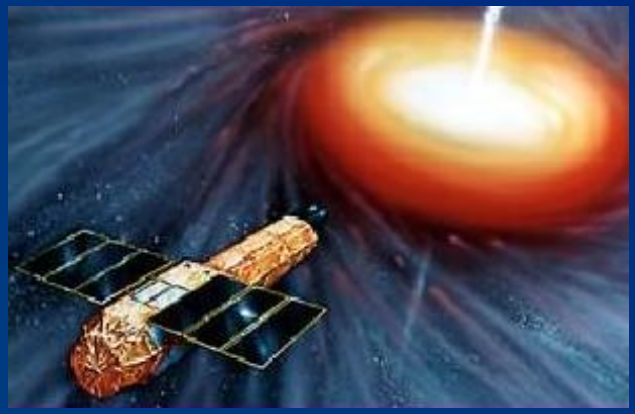
The Suzaku View of Fe Kα Emission Features in Seyferts



Alex Markowitz

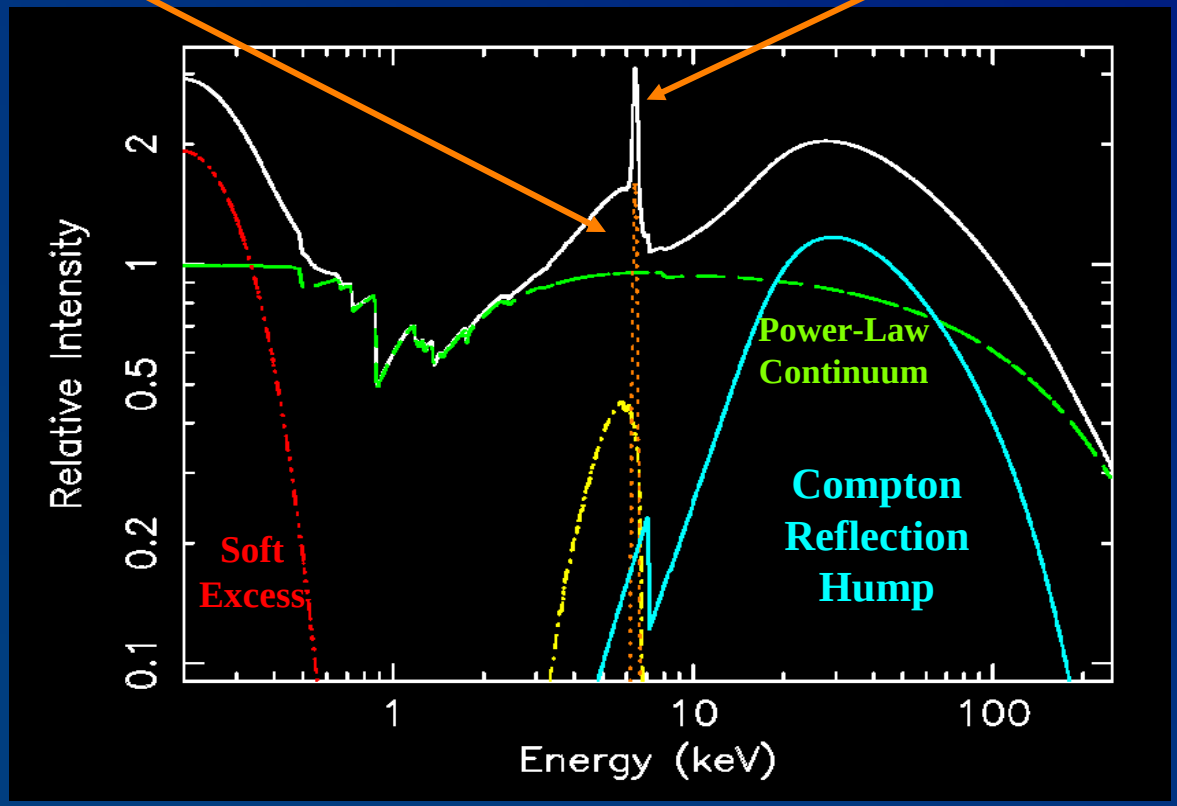
(UCSD/CASS)

Including results from: J. Reeves (Keele), G. Miniutti (IoA), T. Yaqoob (JHU), J. Kataoka (Tokyo Tech), T. Okajima (GSFC), G. Ponti (Bologna), R. Mushotzky (GSFC), A. Fabian (IoA), H. Kunieda (Nagoya), T. Takahashi, S. Watanabe, K. Nakazawa, M. Kokubun (JAXA/ISAS), and MANY others ….

