X ray obscurers: bridging the gap between warm absorbers and ultra-fast outflows

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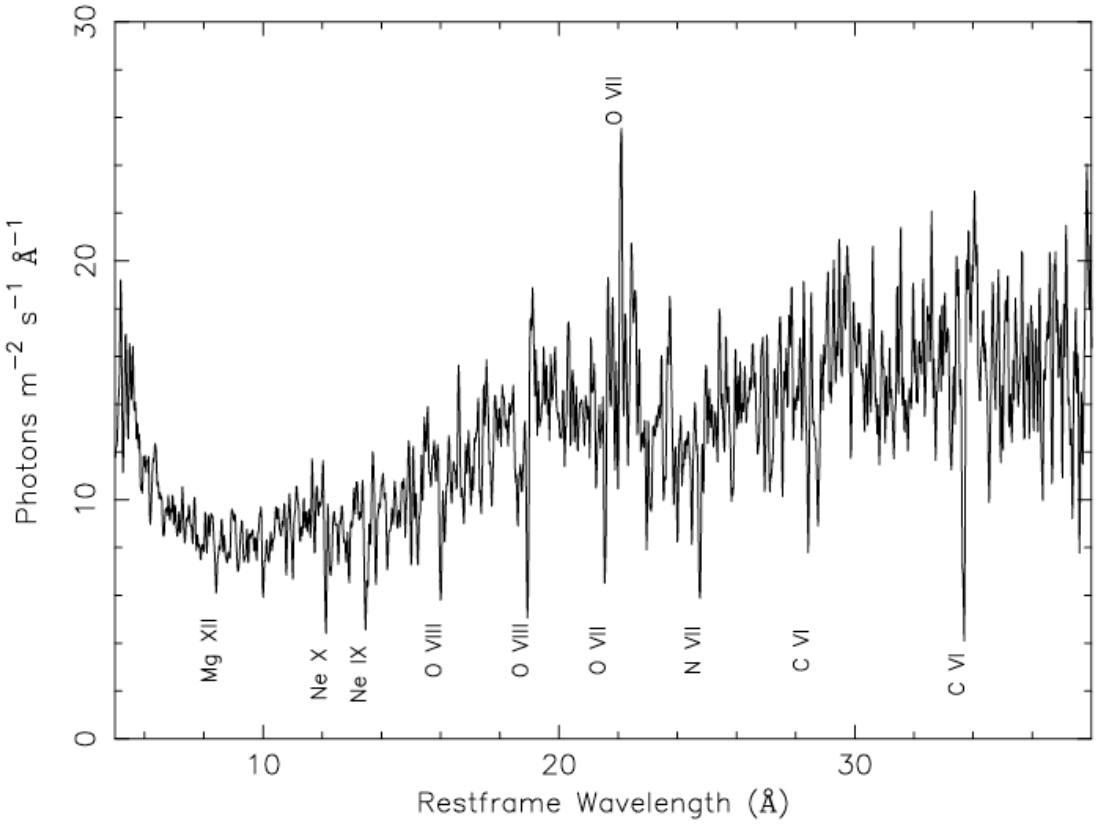
1. First high-resolution spectrum of an AGN



NGC 5548, 11 December 1999, 86 ks, Chandra LETGS

Blueshifted absorption lines from photoionised gas: wind

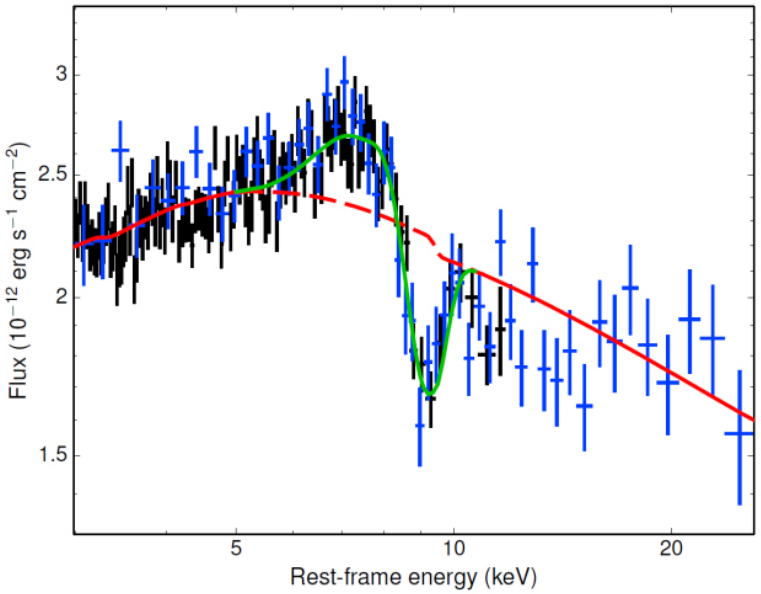
(Kaastra et al. 2000)

