

AGN Obscurers

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SRON & Sterrenwacht Leiden

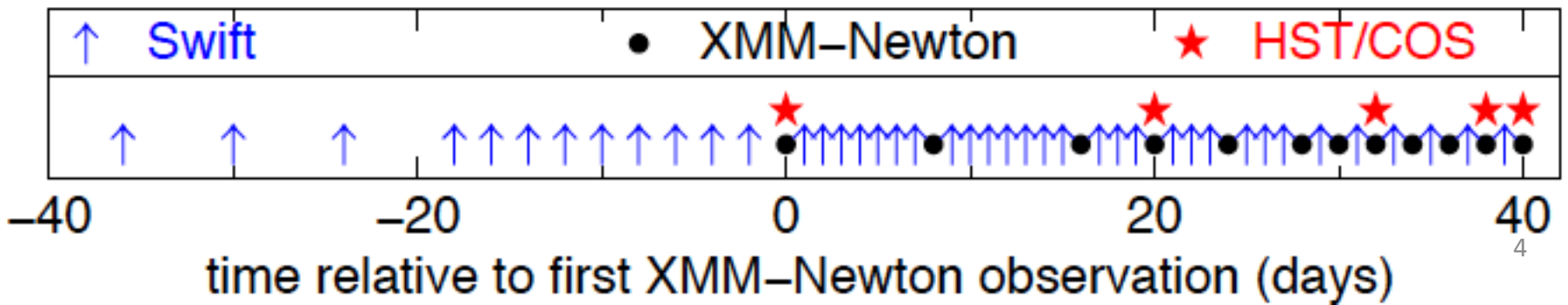
The NGC 5548 campaign

Why a campaign on NGC 5548?

- Successful campaign on Mrk 509 in 2009
- Time for another target: NGC 5548
- One of two best studied Seyfert 1 galaxies (2400 publications over half a century)
- Source was not observed since 2001 with XMM-Newton and 2007 with Chandra

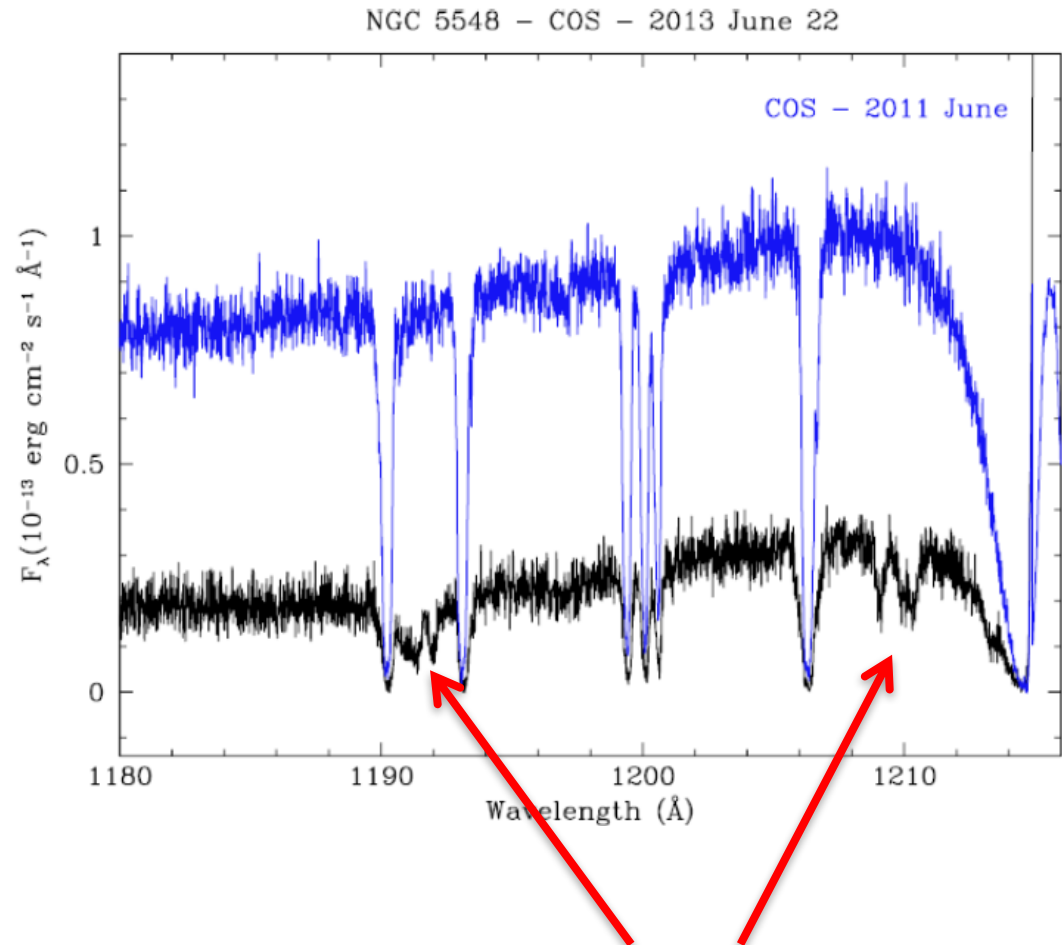
Set-up campaign

- 14 x 50 ks with XMM-Newton (RGS, EPIC, OM)
- 6 x HST/COS
- 4 x NuSTAR
- 4 x INTEGRAL
- 3 x Chandra LETGS
- Daily Swift monitoring (XRT, UVOT)
- Ground-based support (Israel, Chile)
- Core June/July 2013, 2 observations $\frac{1}{2}$ year later



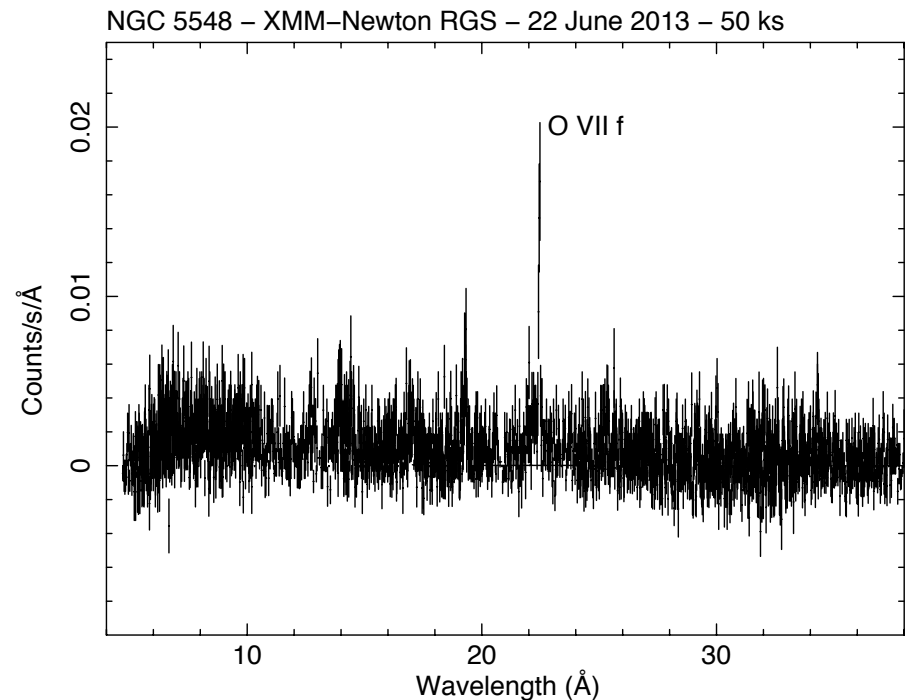
Four big surprises

- 1) Low-ionisation UV lines never seen before
- 2) No RGS data?
- 3) Strongly absorbed X-ray spectrum EPIC
- 4) Broad UV absorption lines



