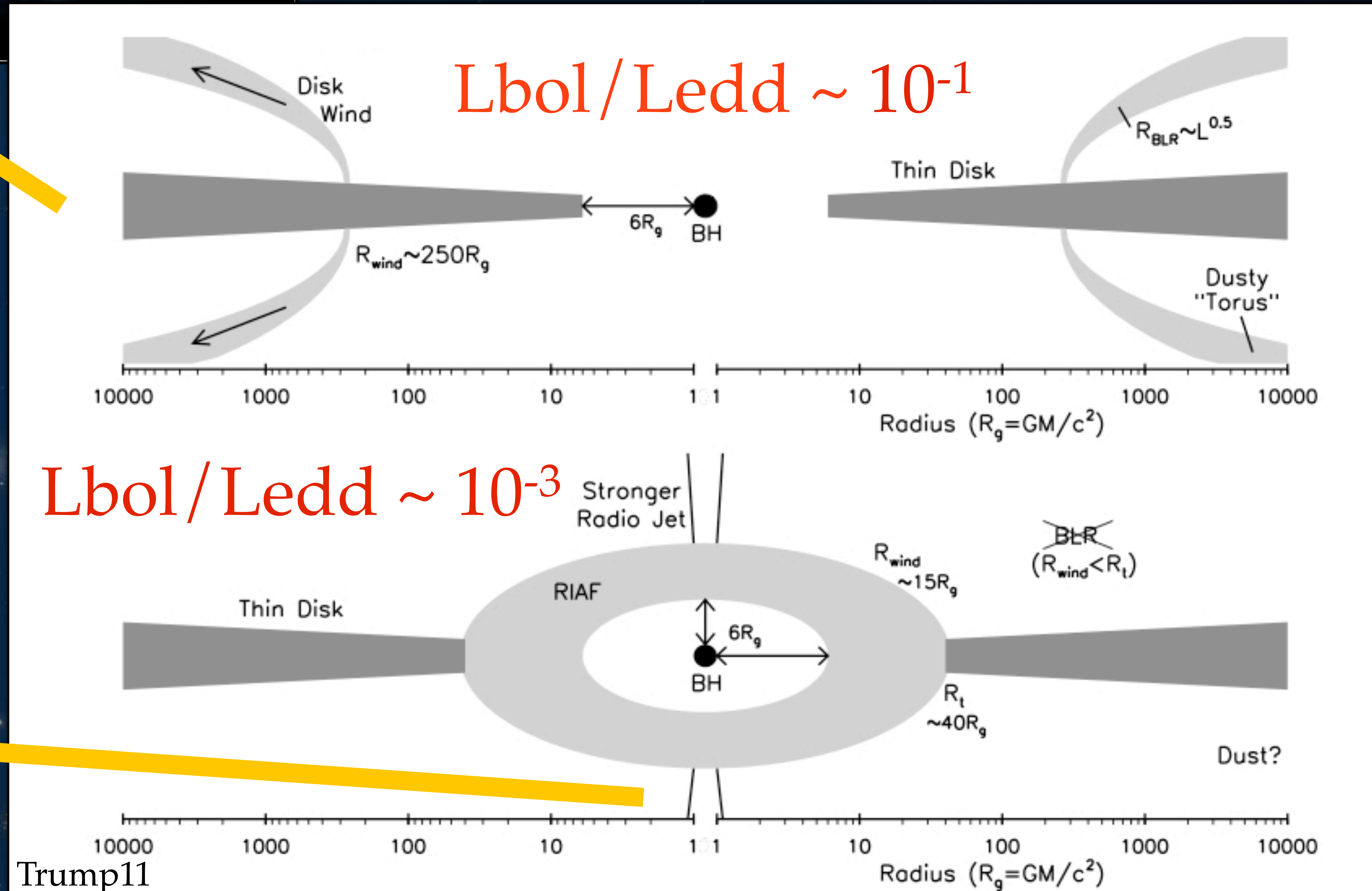
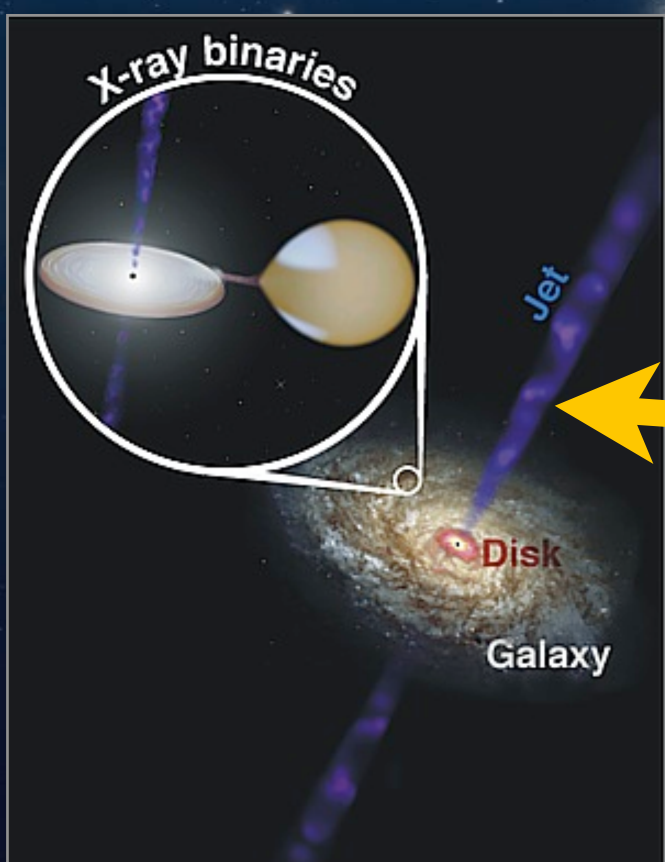
NORTHWESTERN UNIVERSITY
CIERA

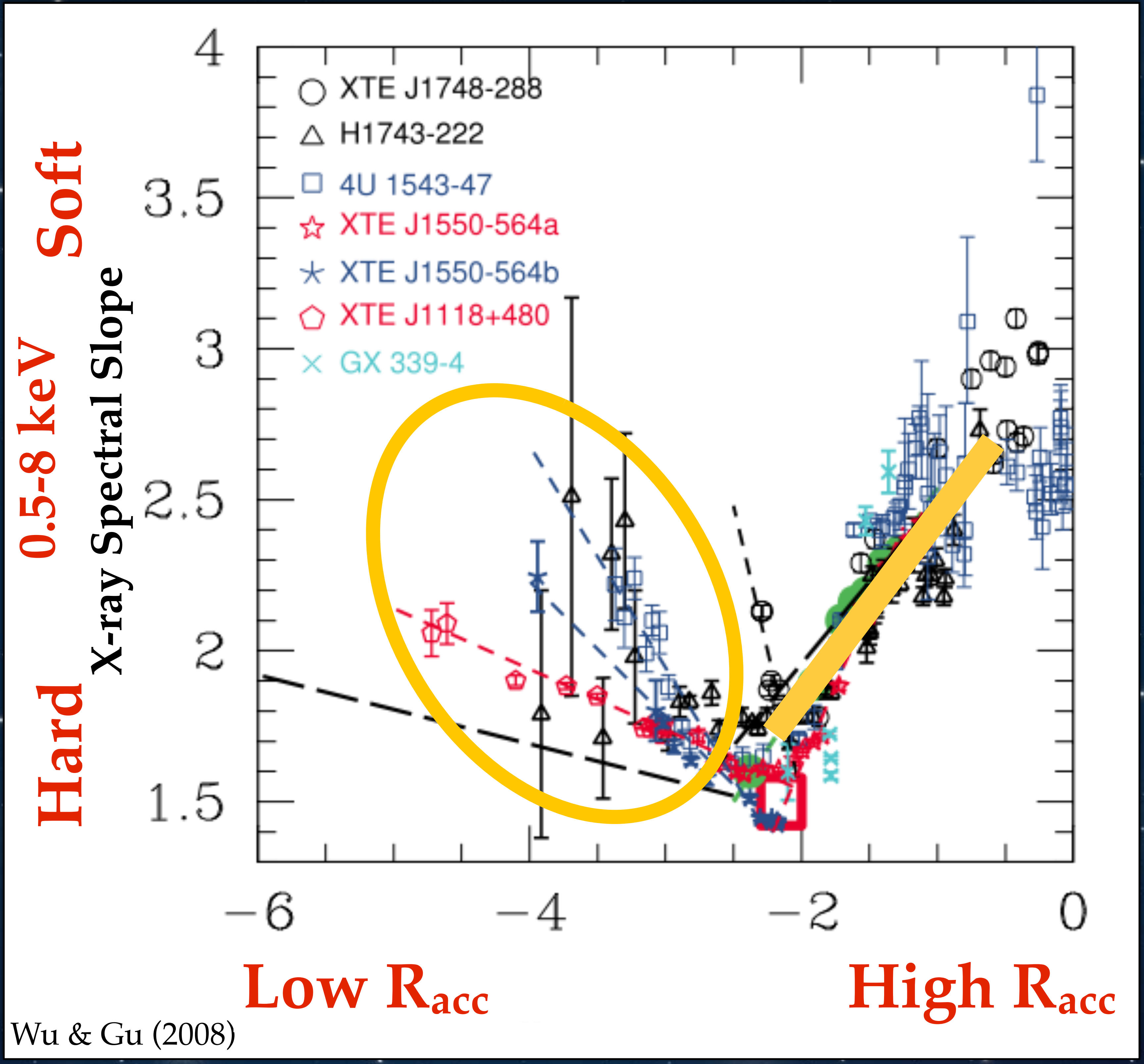






Feedback Changes as the Structure of the Accretion Disk Evolves

Stellar Mass Black Holes: X-ray spectral slope vs. Eddington Ratio



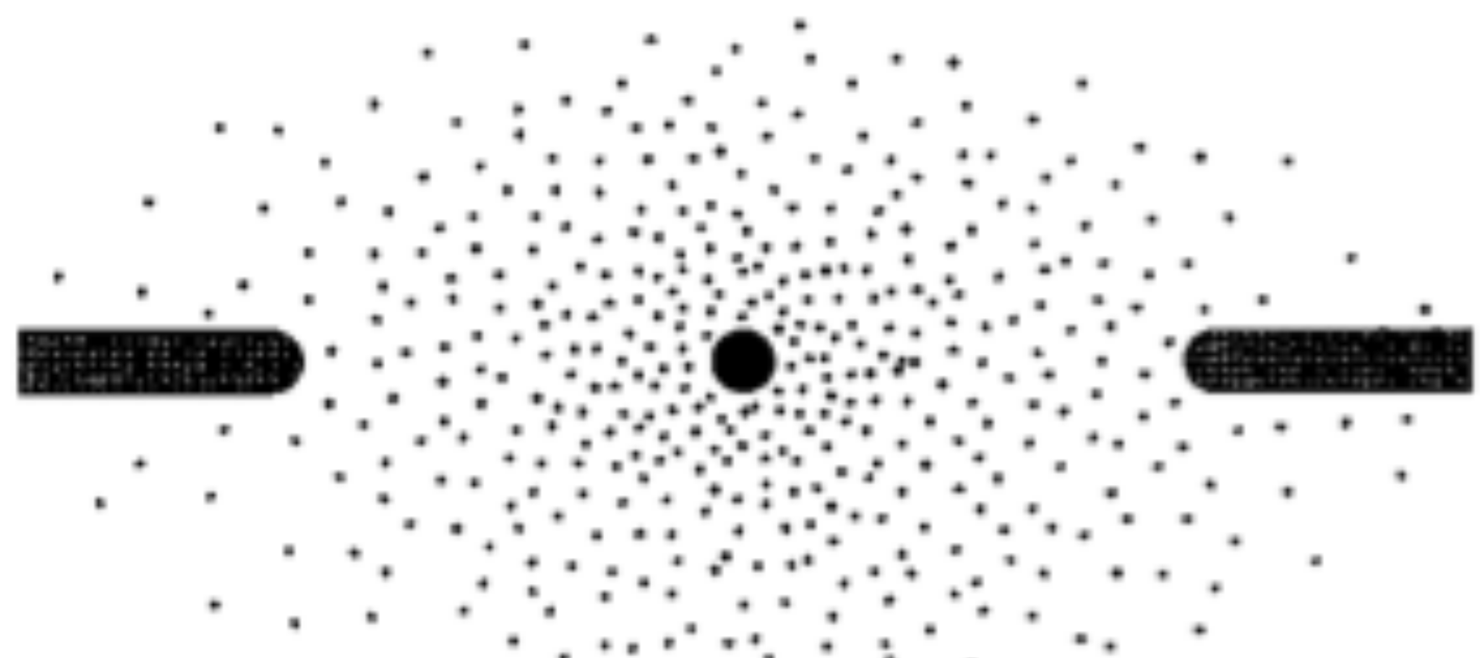
Physical Mechanisms

$L_{bol}/L_{edd} < 10^{-2\,(-3)}$: (radiatively inefficient flow)

(Dominant cooling mech.: Comptonization of synchrotron photons by hot gas)

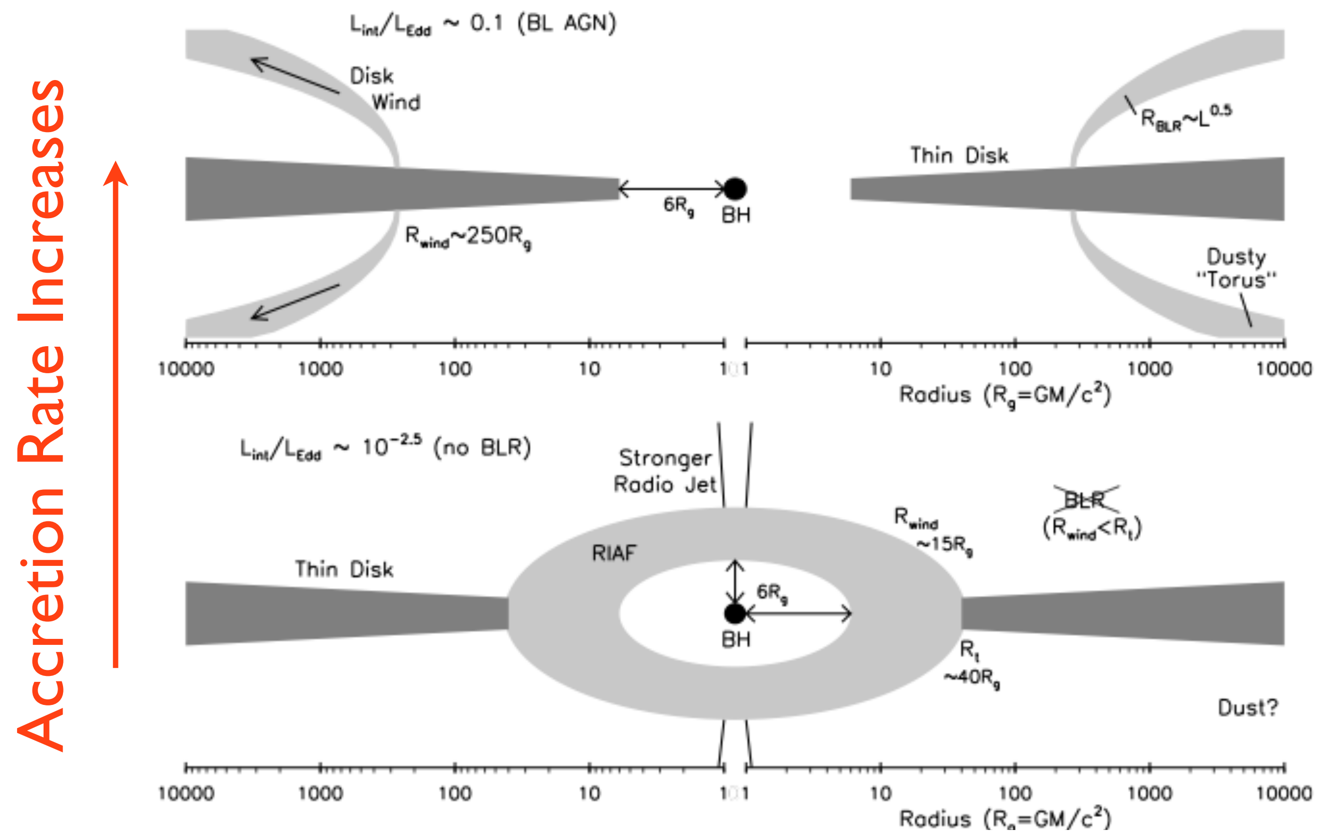
As accretion rate increases

- optical depth of the flow increases
- number of Compton scatterings increases (increasing y-parameter)
- Γ hardens (Esin97, Yuan07, Gu08, Wu08).



Low Accretion Rate (ADAF/RIAF)

Physical Mechanisms



(Dominant cooling mech.: Comptonization of thermal blackbody photons from outer thin disk)

As accretion rate increases

- Transition radius (between outer thin disk & inner RIAF) decreases
- Outer thin disk radiation becomes stronger
- Compton cooling by outer disk photons becomes more efficient
- Electron temperature decreases
- Γ softens/steepens (Wu08).

$L_{bol}/L_{edd} > 10^{-2\,(-3)}$: (standard optically thick disk)

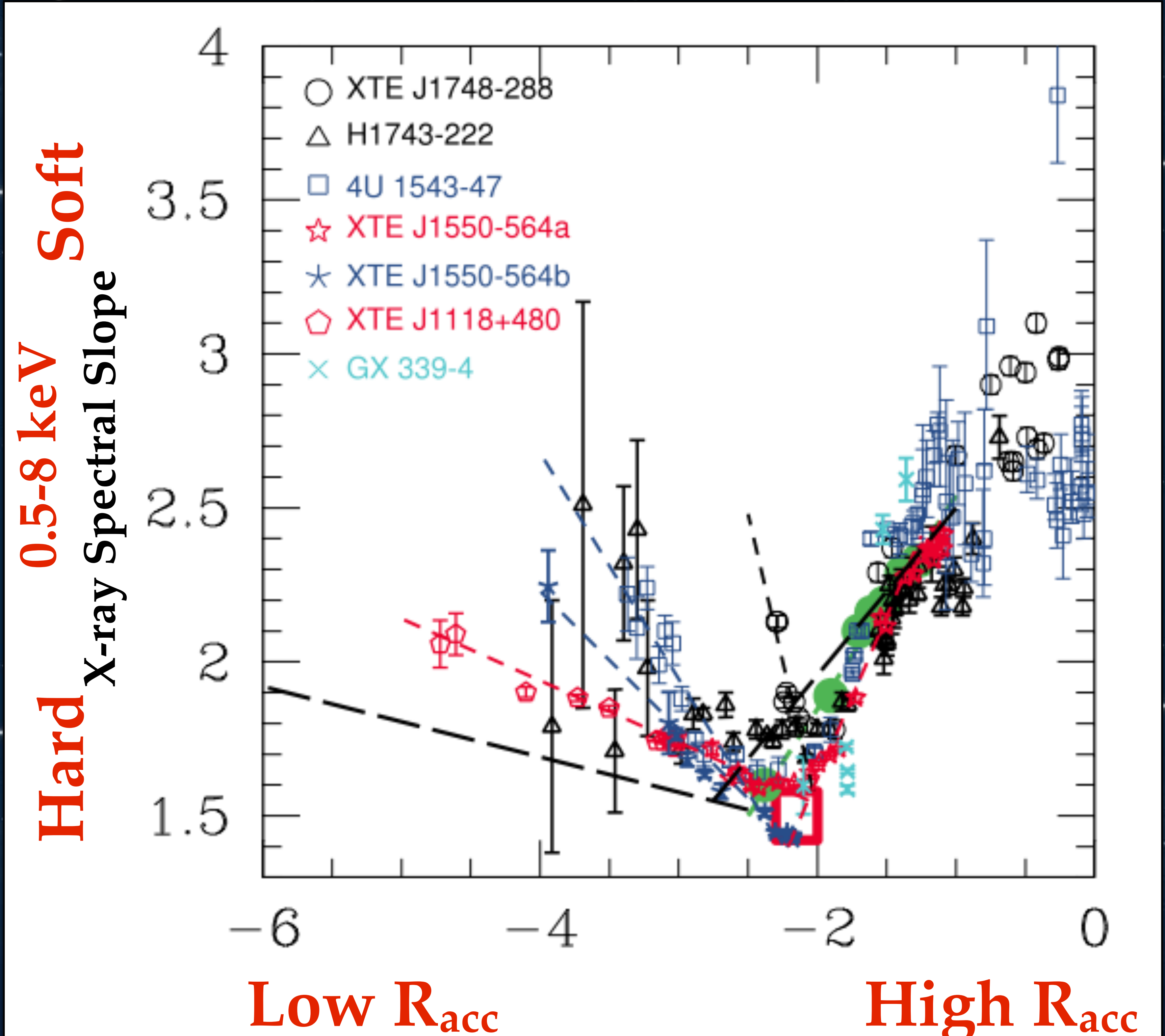
As accretion rate increases

- fraction of accreting energy released to corona decreases (Merloni02, Liu02, Wang04)
- corona becomes weak and shrinks
- optical depth of the corona decreases, reducing y-parameter
- Γ softens/steepens (Wu08).