What have we learned from study of these winds?

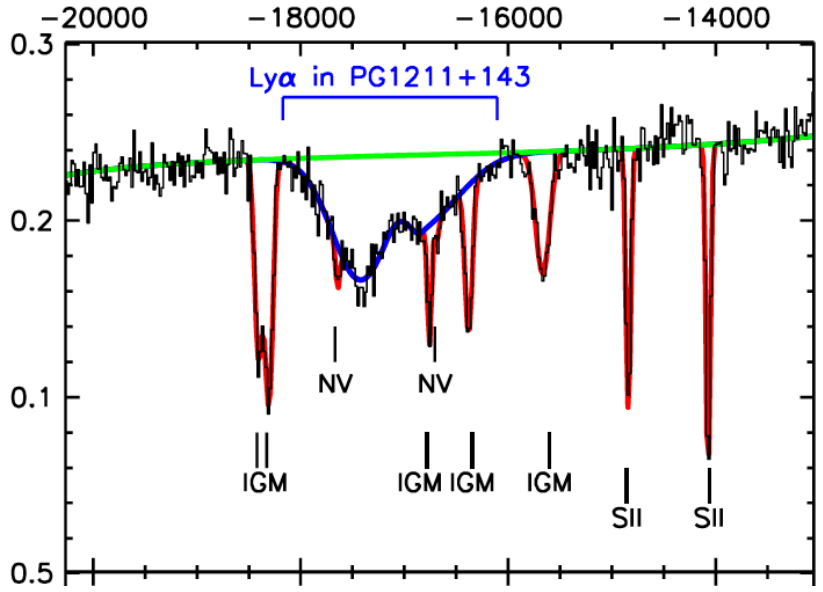
- Relatively persistent features, variability through ionisation changes
- Multiple velocity components 0 – 1000 km/s
- Multiple ionization phases log ξ from 0 – 4
- Moderate column density $N_H < 10^{27}$ m^{-2}
- Majority of ionising photons transmitted
- In some cases @ distance of torus

(review see e.g. Blustin et al. 2005; Laha et al. 2014)

