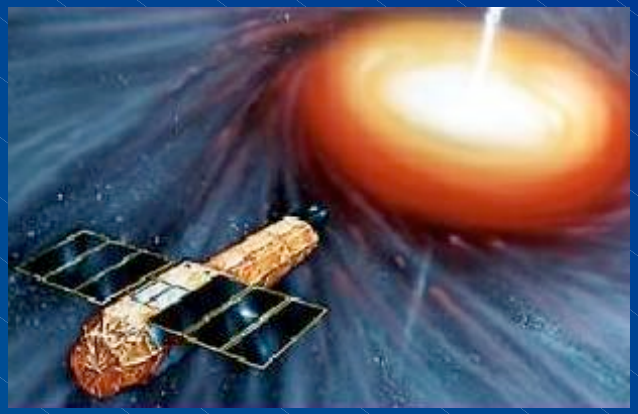
The Suzaku View of Fe Kα Emission Features in Seyferts



Alex Markowitz

(UCSD/CASS)

Including results from: J. Reeves (Keele), T. Yaqoob (JHU), G. Ponti (Bologna), Y. Terashima (Ehime), G. Miniutti (IoA), J. Kataoka (Tokyo Tech), T. Okajima (GSFC), and MANY co-authors ….

Typical Sy 1 X-ray Spectrum

Relativ. Broad Fe Kα lines

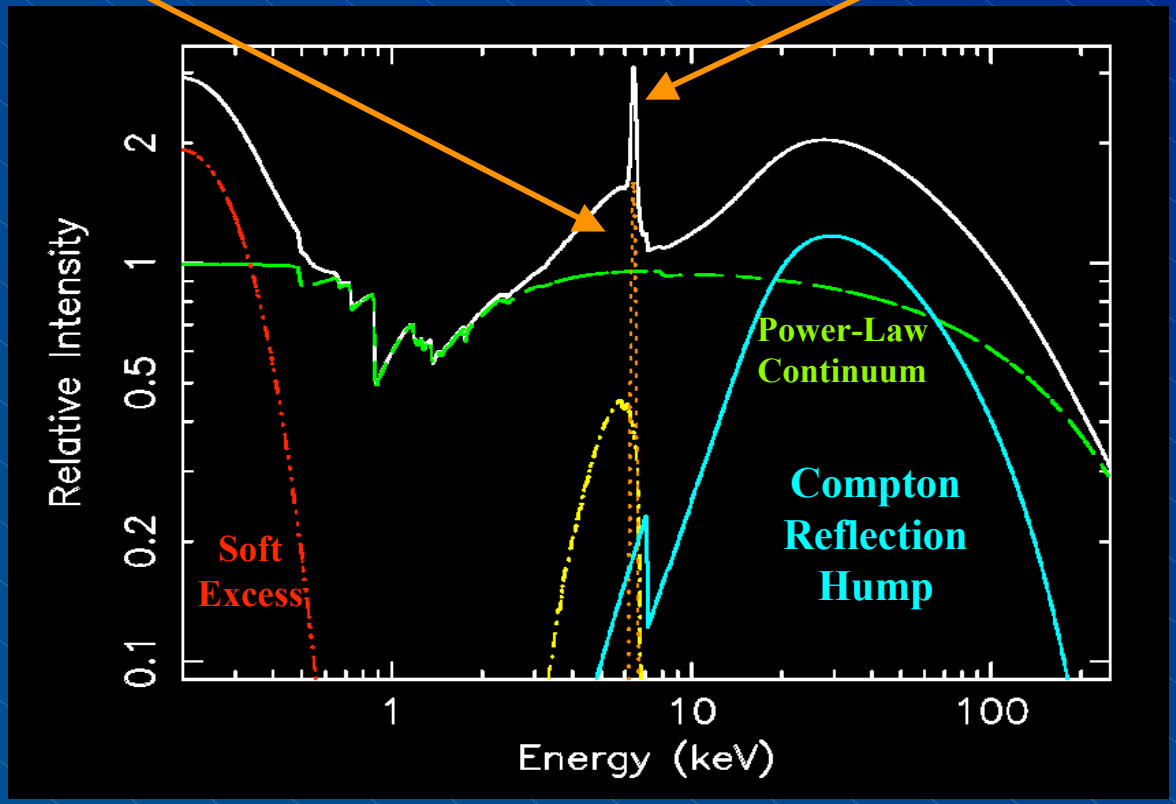
Accretion Disk

FWHM ~ 0.2c

Narrow Fe Kα lines

BLR? Torus?