OR

- disk flux irradiating corona increases
- corona cools more efficiently through Compton cooling
- Γ softens/steepens (Haardt91, Lu99, Wang04, Gu08).

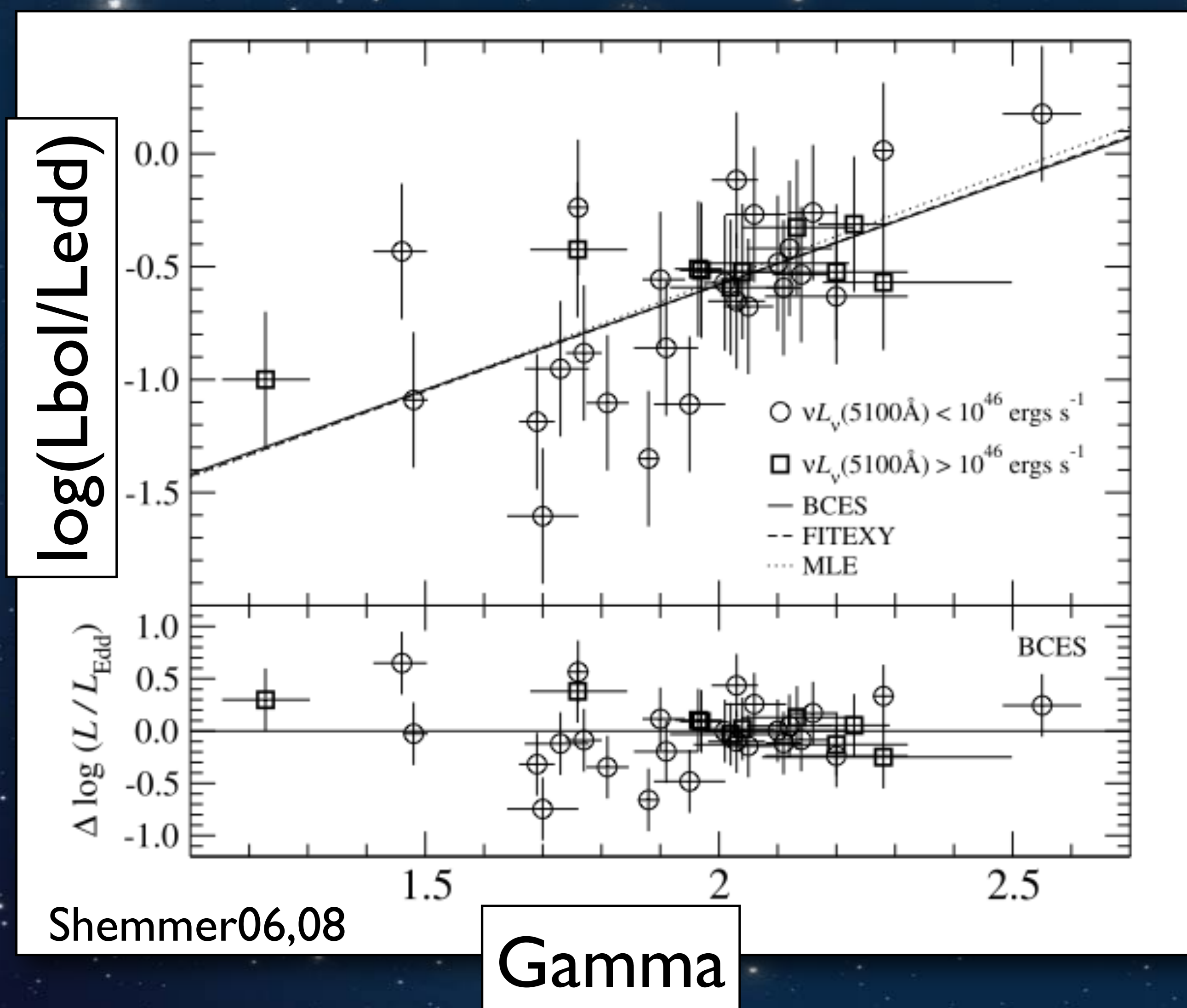
Stellar Mass Black Holes: X-ray spectral slope vs. Eddington Ratio

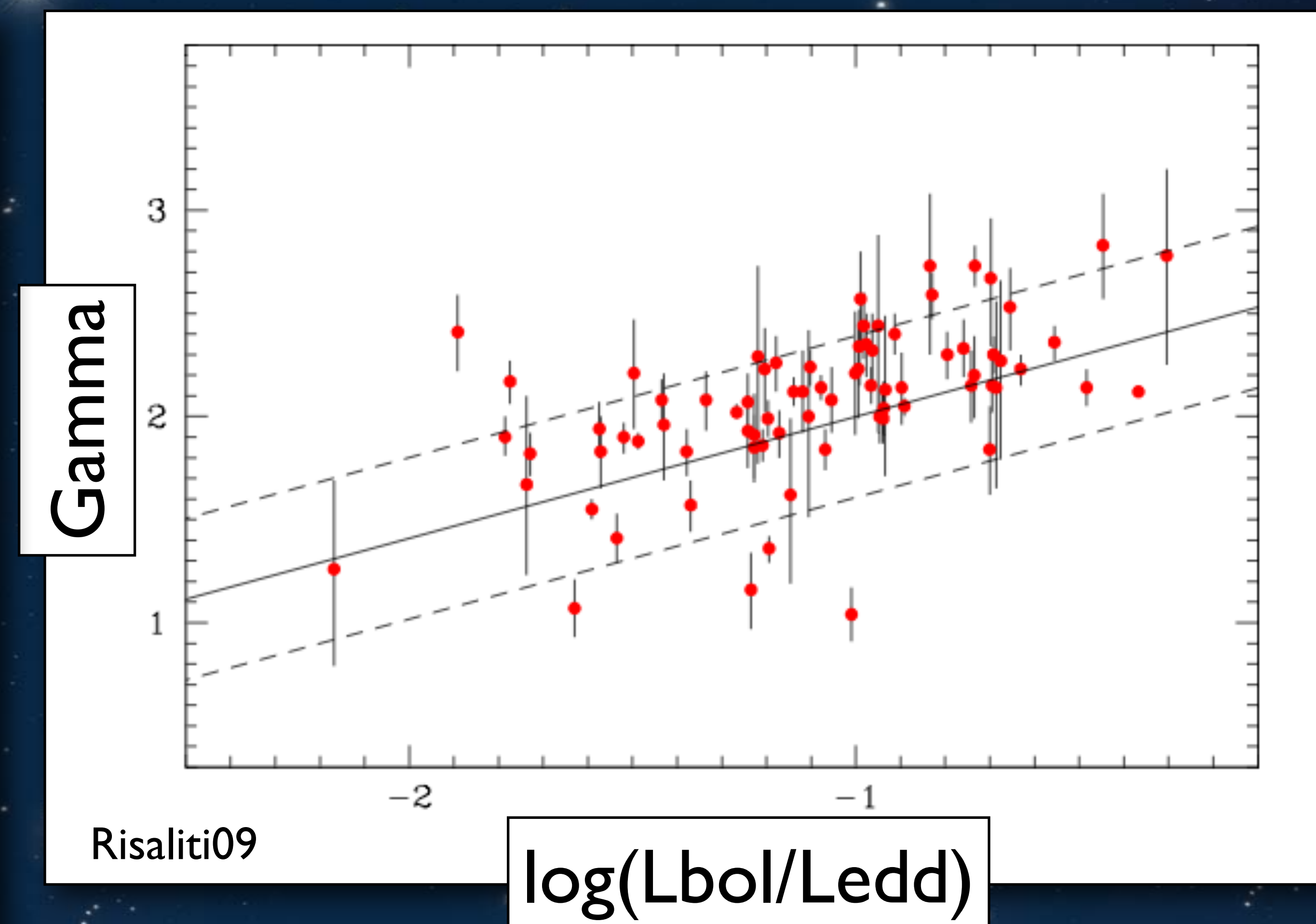


Wu & Gu (2008)

High Accretion Rate AGN:

L_{bol}/L_{Edd} > 10^{-2}: Γ softens with accretion rate

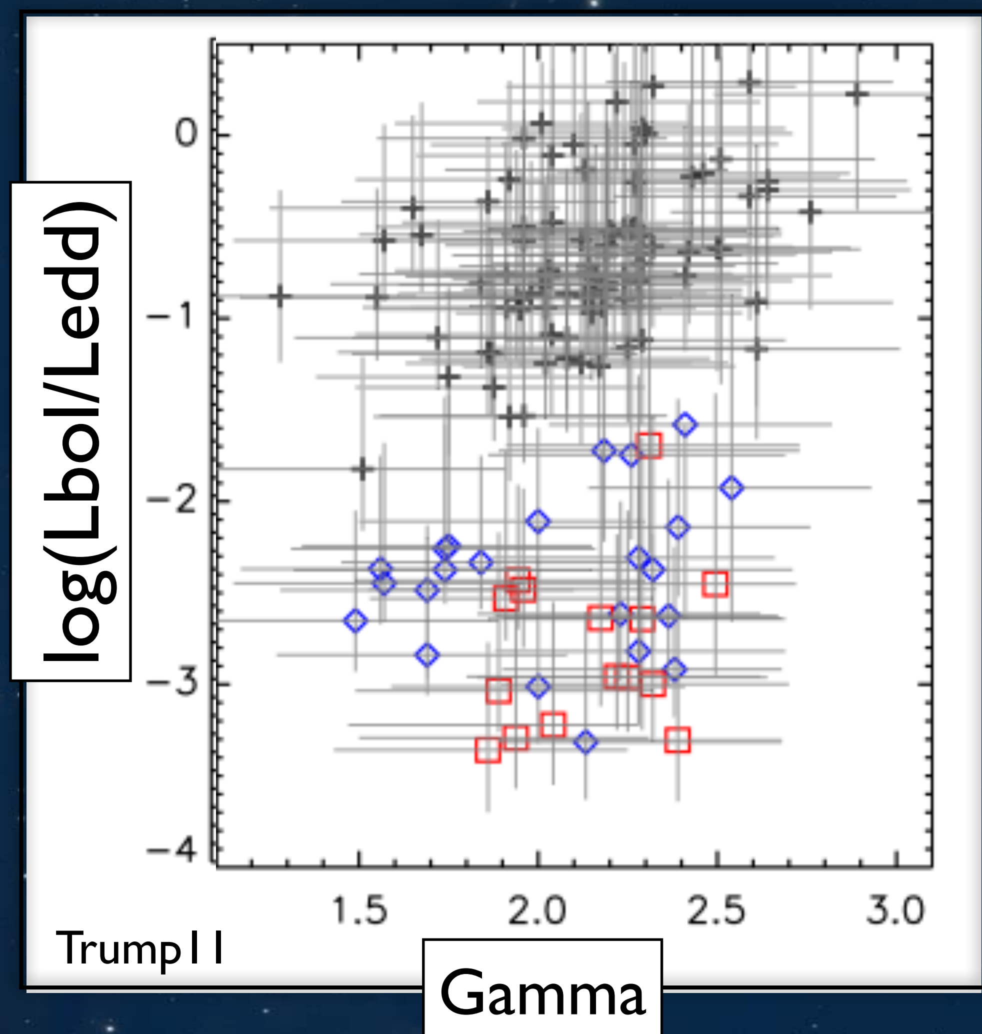


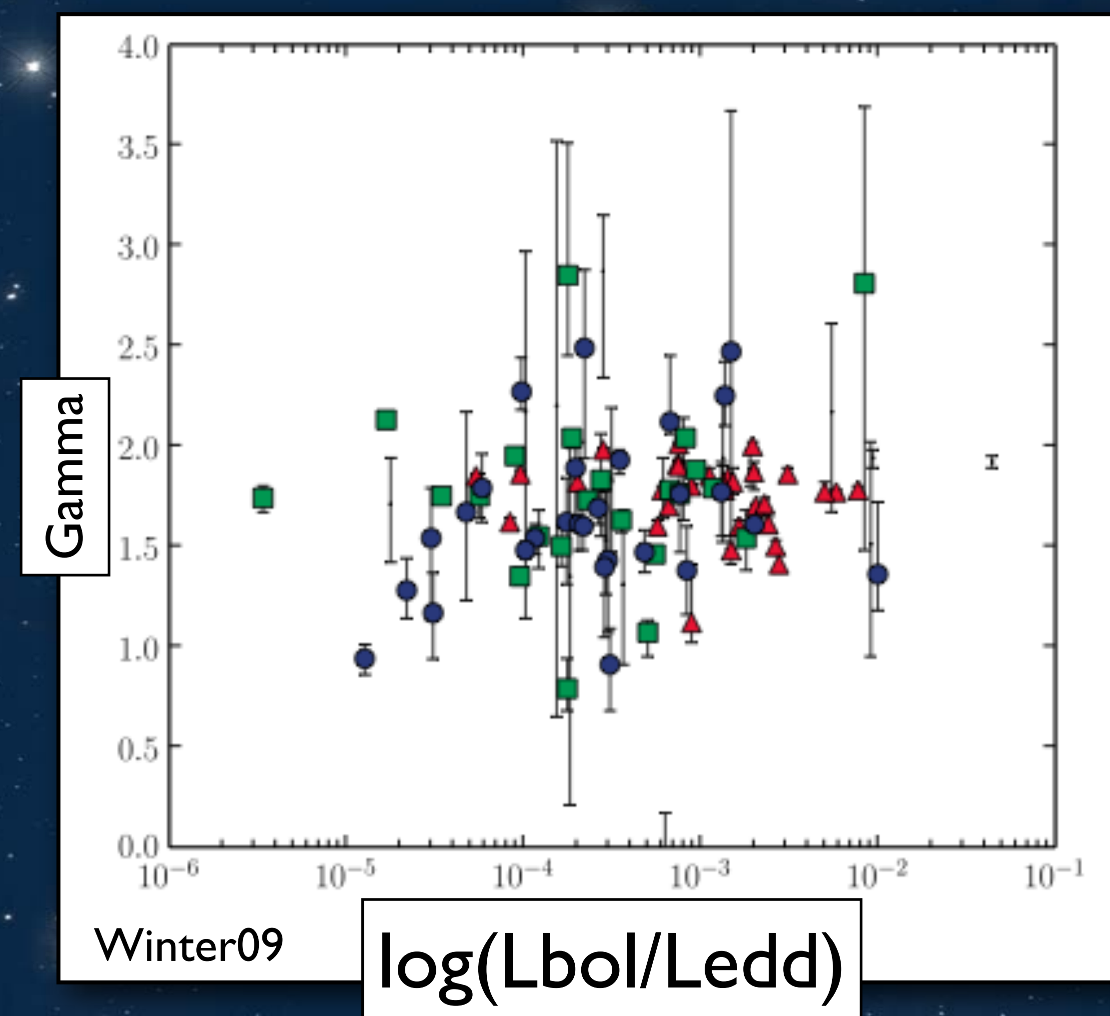


Also see Porquet04, Piconcelli05, Saez08, Kelly08

Lower Accretion Rate AGN:

