Ionized X-ray emission from Compton-thick AGN

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Abstract

Ionized emission lines in the X-ray spectra of heavily absorbed AGN are commonly associated with emission of optically-thin, ionized plasma. We use *XMM-Newton* data of the four brightest Compton-thick AGN to test self-consistent models to study the origin of ionizing X-ray emission. We find that the ionized emission originates in one or several regions of multiple temperatures or ionization states. Ionized iron lines can be associated with ionized reflection.

Motivation

In Compton-thick AGN, the primary X-ray continuum is heavily absorbed and reprocessed in the circumnuclear matter. X-ray spectra are dominated by Compton-reflection in the 2-10 keV band, accompanied by a prominent Fe Kα (6.4 keV) line, and emission lines of highly ionized elements in the 0.3-2 keV band. The latter is commonly associated with scattered emission from photo-ionized plasma (e.g. Guainazzi 2005b) . But ionized iron lines and smearing of the iron K edge are indicators for ionized Compton-reflection. We test self-consistent models for scattered emission and ionized reflection.

Data

Archival data from the *XMM-Newton* EPIC PN camera were used to analyze the 0.3–10 keV range. The data were processed with SAS v11.0.0.

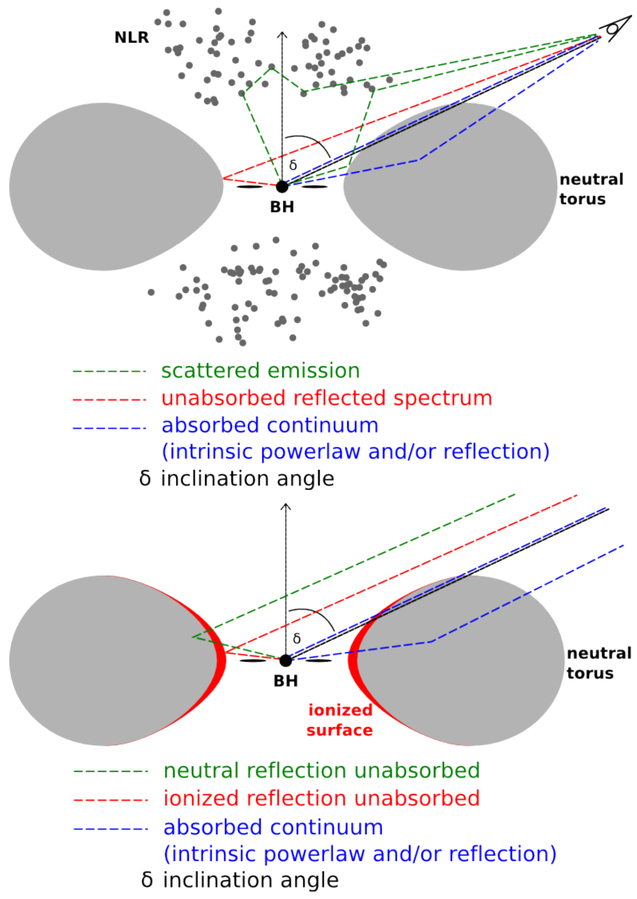
Source name	Redshift	ObsID	t_{obs} [ks]	ObsDate
Circinus	0.0014	0111240101	110	2001-08-06
Mrk3	0.0135	0111220201	61	2000-10-19
NGC 424	0.0117	0550950101	127	2008-12-07
NGC 1068	0.0037	0111200101	35	2000-06-29
NGC 1068	0.0037	0111200201	35	2000-06-30