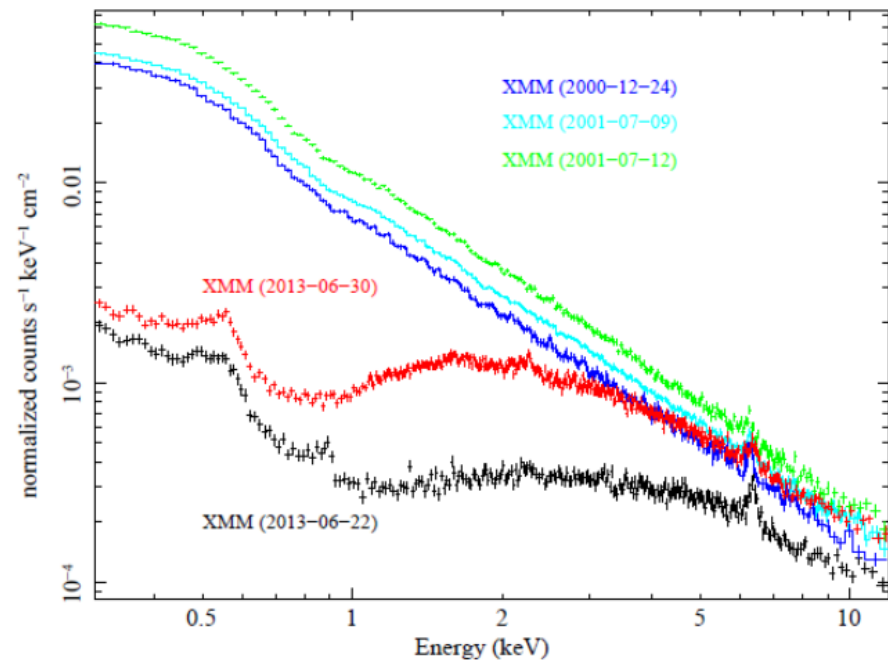
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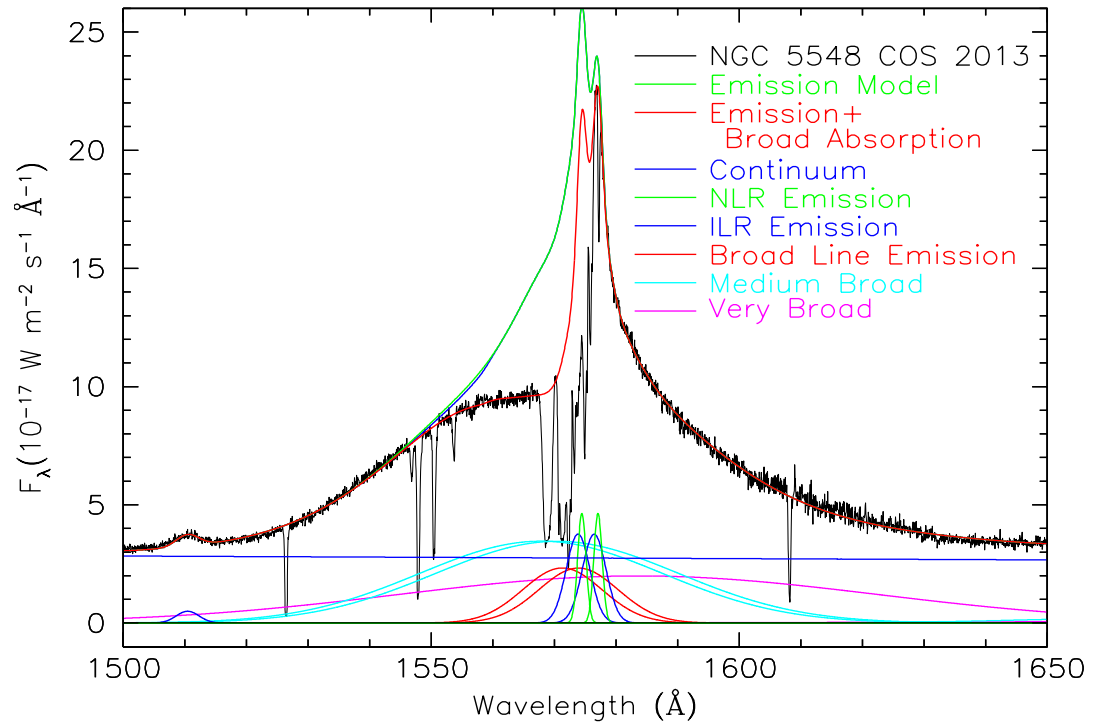
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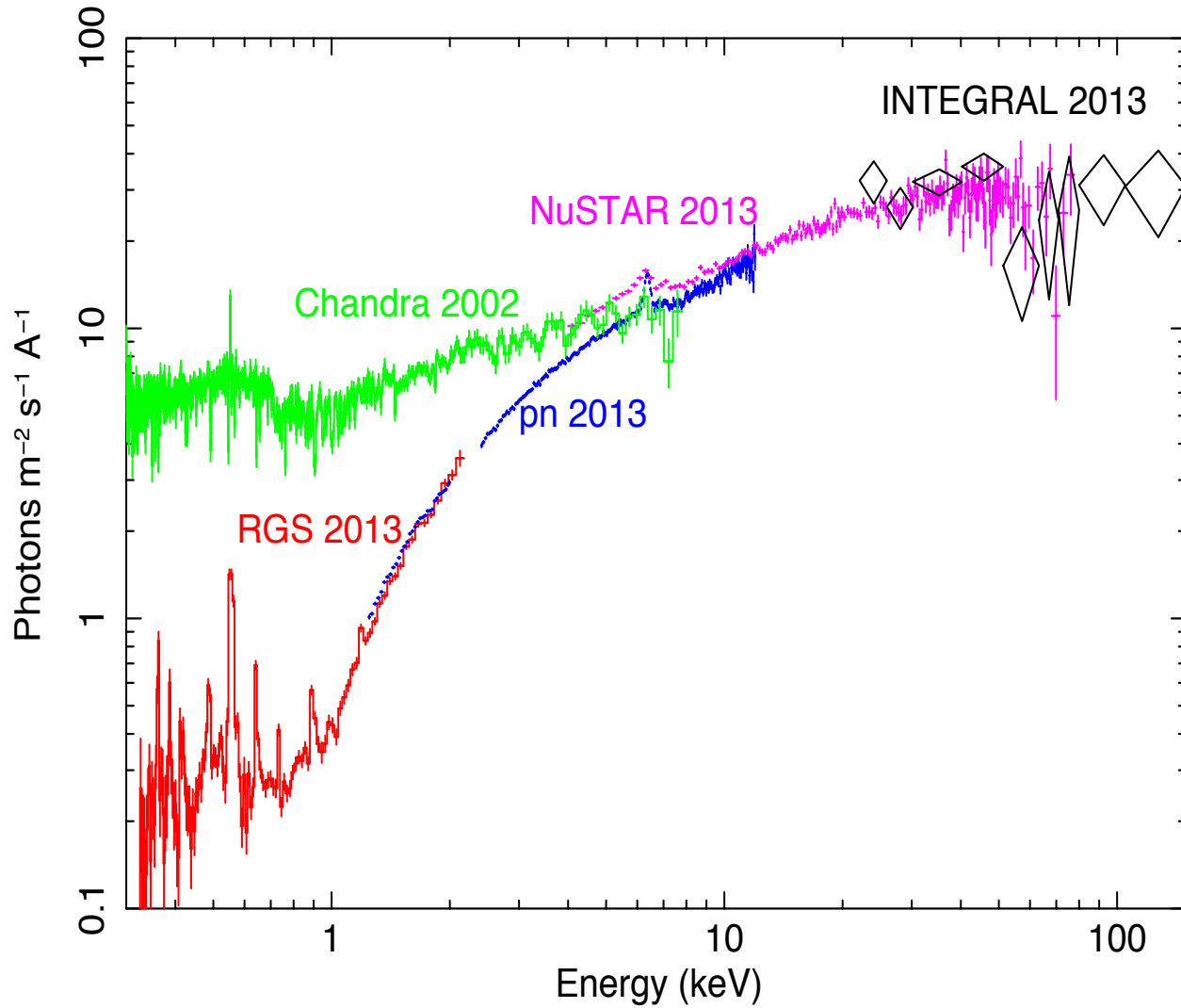


