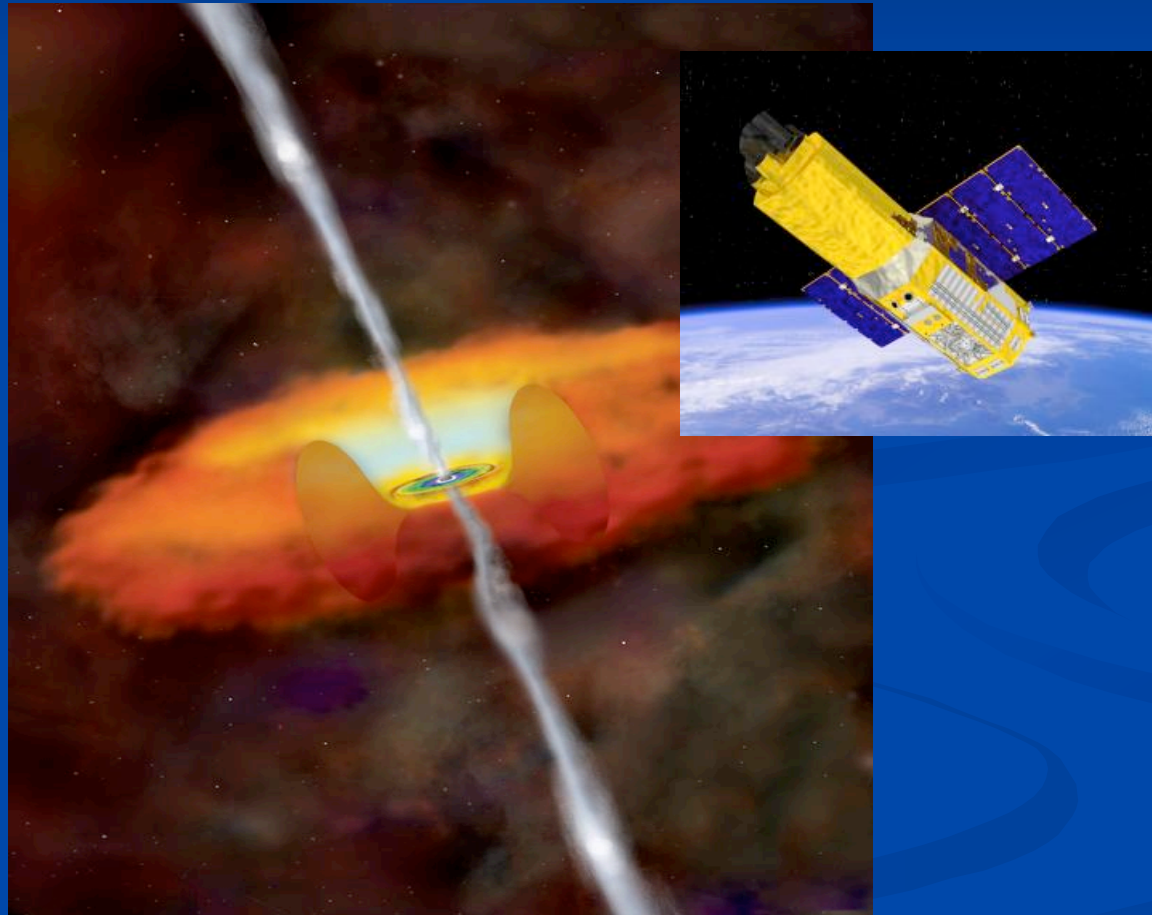


# Fe-K Accretion Disk Diagnostics from *Suzaku* Observations of the LINER Galaxy NGC 1052

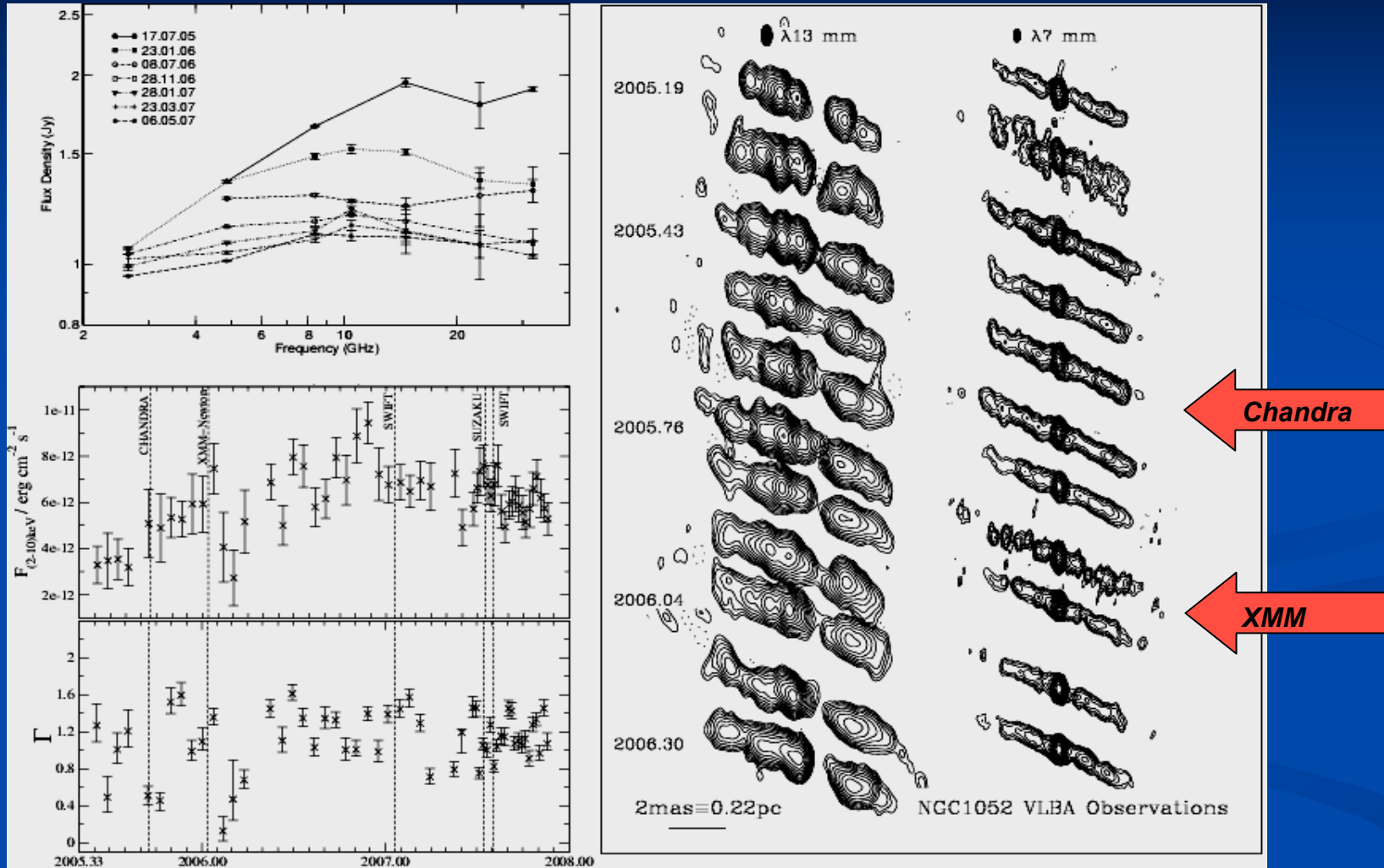


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**Advisor: Kim Weaver**

# Outline

- **Introduction: NGC 1052 and our radio/XR observing campaign.**
- ***Suzaku* spectrum of the central engine: continuum and Fe-K line parameters.**
- **Are we seeing a link between jet formation and structural disruptions in the inner accretion disk?**
- **Evidence for reflection in the inner disk?**
- **Conclusions and future work.**

