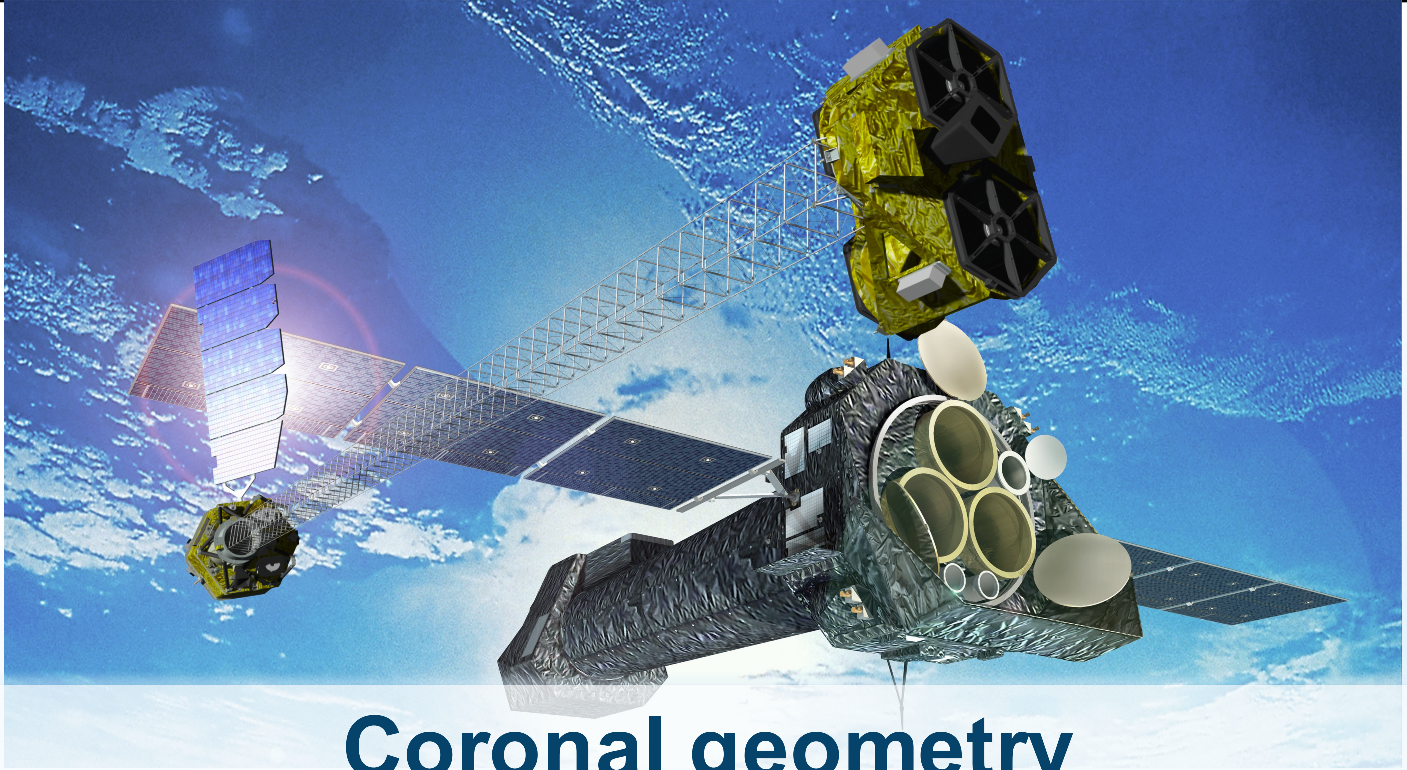


Coronal geometry at low mass-accretion rates from *XMM* and *NuSTAR* spectra

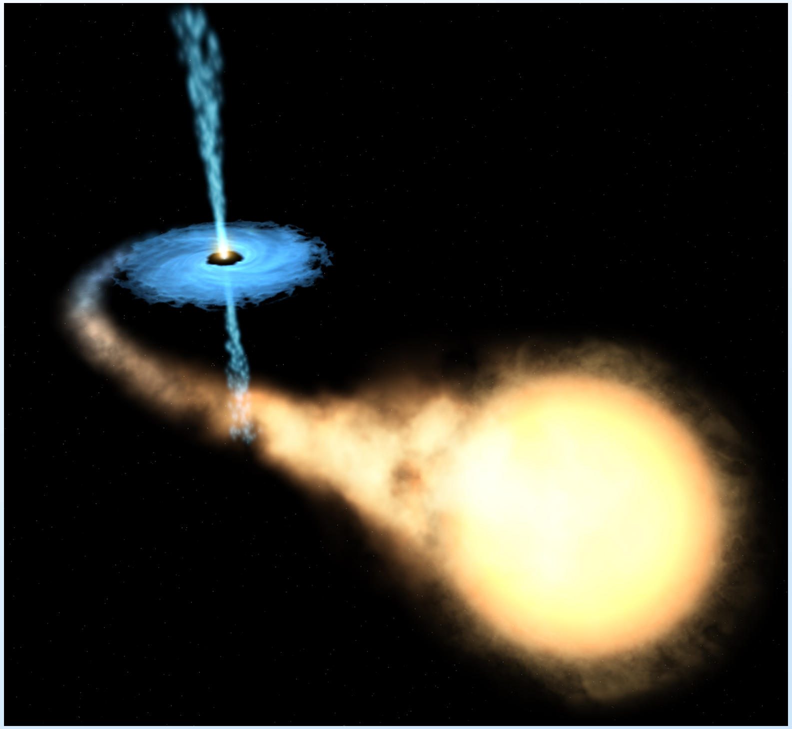
Felix Fürst
Caltech
for the *NuSTAR* AGN physics and binaries teams