2. Ultra-fast outflows



PDS 456 – Nardini et al. 2015
v = -75000 km/s

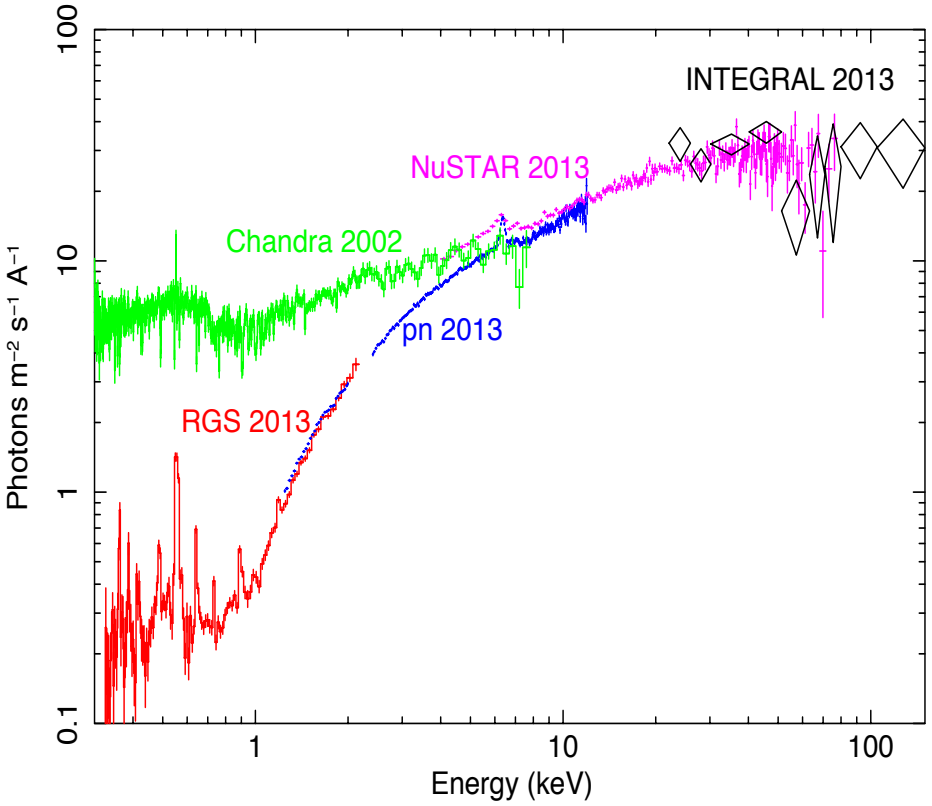


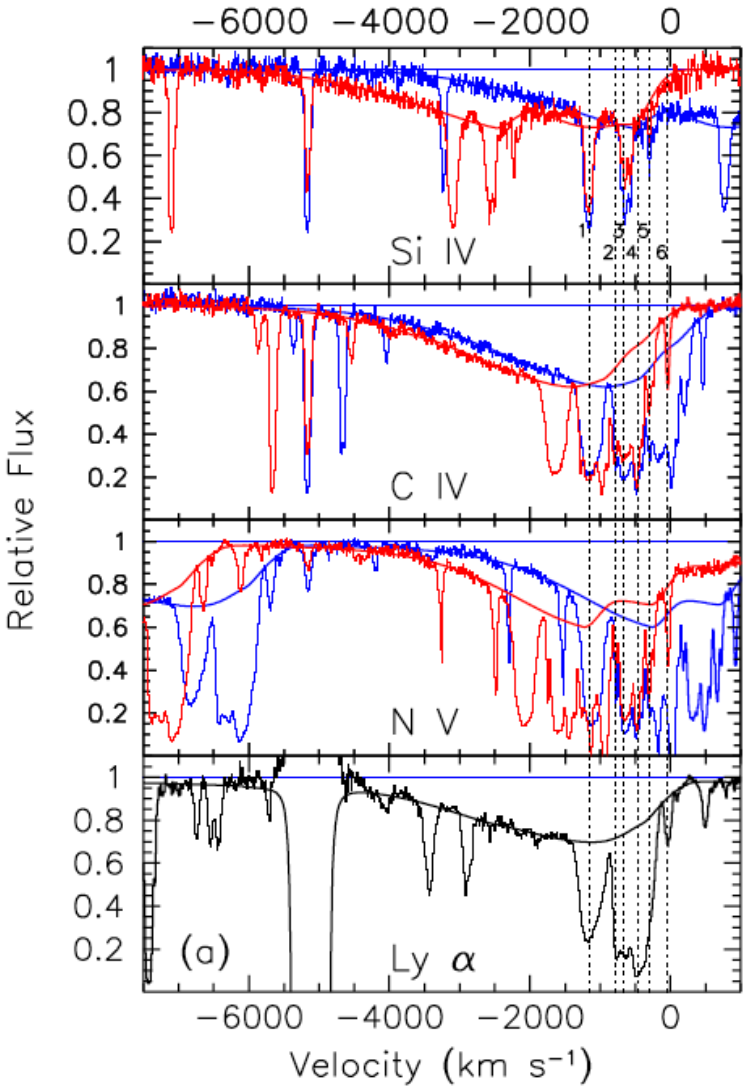
PG 1211+143 – Kriss et al. 2018
v = -17000 km/s

UFO's

- strongly transient phenomenon
- velocities 10 000 – 100 000 km/s
- high ionisation: log ξ from 3 – 5
- high column density: $N_H \sim 10^{26} – 10^{28}$ m^{-2}
- majority of ionising photons transmitted
- large covering factor?
- Likely close to the black hole ($10^2 – 10^4$ R_S)
- Large kinetic power
  (See e.g. Tombesi et al. 2011, 2012)