# NGC 1052: Our Multi- $\lambda$ Campaign



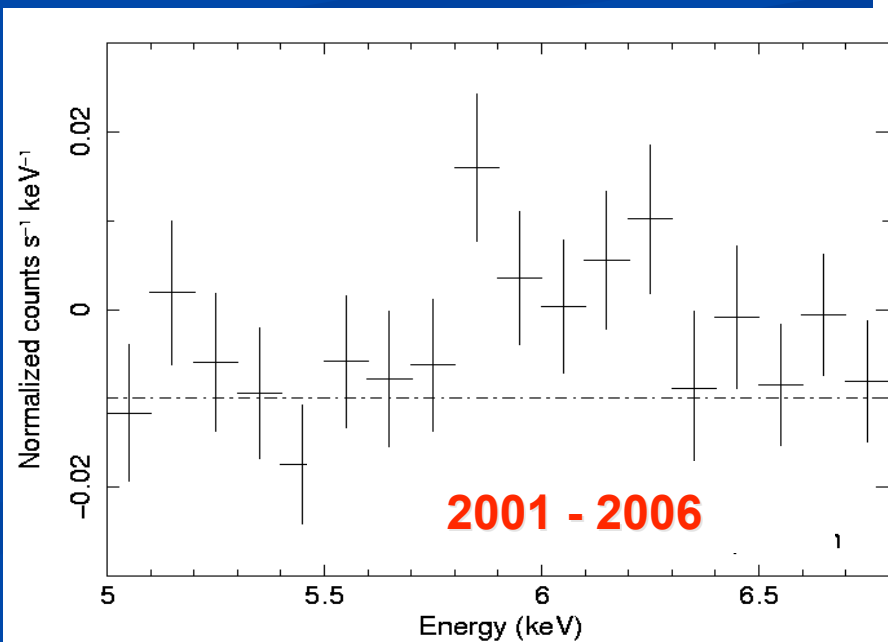
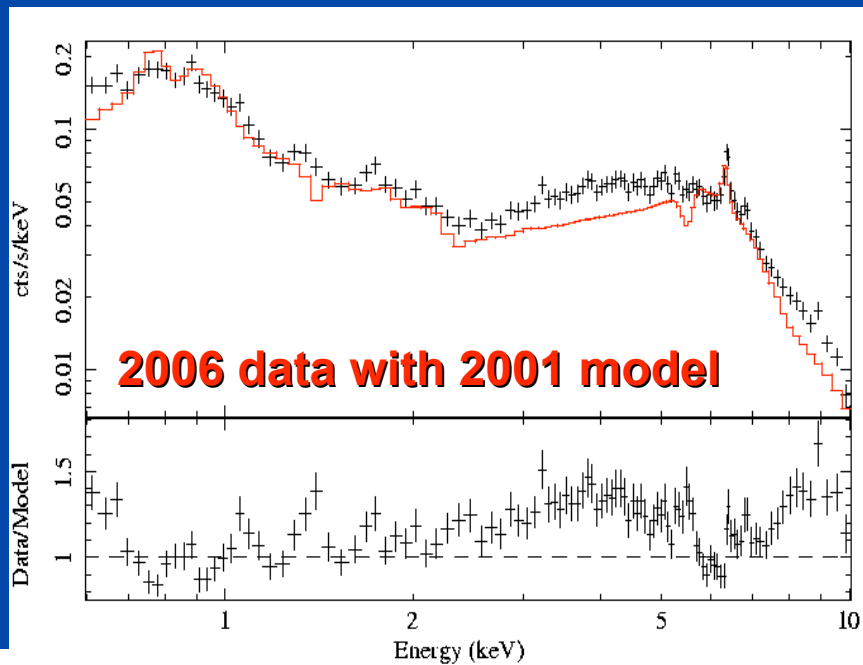
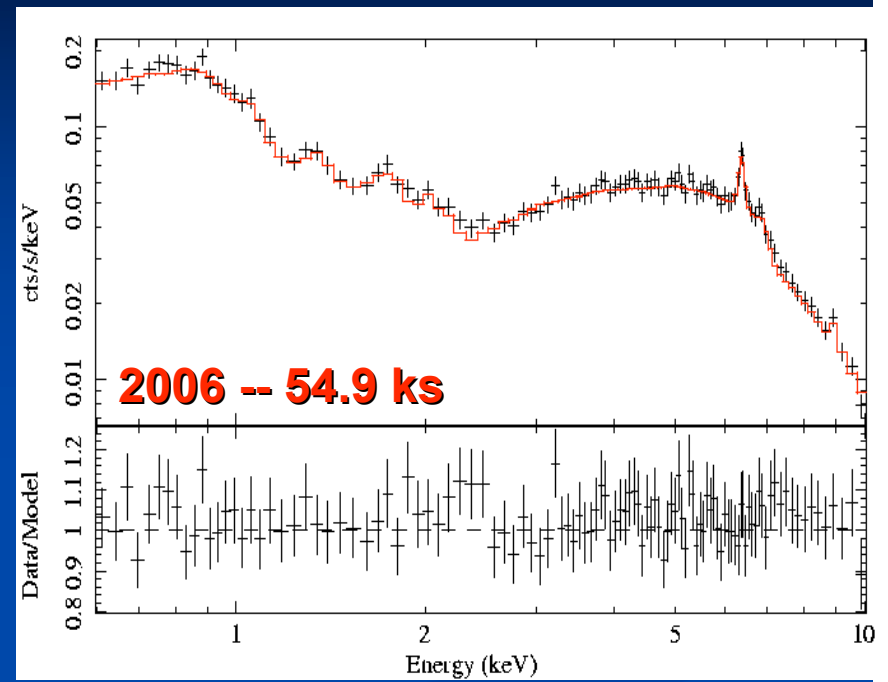
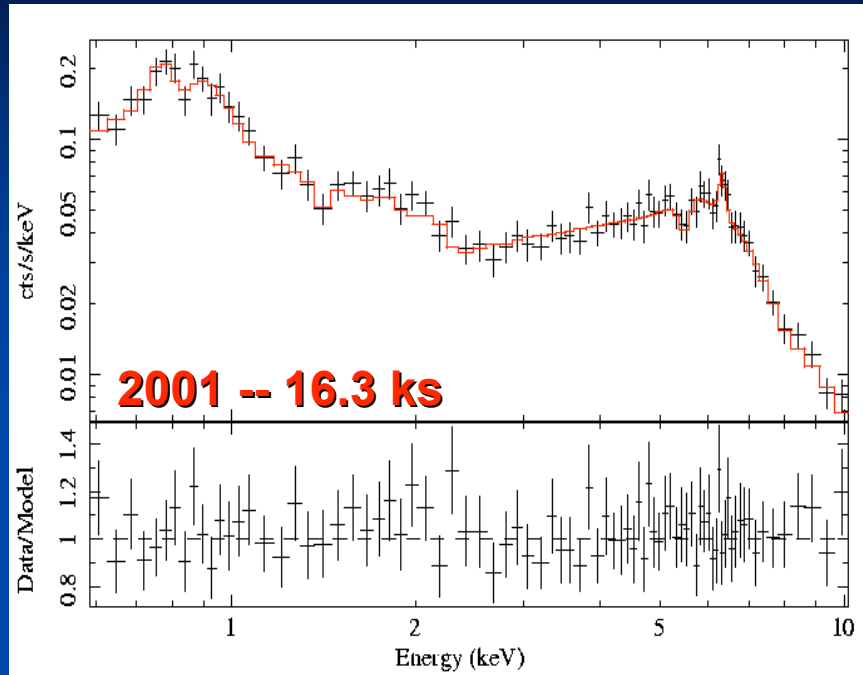
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# A Link Between Jet Formation and Changes in Accretion Flow?