Accreting black holes

Supermassive black hole:
Cen A
Central engine of AGN
$M_{BH} \sim 10^7\ M_{sun}$, d ~ 3.8Mpc

NASA/CXC/CfA/R.Kraft et al

Stellar mass black hole:
GRS 1739-278
X-ray binary
$M_{BH} \sim 10\ M_{sun}$, d ~ 8.5kpc



ESA, NASA, and F. Mirabel (CEA)

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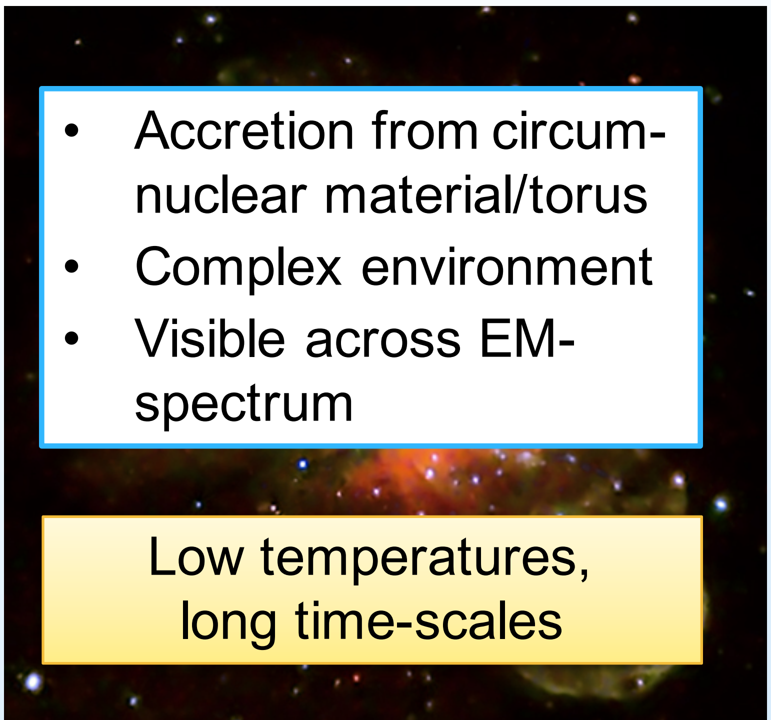

- Accretion from circum-nuclear material/torus
- Complex environment
- Visible across EM-spectrum

Low temperatures, long time-scales

NASA/CXC/CfA/R.Kraft et al

Stellar mass black hole: GRS 1739-278

X-ray binary

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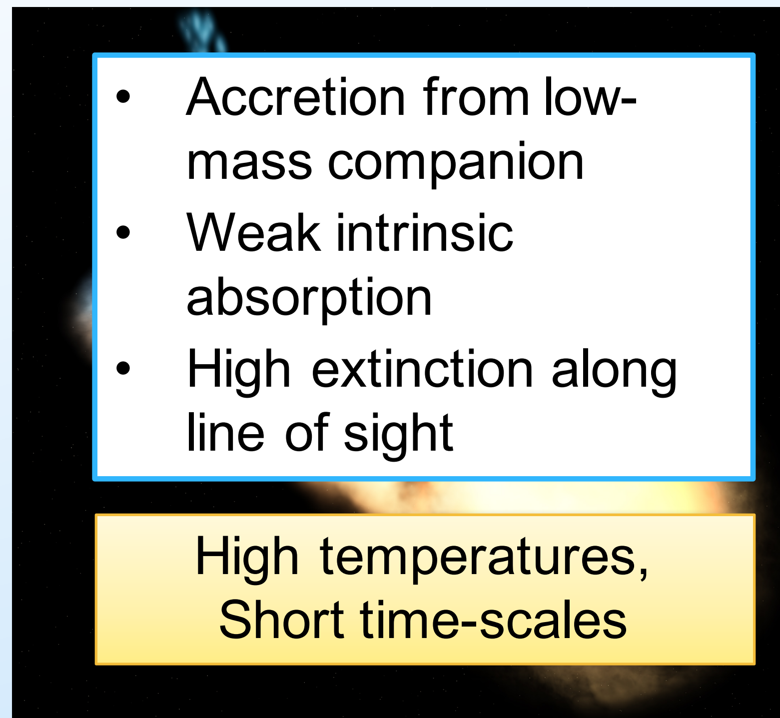

- Accretion from low-mass companion
- Weak intrinsic absorption
- High extinction along line of sight

High temperatures, Short time-scales

ESA, NASA, and F. Mirabel (CEA)

Felix Fürst
Caltech

Accepting black holes

Supermassive black hole:
Cen A
Central engine of AGN
$M_{BH} \sim 10^7\ M_{sun}$, d ~ 3.8Mpc