Typical Sy 1 X-ray Spectrum

Relativ. Broad Fe Kα lines
Accretion Disk
FWHM ~ 0.2c

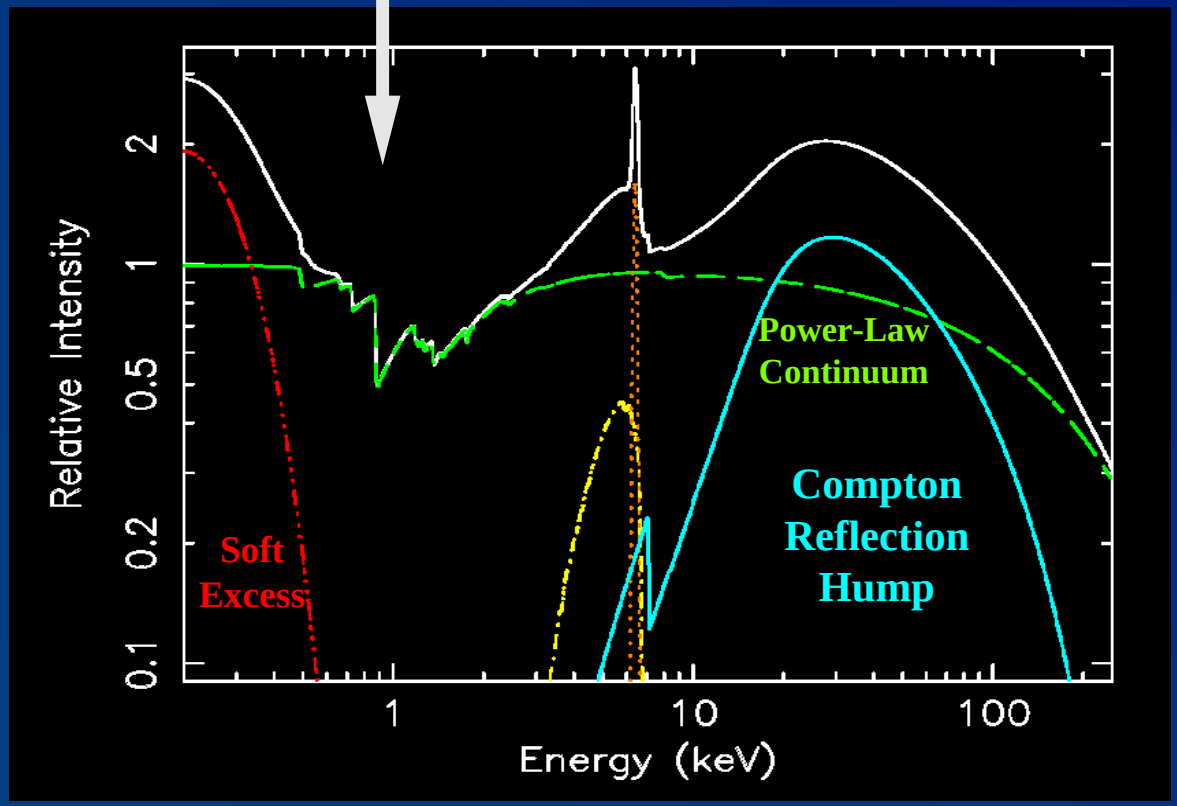
Narrow Fe Kα lines
BLR? Torus?
FWHM ~ $10^{3\text{-}4}$ km/s



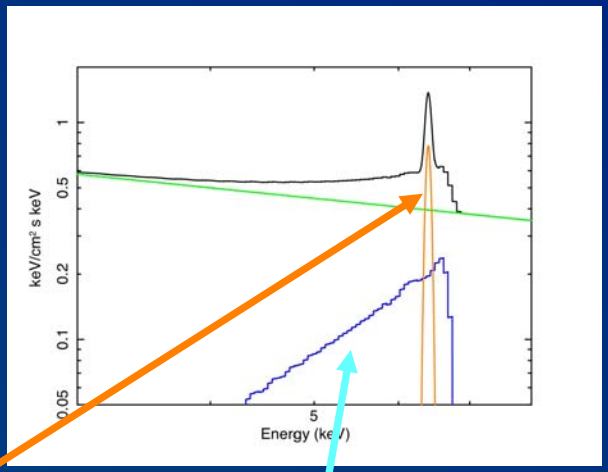
Typical Sy 1 X-ray Spectrum

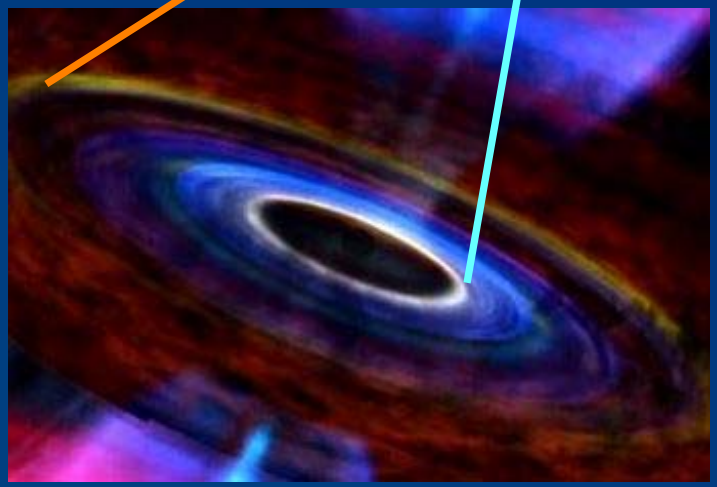
Absorbers in Seyfert 1s:
Ionized (warm) absorbers
(e.g., Fe L edges 1-2 keV)

- Solve degeneracy between power-law continuum, Compton hump, broadband absorbing components, disklines
- Completely deconvolve NLs, BLs



Broad Fe lines in Seyferts: How common are they?