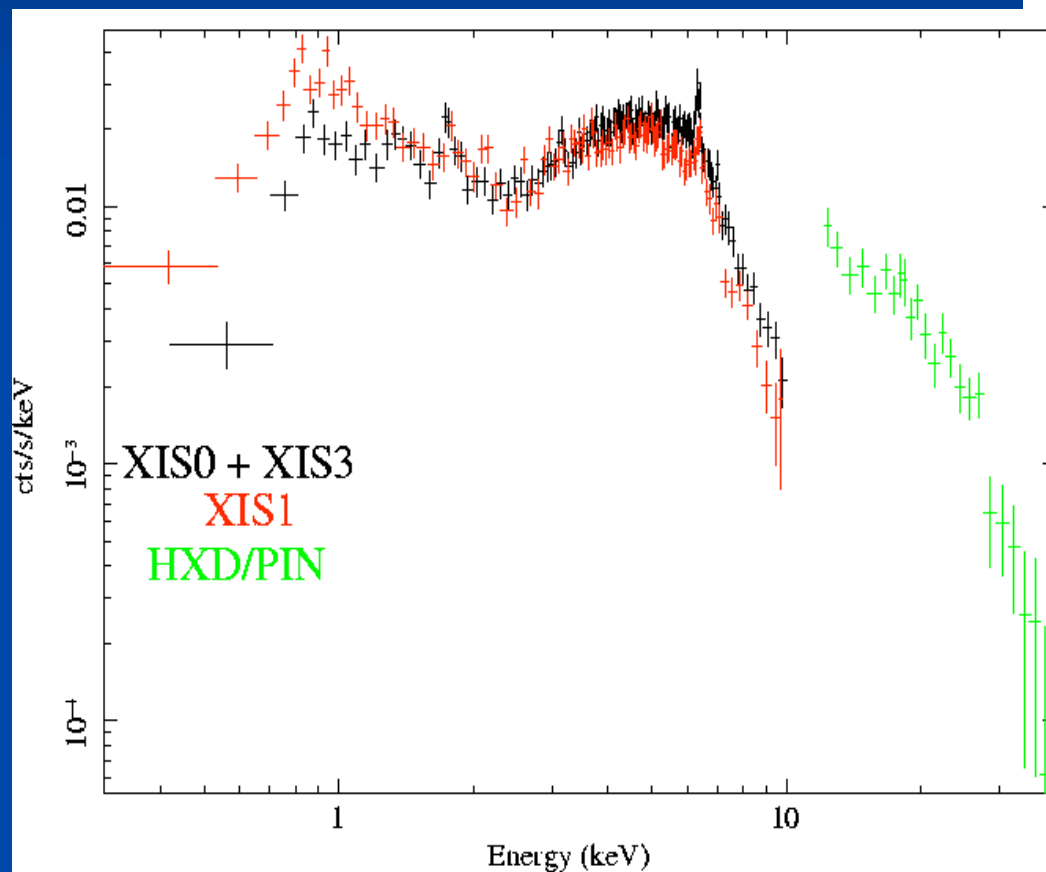
- Observations to test theories of jet production in AGN are elusive.
- To establish a link between jet formation and accretion flow, we must show that structural changes in the jet correspond to dynamical processes in the disk.
- NGC 1052 is one of the few examples we have of an AGN with active jets and a broad iron line with enough proximal radio and XR observations to trace out the structure of and conditions in the inner accretion disk!
- 2-10 keV spectrum varies on same timescale as radio emission, switching from soft to hard states in a qualitatively similar way to Galactic microquasars.
- Ejection of jet “blobs” in radio coincides with a low/hard XR state (*RXTE*) and a strong outburst at high  $\nu$  in radio.
- Broad Fe-K $\alpha$  line also detected; variable between epochs (*XMM*, *Suzaku*).