$L_{bol}/L_{Edd} < 10^{-3}$: Conflicting Results

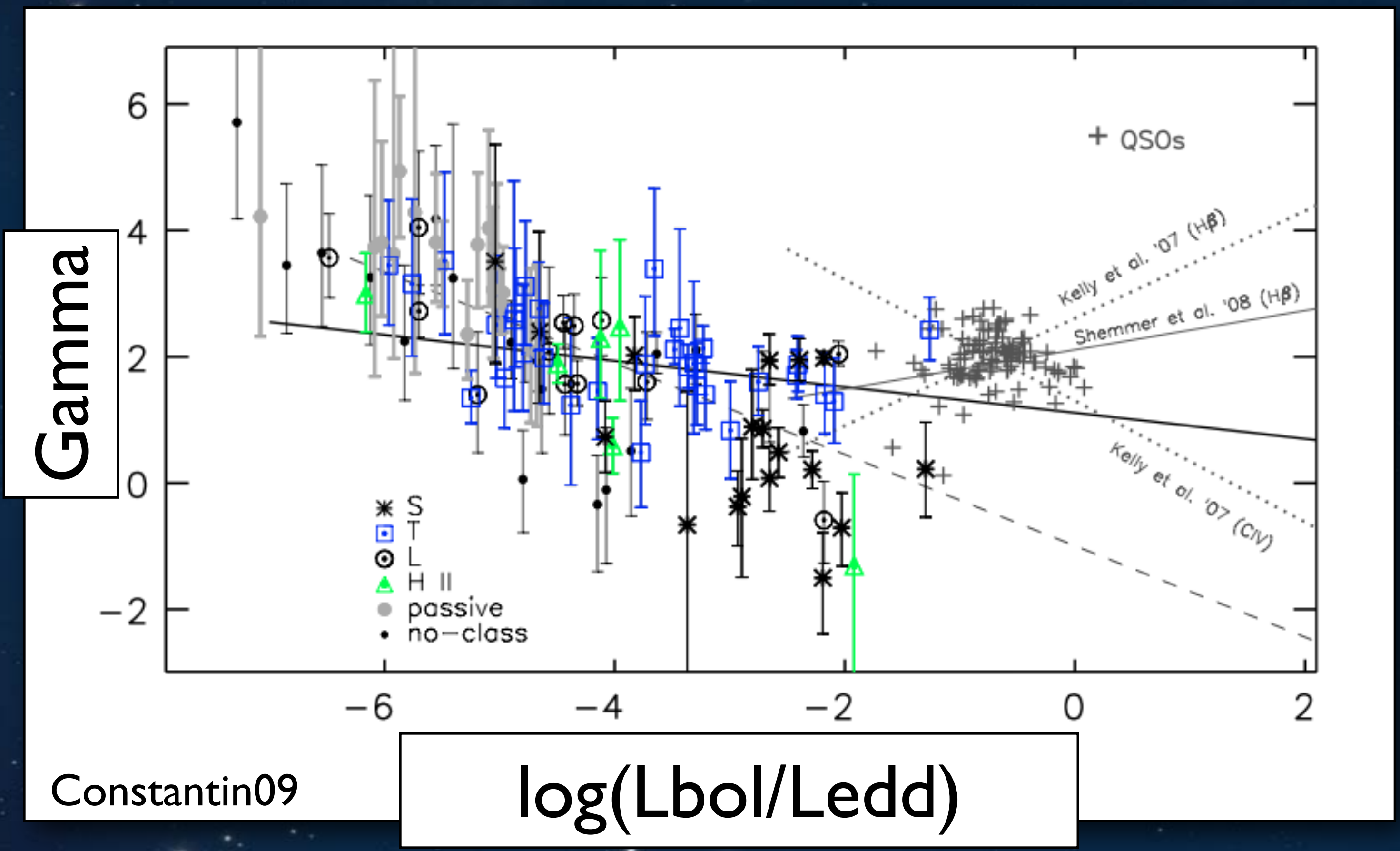


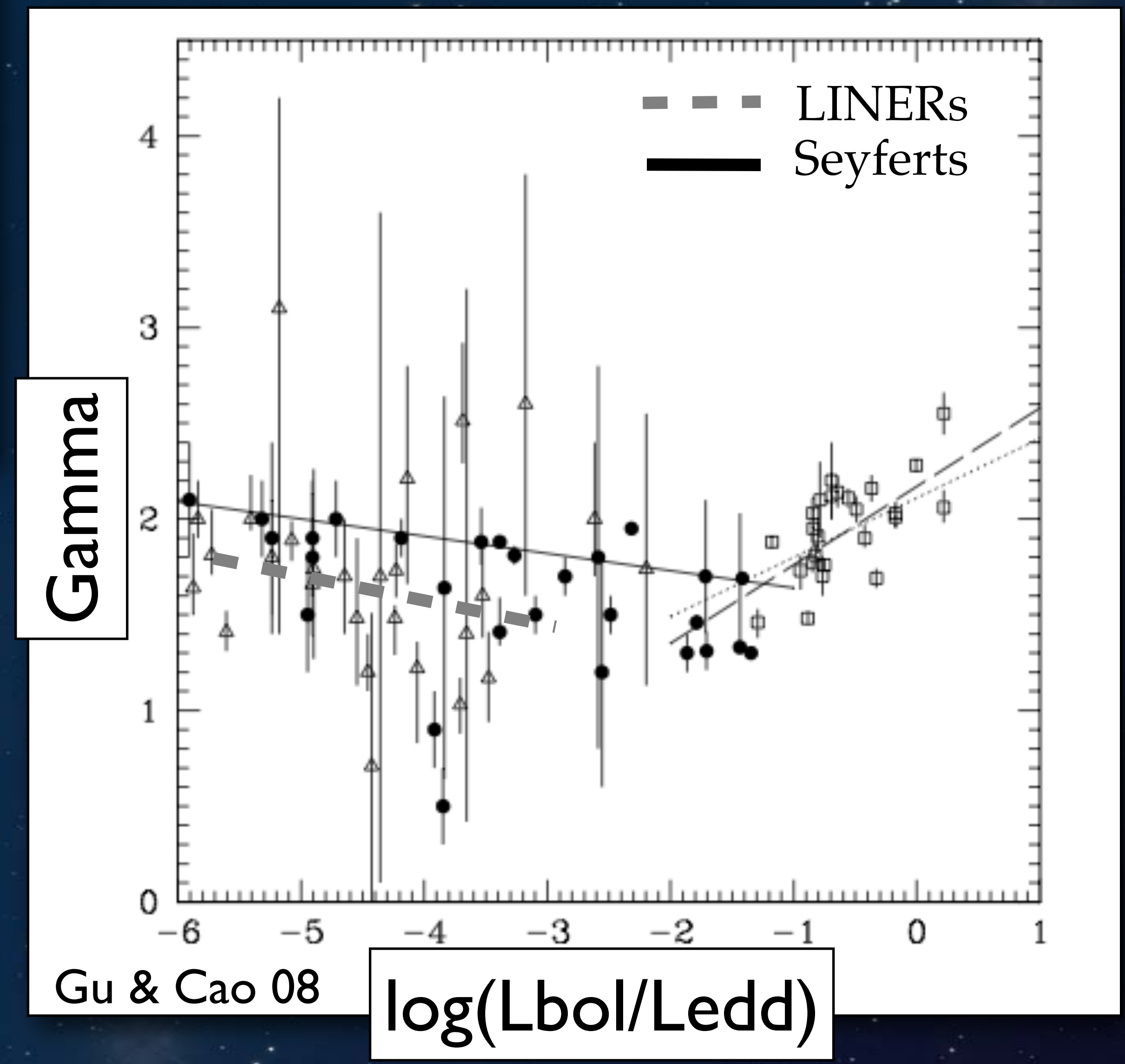


Winter09, Trump11, etc. find no correlation for $L_{bol}/L_{Edd} < 10^{-2}$

Lower Accretion Rate AGN:

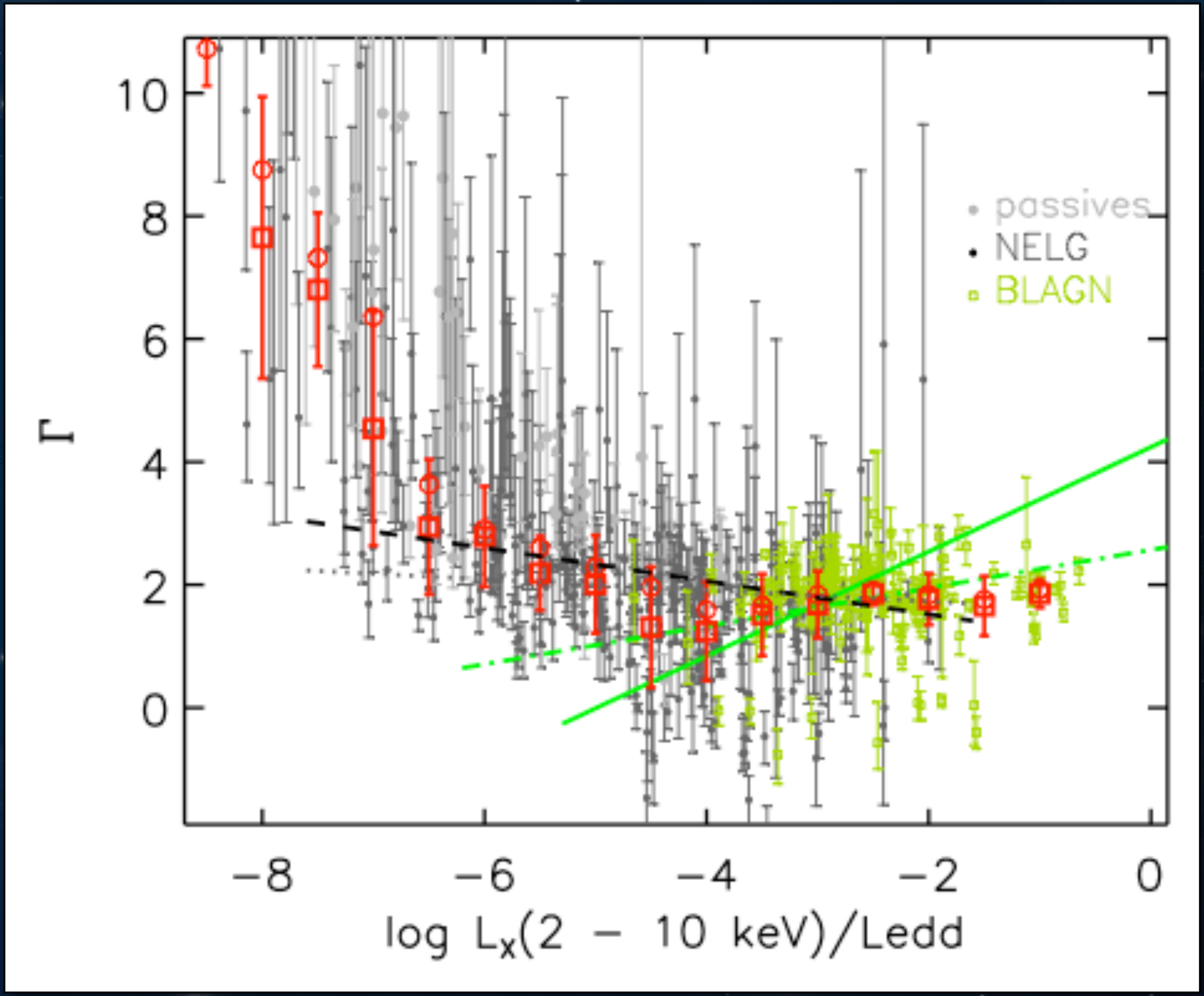
$L_{bol}/L_{Edd} < 10^{-3}$: Conflicting Results



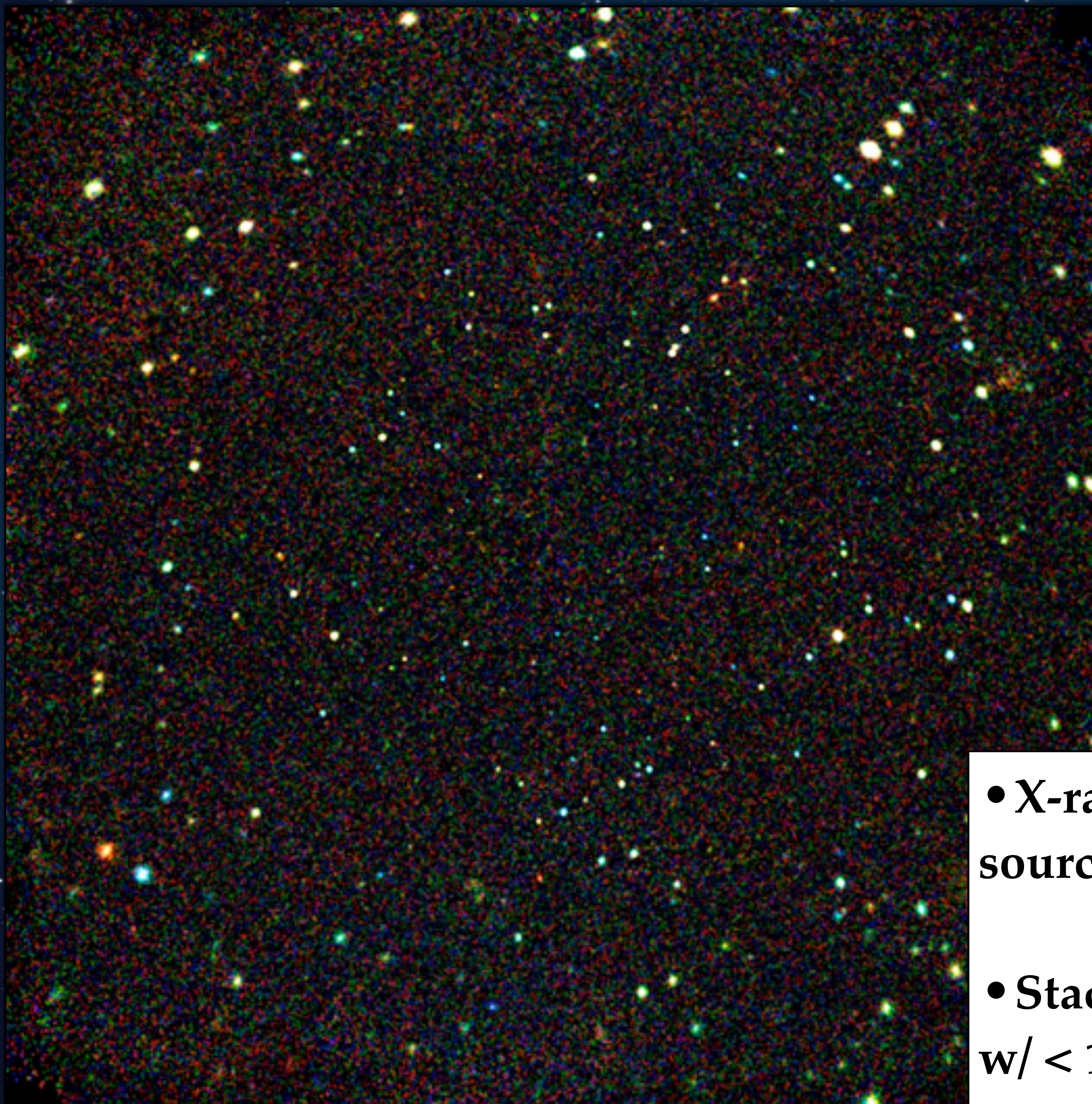


Gu08 & Constantin09,12 see a correlation for $L_{bol}/L_{Edd} < 10^{-3}$

600 ChaMP (SDSS + *Chandra*) Sources
Constantin et al., in prep.



Chandra Deep Field South, 4Ms



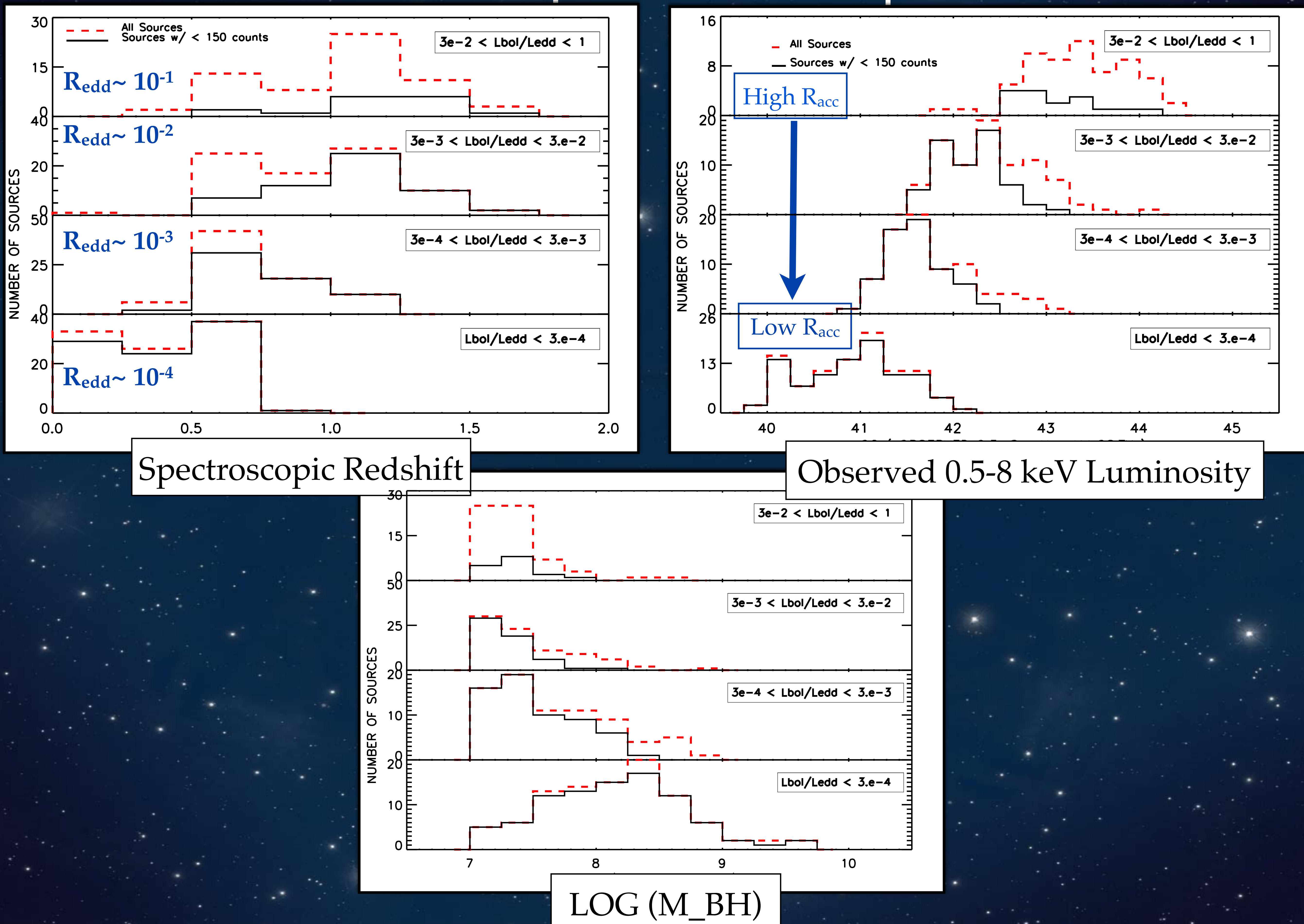
- 740 X-ray sources (Xue11)
- 419 public spec-z

M_{SMBH}:
- 366/419 with $L_{K,\text{rest-frame}}$
- 48/419 with $M_{stellar}$ (Babic07)

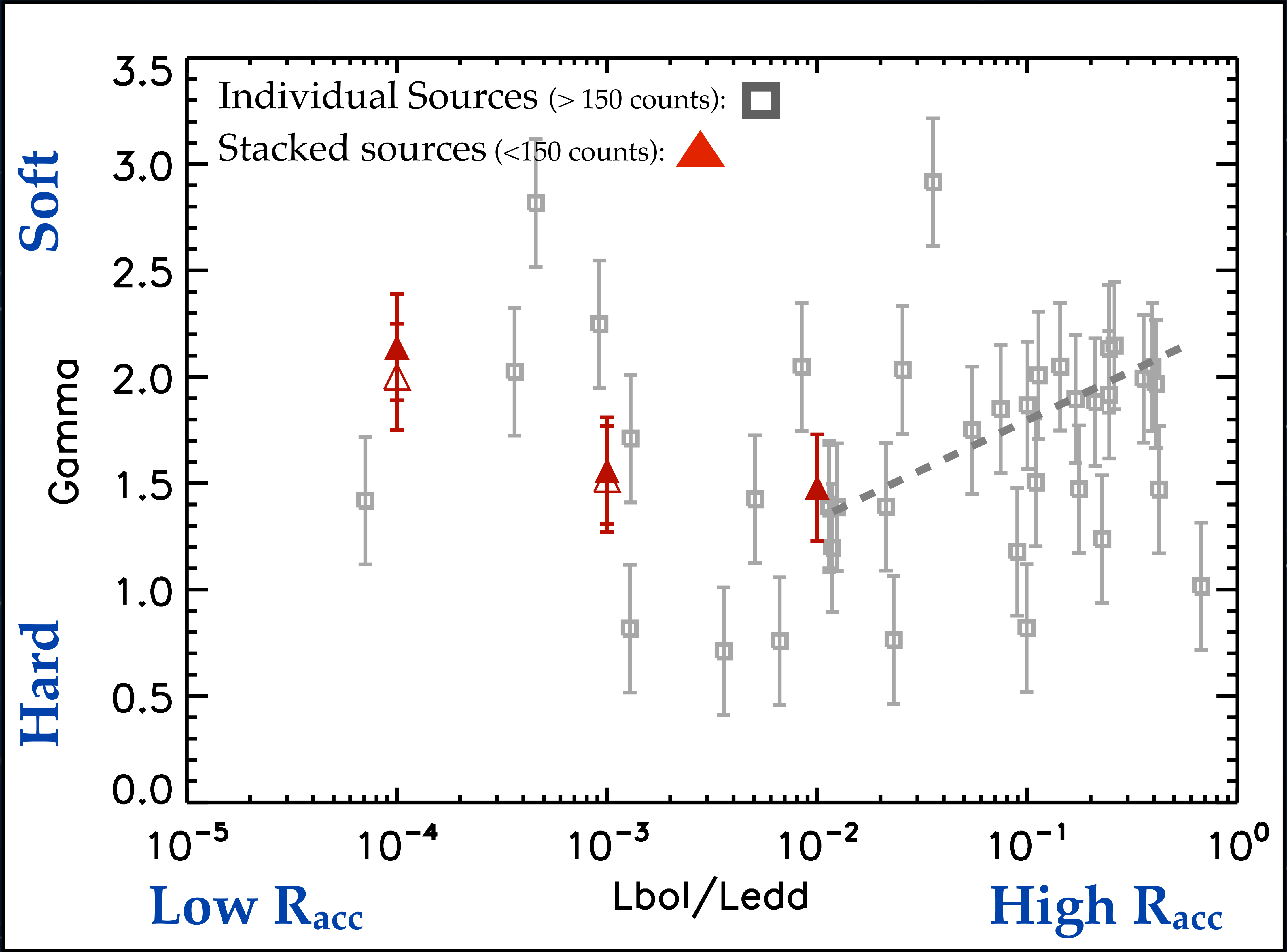
• X-ray spectral fitting of individual sources with > 150 $Cts_{0.5\text{-}8\ keV}$

• Stacking and then fitting of sources w/ < 150 $Cts_{0.5\text{-}8\ keV}$ using STACKFAST (Hickox et al.)