Four big surprises

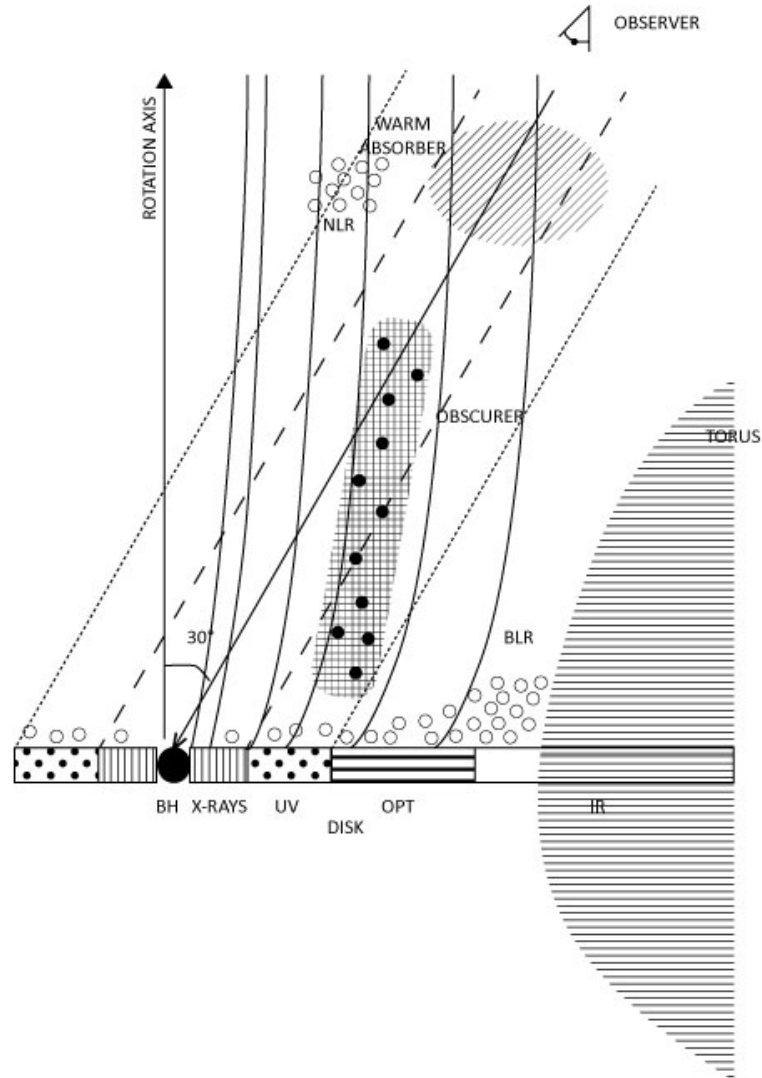
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Strong absorption but normal high-E flux



What is going on?