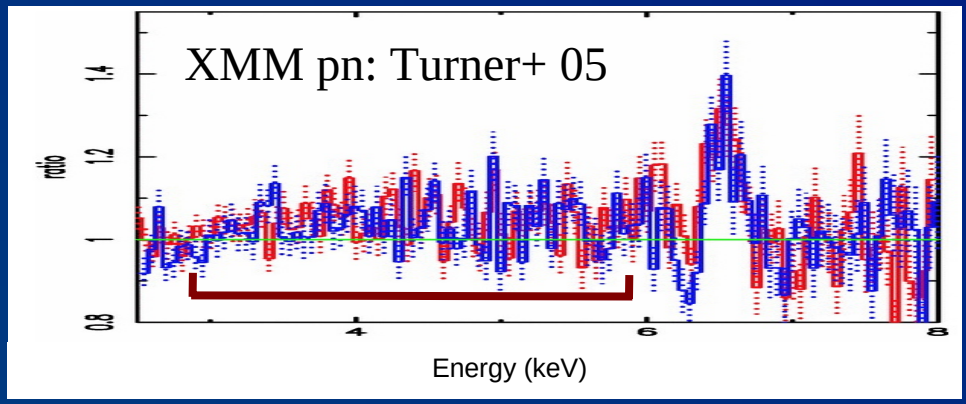


Sample observed w/ XMM-Newton (Nandra+ 07):

Narrow Line: ubiquitous

Broad Line: ~40-70% (depending on model used)

NGC 3516:



Partial-Covering / Broad Fe Line: degeneracy

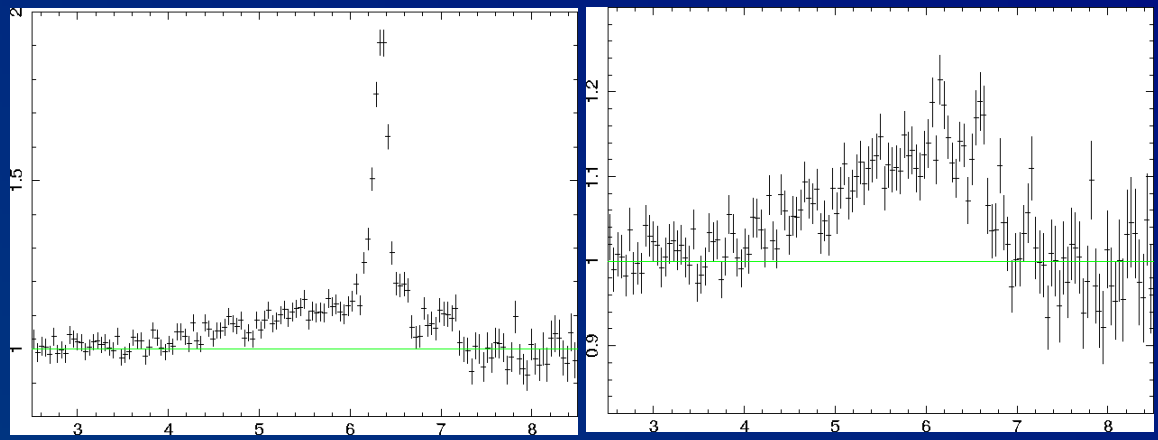
Suzaku: Deconvolving Broad & Narrow Fe Lines

NGC 3516

150 ksec obsn., 2005 (Markowitz+ 08)

$R_{in} < 5\ R_g$

$i = 25 \pm 8^o$



Fe line still required in model even after 2 WA's and PC low-ξ absorber taken into account!

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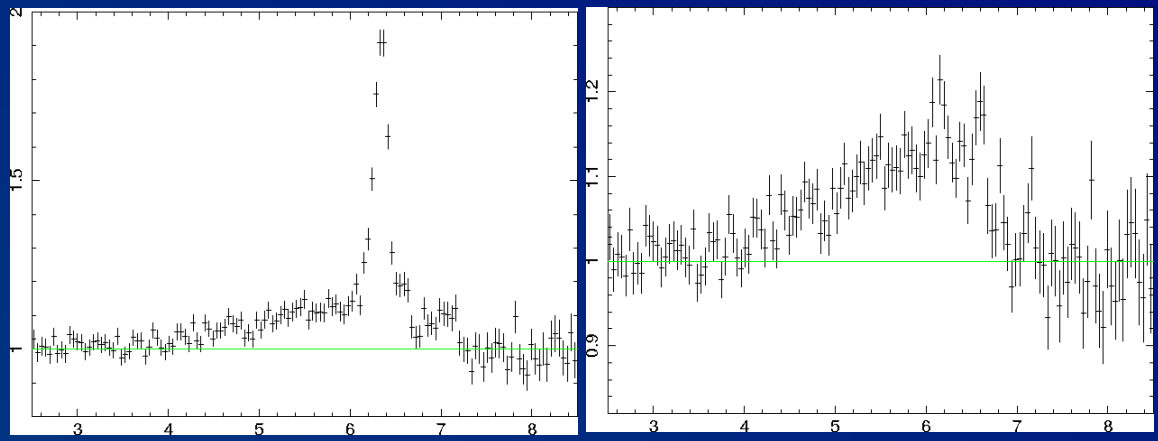