CDFS Subsample: Source Properties



CDFS: Γ vs L_{bol}/L_{Edd}



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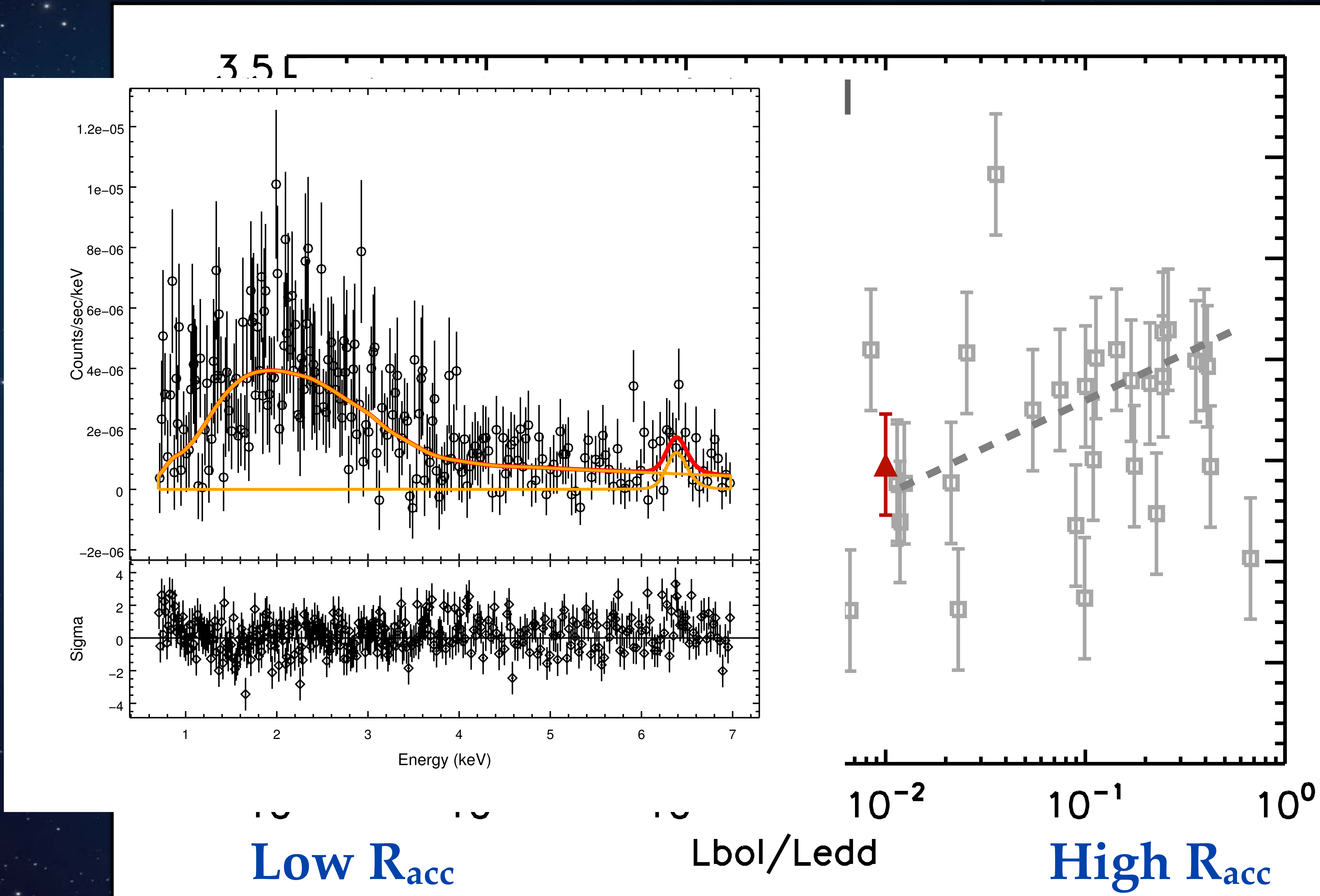

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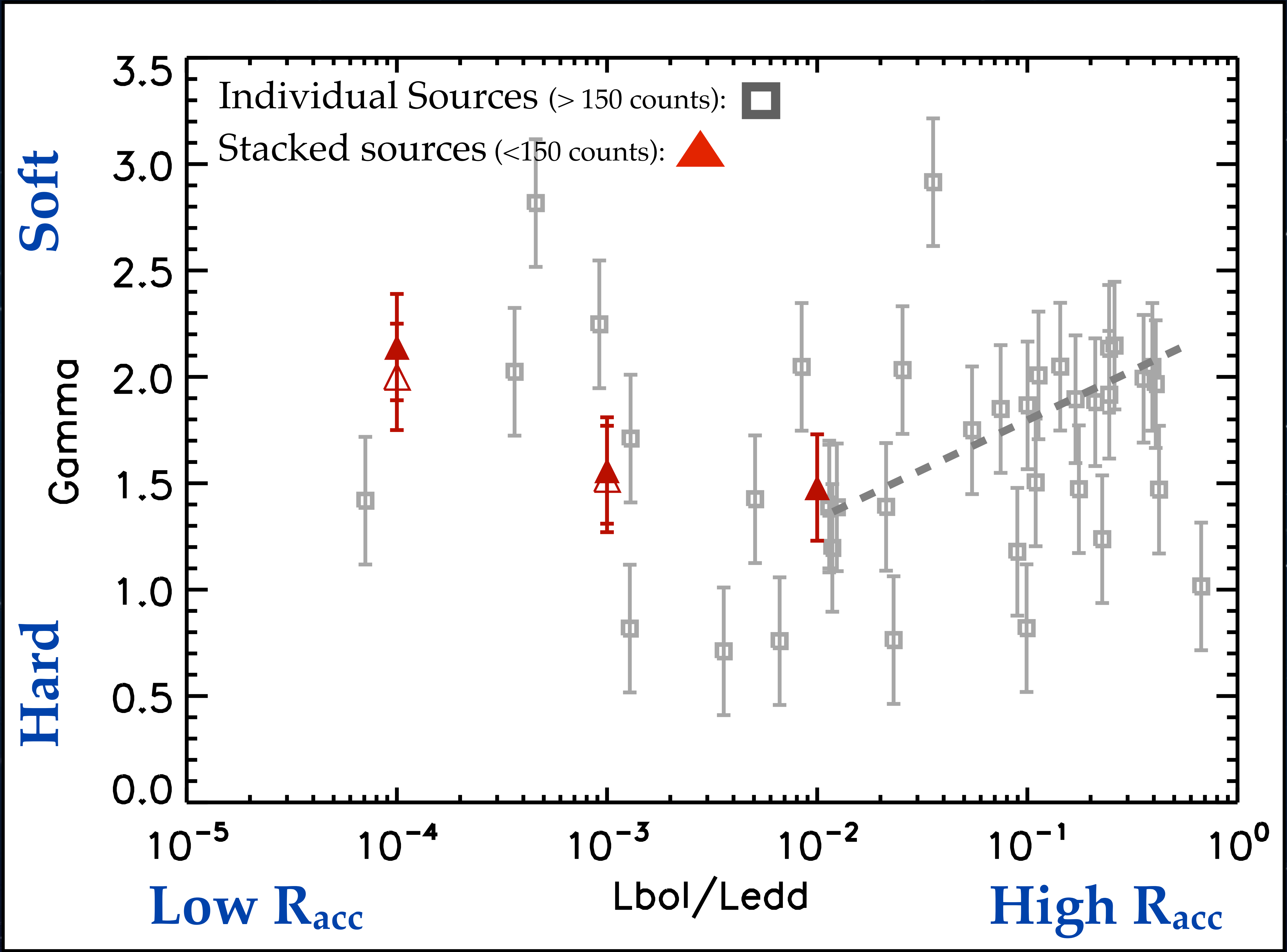

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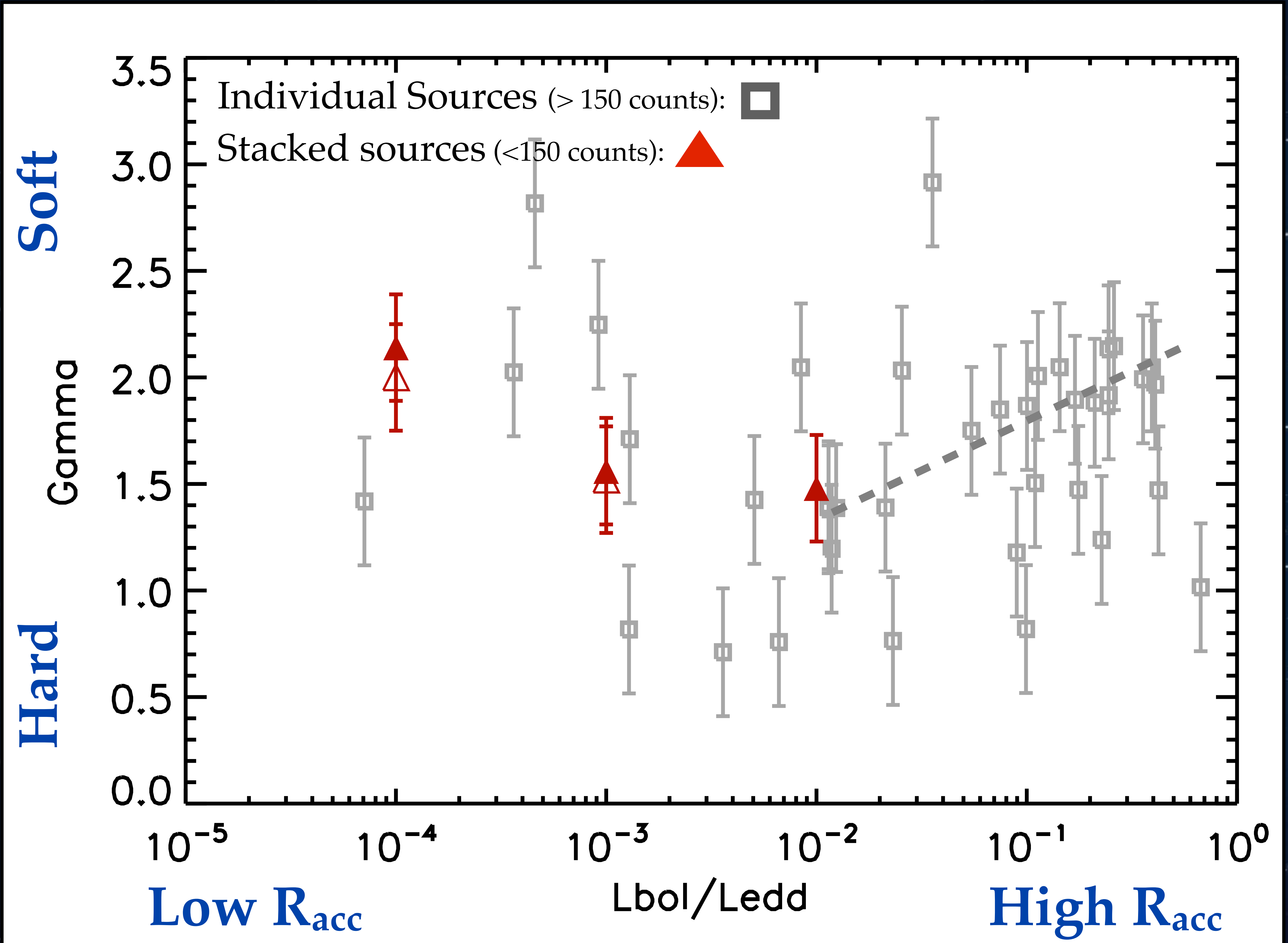
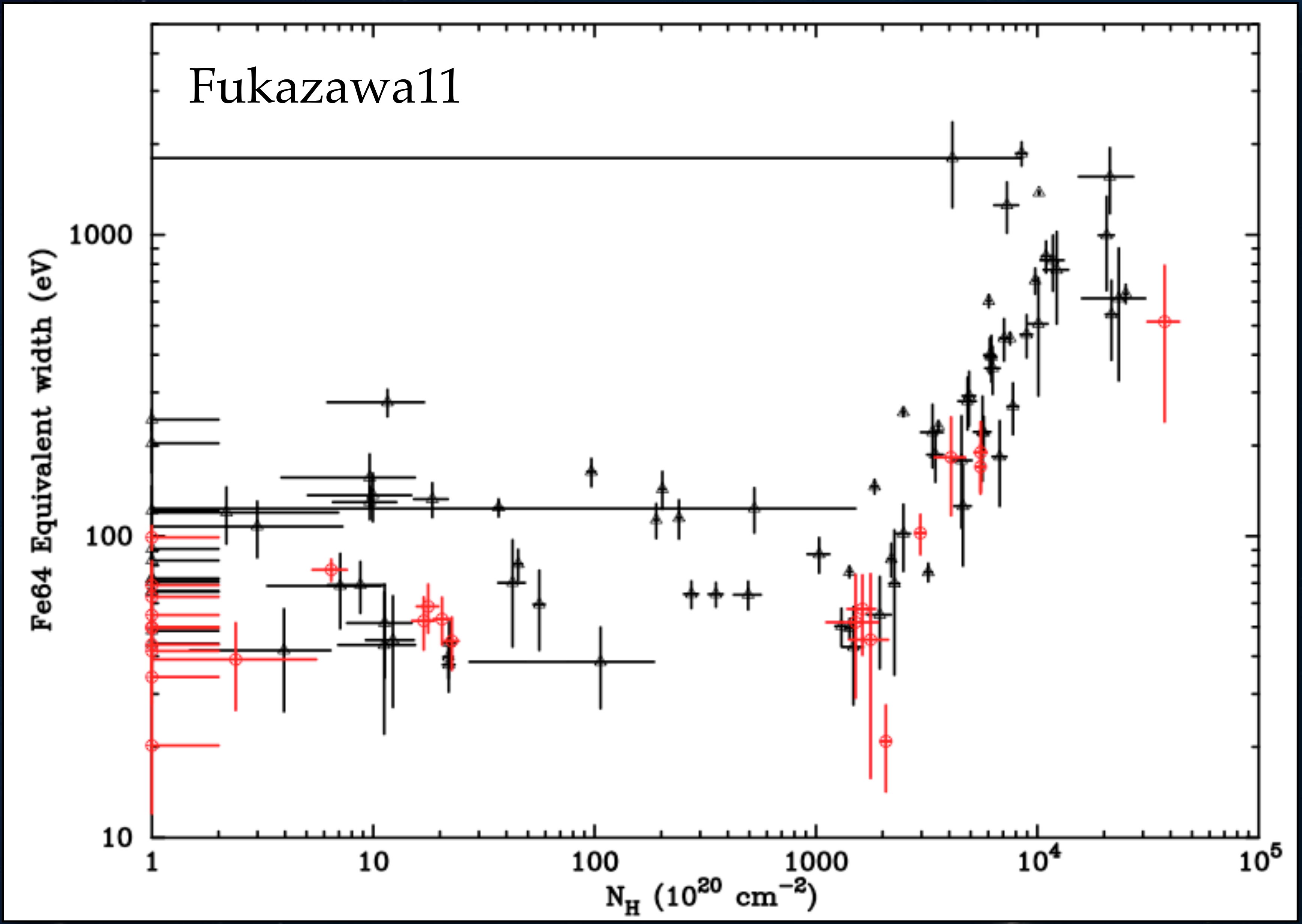


Using Narrow EW(Fe Kα) to Estimate N_H



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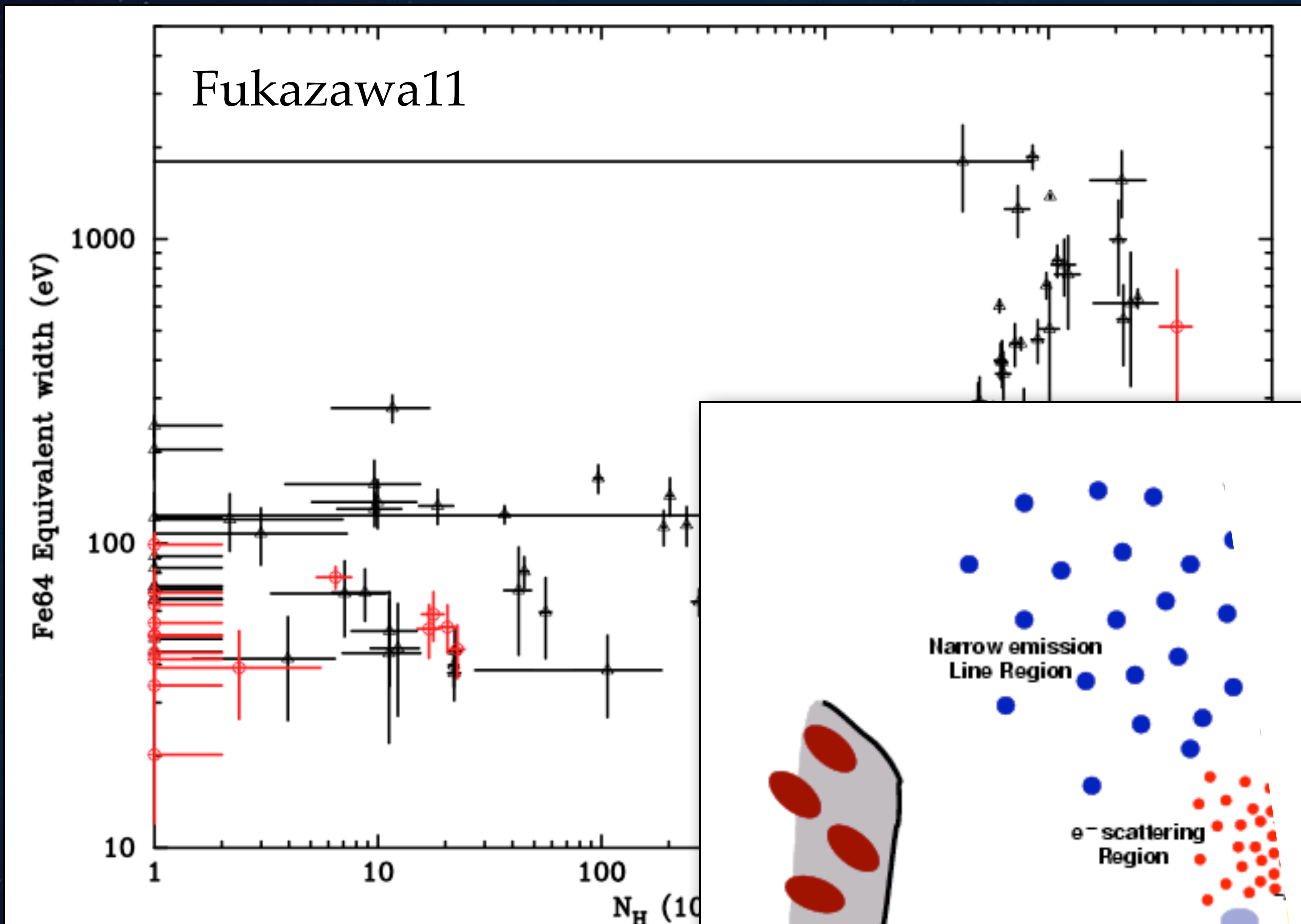