3. Obscuration in NGC 5548



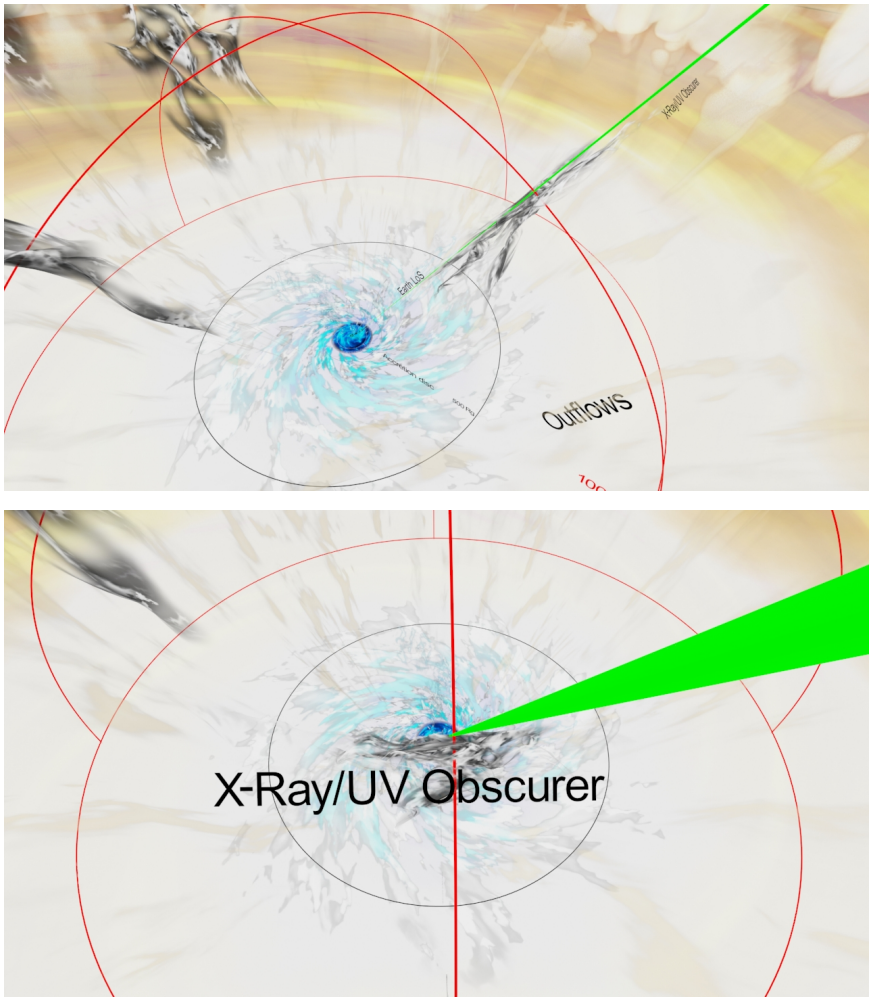


Kaastra et al. 2014

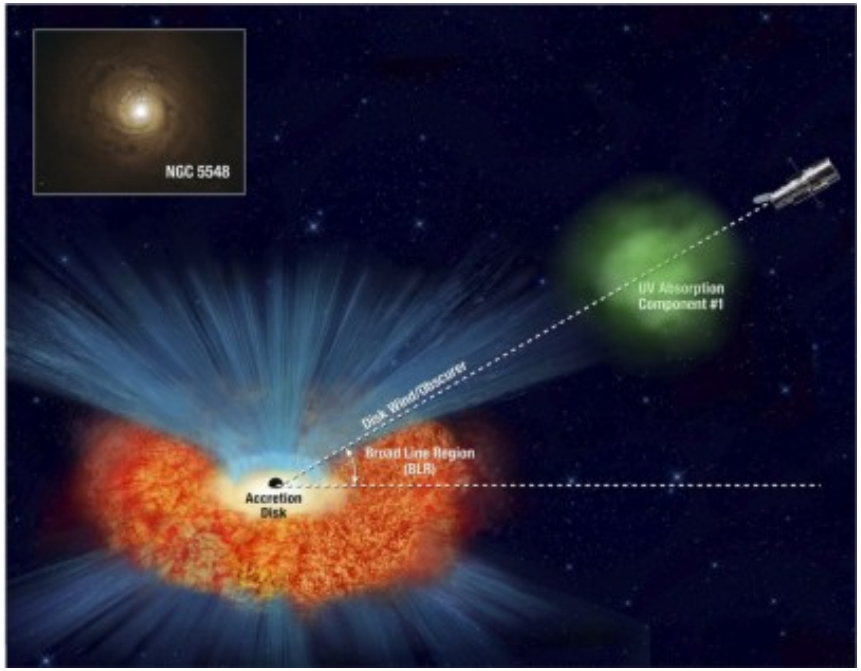
Properties of the obscuring matter

- *Outflowing* with v=5000 km/s, broad profile
- *Two components:*
- Comp 1: log ξ = -1.2, N_H=10^{26} m^{-2},
  produces UV Broad Absorption Lines
- Comp 2: almost neutral, N_H=10^{27} m^{-2}
- *Partial covering inner BLR* ➔ distance few light days
- Obscuration ongoing already for 8 years