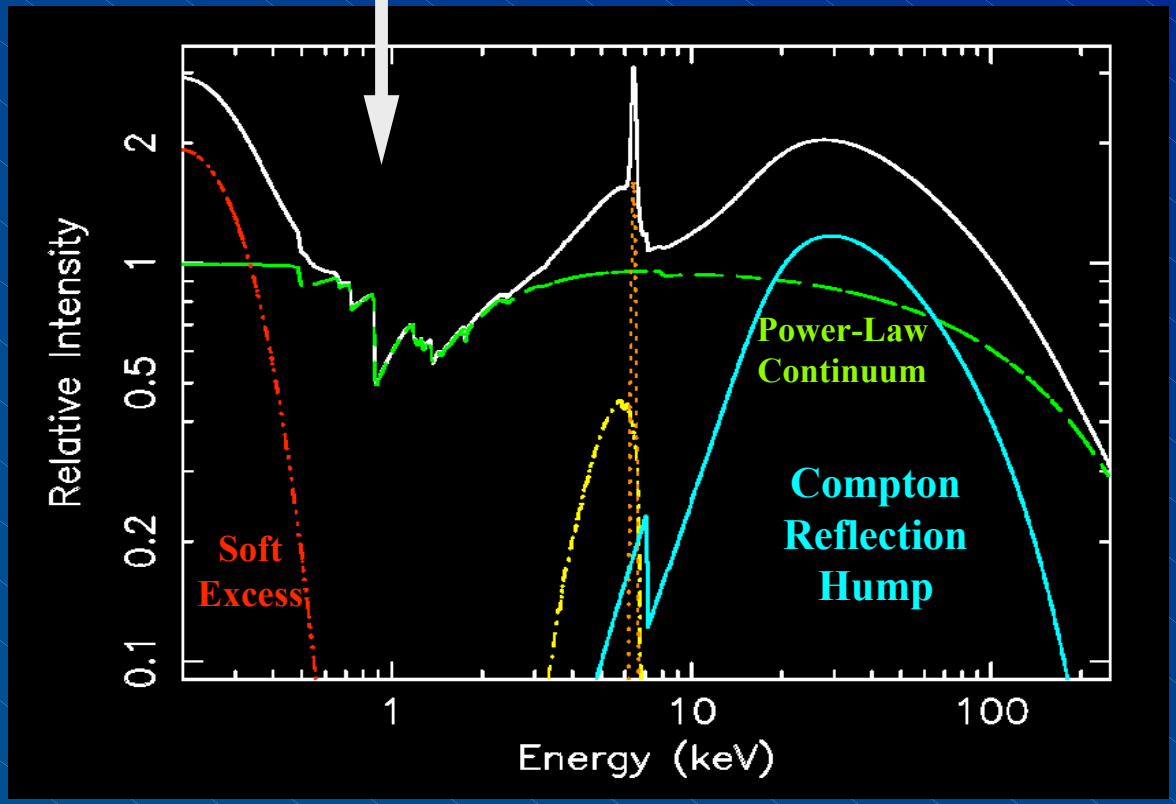
FWHM ~ $10^{3\text{-}4}$ km/s



Typical Sy 1 X-ray Spectrum

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

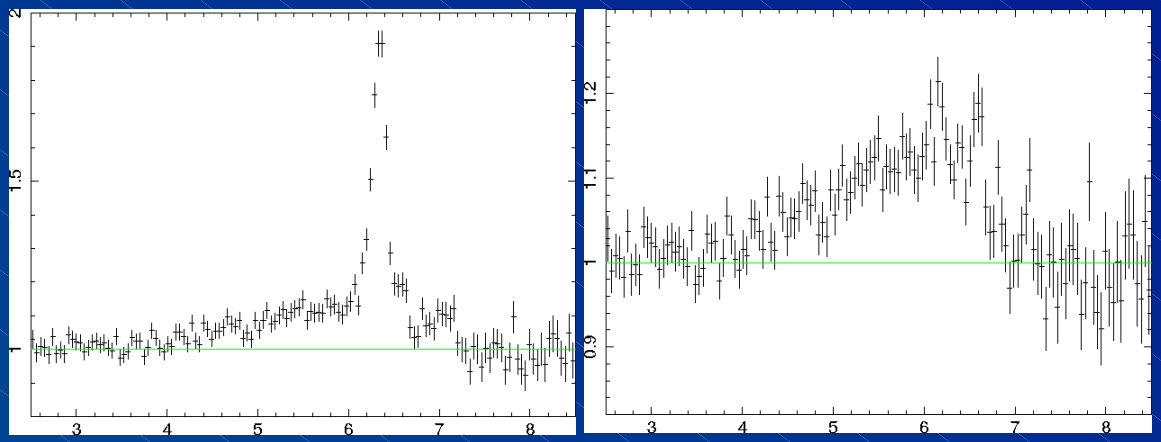
- Solve degeneracy between power-law continuum, Compton hump, broadband absorbing components, disklines
- Completely deconvolve NLs, BLs