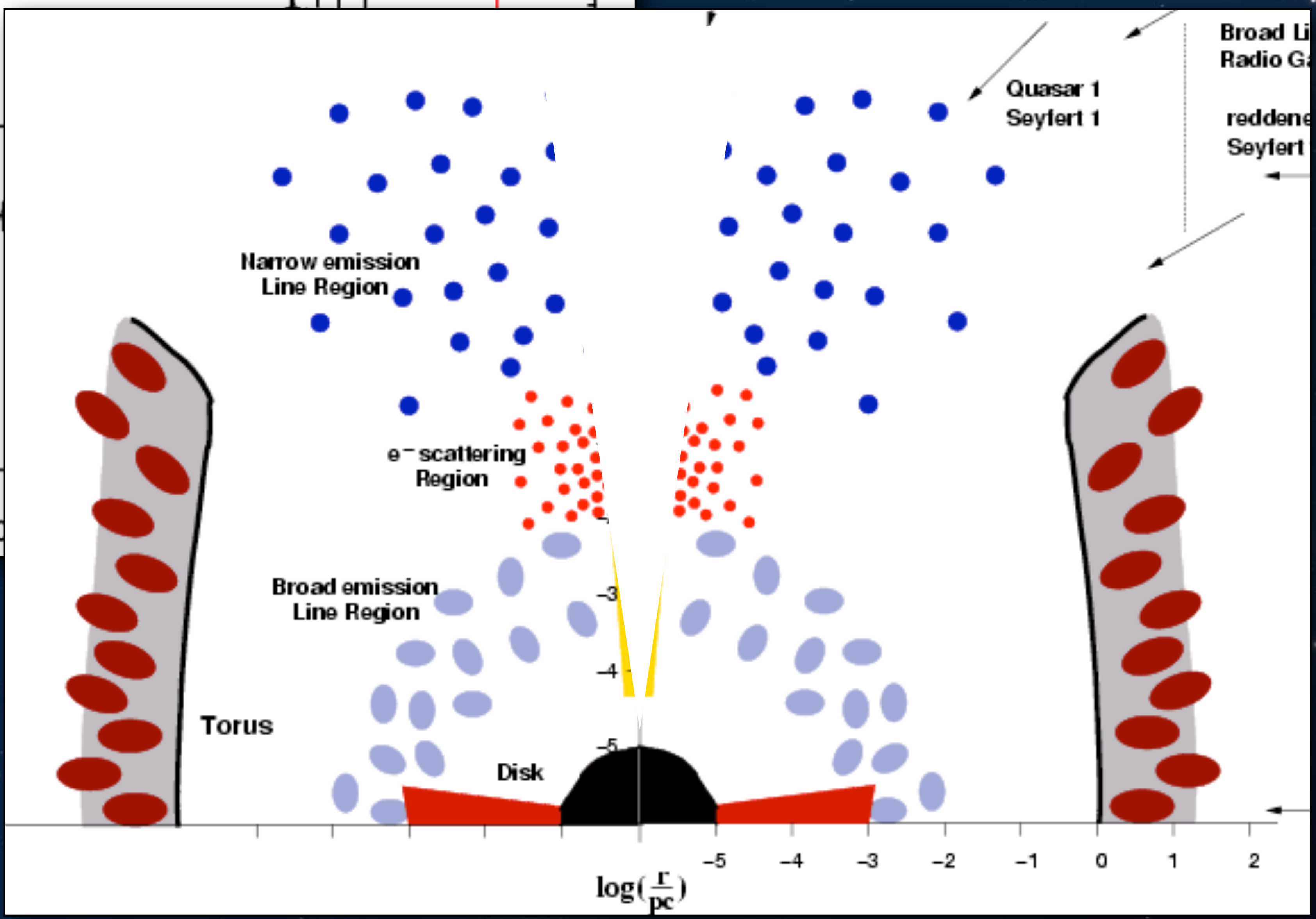

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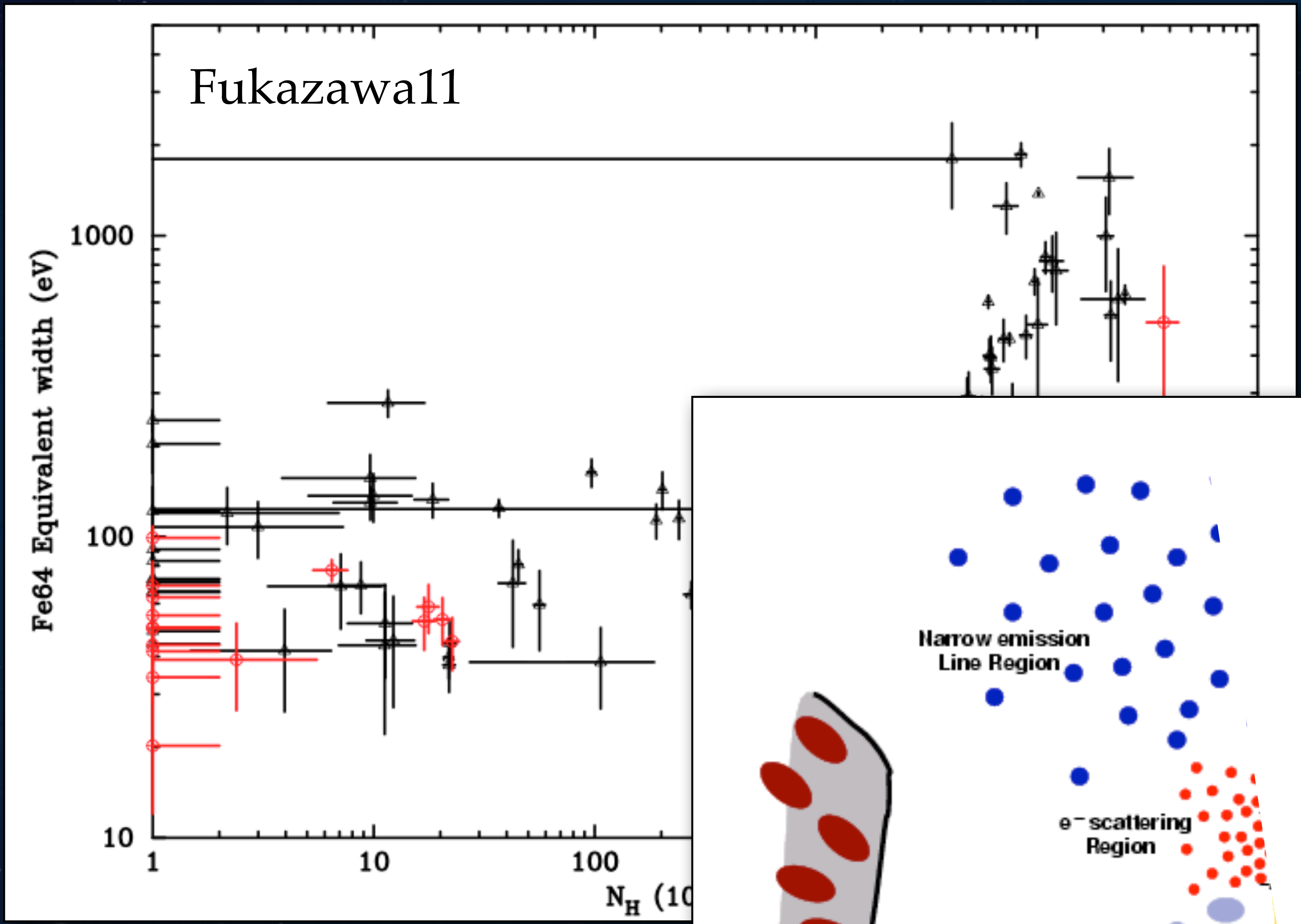

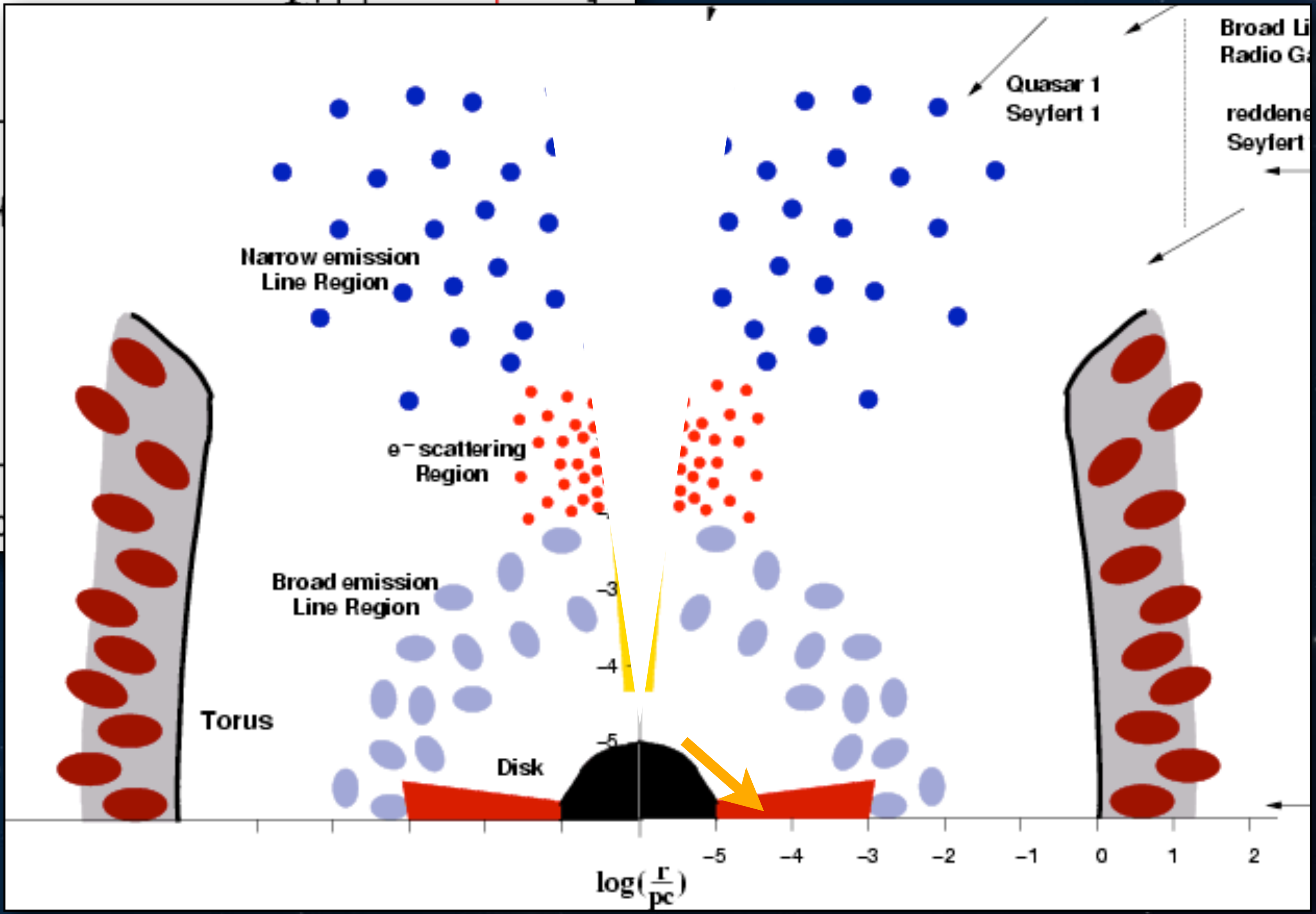

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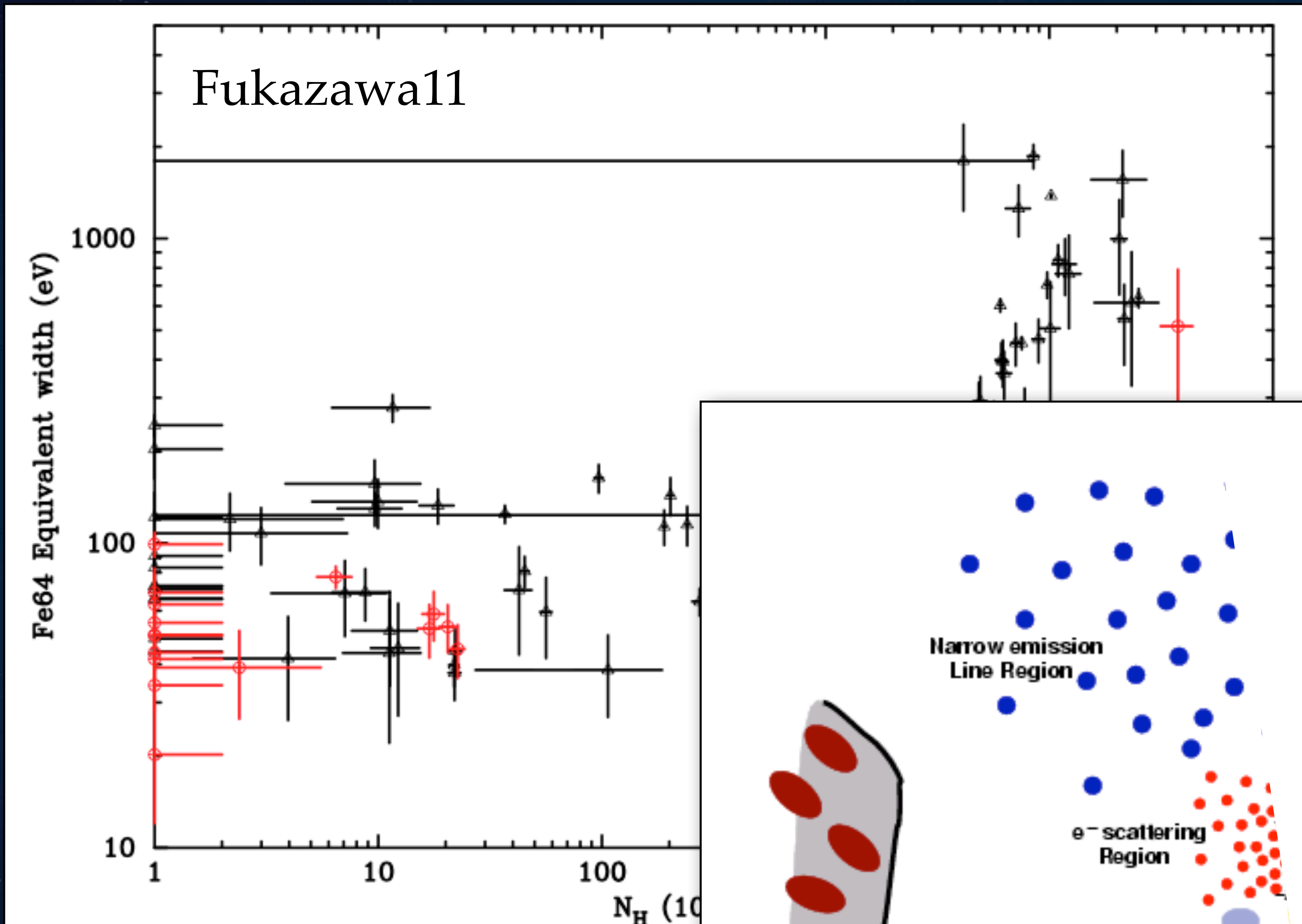