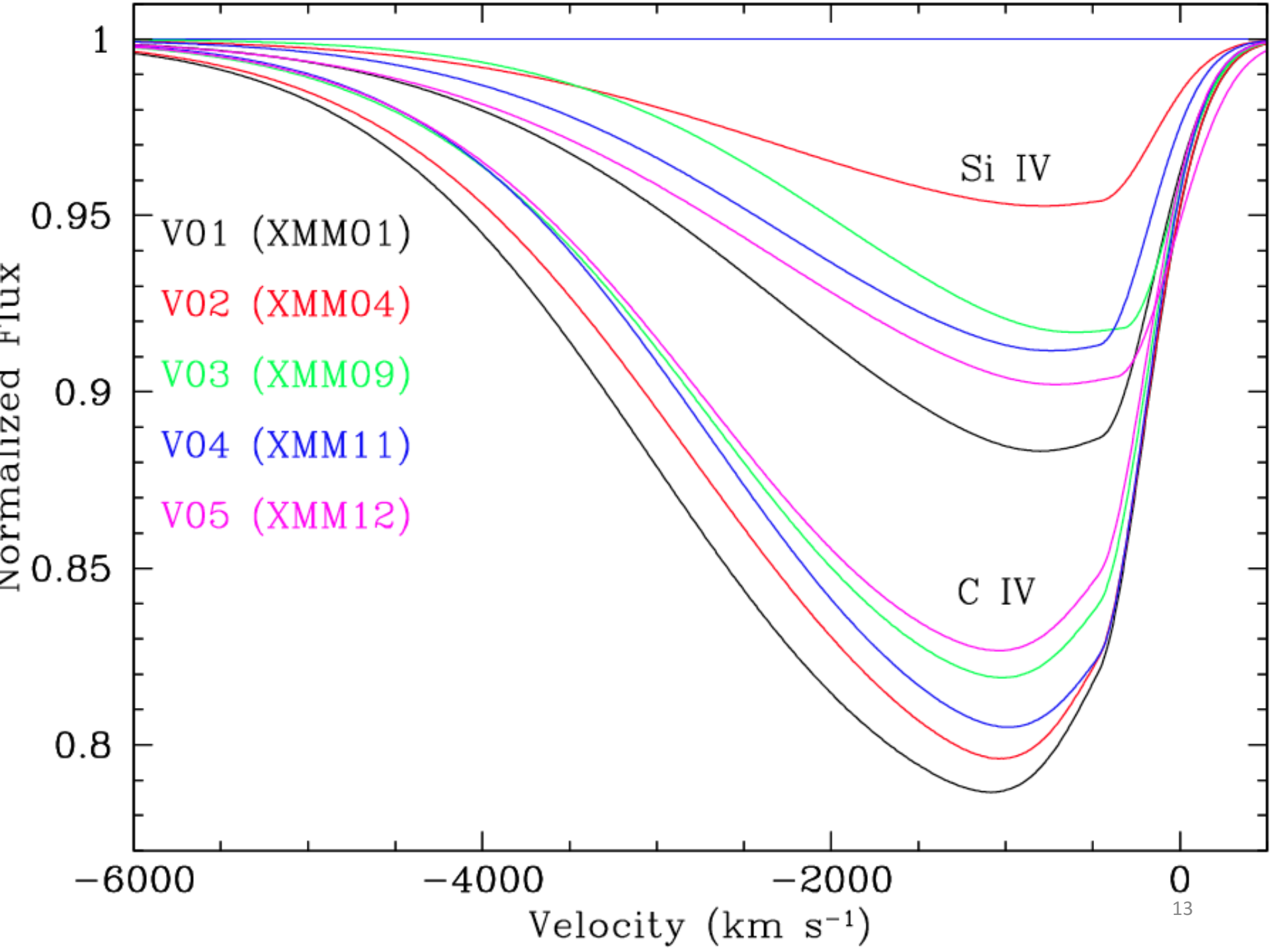


What is the obscurer and where is it?

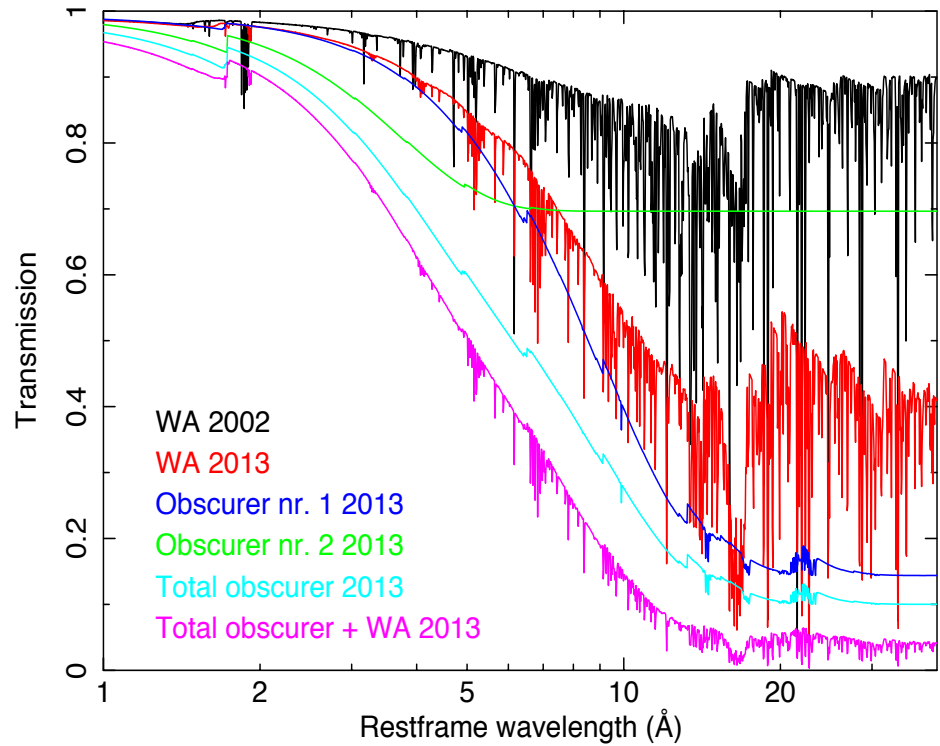
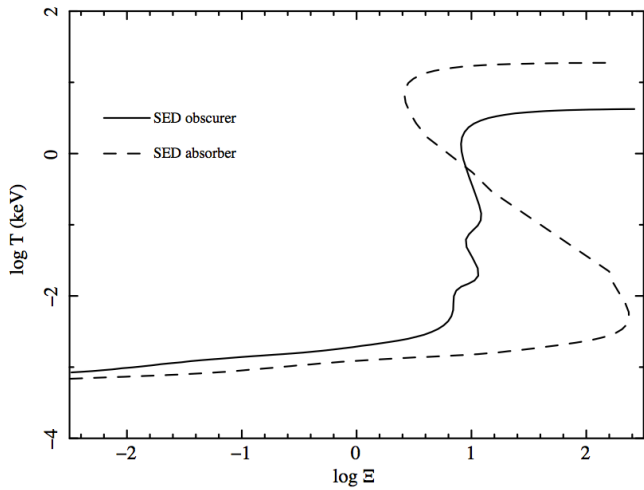
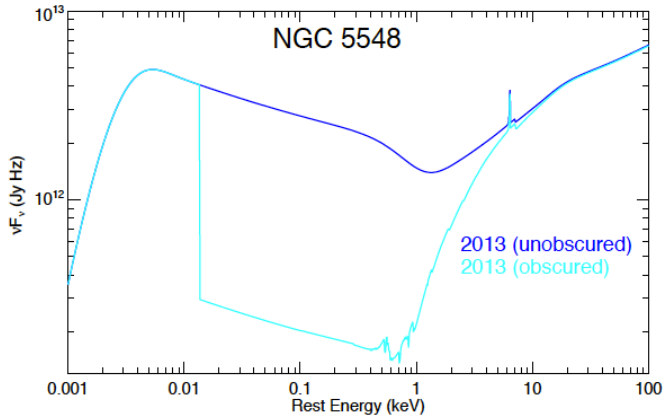
- UV BLR covered by 20-40% → R 2-7 lightdays from core ($\sim 10^{14}$ m)
- WA de-ionized → $R < 3$ pc (10^{17} m)
- F_{cov} high → likely close to BLR
- High velocity up to 5000 km/s → close to BLR
- Variations in obscuration @ 2 days: for size $\sim 20GM/c^2$ and $M = 4 \times 10^7 M_{\text{sun}}$, needed crossing velocity ~ 3000 km/s → comparable to v_{rad}
- Line of sight inclined by about 30 degrees (Pancoast et al. 2014) → predominantly poloidal outflow (from accretion disk?)