Suzaku: Deconvolving Broad & Narrow Fe Lines

NGC 3516

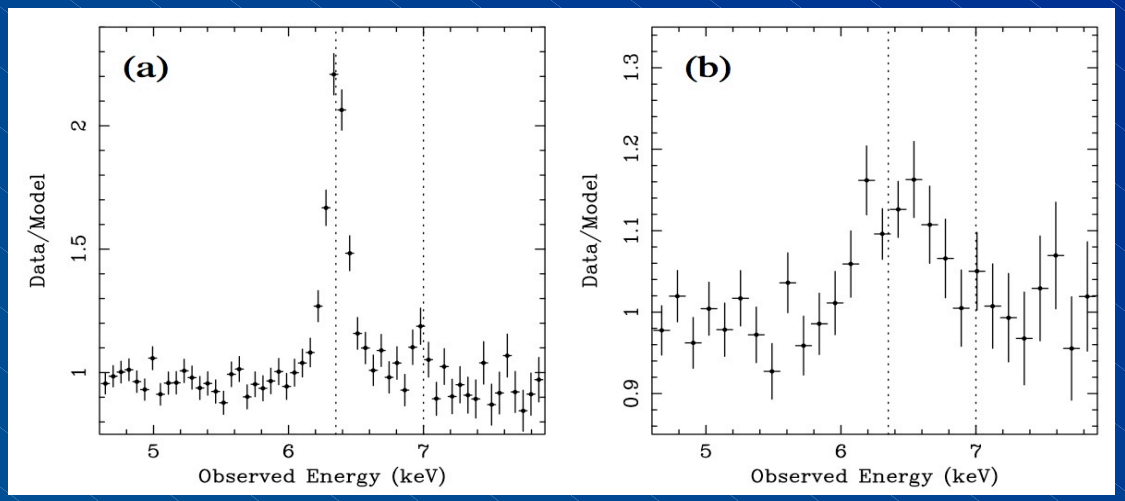
150 ksec obsn., 2005
(Markowitz+ 08)
$R_{in} < 5\ R_g$
$i = 25 \pm 8^o$



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

NGC 2992

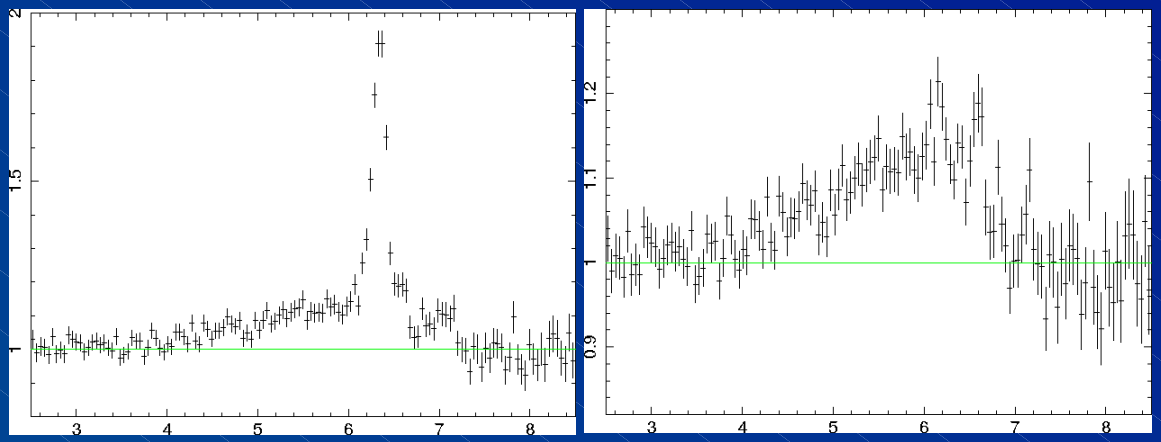
110 ksec obsn., 2005
(Yaqoob+ 07)
$R_{in} = 6\ R_g$ $\quad i > 31^o$