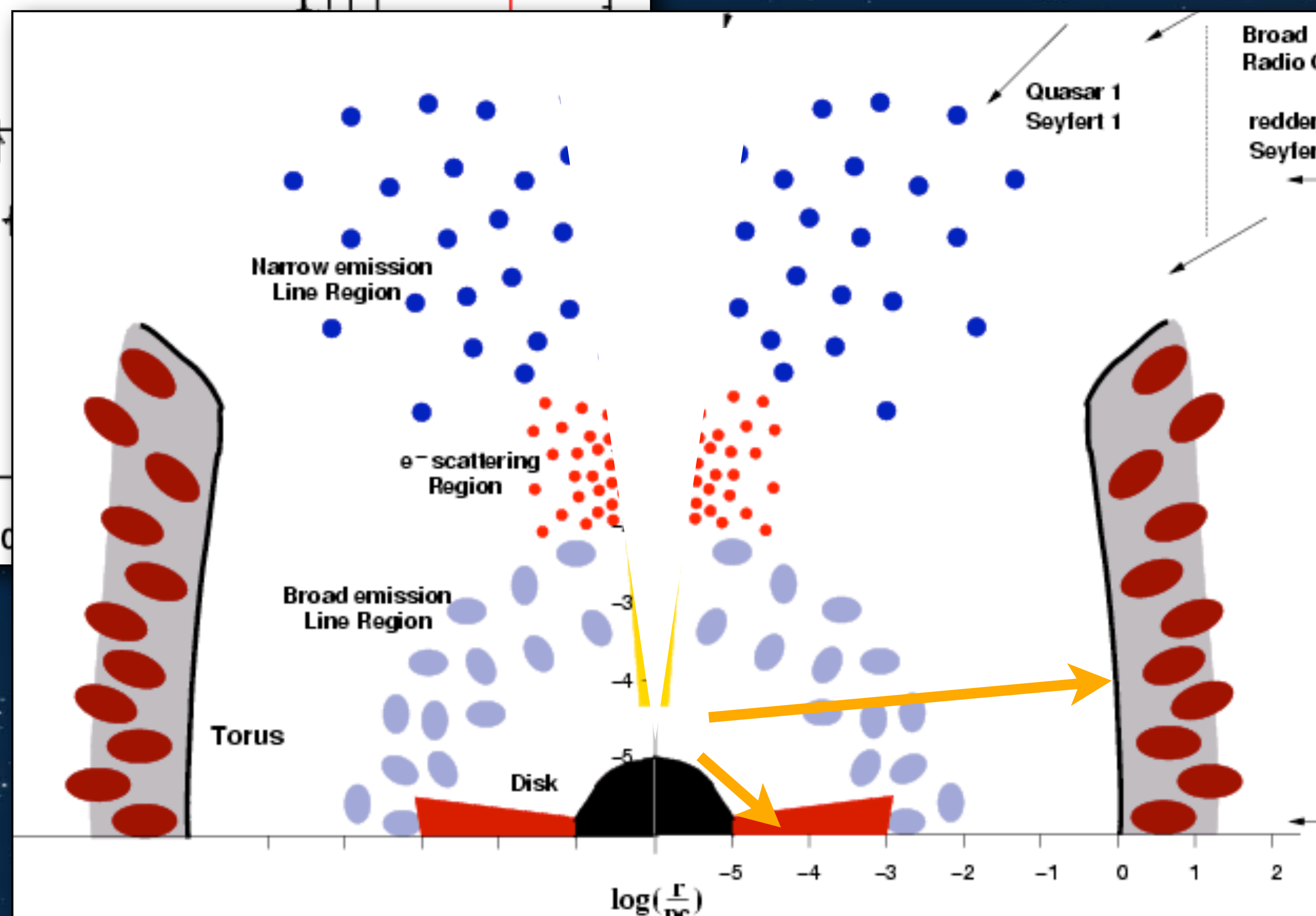

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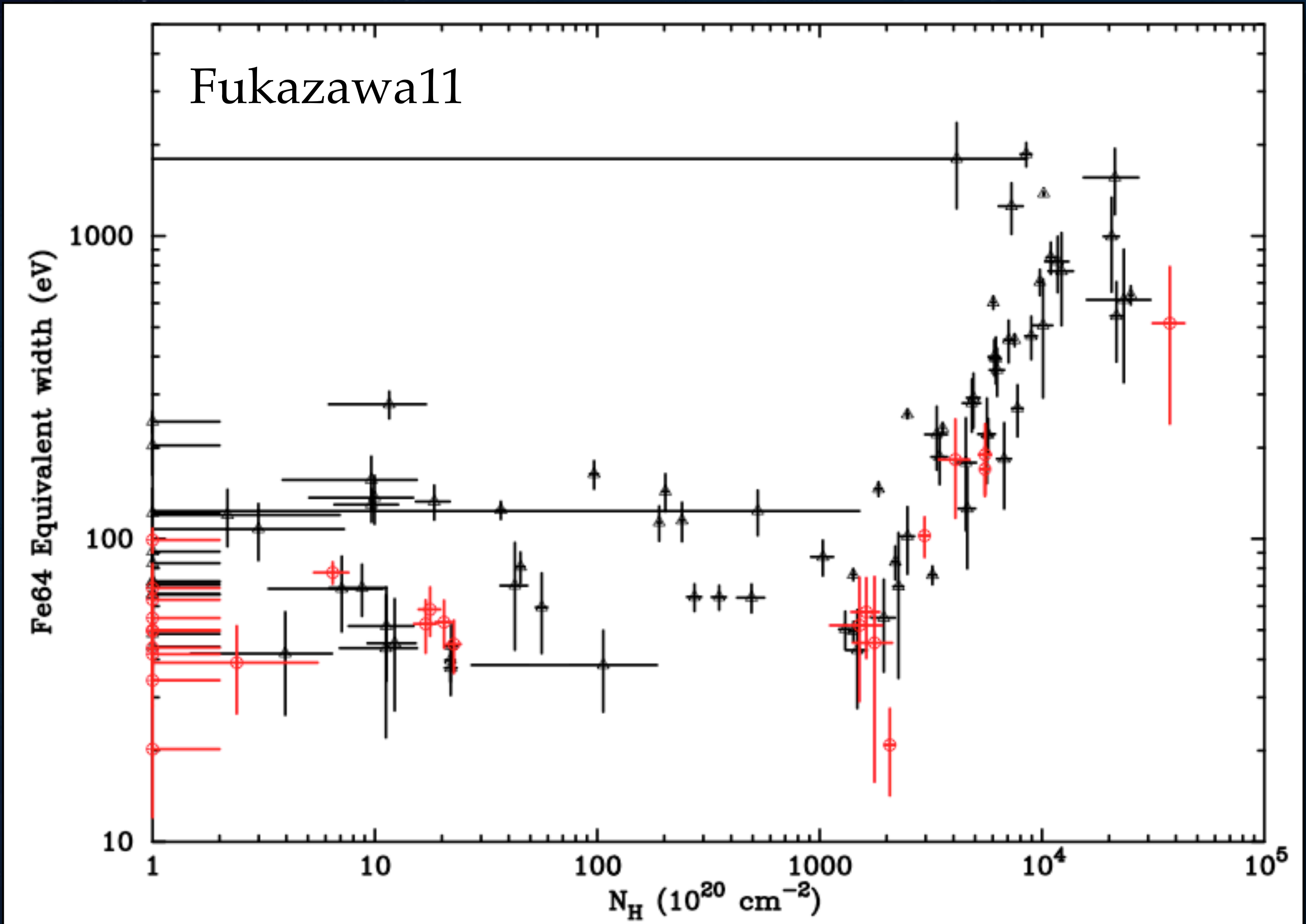

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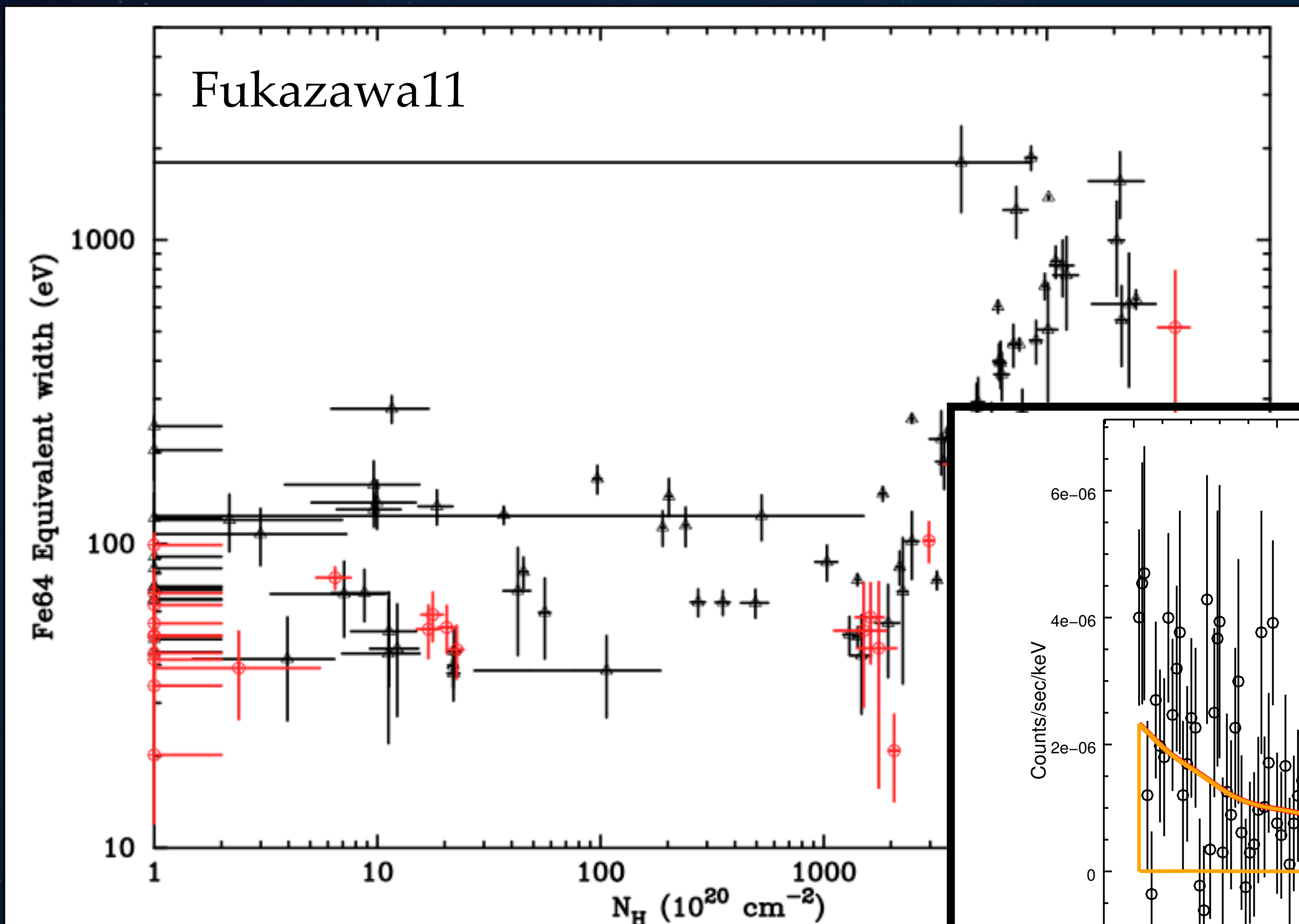

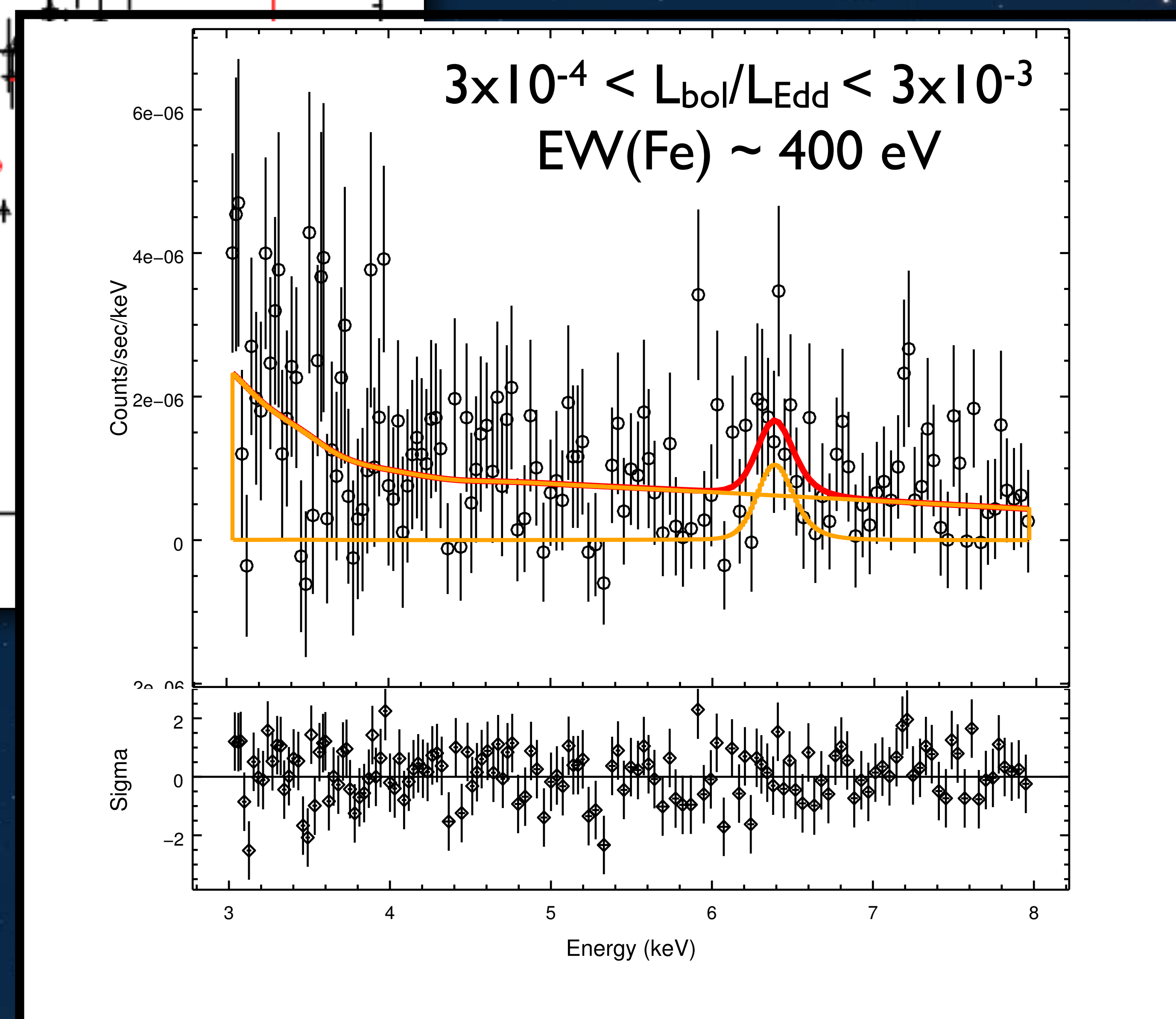

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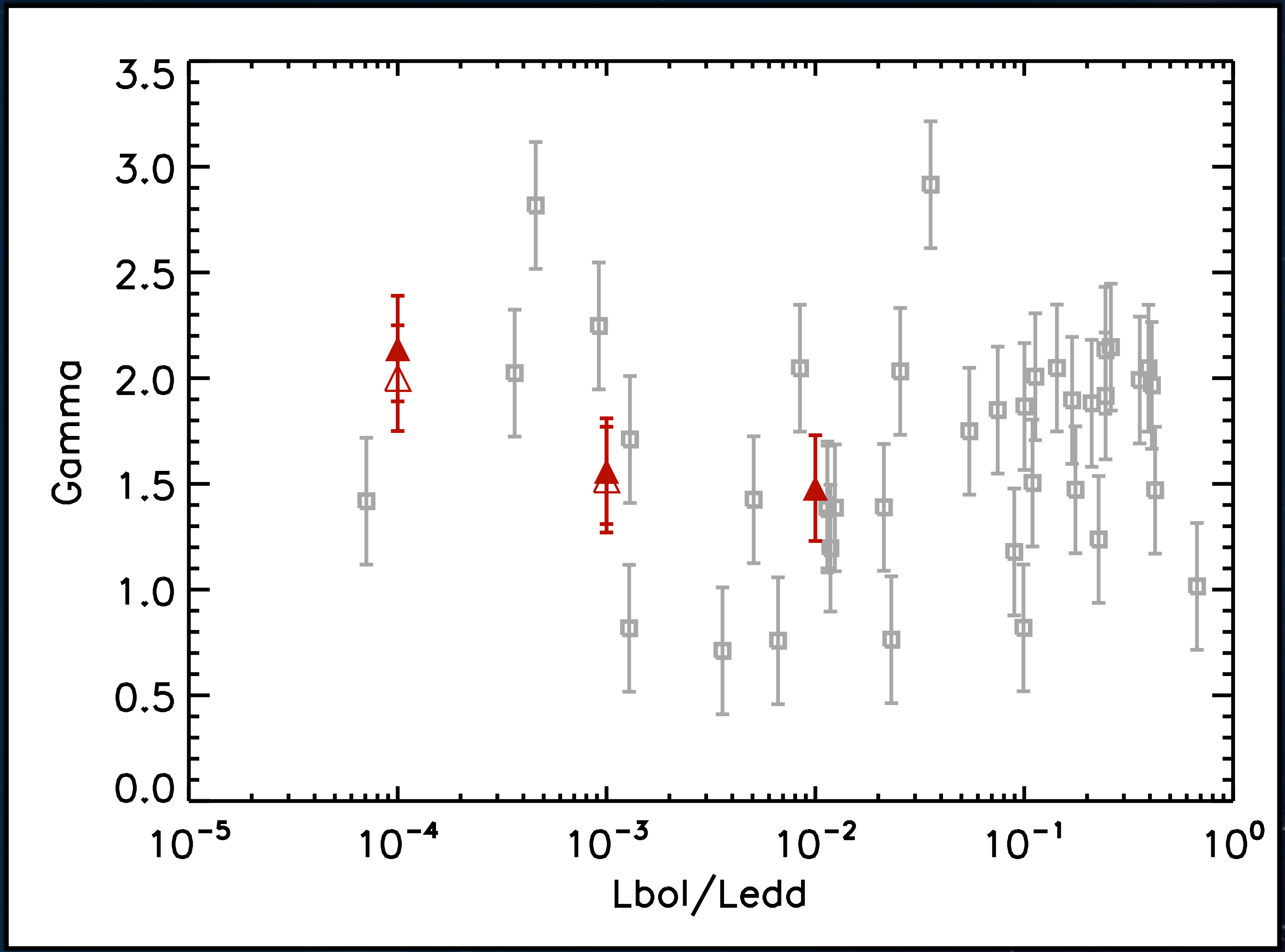

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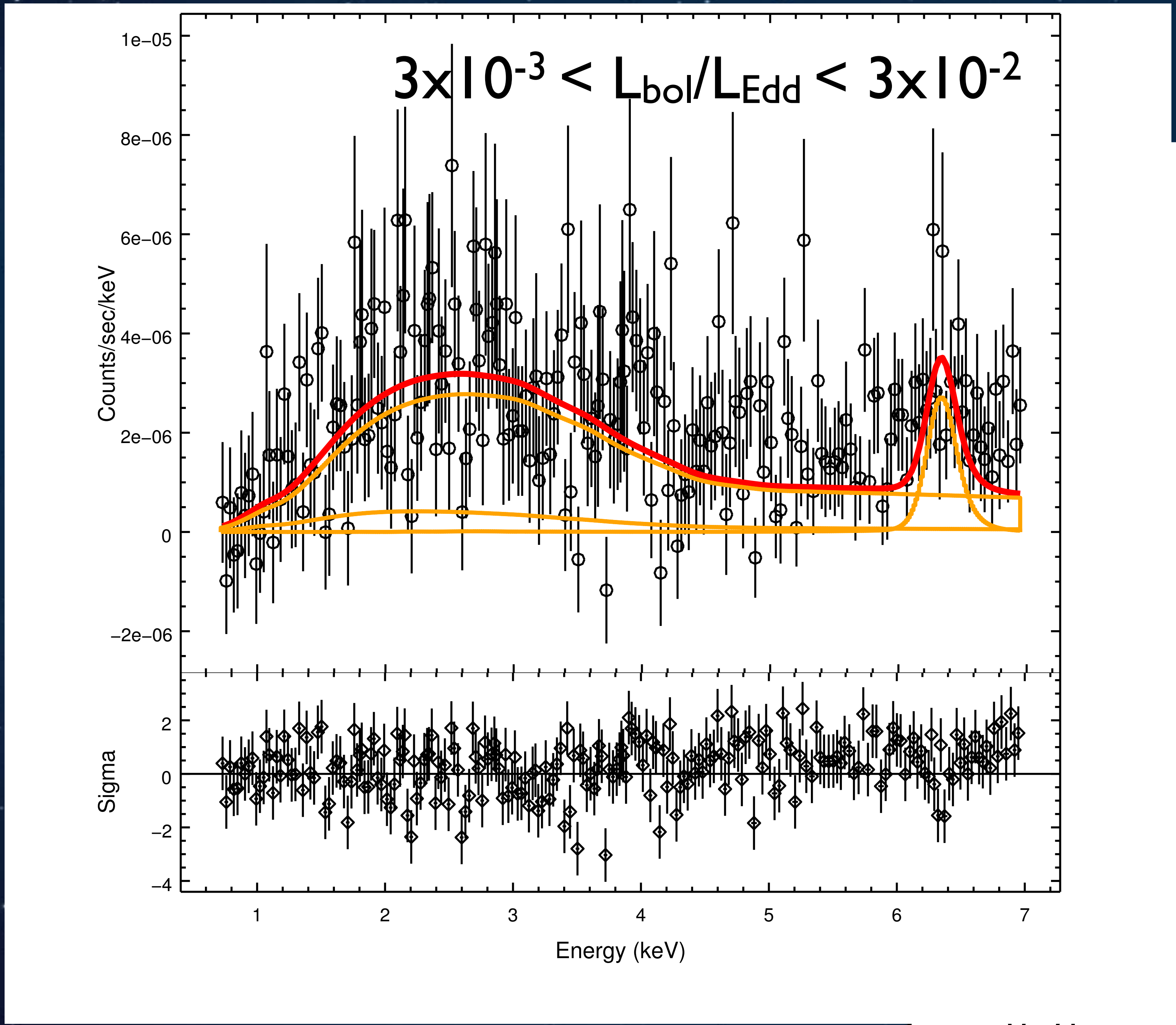