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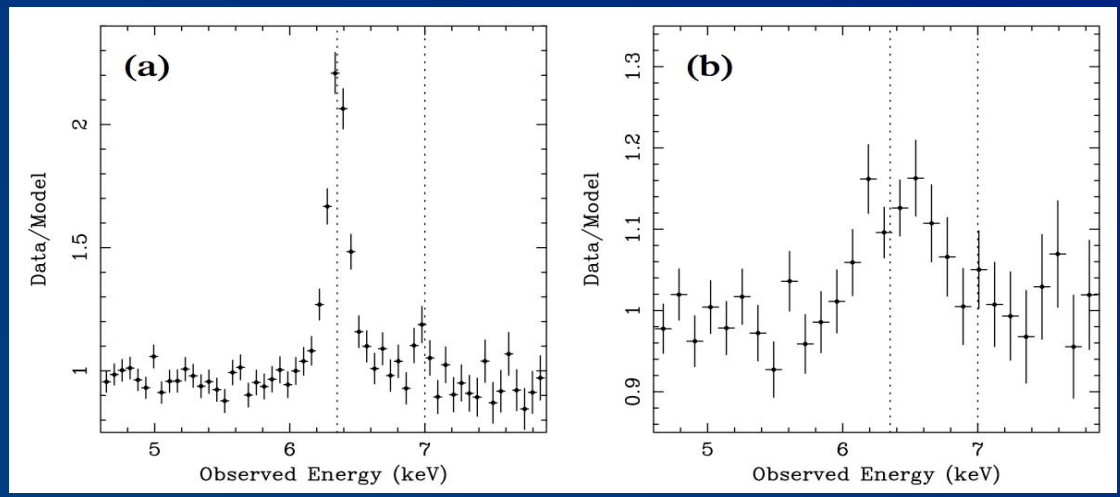
NGC 2992

110 ksec obsn., 2005
(Yaqoob+ 07)
$R_{in} = 6\ R_g$ $\quad i > 31^o$



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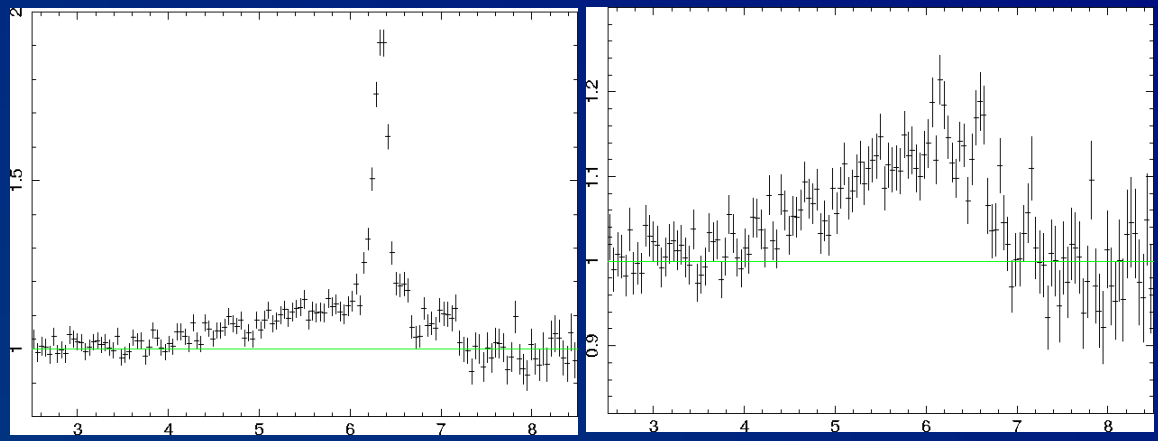