Suzaku: Deconvolving Broad & Narrow Fe Lines

NGC 3516

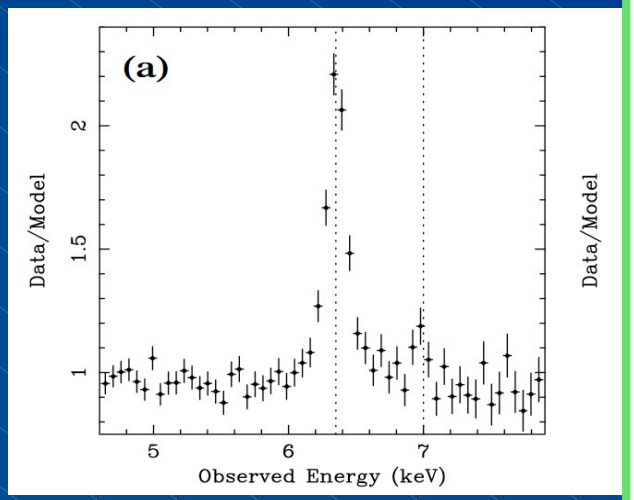
150 ksec obsn., 2005
(Markowitz+ 08)
$R_{in} < 5\ R_g$
$i = 25 \pm 8^o$

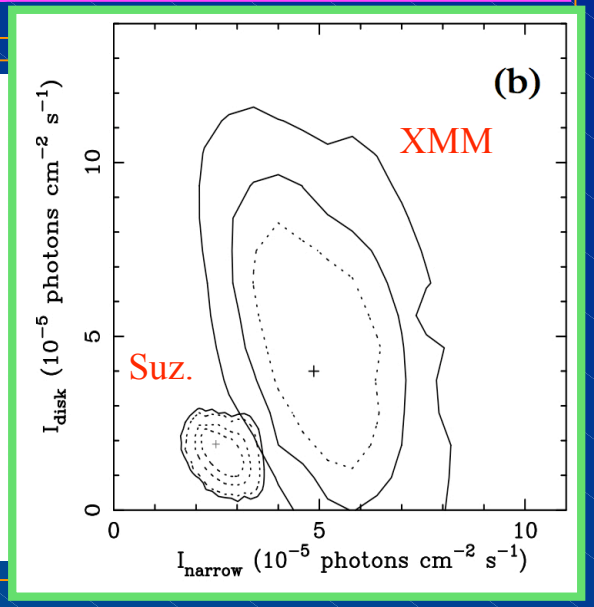


Fe line still required in model even after 2 WA's and PC low-ξ absorber taken into account!