Obscuring stream

- *Two components:*
- **Main:** $\log \xi = -1.2$, $N_{\text{H}} = 10^{26} \text{ m}^{-2}$, $f_{\text{cov}} = 0.86$ (X-ray) and ~ 0.3 in UV; produces UV BAL
- **Second:** almost neutral, $N_{\text{H}} = 10^{27} \text{ m}^{-2}$, $f_{\text{cov}} = 0.3$ (X-ray) and < 0.1 in UV
- Partial covering inner BLR, v up to 5000 km/s, inside WA \rightarrow distance few light days ($\sim 10^{14} \text{ m}$, 0.003 pc)
- Obscuration already 3 years ongoing



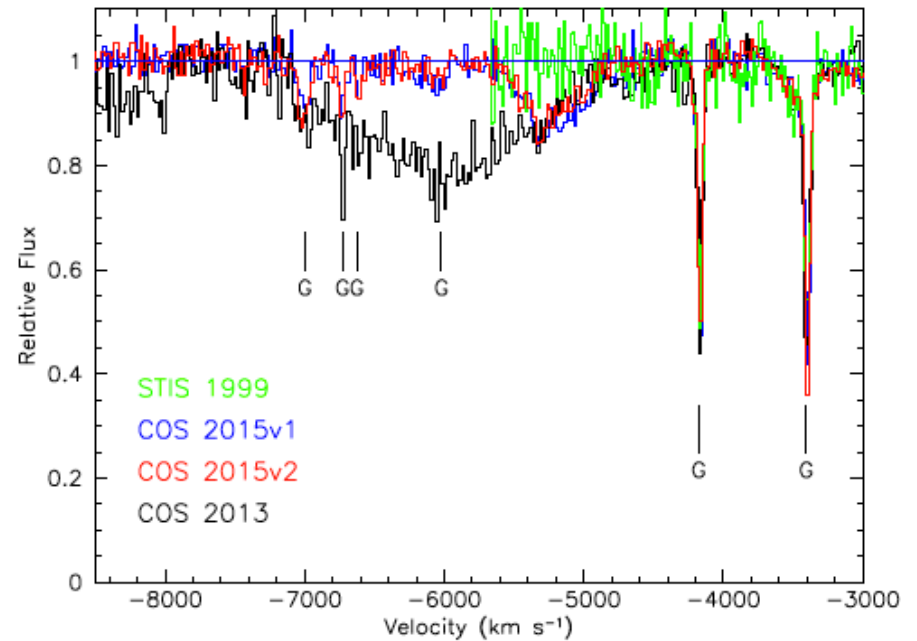
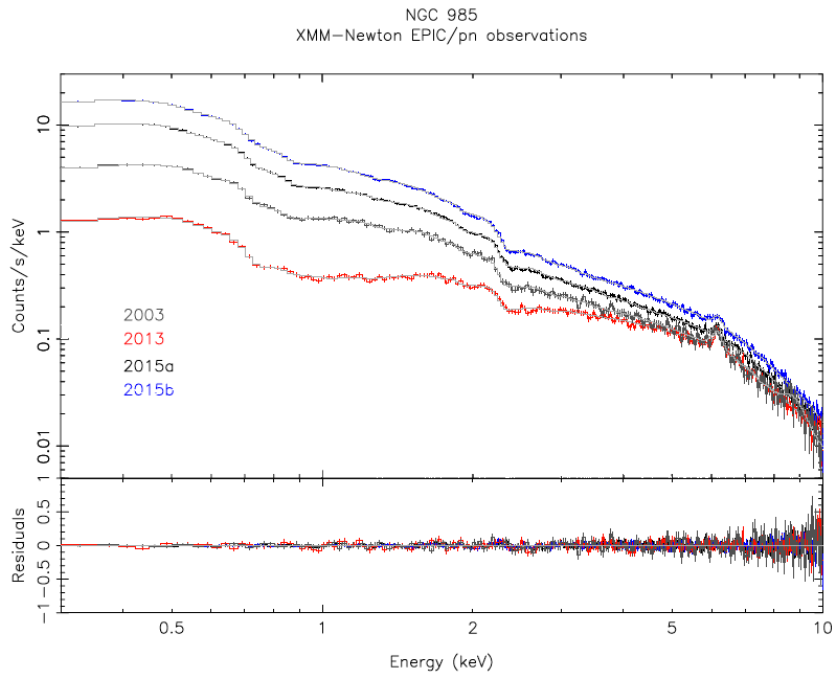
Obscured SED modeling



NGC 985

Another case: NGC 985

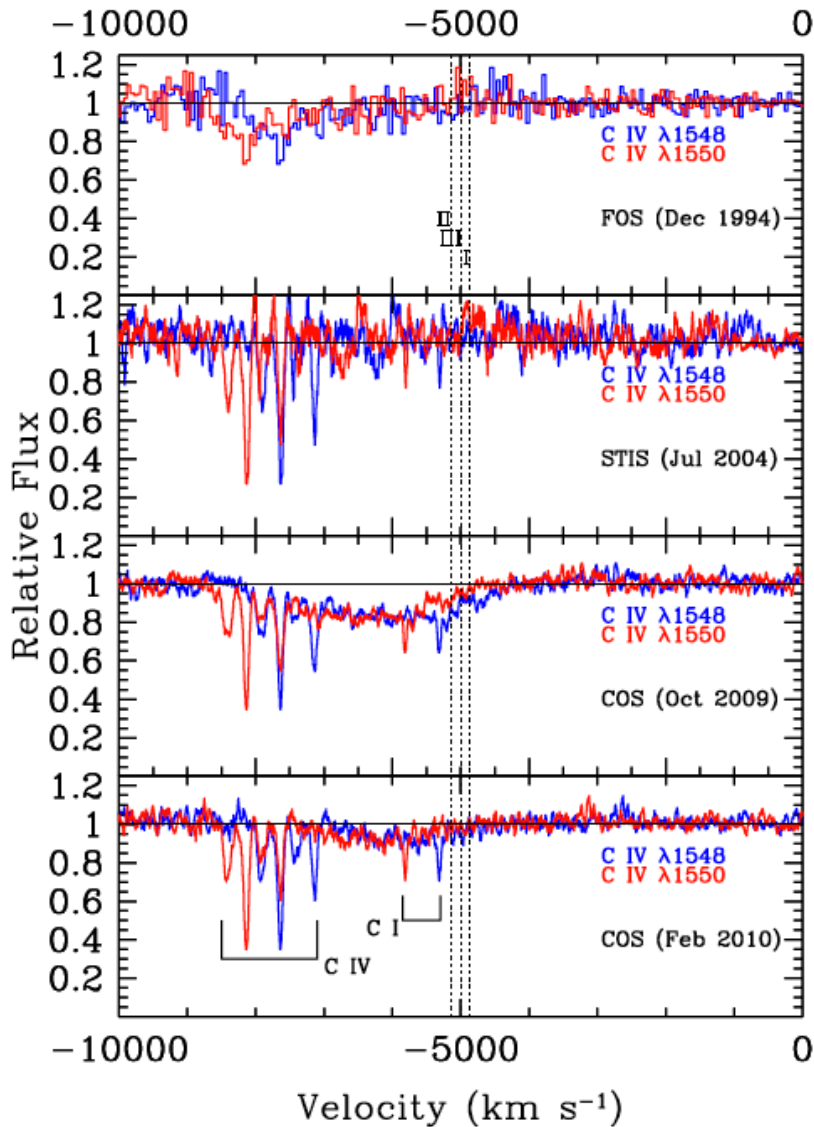
(Ebrero et al. 2016)