Spectral modeling

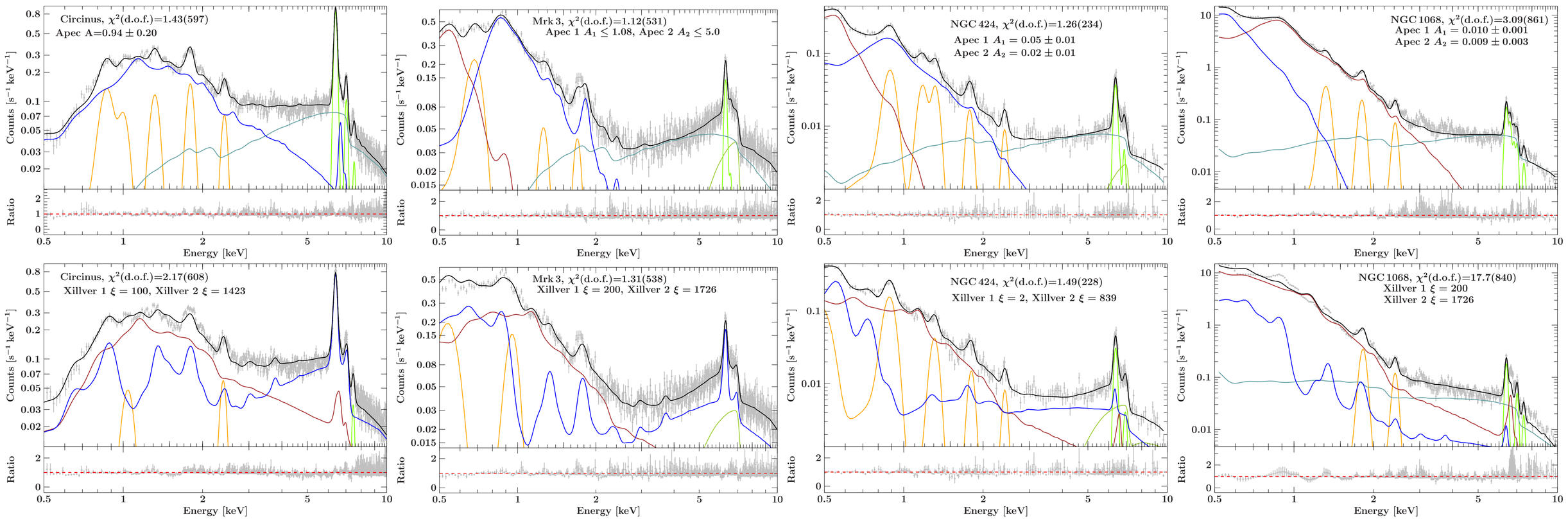
Analysis with ISIS v1.6.2-4 (which uses Xspec models). Photo-absorbed powerlaw. Two scenarios for the ionized emission:

[A] Ionized Plasma-Scattering: Scattering off optically-thin collision-driven plasma, Model: APEC (Smith et al. 2001). Plus Compton-reflection from a slab of cold electrons (PEXRAV, Magdziarz & Zdziarski 1995) and Gaussians for fluorescence lines.

[B] Ionized Reflection: Strong radiation may ionize the illuminated inner walls of the torus. Model: XILLVER (García & Kallman 2010) for ionized reflection, PEXRAV for neutral reflection.



Results



Grey: data. Black: total model. Blue: XILLVER or APEC component 1., Red: XILLVER or APEC component 2. Cyan: PEXRAV. Yellow-Green: neutral fluorescence lines. Orange: Single emissionl lines. Green: absorbed powerlaw.

Ionized Plasma-Scattering:

- Two-temperature plasma (0.06 keV, 0.8 keV) required (exception: Circinus)
- metal abundances only a few percent of solar values for NGC 1068 and NGC 424
- blend of emission lines mistreated as strong contribution of bremstrahlung
- additional ionized emission lines needed

Ionized Reflection:

- Accounts for ionized iron lines and major contribution in soft X-rays
- metal abundances are super-solar
- Two different ionization parameters required (exception: Circinus)
- NGC1068 and NGC424: best fit with a combination of APEC and XILLVER. ($\chi^2 = 2.24(839)$ and $\chi^2 = 1.84(240)$, respectively)

Conclusions

- **Ionized reflection is non-neglible for the ionized emission spectrum of Compton-thick AGN.**
- **Ionized reflection model preferred, because the ionized plasma-scattering model yields unusualy metal abundances.**
- **Multiple components suggest that the soft X-rays originates from matter of different ionization or temperature states, potentially a multi-phase region (e.g. Chakravorty et. al 2008), or indicate non-equilibirum states, such as outflows.**

References

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