NGC 2992

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



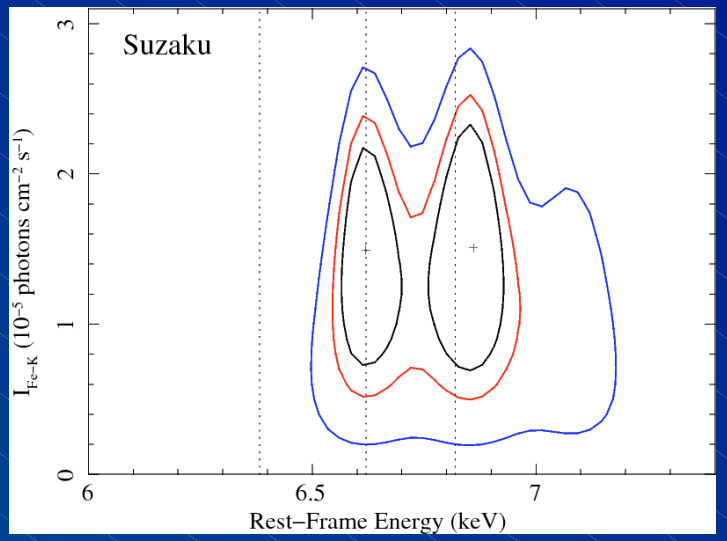


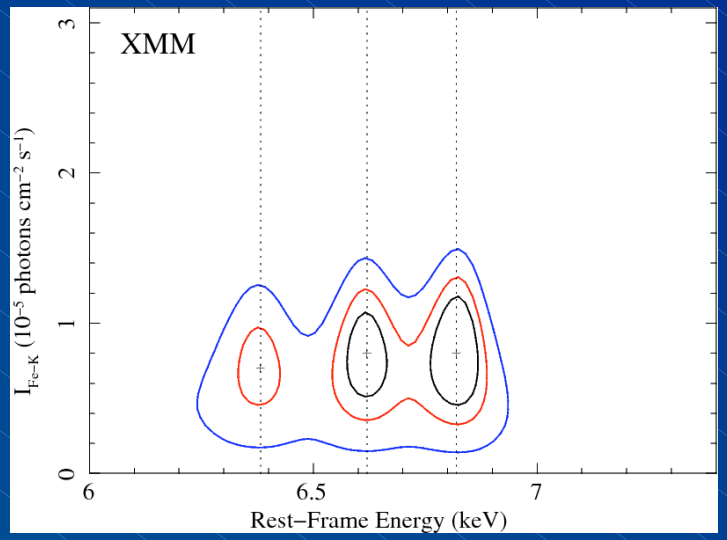
Suzaku-XIS: Narrow Emission Lines in 3C 273

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





Summary (so far): Relativistic Fe Lines from Suzaku

Broad Lines /reflection

- **NGC 3783**: Weak broad line, weak refl. (R~0.3) (Markowitz+, in prep.)
- **MCG -6-30-15*:** Strong broad line, (EW=200 eV) + reflection (R~3) (Miniutti+ 07)
- **MCG -5-23-16**: R_{in}=20-30 R_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)

No Broad Lines

- **NGC 4051:** Narrow line only (Terashima+, submitted to PASJ)
- **NGC 2110**: No broad line and no reflection (Okajima+ in prep)
- **3C273:** Narrow Fe XXV & XXVI lines detected (Yaqoob+, in prep.)
- **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)

Publications on additional observed AGN forthcoming…

Summary (so far): Relativistic Fe Lines from Suzaku

Broad Lines /reflection

- **NGC 3783**: Weak broad line, weak refl. (R~0.3) (Markowitz+, in prep.)
- **MCG -6-30-15*:** Strong broad line, (EW=200 eV) + reflection (R~3) (Miniutti+ 07)
- **MCG -5-23-16**: R_{in}=20-30 R_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)

No Broad Lines

- **NGC 4051:** Narrow line only (Terashima+, submitted to PASJ)
- **NGC 2110**: No broad line and no reflection (Okajima+ in prep)
- **3C273:** Narrow Fe XXV & XXVI lines detected (Yaqoob+, in prep.)
- **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)

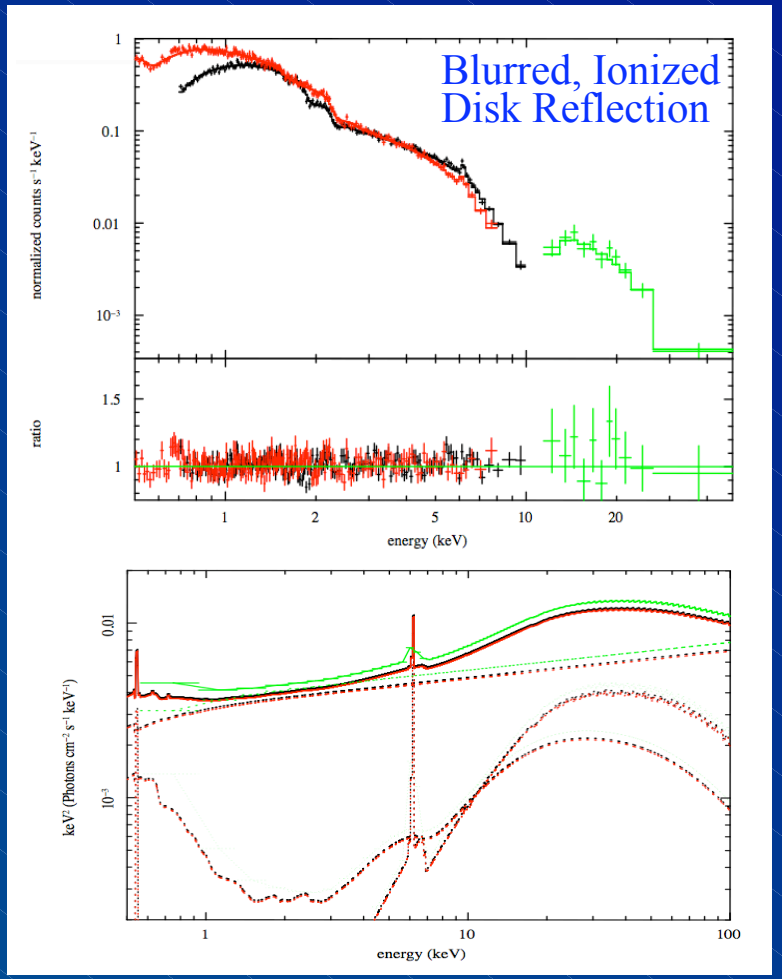
Publications on additional observed AGN forthcoming…