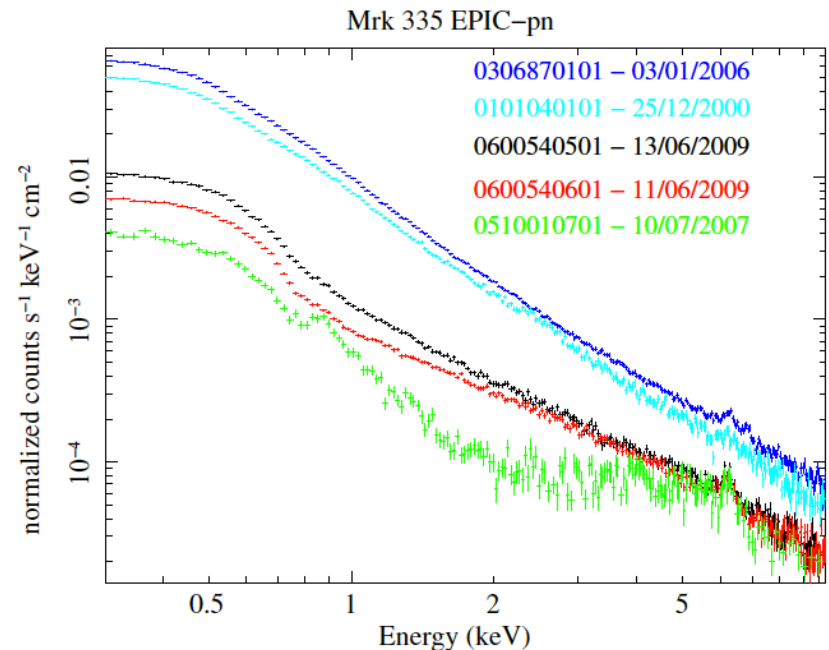
Obscuration seen in August 2013
Present but weaker in Jan 2015

Mrk 335

The case of Mrk 335



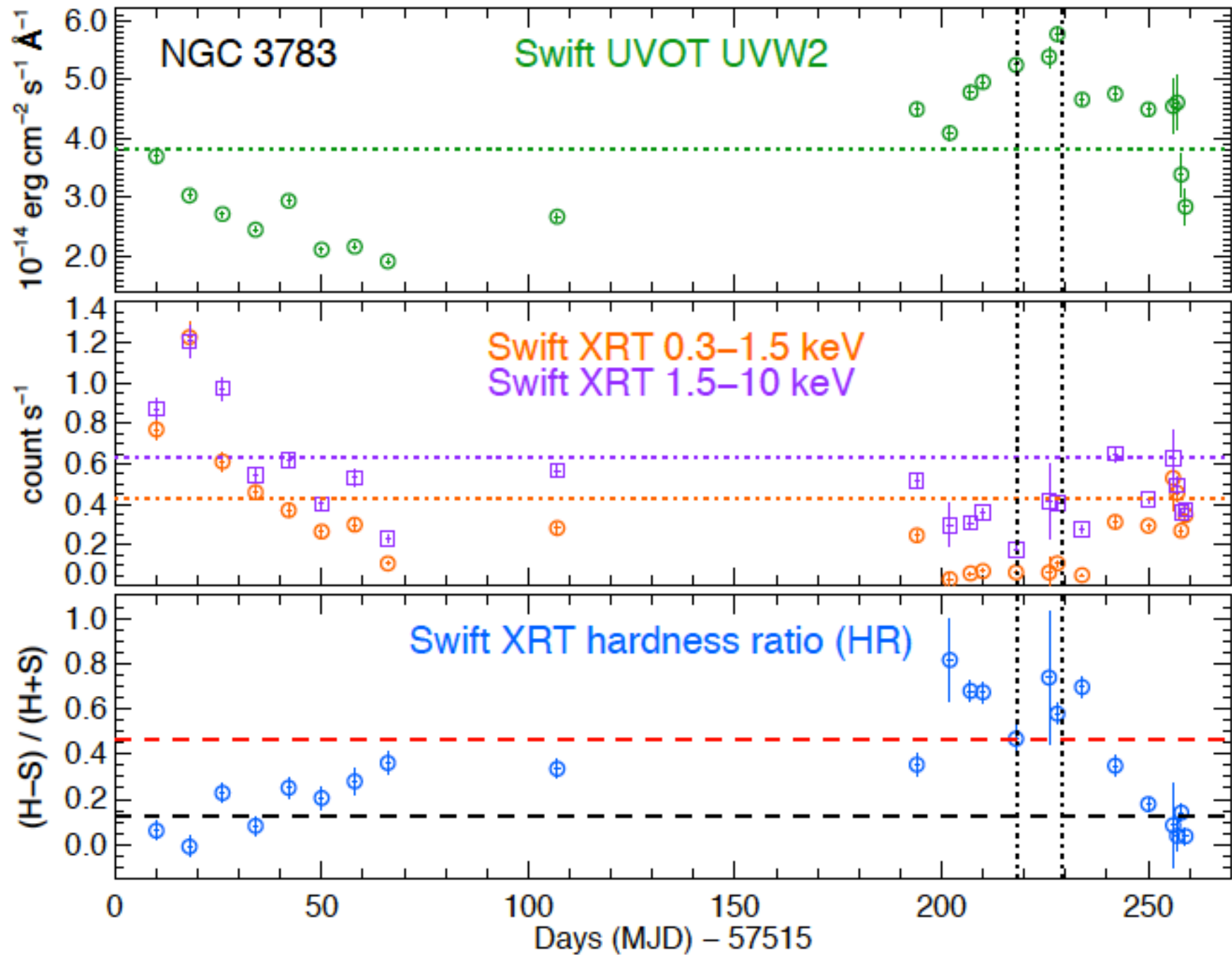
- UV data non-simultaneous with X-ray
- X-rays: more like “normal” WA (high ξ) in medium flux state (with UV BAL)
- Published by Longinotti et al.