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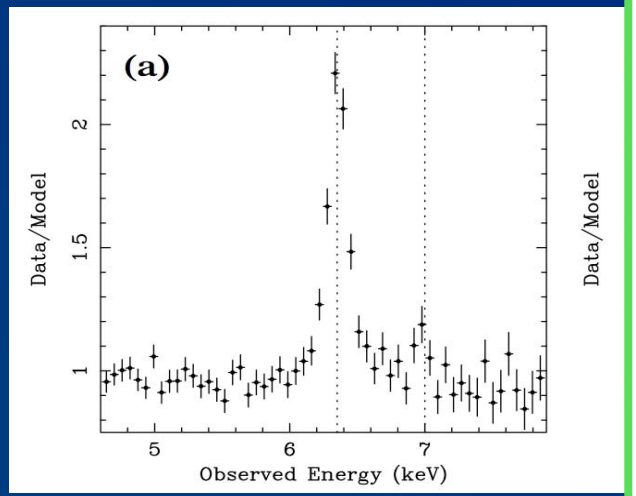
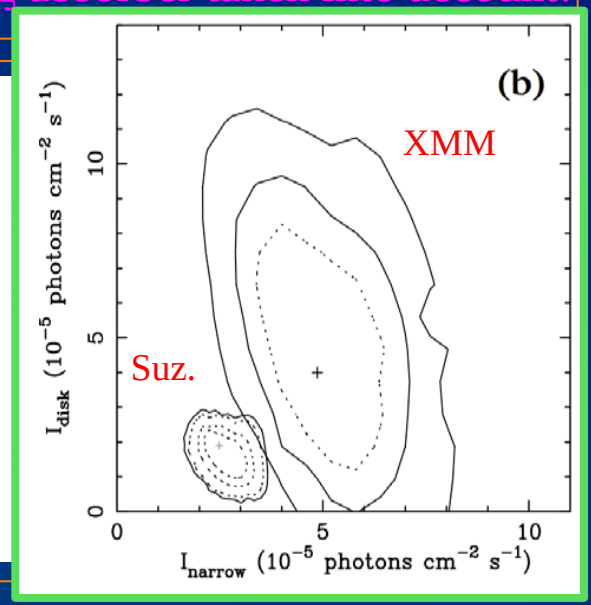


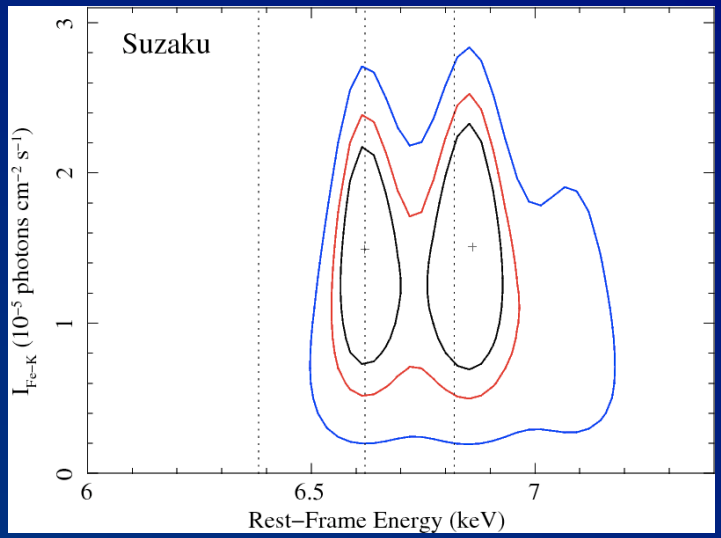


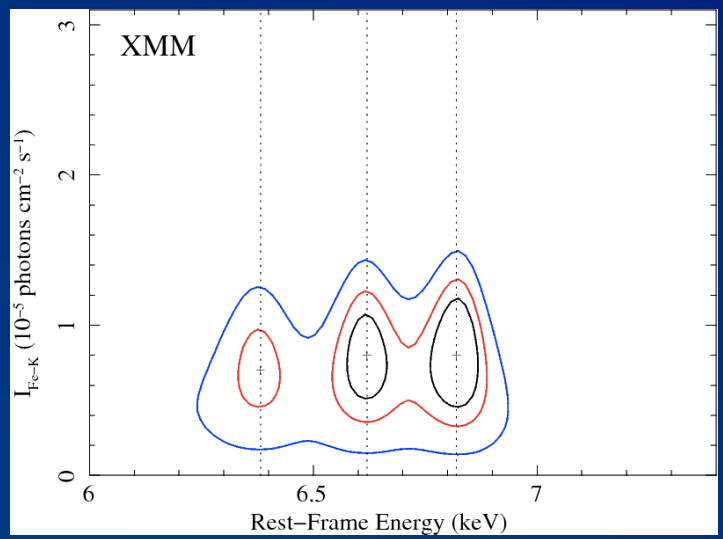
Suzaku-XIS: Narrow Emission Lines in 3C 273

Yaqoob et al., in prep:

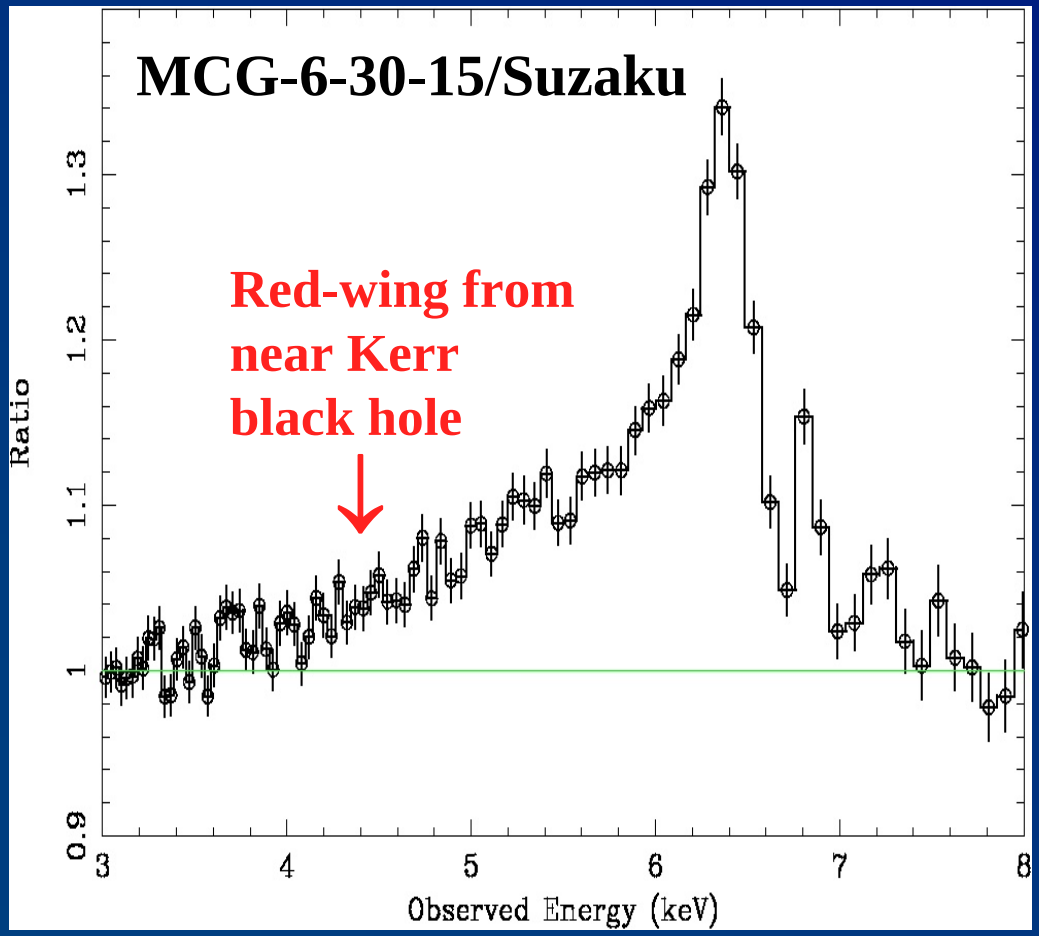
Suzaku: 47 ksec obsn., 2007: Narrow emission lines due to Fe XXV+Fe XXV.

XMM-Newton: 10 obsns (130 ksec) , 2000-3





Probing effects of strong gravity



300 ksec observation of MCG–6-30-15 (Miniutti et al. 2007)

$R_{in} < 2.2\ R_g$

Spin parameter
a_* > 0.917

*But see also paper by L. Miller et al., arXiv/0803.2680

Summary (so far): Relativistic Fe Lines from Suzaku

Broad Lines /reflection

- **MCG -6-30-15*:** Strong broad line, (EW=200 eV) + reflection (R~3) (Miniutti+ 07)
- **MCG -5-23-16**: R_{in}=20-30R_g. Moderate refl. (*R*=1.2) (Reeves+ 07)
- **NGC 2992**: Narrow+broad deconvolved (Yaqoob+ 07)
- **NGC 3516**: Broad line + reflection robust to complex absorber. (Markowitz+ 08)
- **3C 120**: Mod. strong broad line, R_{in}=10R_g. Weak reflection (*R*=0.6) (Kataoka+ 07)
- **NGC 3783**: Weak broad line, weak refl. (*R*~0.3) (Markowitz+, in prep.)

No Broad Lines

- **NGC 2110**: No broad line and no reflection (Okajima+ 08)
- **NGC 7213**: No broad line; weak reflection (Reeves+, in prep.)
- **NGC 5548:** Narrow line only (Elvis/Reeves+, in prep.).
- **Cen A**: No broad line nor reflection (Markowitz+ 2007)
- **3C273: Narrow Fe XXV & XXVI lines detected (Yaqoob+, in prep.)**