- Accretion from circum-nuclear ma
- Complex e
- Visible acr spectrum

Low temp long time-scales

NASA/CXC/CfA/R.Kraft et al

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- Accretion from low- nion c
- on along

atures,
Short time-scales

ESA, NASA, and F. Mirabel (CEA)

Physics deteremined by Eddington luminosity

$$L_{Edd} = 4\pi G M m_p c/\sigma_T$$

And gravitational radius

$$R_g = G M / c^2$$

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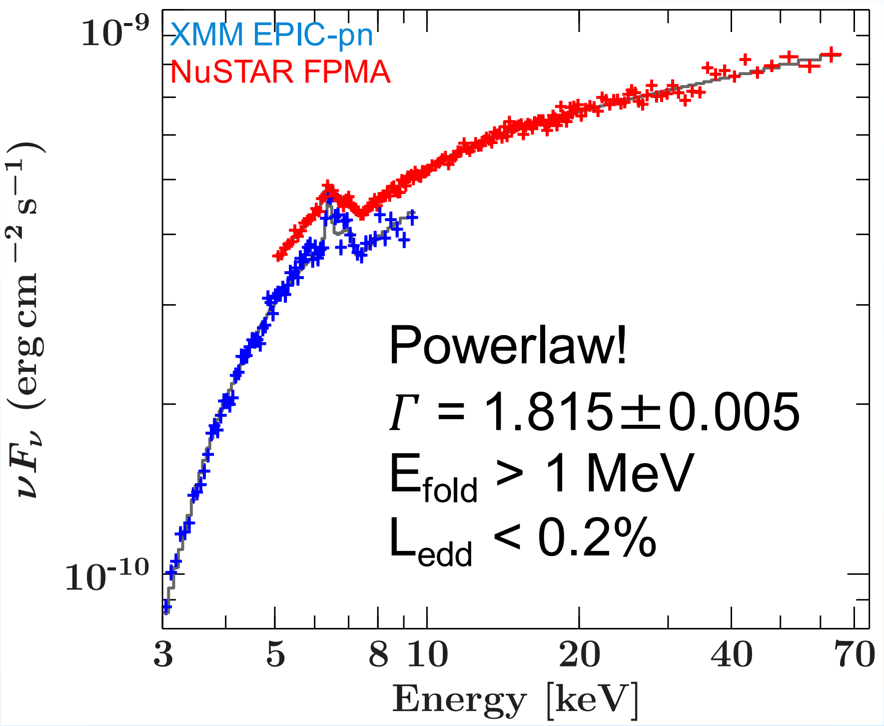
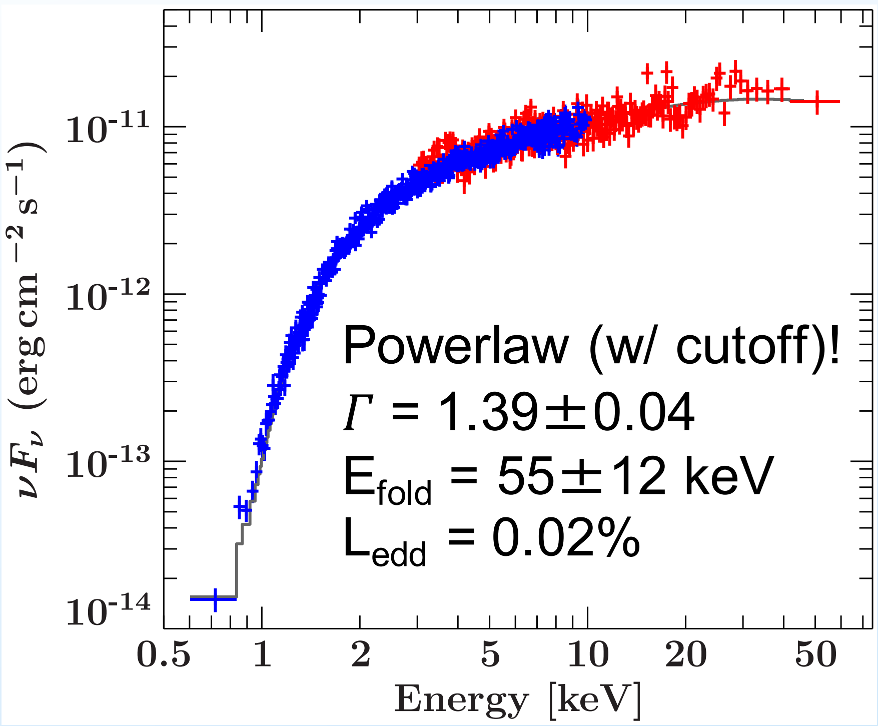
Broad band spectra