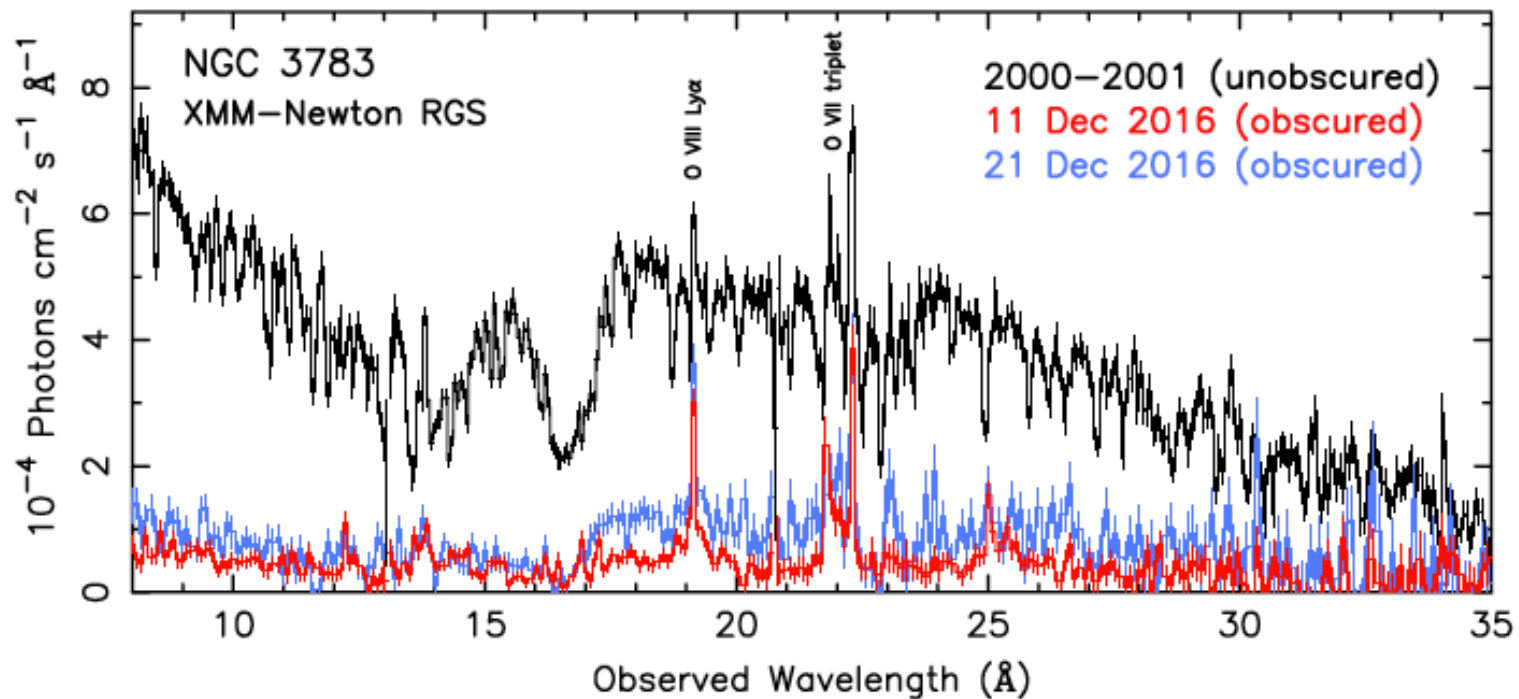
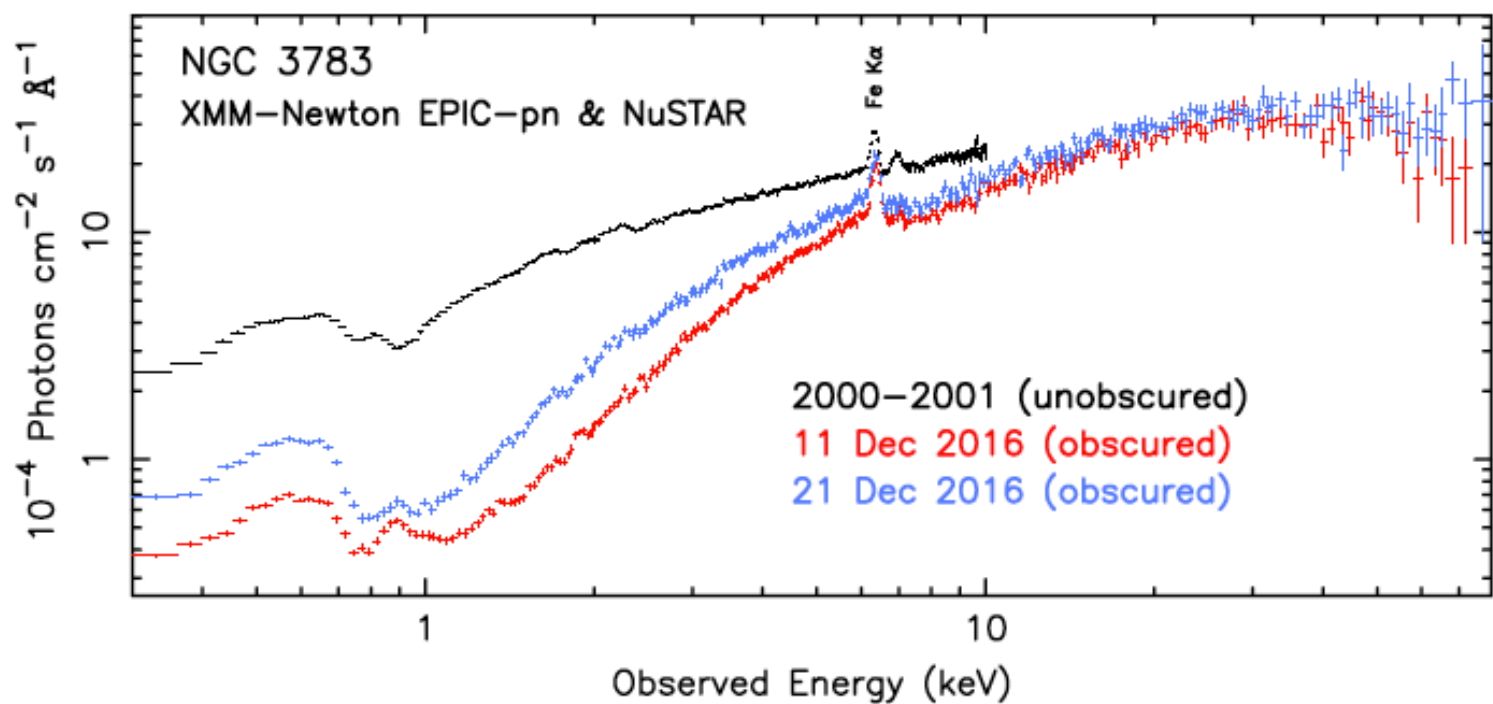