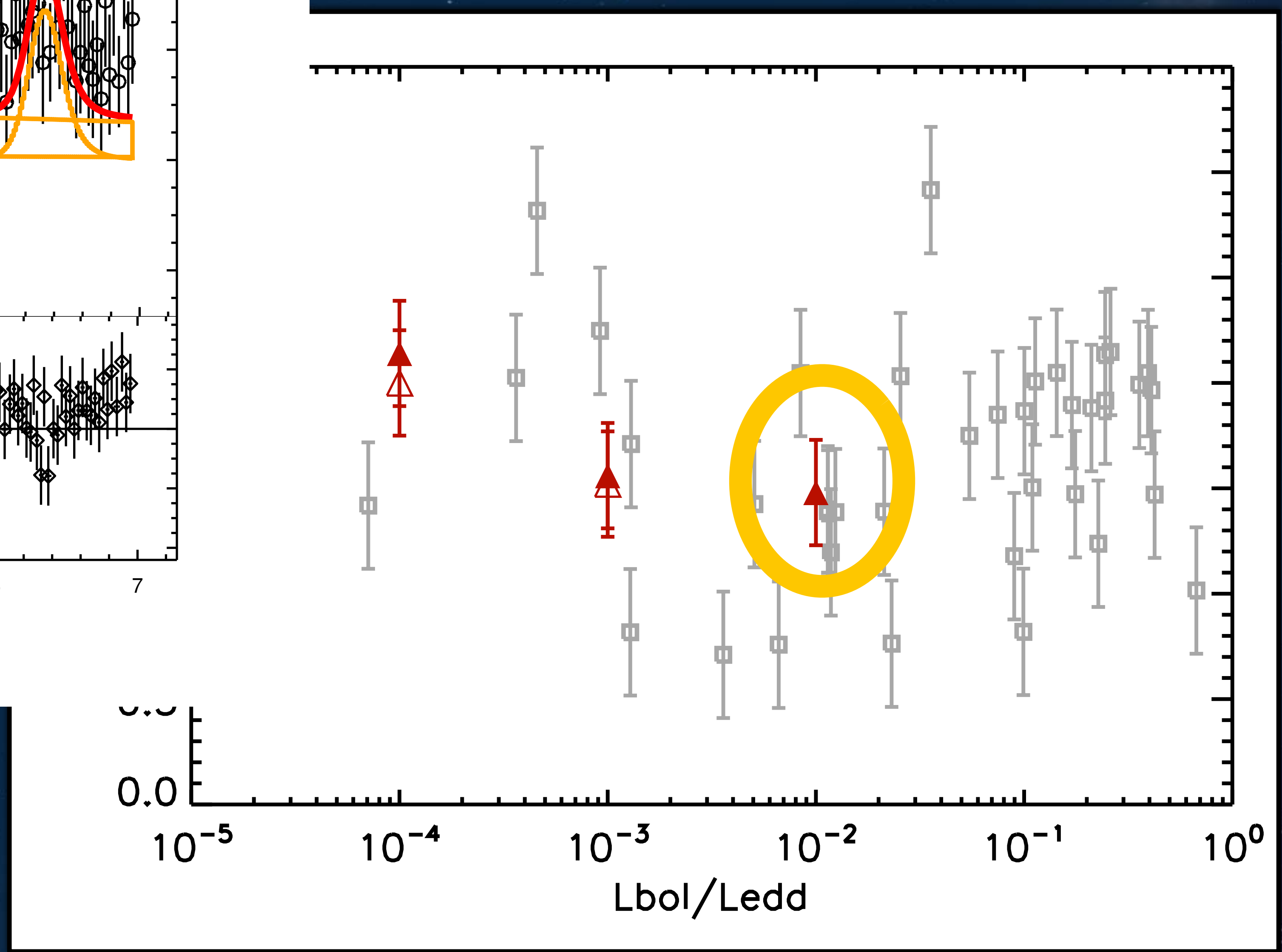

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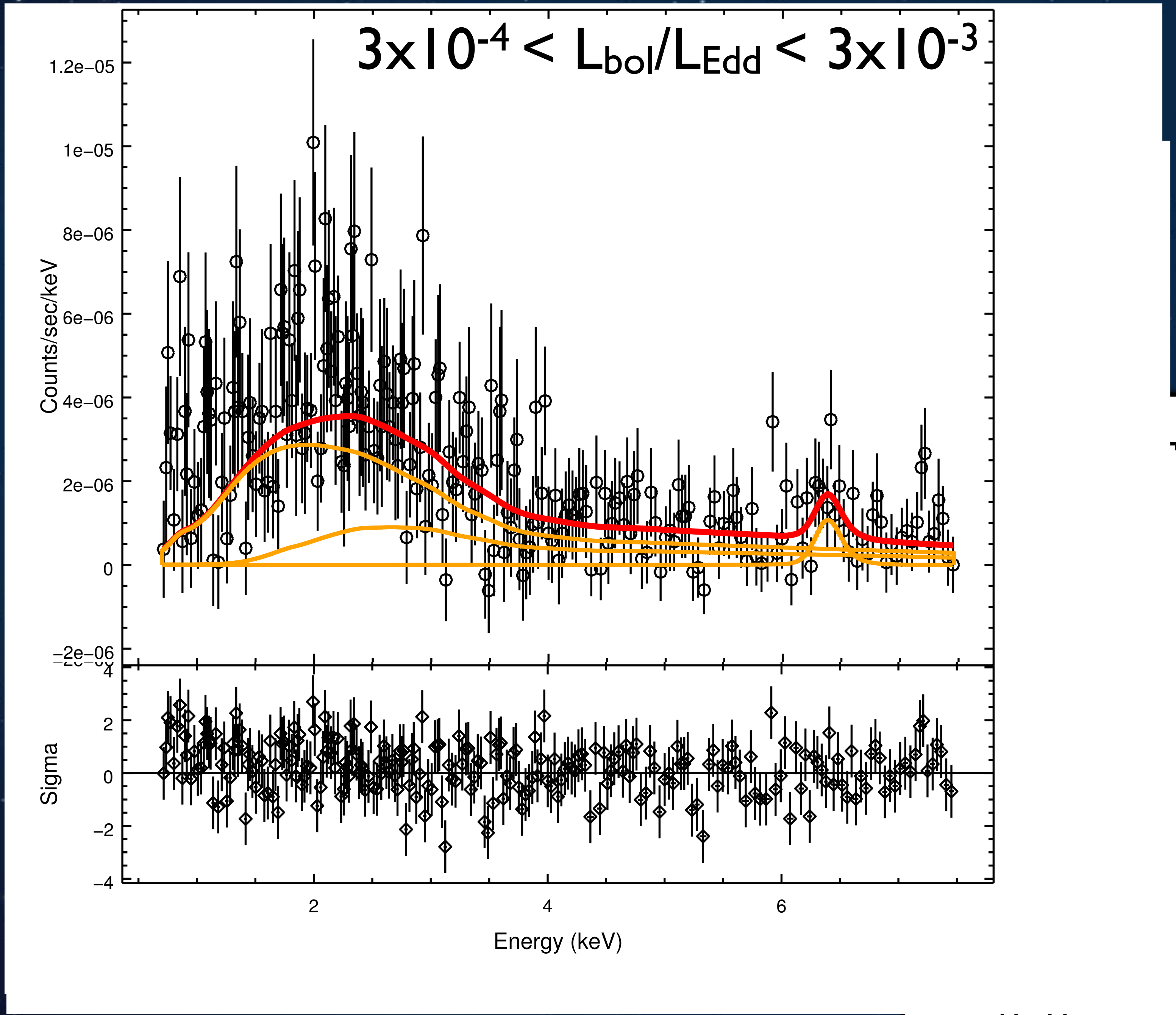

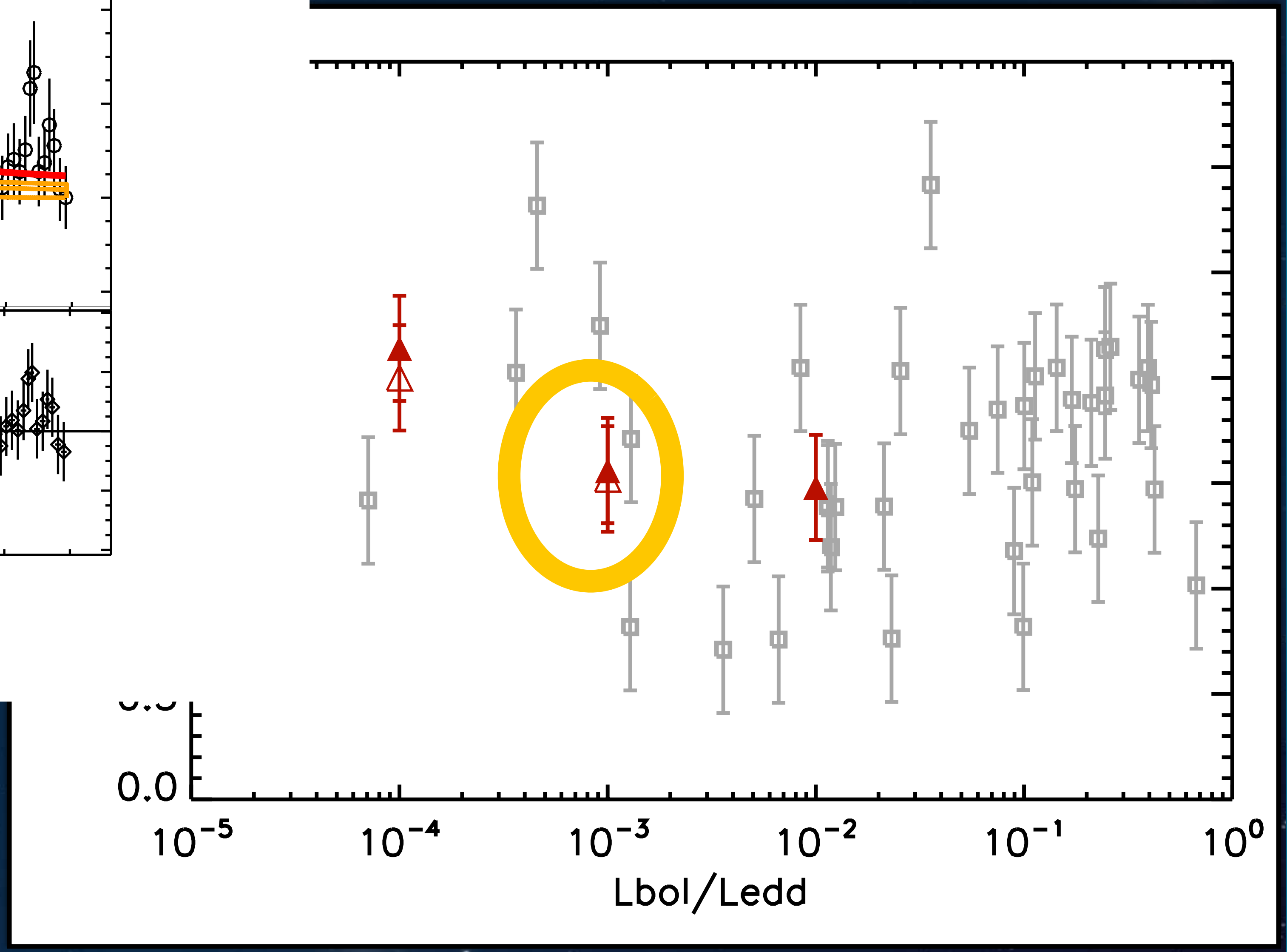

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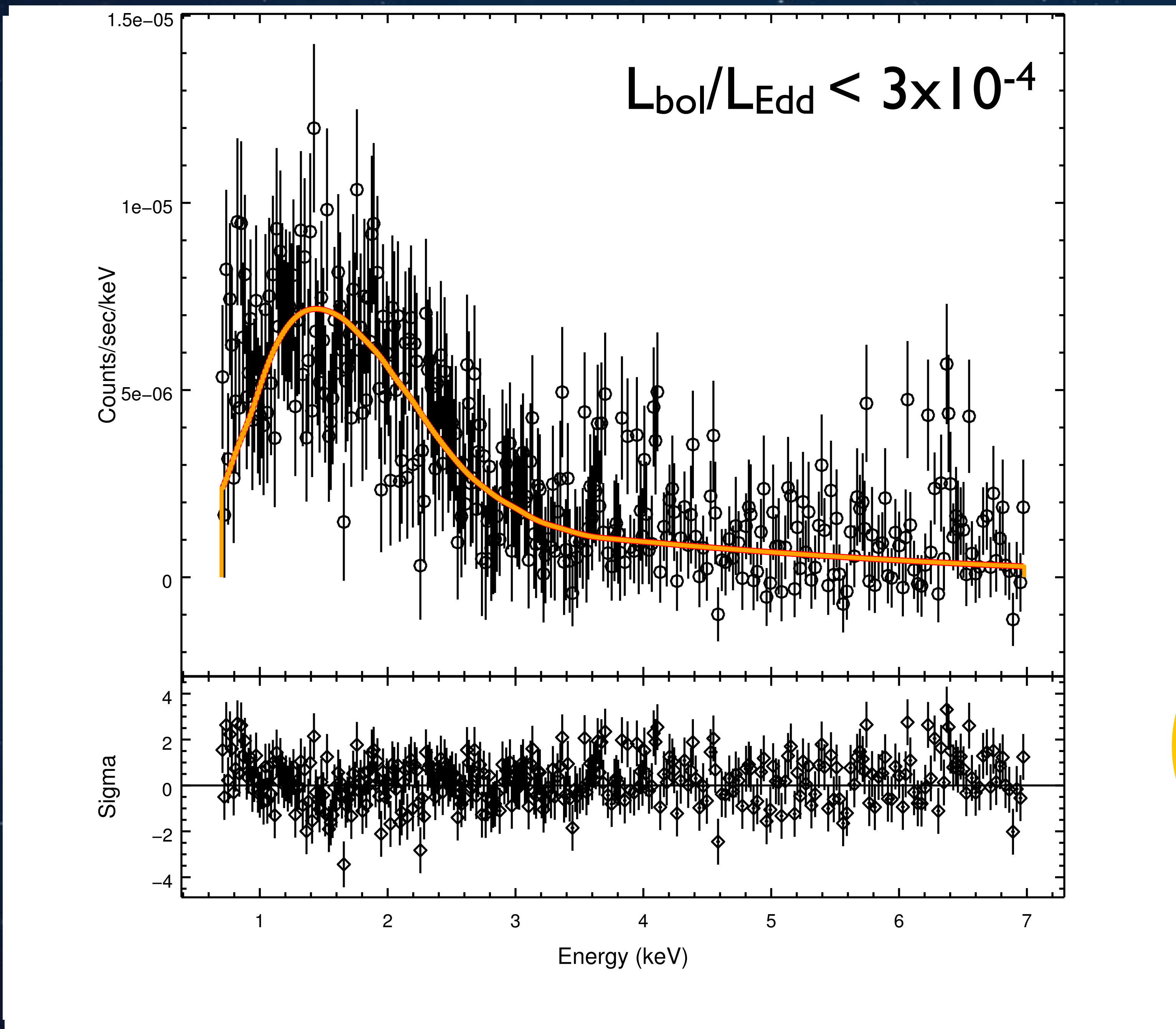
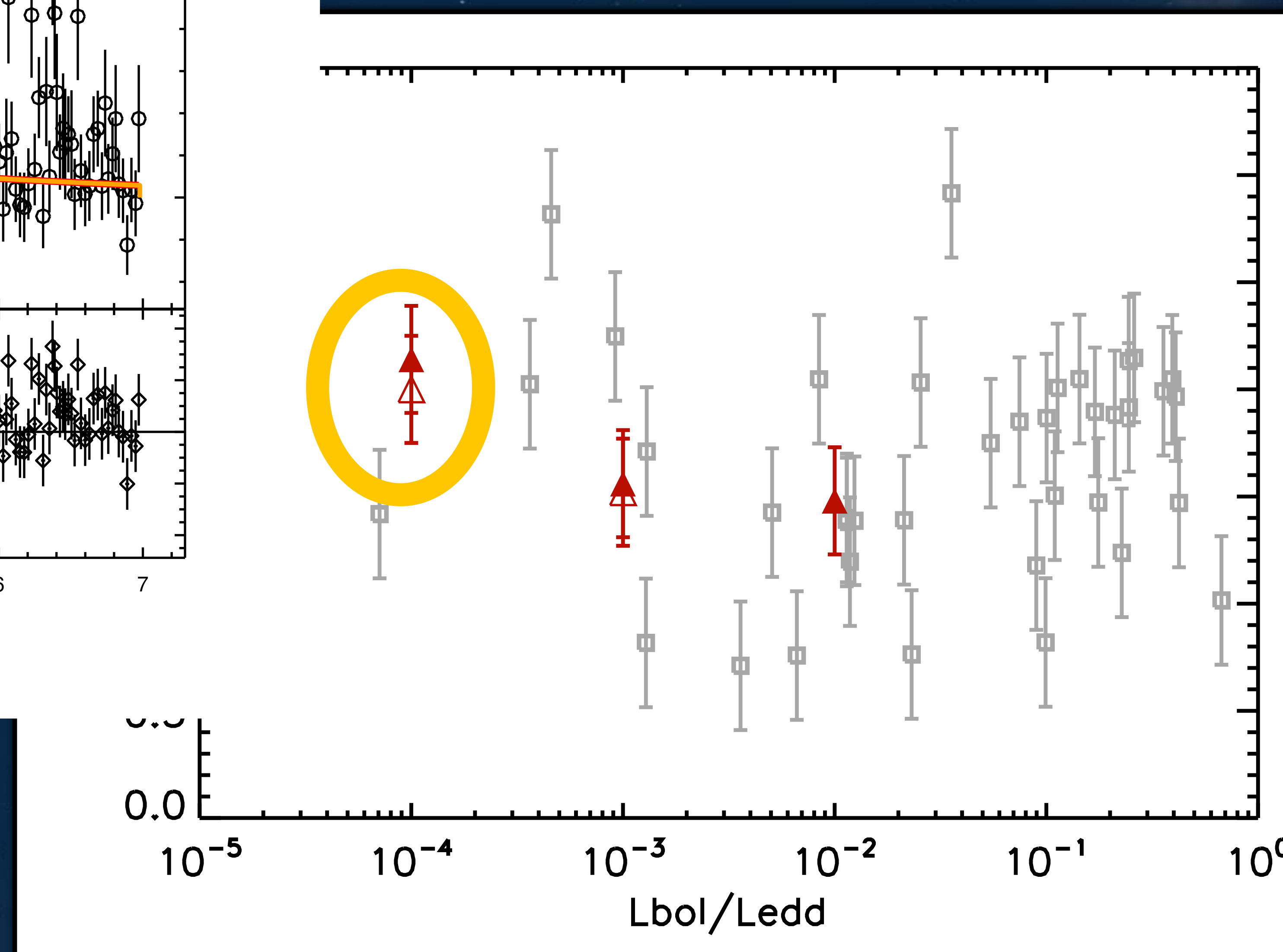
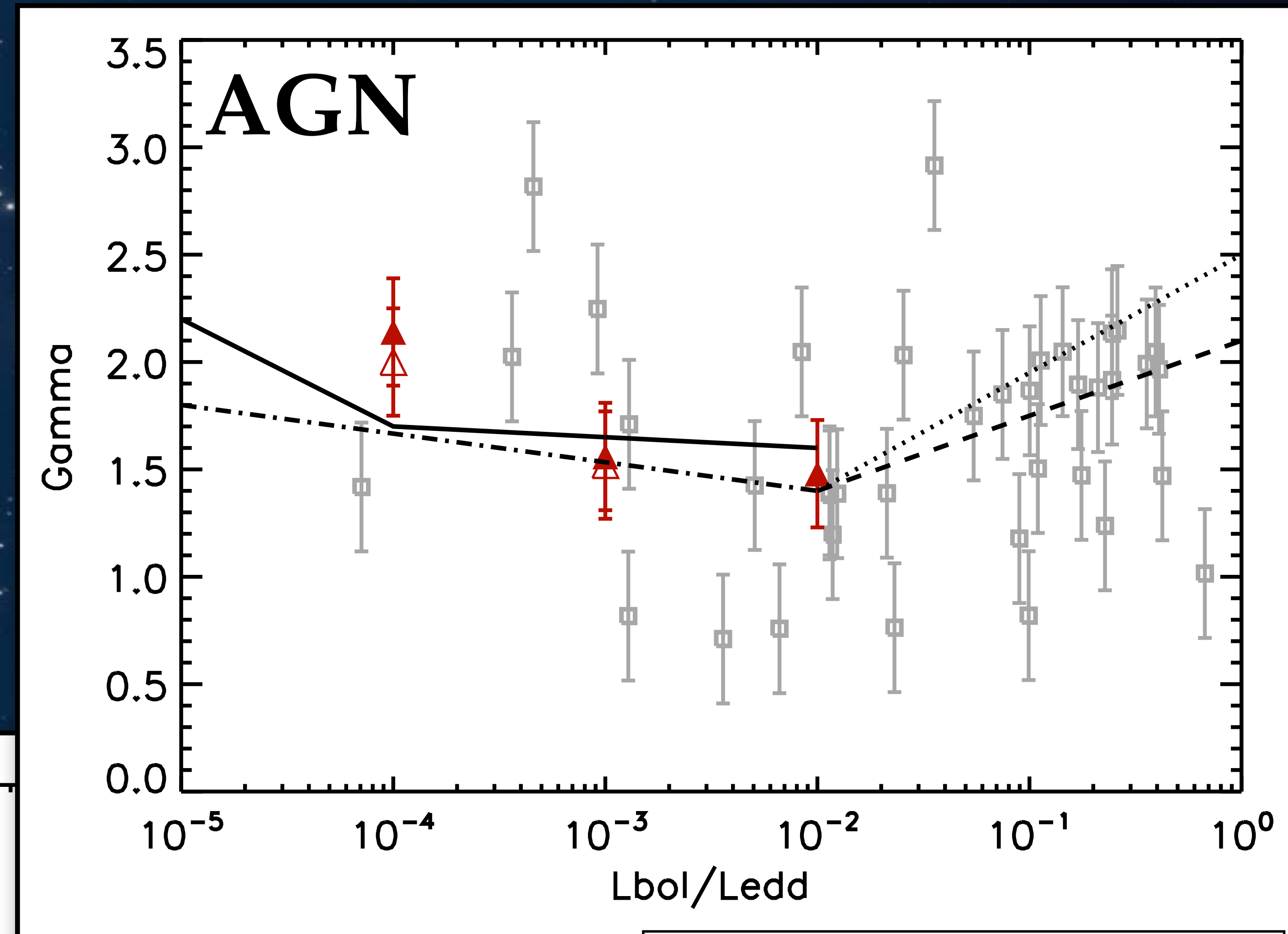
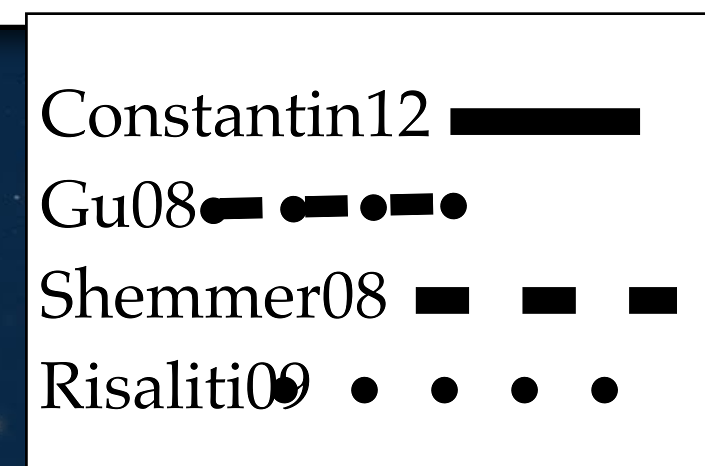
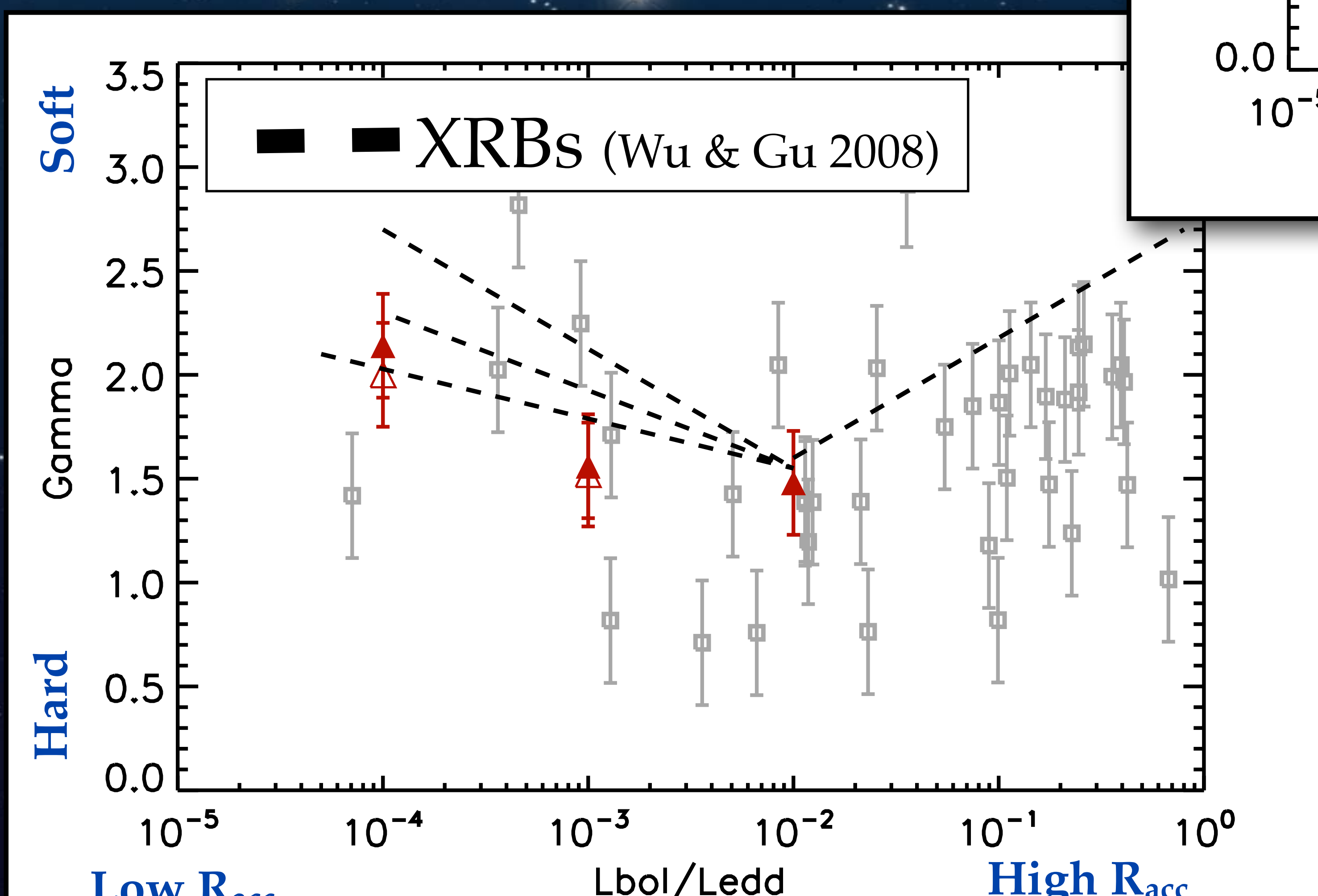