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.)

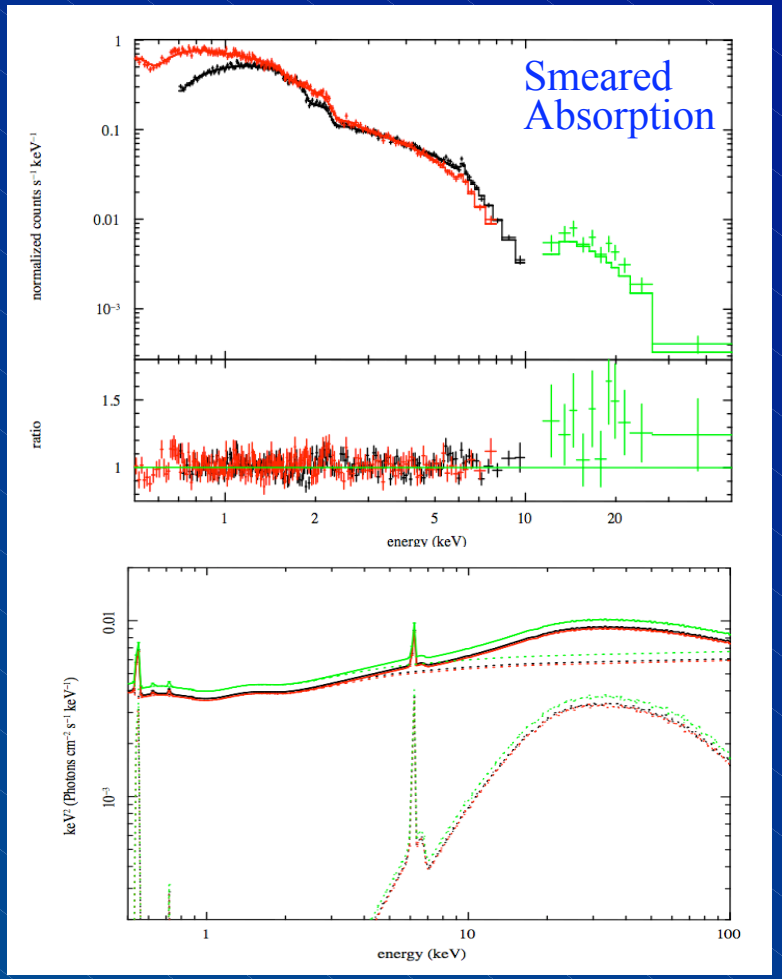


Suzaku broadband modeling: Blurred, Ionized Disk Reflection

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

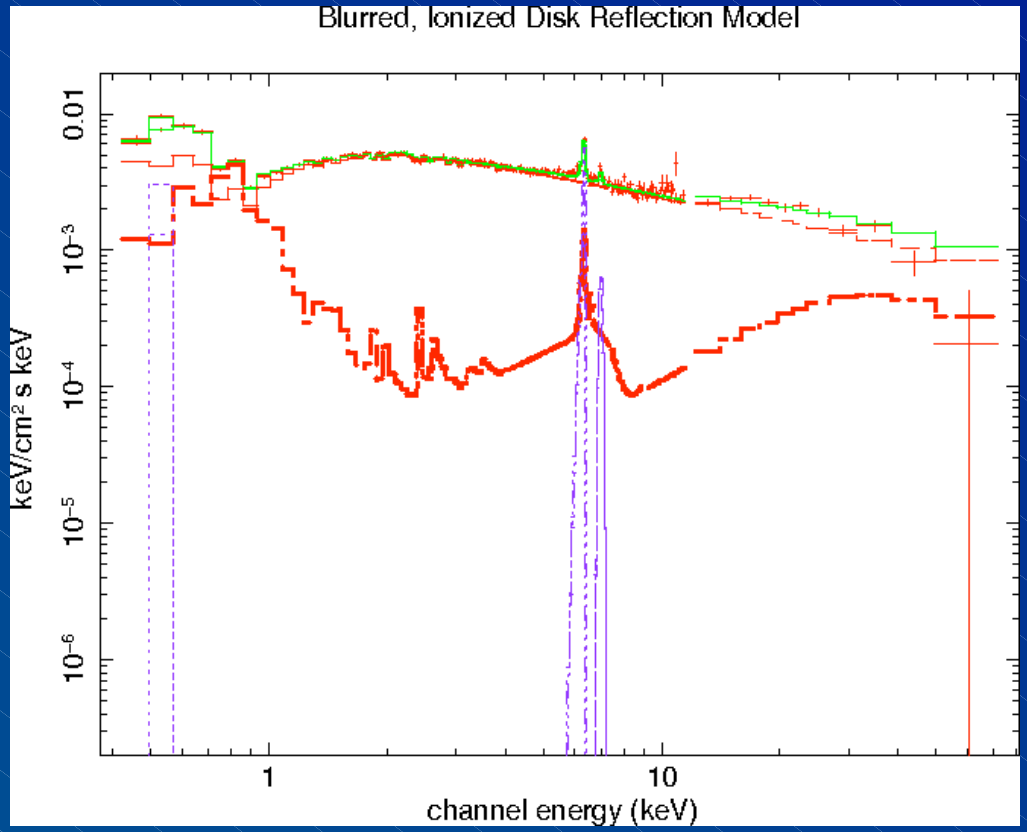
G. Ponti+ (in prep.): Suz obsn of Mkn 841: ionized