Supermassive black hole: Cen A



Absorption is 17×10^{22} cm^{-2}

Stellar mass black hole: GRS 1739-278



Low/hard state at the very end of a the outburst

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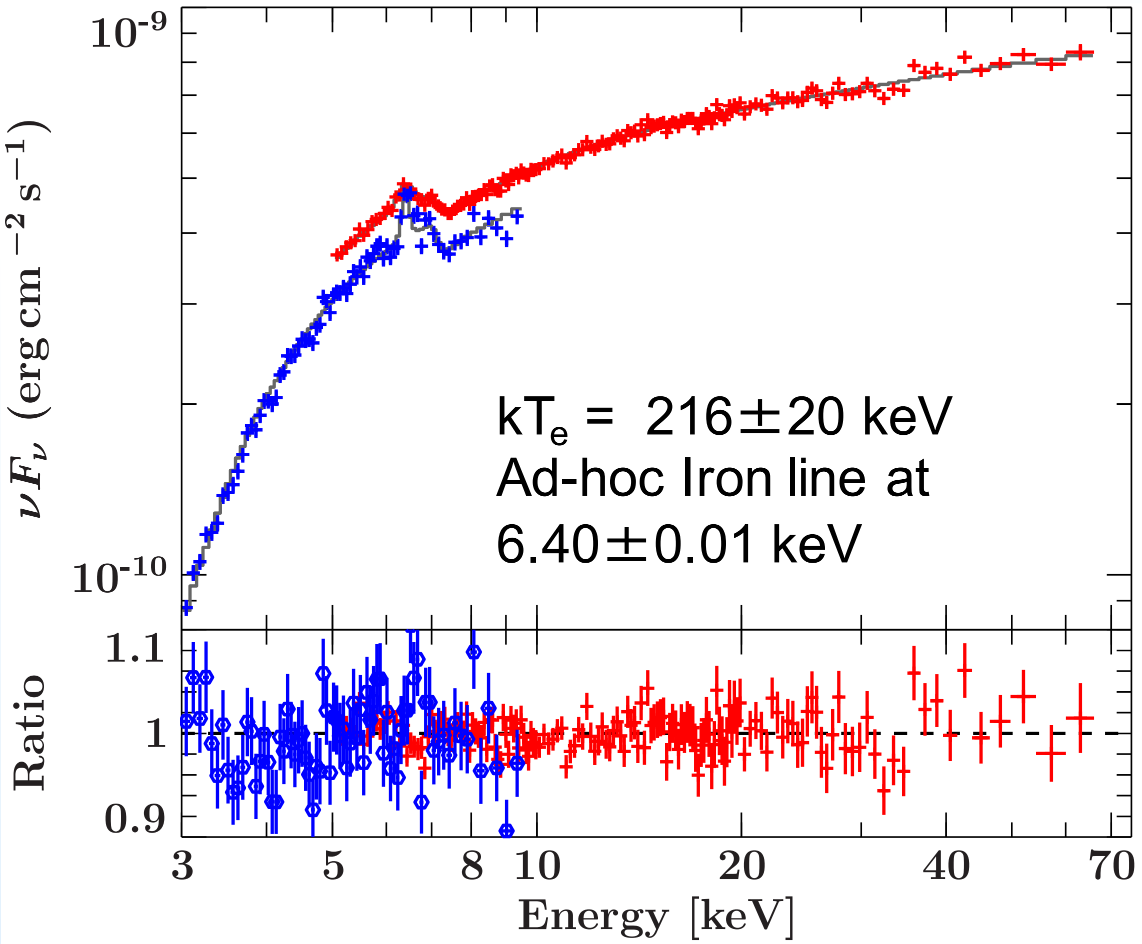
Centaurus A