Geometry of obscurers



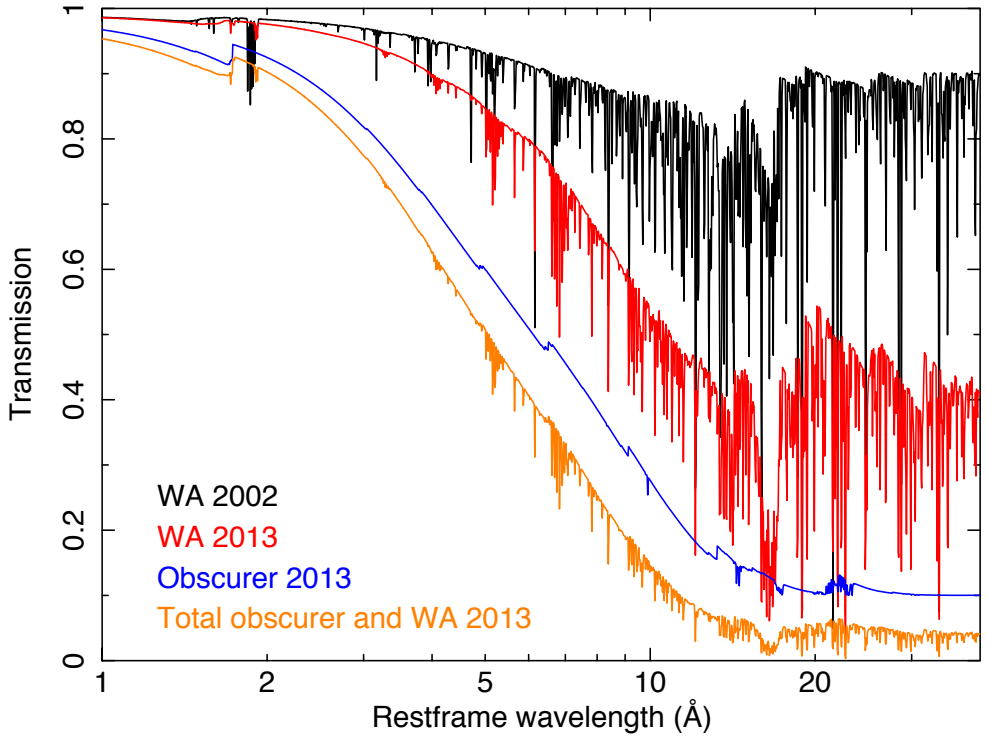
Credit: Renaud Person



Dehghanian et al. 2019

Effects of obscuration

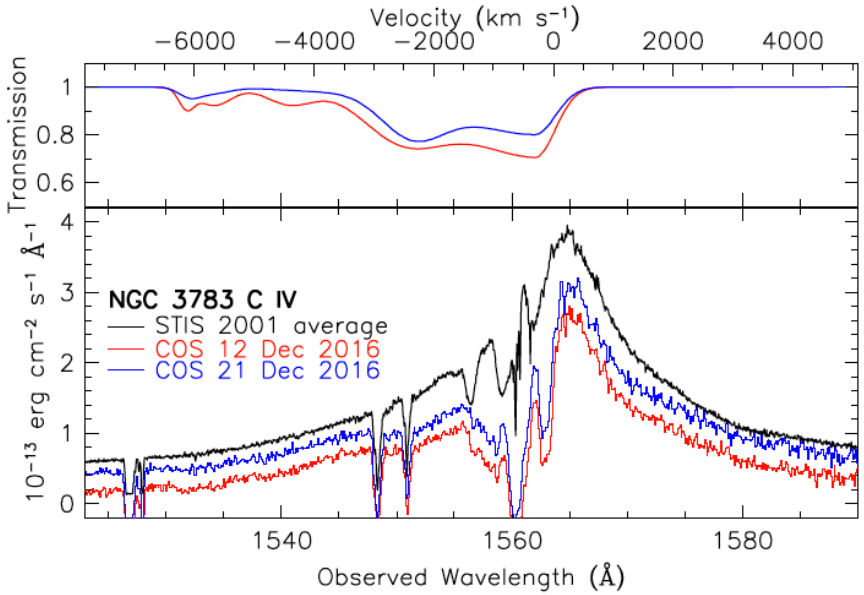
- Modifies *transmission WA* due to recombination (de-ionisation)
- Modifies *EUV SED* ➔ implications for BLR modeling
- *Shielding effect* allows acceleration (UV-driven)
- At low X-ray resolution, neglect obscuration would lead to *wrong continuum*