disk reflection model fits well (better than smeared absorption.)



Suzaku broadband modeling: Blurred, Ionized Disk Reflection

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

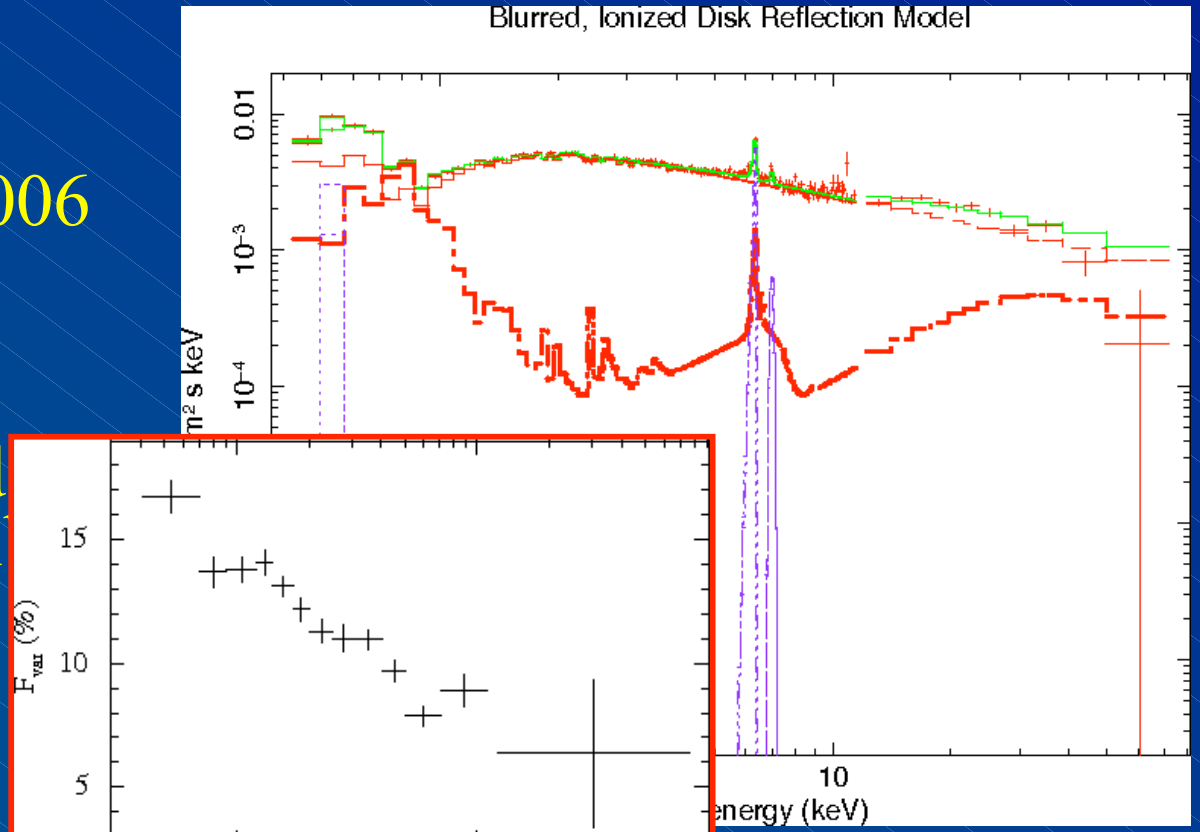
Blurred, ionized reflection describes soft excess (and full spectrum) well!