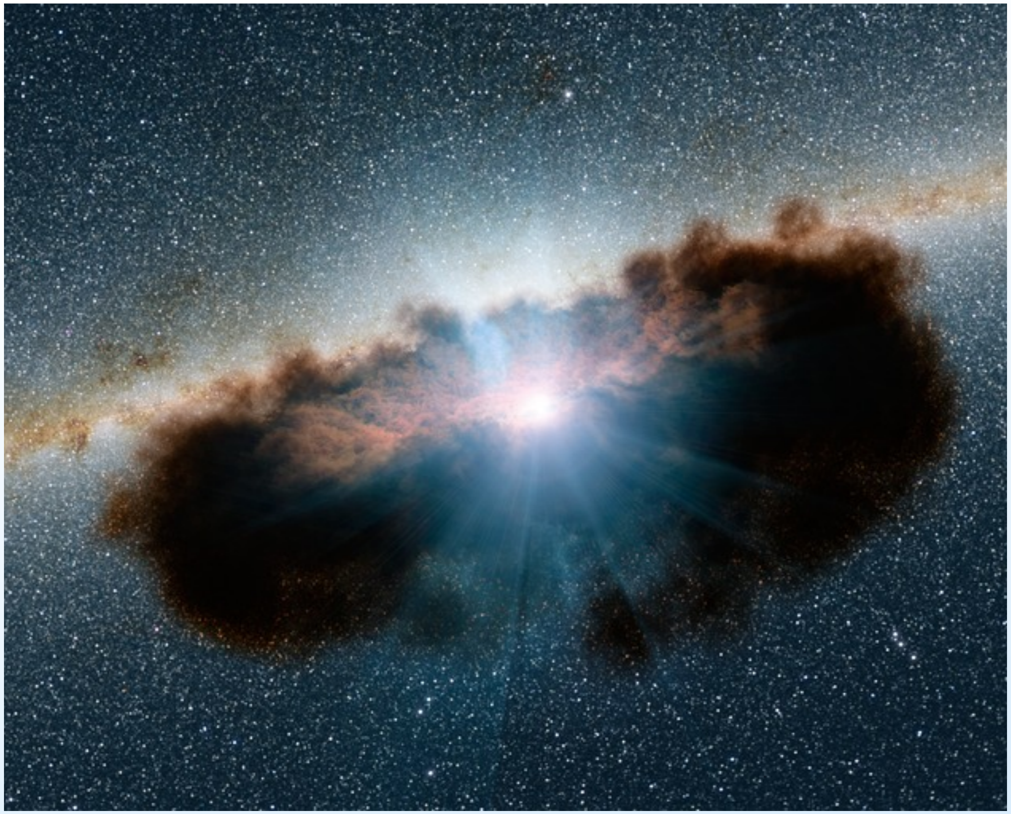
Fürst et al., 2016

Iron line cannot be modeled with reflection model (pexrav): R < 0.011!

Comptonization model gives realistic temperature (for compact corona, see Fabian et al., 2015)

Cutoffpl is not the correct model to describe the shape, measured folding energies are unreliable

Centaurus A: iron line



NASA/JPL-Caltech

A torus model can explain iron line strength self-consistently.

Torus material not Compton-thick, therefore no Compton hump at high energies seen.

Inclination >63 deg,
Opening angle ~60 deg

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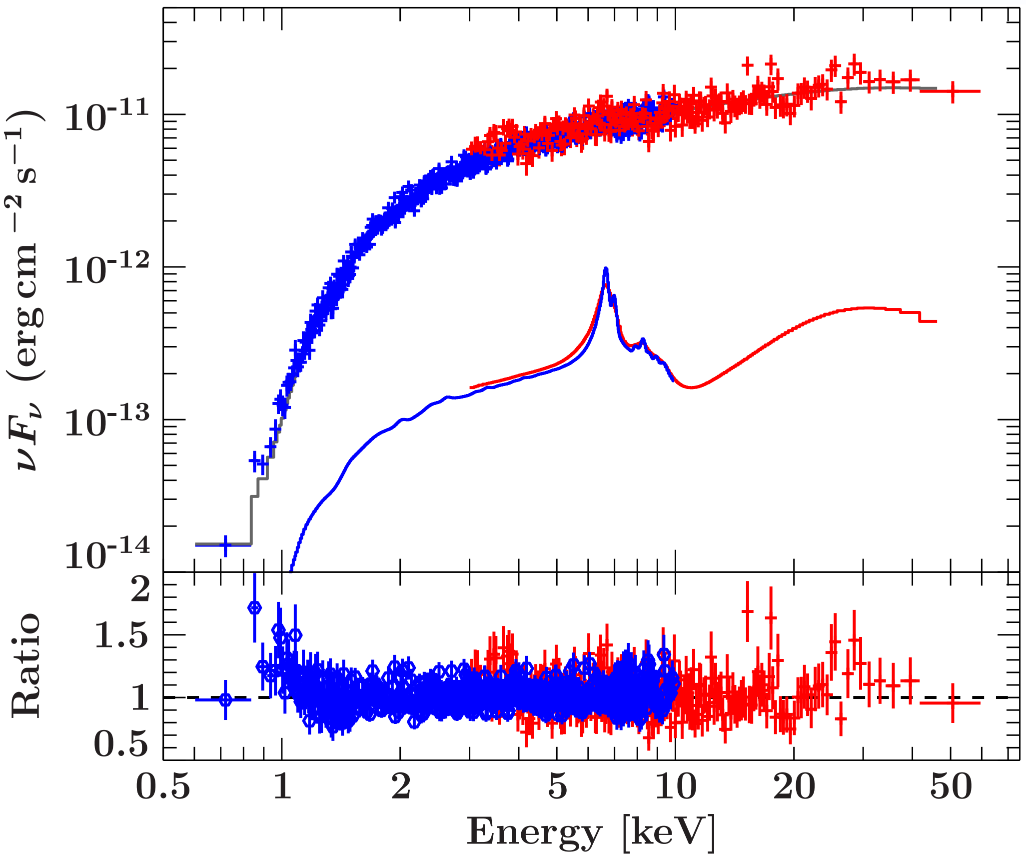
GRS 1739-278



Fürst et al., in prep.

Can be self-consistently fitted with reflection model (xillver): $R = 0.047^{+0.039}_{-0.024}$

Relativistic effects are difficult to constrain, as reflection is very weak.