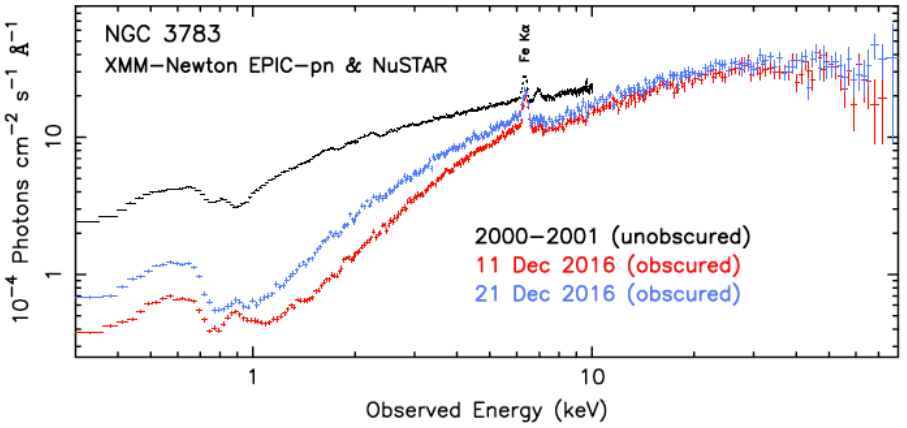


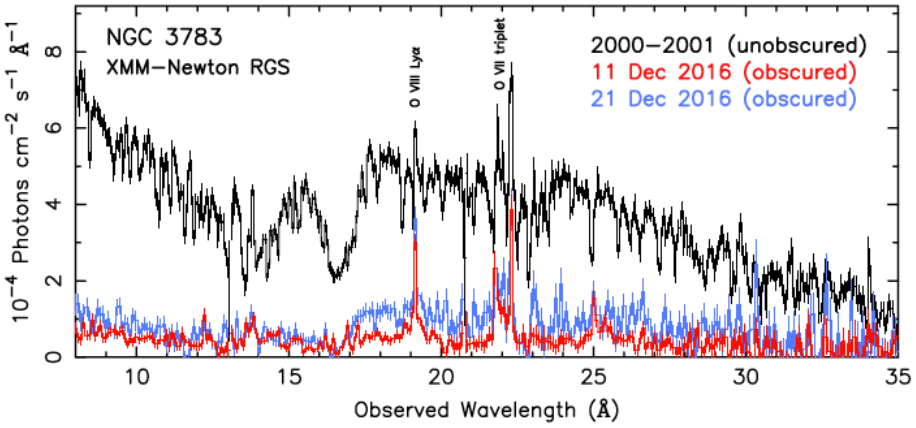
Another case: NGC 3783

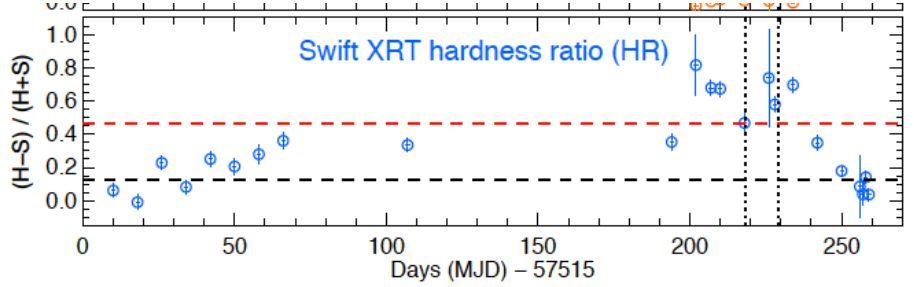
- Joint XMM-Newton/HST/NuSTAR/Swift
- ToO in Dec 2016

See Mehdipour et al. 2017