Suzaku broadband modeling: Blurred, Ionized Disk Reflection

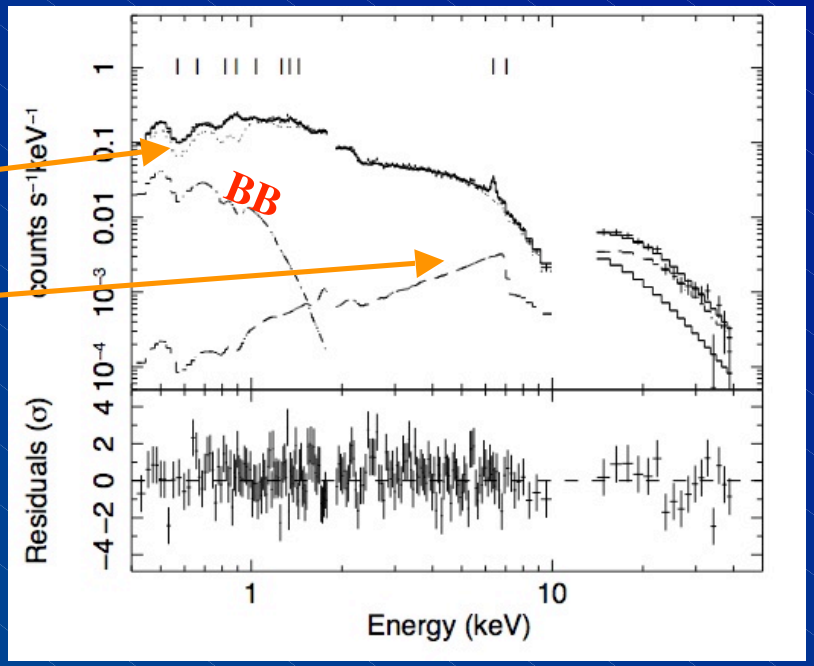
75 ksec Suzaku observation of NGC 3783 in 2006 (Markowitz+ in prep.)

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

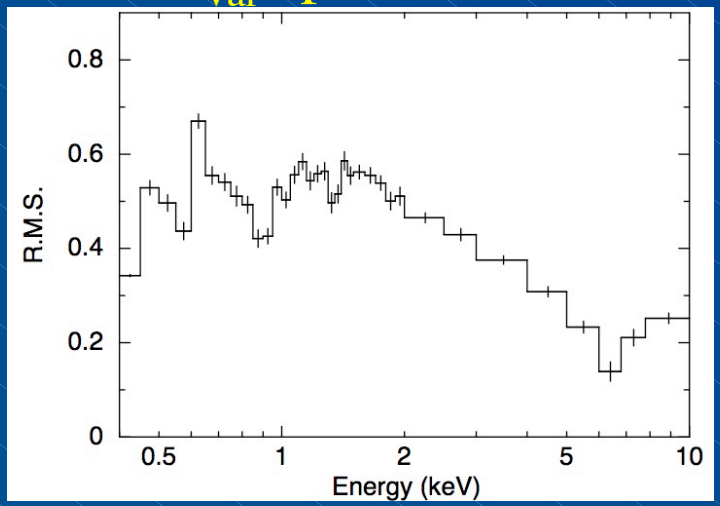


Partial-Covering Absorption Explains Spectral Variability in NGC 4051 (Terashima et al., PASJ subm.)

Spectral variability during Suzaku obsn. explained via modeling a partially-covered (10^{23} cm^{-2}) PL + independent partial covering (10^{24} cm^{-2}) for the Compton reflector



F_{var} spectrum:



PL norm varies (Γ constant) **AND** covering fraction of PC absorber varies (yielding extra spectral variability < 3 keV)

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.