# Previous *XMM* Observations



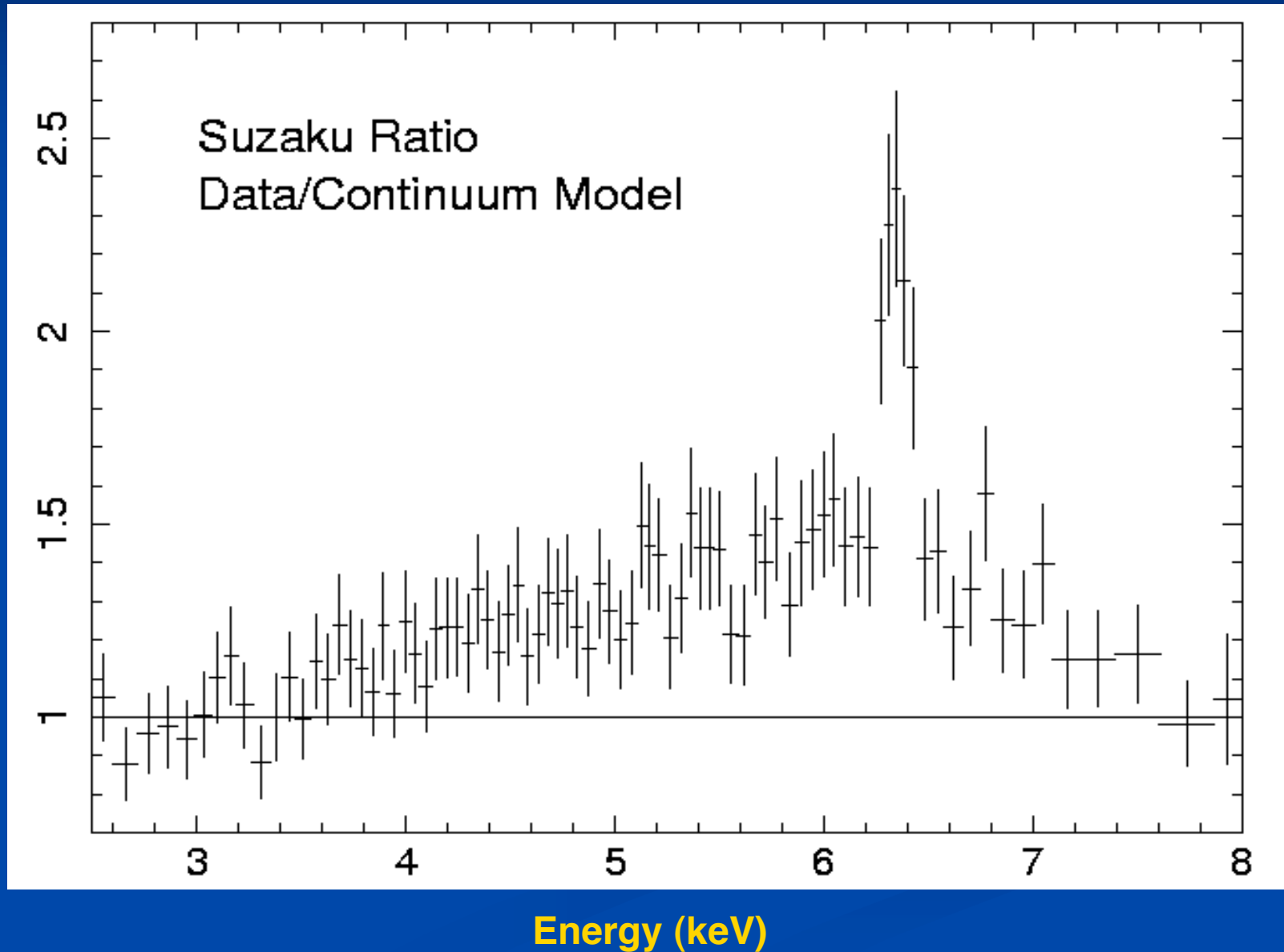
# 2007 *Suzaku* AO2 Observation

- Observed July 16-18, 2007.
- Total Exposure: 100.7 ks.
- Count rates: XIS = 0.13 cts/s, HXD/PIN = 0.59 cts/s.
- HXD response current as of October 17, 2007.