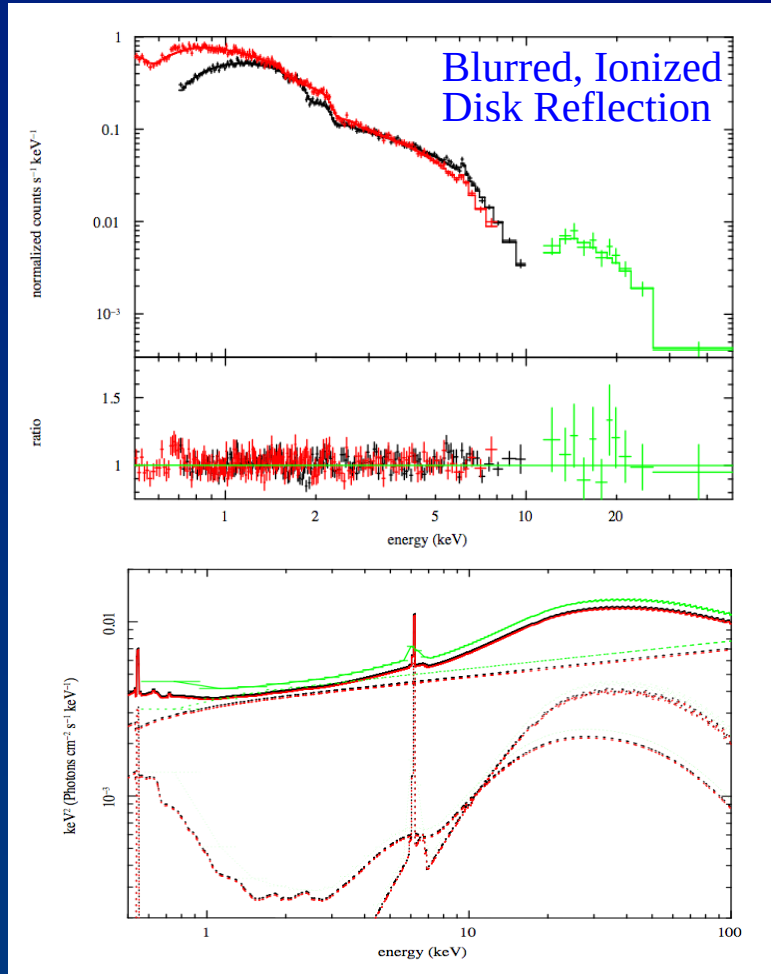
Publications on additional observed AGN forthcoming…

Suzaku broadband modeling: Blurred, Ionized Disk Reflection

Suzaku HXD/PIN is crucial in constraining the amount of Compton reflection > 10 keV!

Broadband modeling (XIS + HXD): constrain relative strengths of reflection components, remove ambiguity due to variability

G. Ponti+ (in prep.): Suz obsn of Mkn 841: ionized disk reflection model fits well (better than smeared absorption.)



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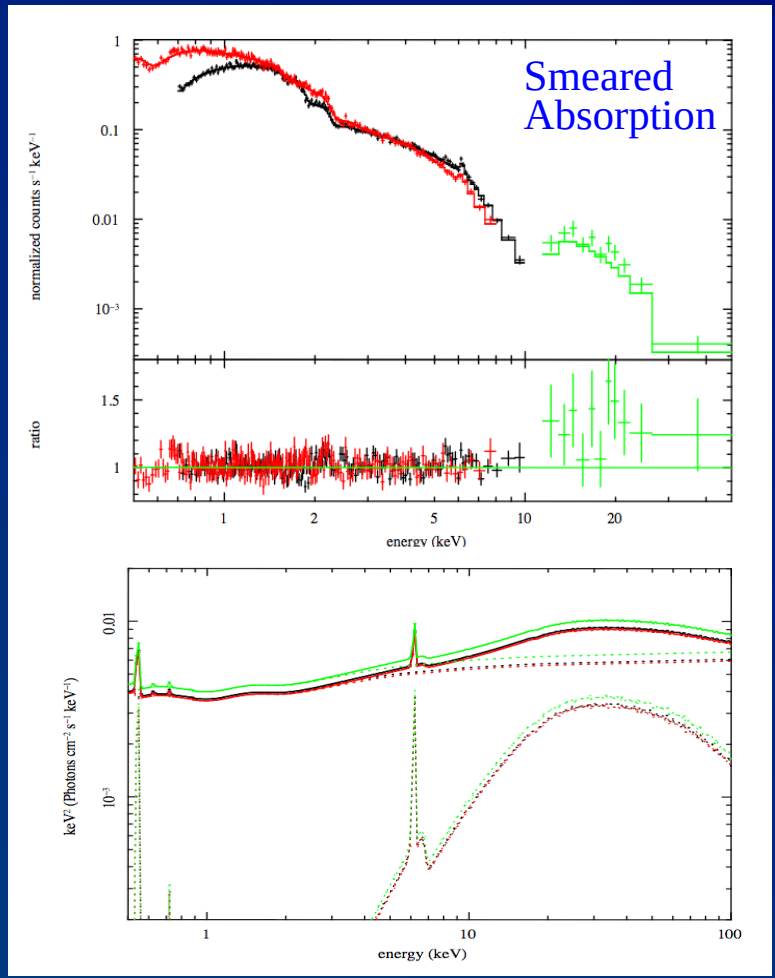
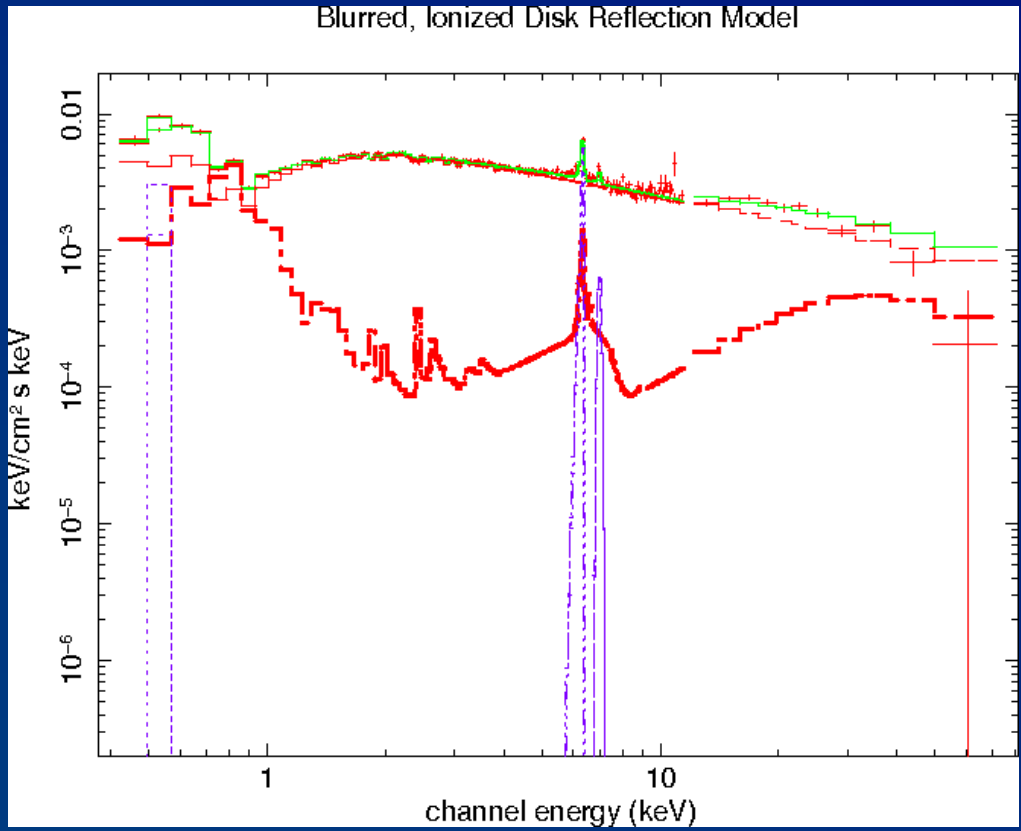