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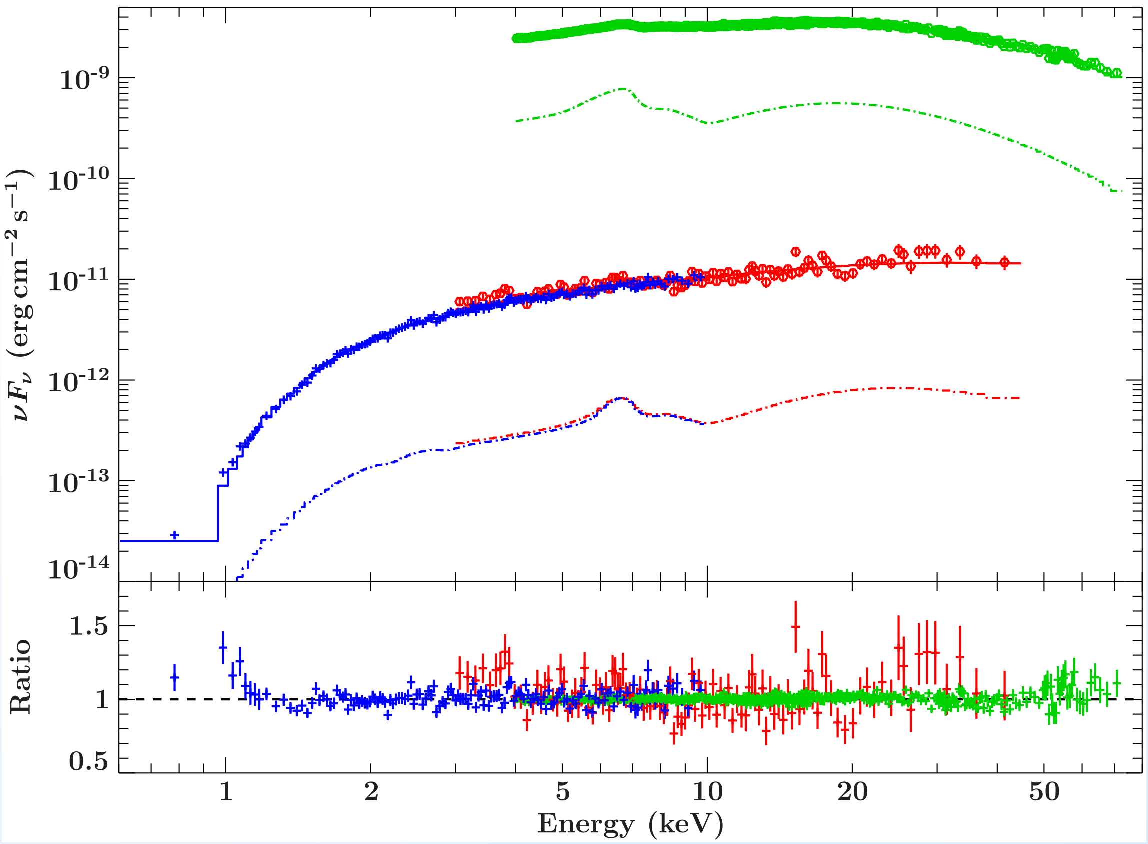
GRS 1739-278: multi-epoch



Fürst et al., in prep.

Using previous observations during bright hard state (Miller et al., 2015) to fix coronal geometry, assuming lamppost geometry

→ Inner radius in low state is 54^{+70}_{-25} r_g

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Results

Supermassive black hole: Cen A

- No reflection visible: **inner accretion disk must be truncated strongly**
- Continuum described by hot Comptonizing corona, additional features through torus

Stellar mass black hole: GRS 1739-278

- Weak reflection: **inner accretion disk truncated around 50 r_g**
- Continuum described by hot Comptonizing corona, additional features reflection

Low Eddington accretion rates are consistent with the picture of a truncated accretion disk; replaced, e.g., with ADAF (Narayan & Yi 1995)