- HXD/GSO did not detect source above background.
- Data reduction on XSELECT, using *Suzaku* FTOOLS as per ABC guide.
- Spectral analysis using XSPEC12.

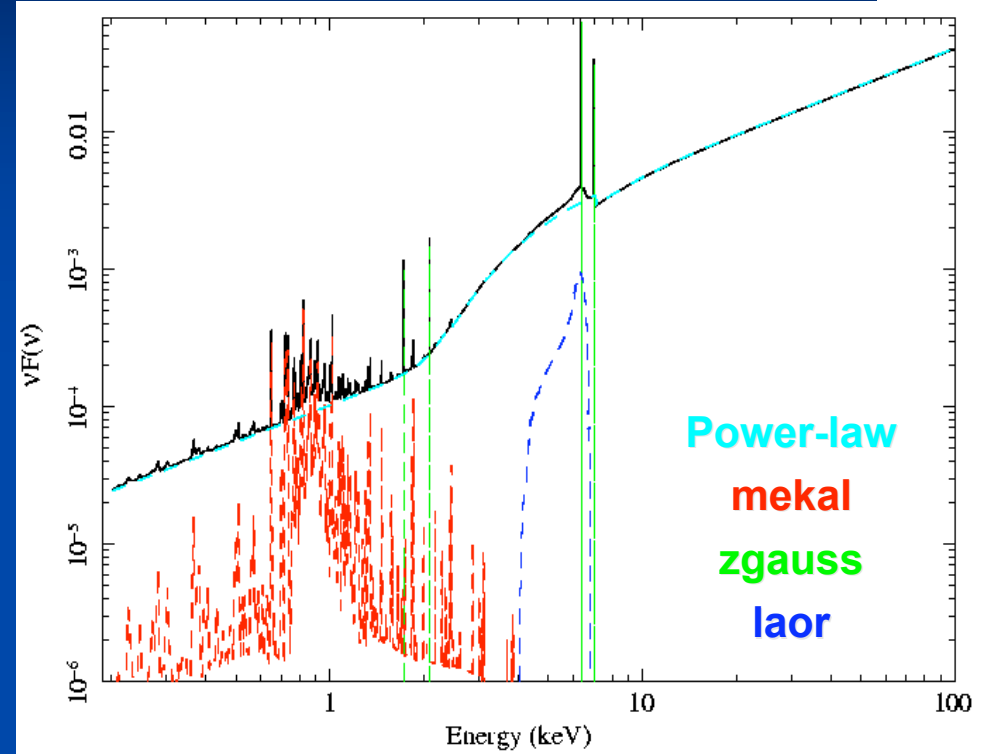
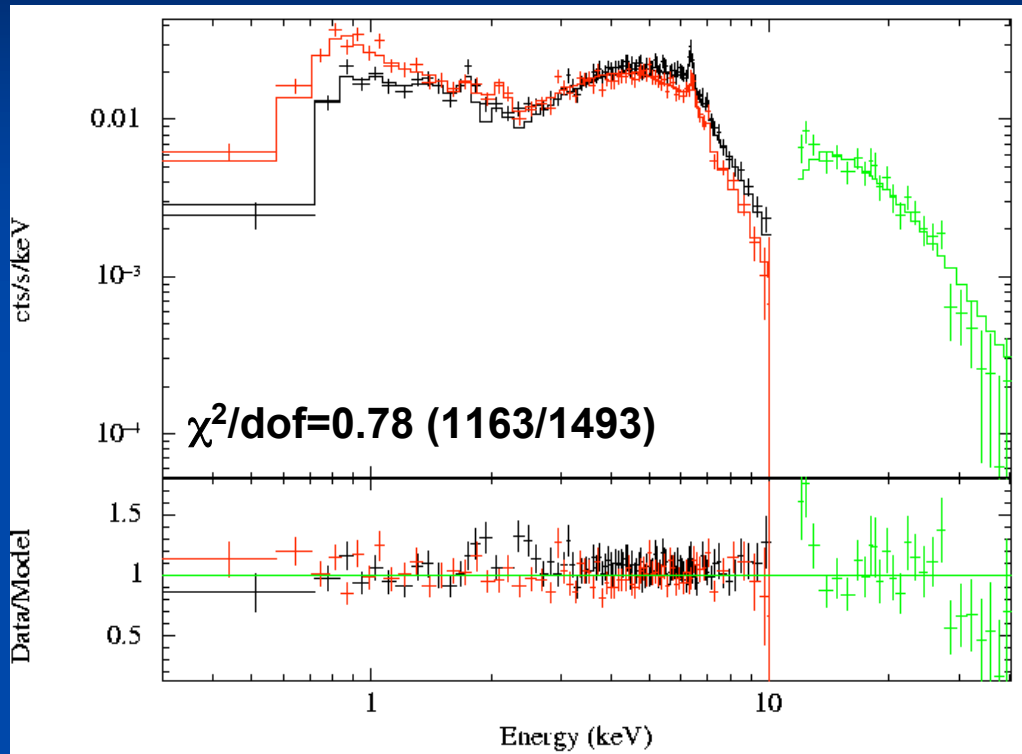