Comparison with AGN & XRB Results







NEXT

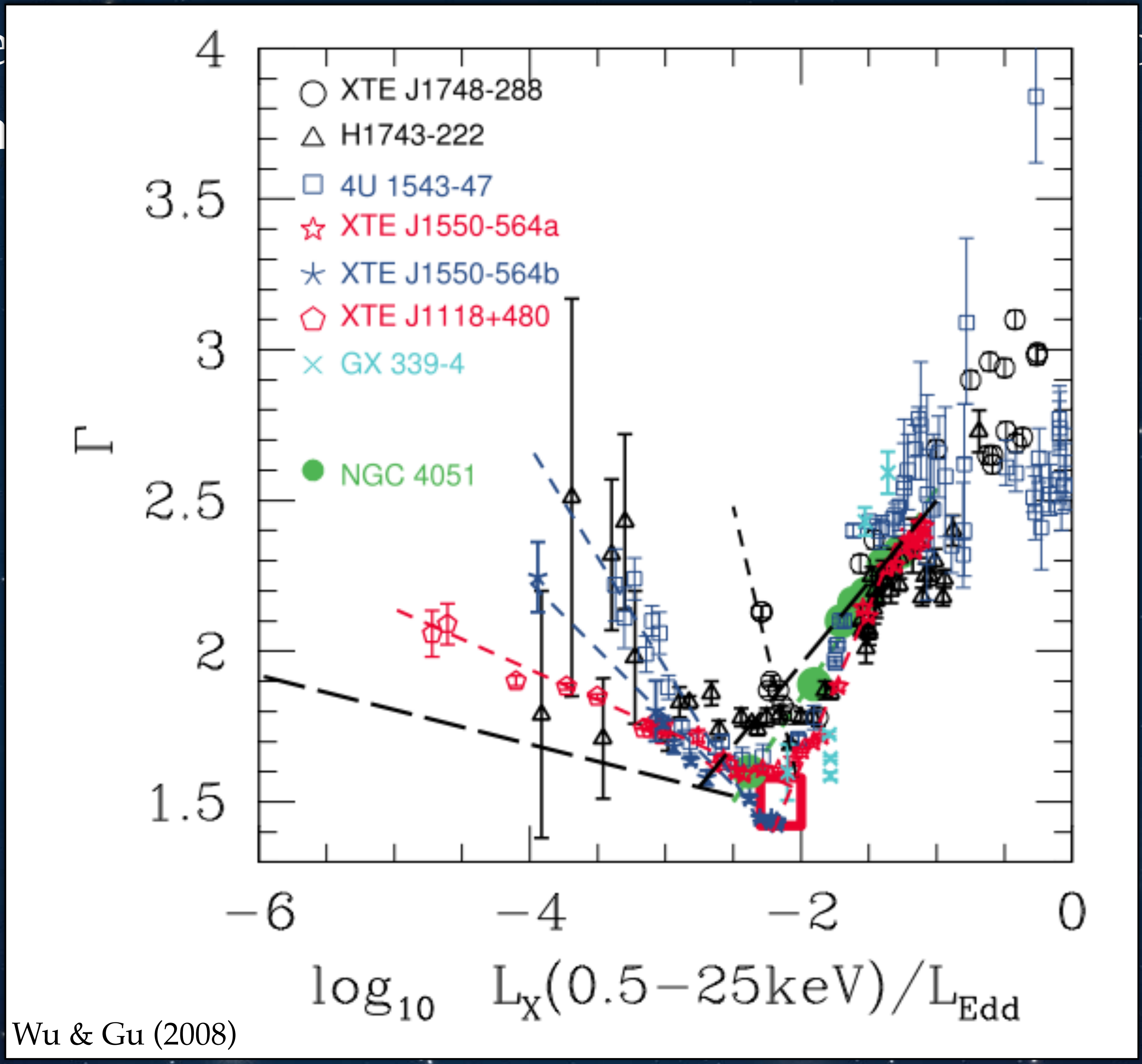
- Larger sample, better statistics (OPTX, Trouille09,10,11)
- Test reflionx -- better modeling of impact of NH (Brenneman talk)
- Jet contribution
  - For sources where jet dominates in X-ray, what is the expected slope and keV range?

QUESTIONS

- Is there a theoretically predicted lower limit to the X-ray spectral slope for XRBs?

QUESTIONS

- Is the ... the X-ray spectra ...



Wu & Gu (2008)

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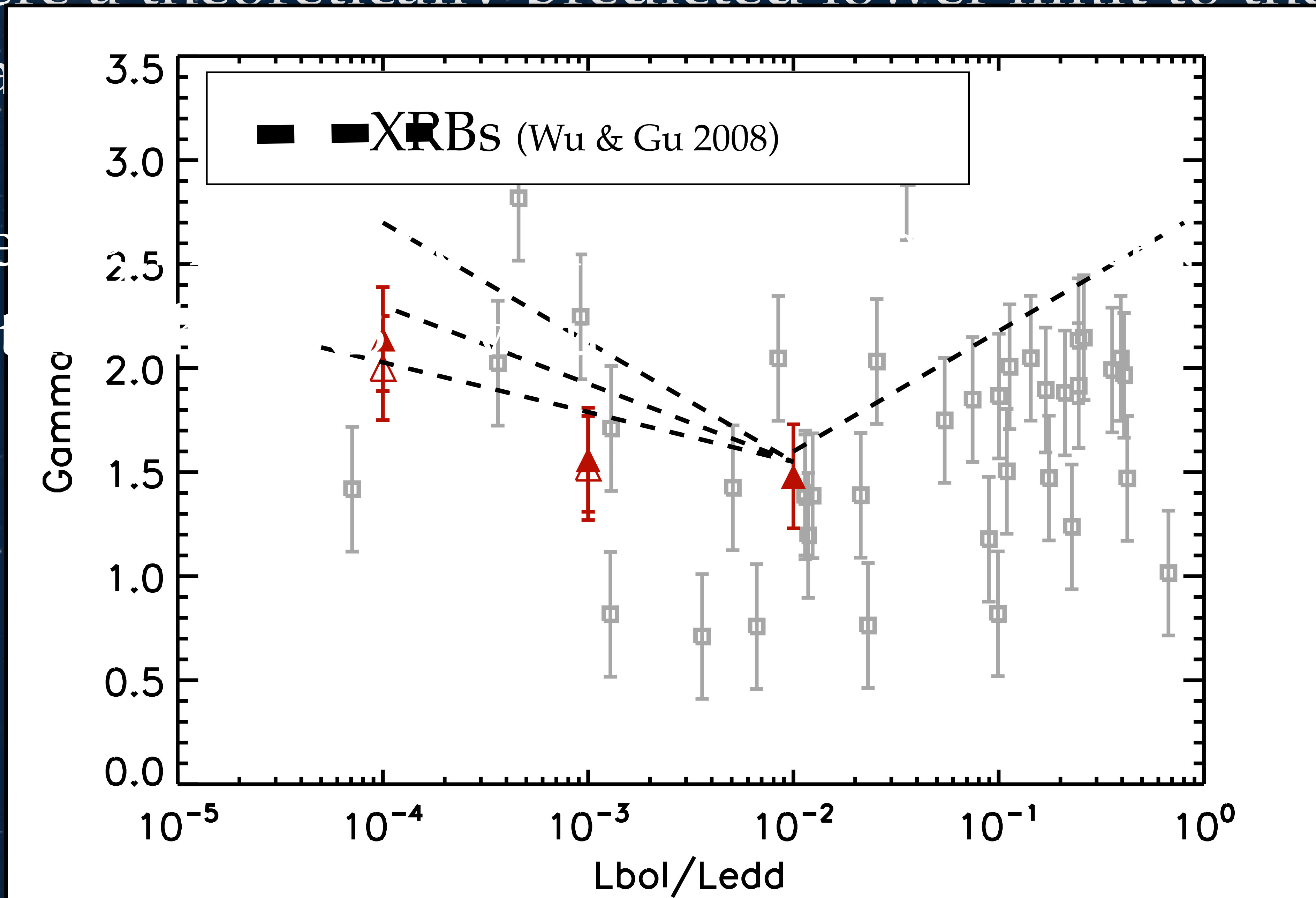

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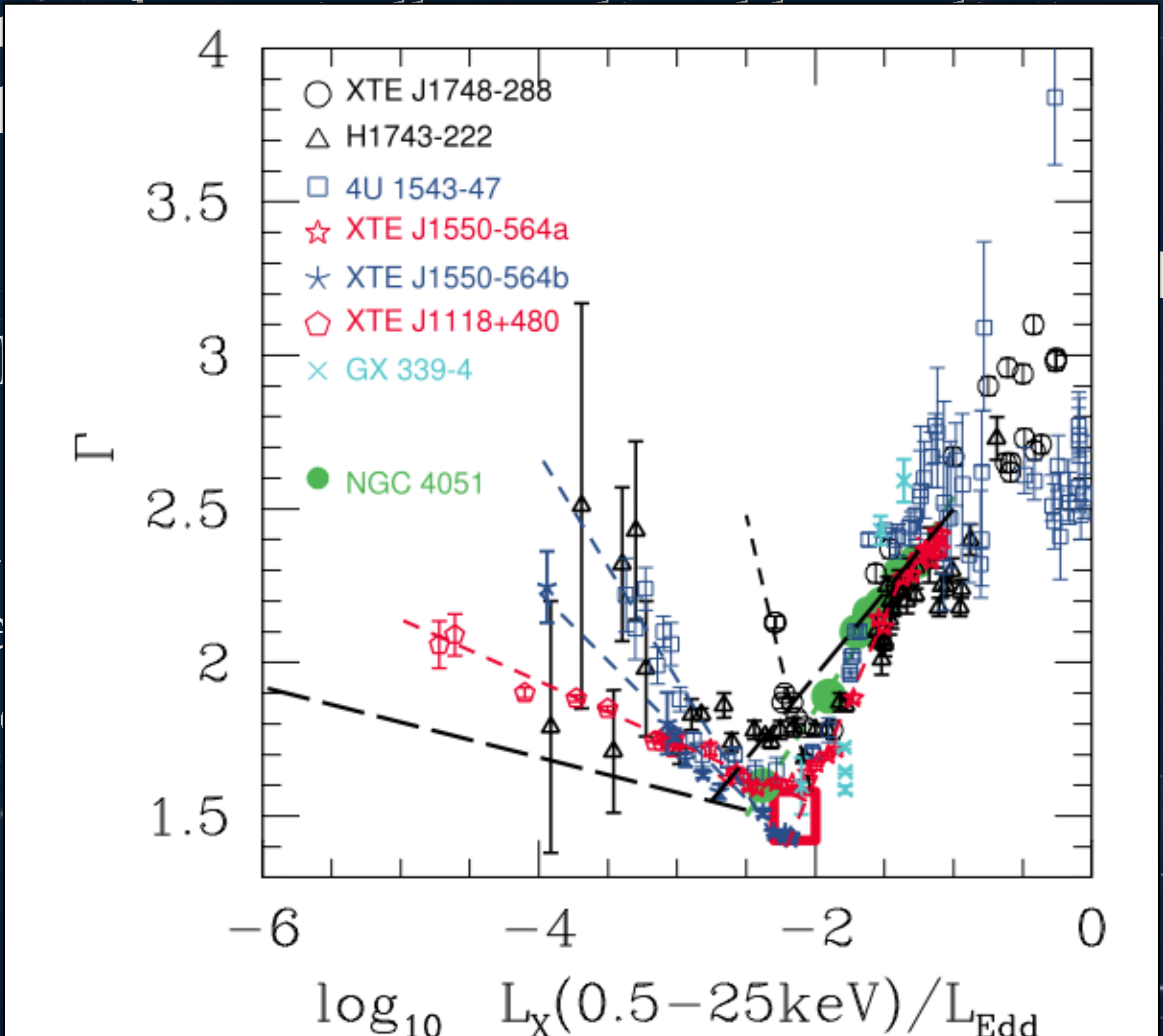

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- For either XRBs or AGN, is there consensus on where in Lbol/Ledd the inflection point occurs?

FIN