Summary

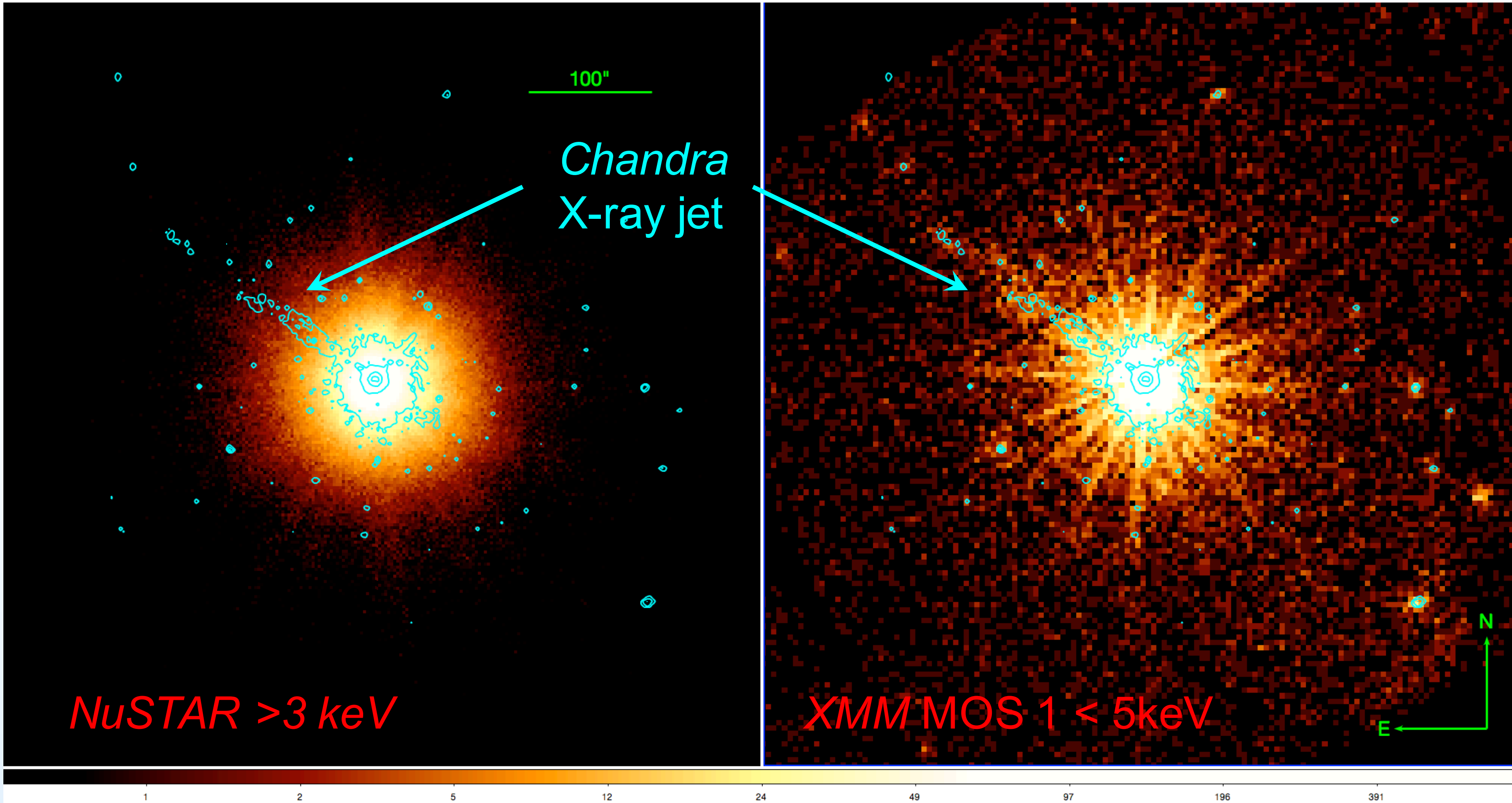
- Hard spectra at low fluxes with weak reflection features are connected to radio activity
- X-ray – radio correlation important tool to understand physics
- Corona could be the base of the jet (Markoff et al., 2005) and outflowing (Beloborodov et al., 1999)

XMM+NuSTAR is unique to study low-luminosity black holes

- Will continue to be unique for the next decade
- But proper (cross-)calibration is very important

Backup slides

Centaurus A



X-ray jet not visible at hard X-rays!

Fürst et al., 2016

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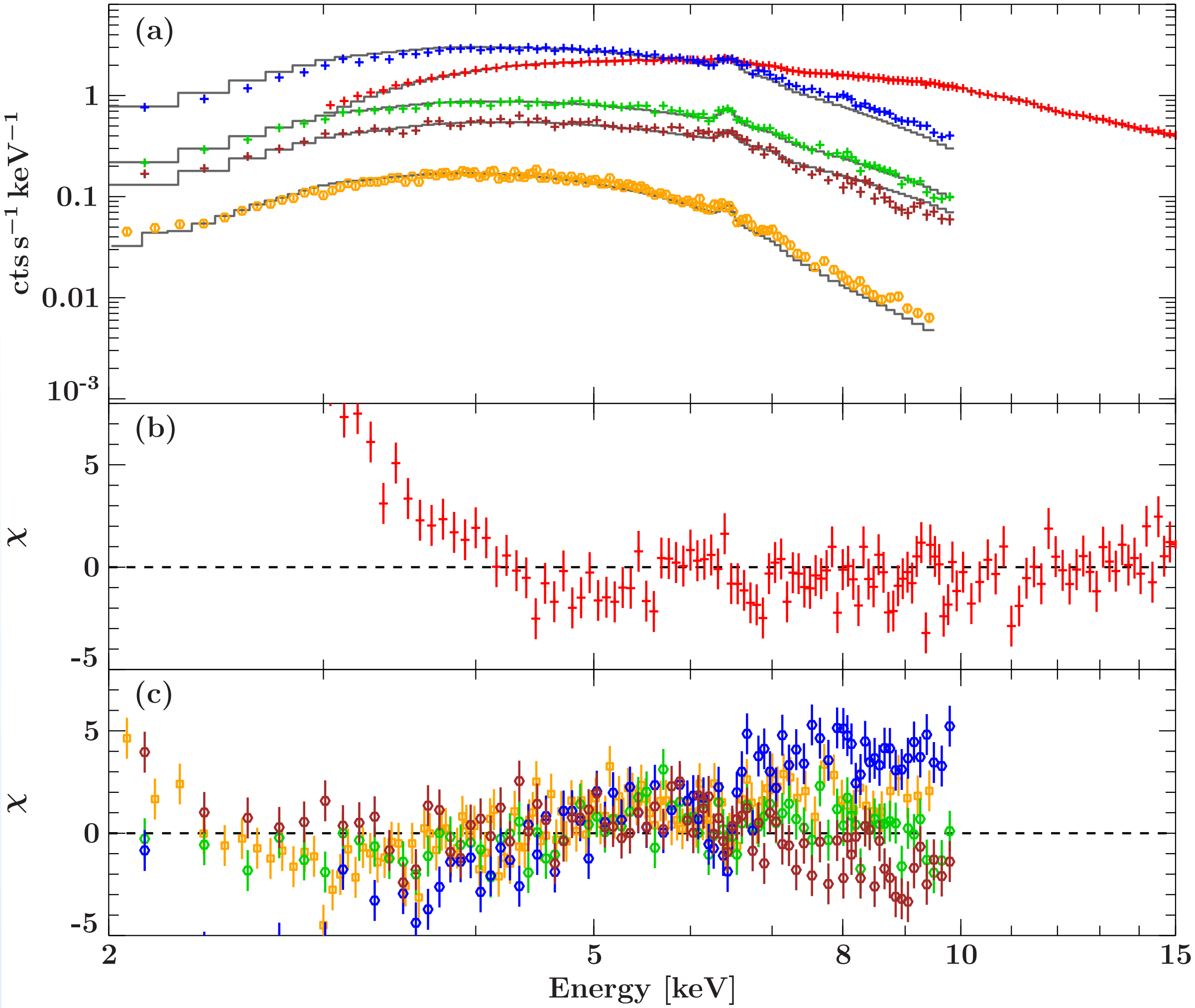
Cen A: calibration