# The Fe-K Line Residual

Data/Model



# Our Best-fit Model



**Pcfabs**:  $nH=6.98 \pm 0.64e+22$  ,  $\text{frac}=0.82 \pm 0.03$

**Zedge**:  $E=7.11$  keV,  $\tau < 0.12$  (marginal)

**Power-law**:  $\Gamma=1.05 \pm 0.10$ ,  $\text{flux}=5.51 \pm 1.10e-4$  ph/cm<sup>2</sup>/s

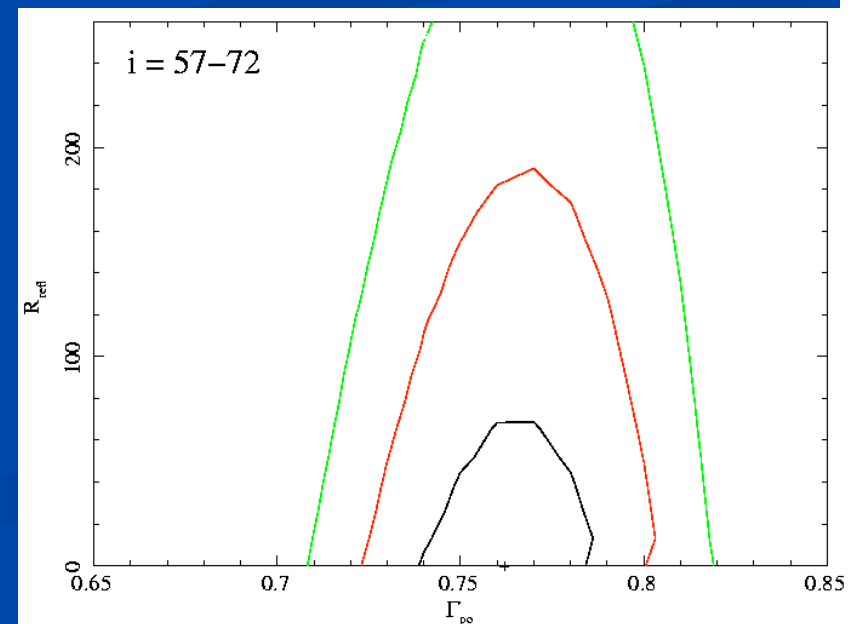
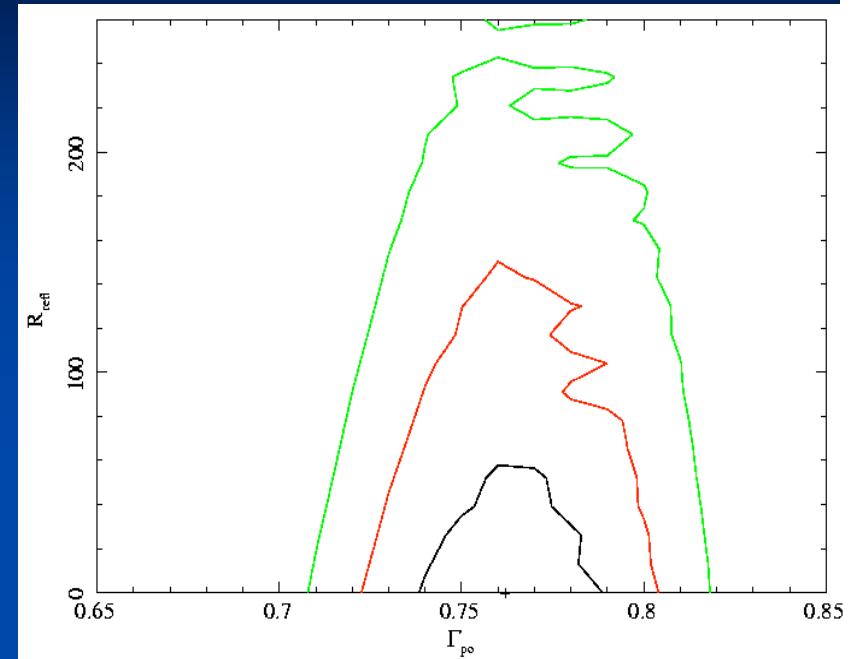
**Mekal**:  $kT=0.62 \pm 0.04$  keV,  $\text{abund}=0.84 \pm 0.84$  (x solar)