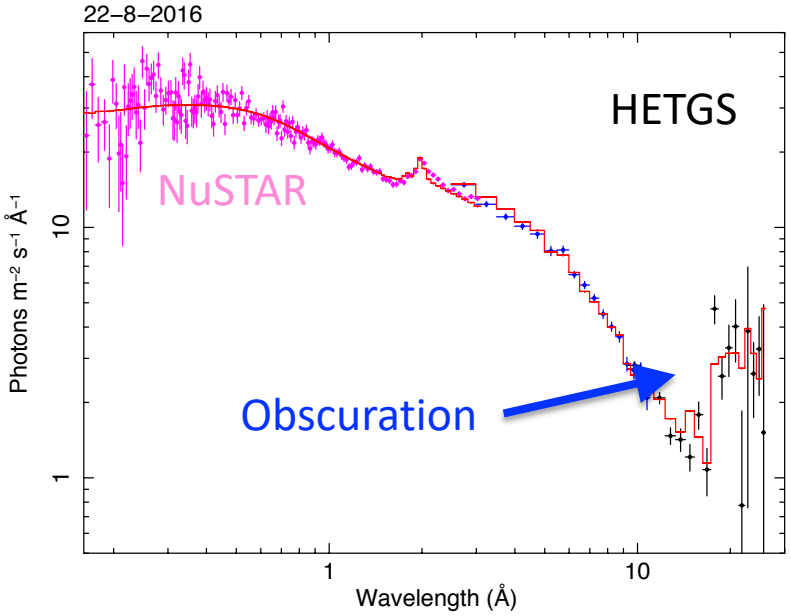


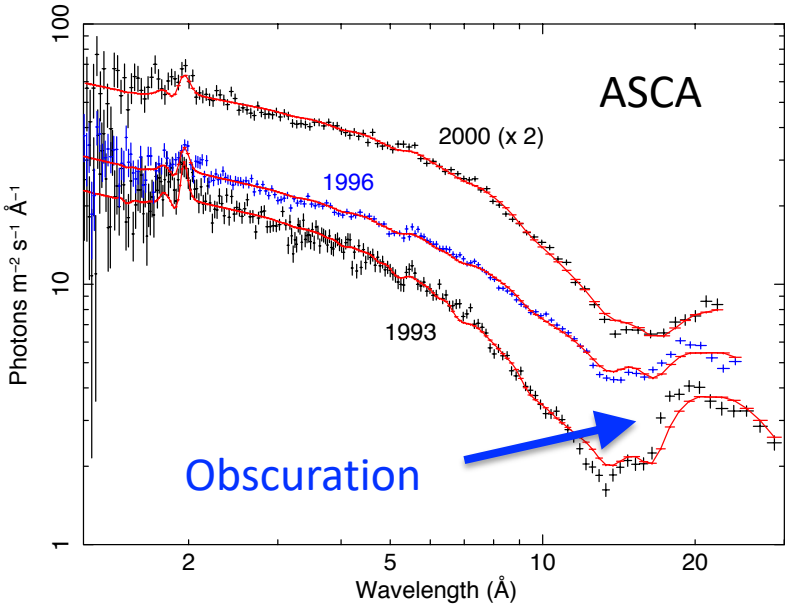




Recurring obscuration in NGC 3783

Moderate obscuration, N_H 10x lower than in Dec 2016, but still 2×10^{26} m^{-2}
(Kaastra et al. 2018)