- Known issues with gain in *NuSTAR*
- Pile-up in EPIC-pn
- Dust scattering in the prominent dust band changes spectrum as function of extraction region size and PSF

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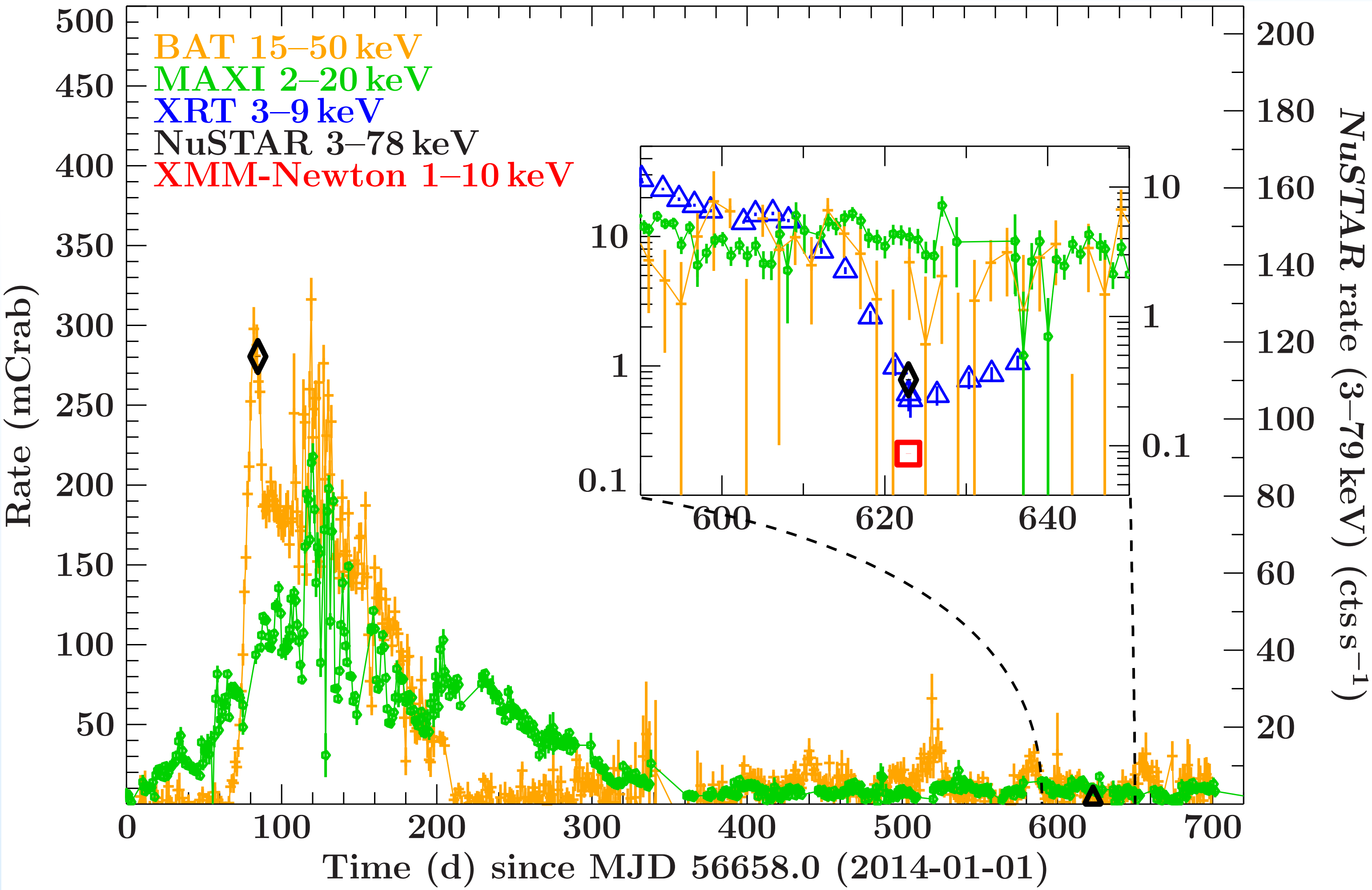
GRS 1739-273: light curve



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Cen A

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GRS 1739-278