Chasing obscuration in type-I AGN: discovery of an eclipsing wind in NGC 3783

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Transient obscuration in type-I AGN

X-ray hardness ratio spike

Markowitz+14 RXTE study ➔ X-ray eclipses in 8 type-I AGN

✧ Origin of X-ray hardening events?
✧ X-ray eclipses by absorption?
✧ Outflowing? Location?
✧ Obscuring disk wind (like in NGC 5548, Kaastra+14)?
Catching transient obscuration with Swift

X-ray & UV spectroscopy of an eclipse is needed

Swift monitoring program ➔ ToO observations with:
icator

- XMM-Newton (2 obs)
- HST/COS (4 orbits)
- NuSTAR (2 obs)

Weekly Swift observations in 2016-2017

Monitored type-I AGN:
Ark 564, MR 2251-178, Mrk 335, Mrk 509, Mrk 841, NGC 3783, NGC 4593, NGC 7469
Swift lightcurve of NGC 3783

Swift UVOT UVW2

Swift XRT 0.3–1.5 keV
Swift XRT 1.5–10 keV

Swift XRT hardness ratio (HR)

HR triggering limit

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ToO with XMM, HST & NuSTAR - Dec 2016

Intrinsic $\Gamma \approx 1.7$

$N_H \approx 2 \times 10^{23} \text{ cm}^{-2}$

$C_f \approx 0.5$

Narrow X-ray emission lines unaffected

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Broad, blue-shifted absorption appears when obscured.

Photoionisation modelling ➔ ionisation of the obscurer: log $\xi \sim 1.8$ (more ionised than the obscurer in NGC 5548)

Also seen in N V and Lyα

See the talk by Jerry Kriss
Line absorption in the Fe K band when obscured

Appearance of a new high-ionisation component in 2016

Outflow velocity:
few thousand km/s
(similar to C IV in UV)

$N_\text{H} \sim 2 \times 10^{23} \text{ cm}^{-2}$

Fe XXVI Lyα absorption diminishes Fe Kβ line

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Line absorption associated to transient X-ray obscuration in type-I AGN

Transient X-ray obscuration associated with:

1) transient broad, blue-shifted UV absorption
   - Mrk 335 (Longinotti+13)
   - NGC 5548 (Kaastra+14)
   - NGC 985 (Ebrero+16)
   - NGC 3783 (Mehdipour+17)

2) transient high-ionisation component
   - NGC 3516 (Turner+08)
   - PDS 456 (Reeves+09)
   - NGC 3783 (Mehdipour+17)
Obsculer $N_H \sim 2 \times 10^{23} \text{ cm}^{-2}$, $C_f \sim 0.5$, $\log \xi \sim 1.8$, $v \sim \text{few } 10^3 \text{ km/s}$

Two partially-covering absorption components $\rightarrow$ clumpy

Ionising luminosity higher when obscured
From our modelling we find obscurer density $\sim 3 \times 10^9 \text{ cm}^{-3}$
Obscurer radius $\sim 10$ light days $\Rightarrow$ outer BLR

BLR radius $\sim 1.4 \text{ (He II)}$ to $10.2 \text{ (H}$β$)$ light days (Peterson+04)
torus radius $\sim 250$-357 light days (Beckert+08)
WA radius $\sim$ pc scale (Behar+03; Gabel+05)

X-ray eclipses in NGC 1365 and Mrk 766 also produced by BLR clouds (Risaliti+07,+11)

Consistent with clouds in the base of a radiatively-driven disk wind at the BLR of the AGN (Murray+95)

Shielding of X-rays by obscurer prevents over-ionisation $\Rightarrow$ radiative acceleration through UV line absorption (Proga+04)
Summary

✧ Transient X-ray obscurer in NGC 3783 is outflowing at few thousand km/s

✧ Density and location of the X-ray obscurer matches the BLR. Properties different from warm absorbers

✧ X-ray obscuration associated with transient UV and high-ionisation line absorption

✧ X-ray obscuration consistent with clouds at the base of a radiatively-driven disk wind

✧ ToO multi-wavelength spectroscopy is an effective way to probe the link between the disk, BLR, and outflows
Supplementary slides
Absorption model components