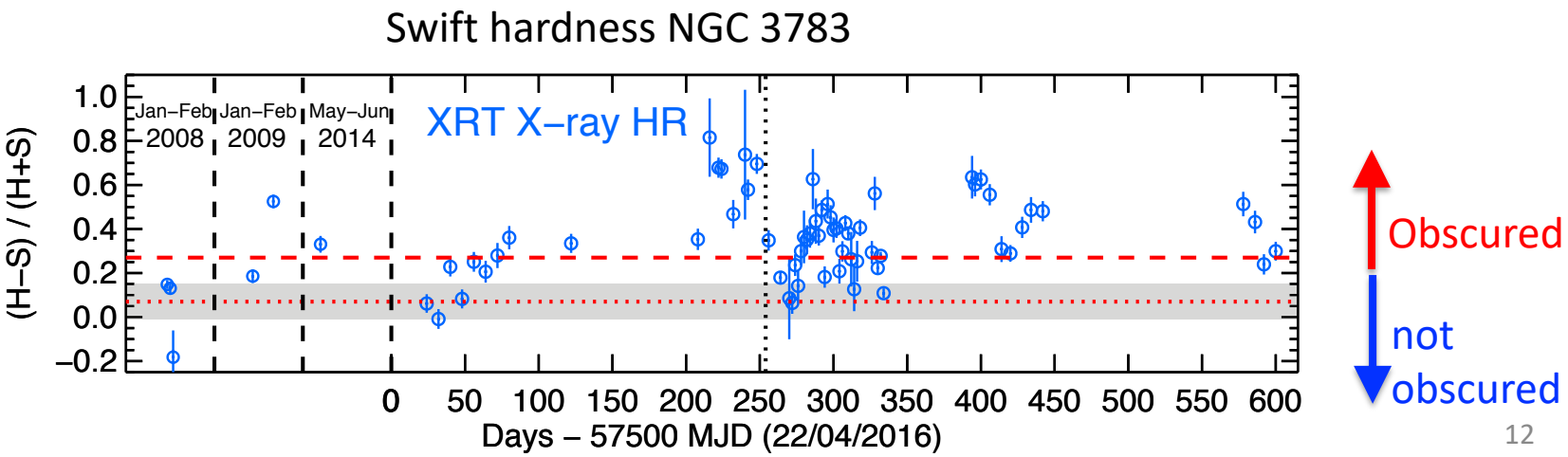


Obscuration frequency

Sparse info on how often and in how many AGN obscuration occurs

Some best-studied cases:

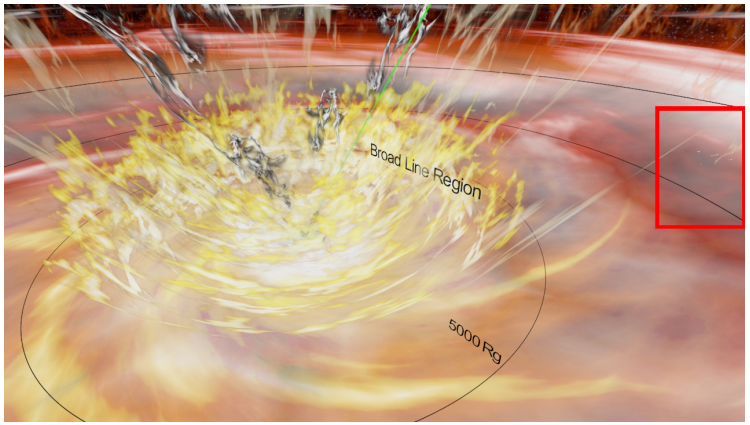
NGC 5548 (Kaastra et al. 2014)
NGC 3783 (Mehdipour et al. 2017)
Mrk 335 (Longinotti et al. 2013)
NGC 985 (Ebrero et al. 2016)
NGC 3227 (Turner et al. 2018)



Summary & conclusions

Simplified representation

	v (km/s)	log ξ	log N_H	Shielding	Distance
"Warm absorber"	300	0-3	<27	low	large
Obscurer	3000	<0	<27	high	medium
UFO	30000	3-5	<28	low	small



Credit: Renaud Person

- Obscuring material has large impact on its environment
- likely part of disk wind, close to BLR
- Physics complex due to strong shielding
- Simultaneous UV/X-ray spectroscopy is key
- Obscuration cannot be ignored in modelling