**Laor**:  $E=6.4$  keV,  $\alpha=3.29 \pm 0.45$ ,  $r_{\text{in}}=2.37 \pm 0.55 r_g$ ,  $r_{\text{out}}=400 r_g$ ,  $i=35 \pm 7$ ,  
 $\text{flux}=6.25 \pm 2.33e-5$  ph/cm<sup>2</sup>/s



# Signatures of Reflection?

- No prominent Compton “hump” seen peaking around  $\sim 30$  keV.
- Is this indicative of little reflection? Heavy intrinsic absorption?
- This source does show a broad (EW  $\sim 300$  eV) Fe-K line: significant improvement in fit seen when a laor line added vs. simple Gaussian.
- We should expect to see reflection, but don't...
- Other AGN known to show broad Fe-K lines have also not had reflection humps detected with *Suzaku* (e.g., NGC 2992; Yaqoob et al. 2007).
- PIN background calibration??



# Physical Implications of our Results

- Significant continuum and broad Fe-K line variability seen between different epochs with *XMM* and *Suzaku*.
- No evidence for Compton reflection “hump” at  $\sim 30$  keV... puzzling, given the robust detection of a broad Fe-K line, and perhaps indicative of background calibration issues with the HXD/PIN (need for longer exposures).
- High precision, low accuracy: 2 *XMM* pointings and 1 *Suzaku* pointing show range in laor disk inclination between  $30$ - $60^\circ$ ... clearly disk is not changing its inclination in such a short period of time; should be closer to edge-on given radio observations.
- Unknown what changes in the broad line mean, physically... laor is clearly not an accurate description of the broad Fe-K line profile, though. ADAF, etc.?

# Future Work

- Currently finishing *Suzaku* data analysis from our AO2 observation (Brenneman et al., 2008, in prep.).
- Radio/XR campaign is ongoing: *VLBA* (3-4 observations per year), *RXTE* (every 3 weeks) and *Swift*/BAT monitoring (every 1-2 months).
- We have proposals in for longer *XMM* and radio-triggered *Suzaku* (coincident with *Swift*) observations to track the Fe-K line morphology at different epochs, tracing the accretion flow and disk structure, and to determine whether other Compton reflection signatures are truly absent from this source.

# References

- **Brenneman *et al.*, 2008, in prep.**
- **Kadler *et al.*, 2004a, A&A, 426, 481.**
- **Kadler *et al.*, 2004b, A&A, 401, 113.**
- **Kadler *et al.*, 2008, in prep.**
- **Vermeulen *et al.*, 2003, A&A, 401, 113.**
- **Weaver *et al.*, 1999, ApJ, 520, 130.**
- **Yaqoob *et al.*, 2007, PASJ, 59S, 283.**