Suzaku broadband modeling: Blurred, Ionized Disk Reflection

75 ksec Suzaku observation of NGC 3783 in 2006 (Markowitz+ in prep.)

Blurred, ionized reflection describes soft excess (and full spectrum) well!



Summary

•Suzaku's broad X-ray bandpass & narrow CCD response are allowing us to deconvolve broad & narrow Fe Kα lines and (ionized + neutral) absorbing components

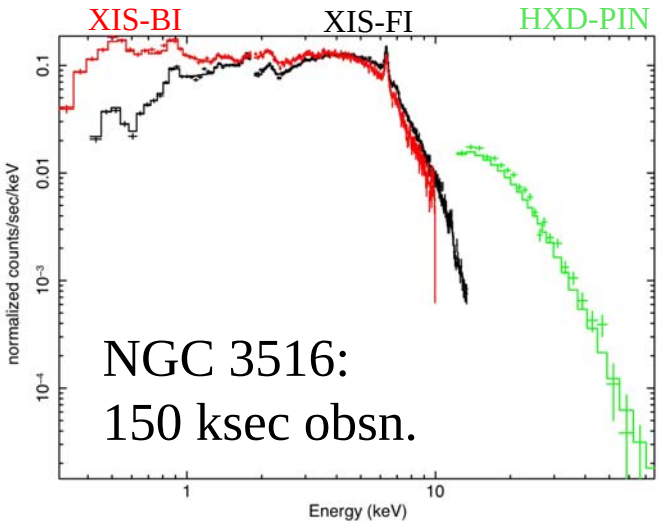
•The community is critically testing for the presence of broad Fe disklines on a per-object basis, as well as testing models incorporating blurred (disk), ionized reflection

•The sample of Seyferts observed with Suzaku is gradually accumulating; Suzaku will accurately gauge frequency of occurrence of broad Fe lines and applicability of blurred ionization reflection models.

Suzaku

(JAXA/ISAS)

- Launched 2005 July 10; AO3 observations start April '08
- **X-ray Imaging Spectrometer (XIS) CCDs:** 0.3 to 12 keV
- **Hard X-ray Detector (HXD):** 12 to >300 keV



- Broad bandpass: deconvolve broadband components (power-law, WA's, Partial Coverers, broad Fe lines)
- > 10 keV coverage (Compton reflection hump)
- Narrow CCD response: ~150 eV FWHM