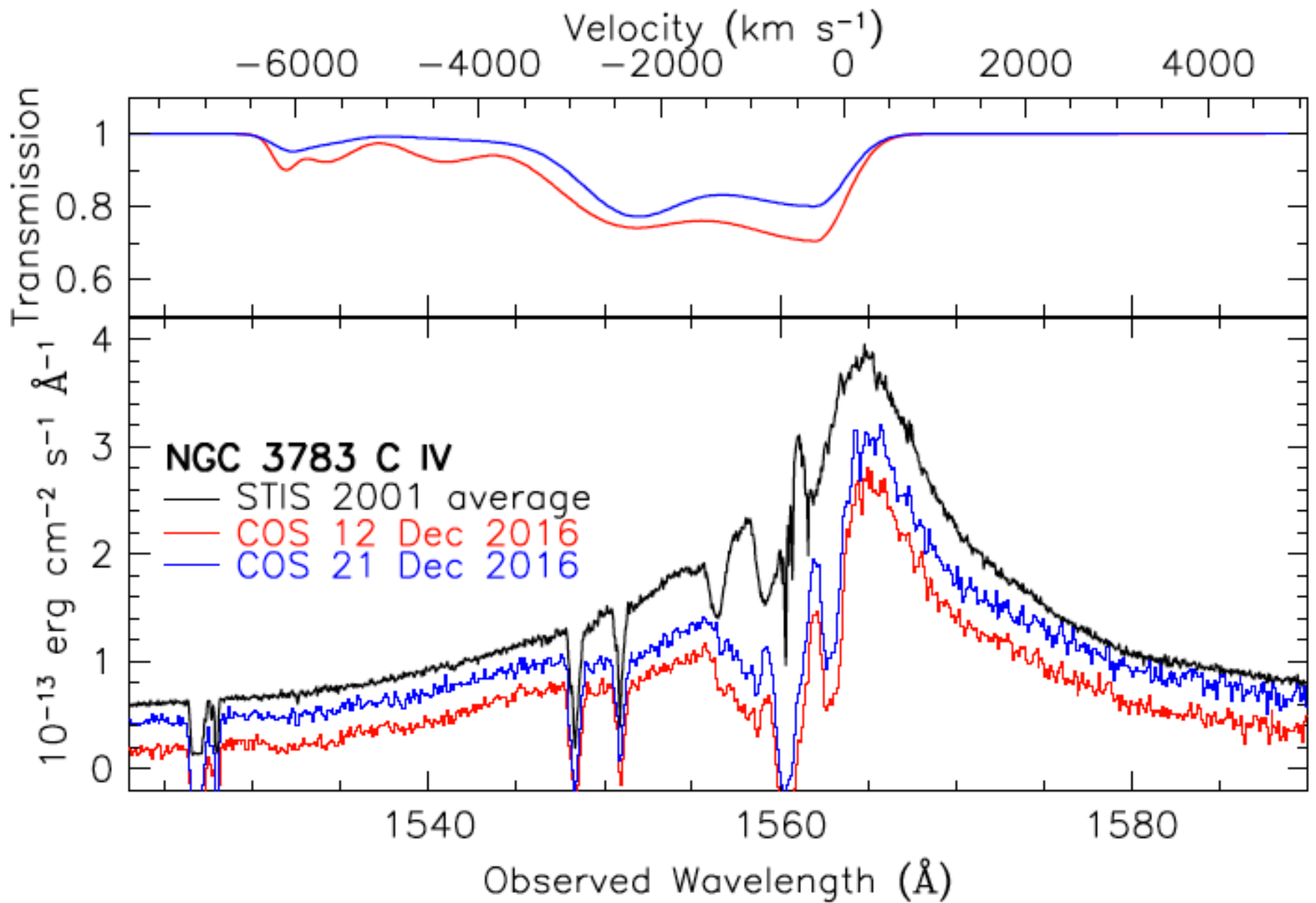
Statistics

- Markowitz et al. (2014):
- 260 years observing time RXTE
- 12 X-ray eclipse events in 8 sources
- NGC 3783 is one of them

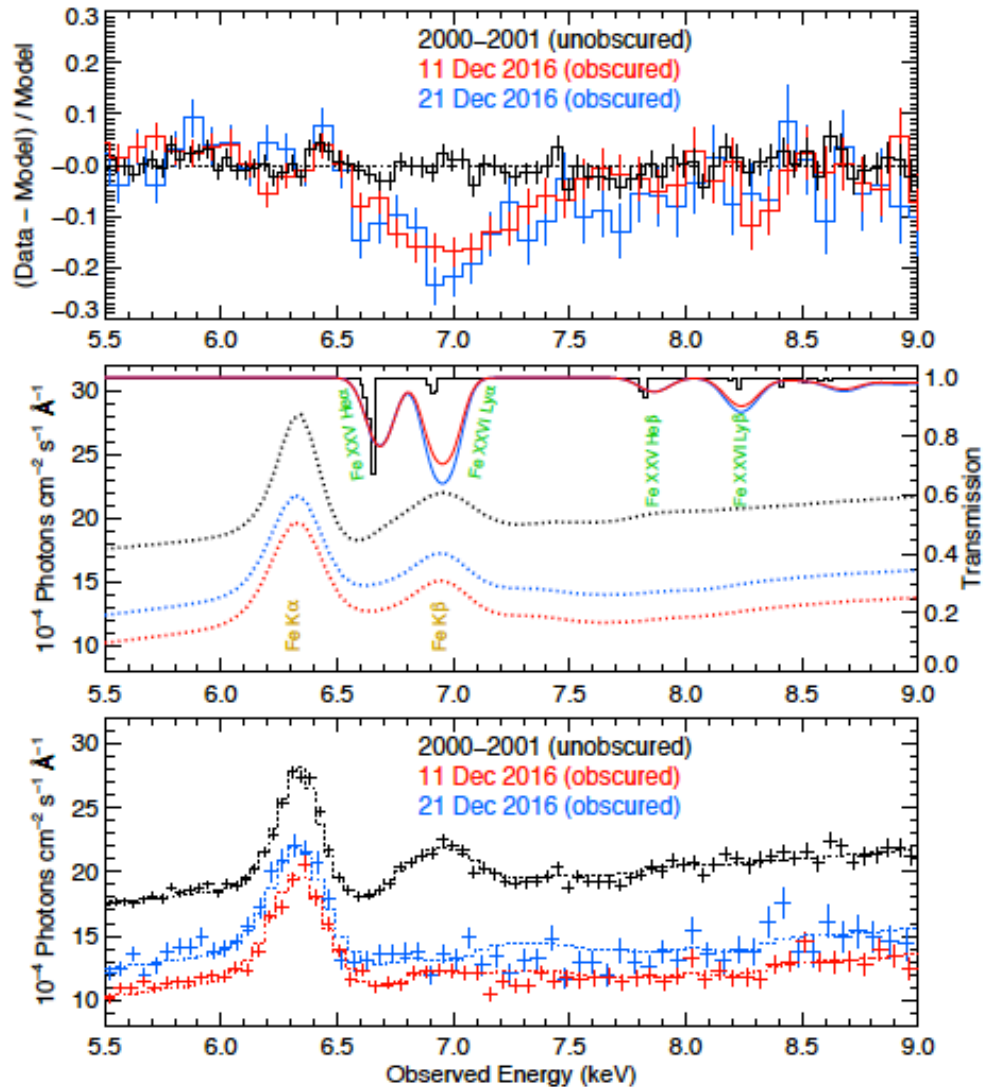
NGC 3783





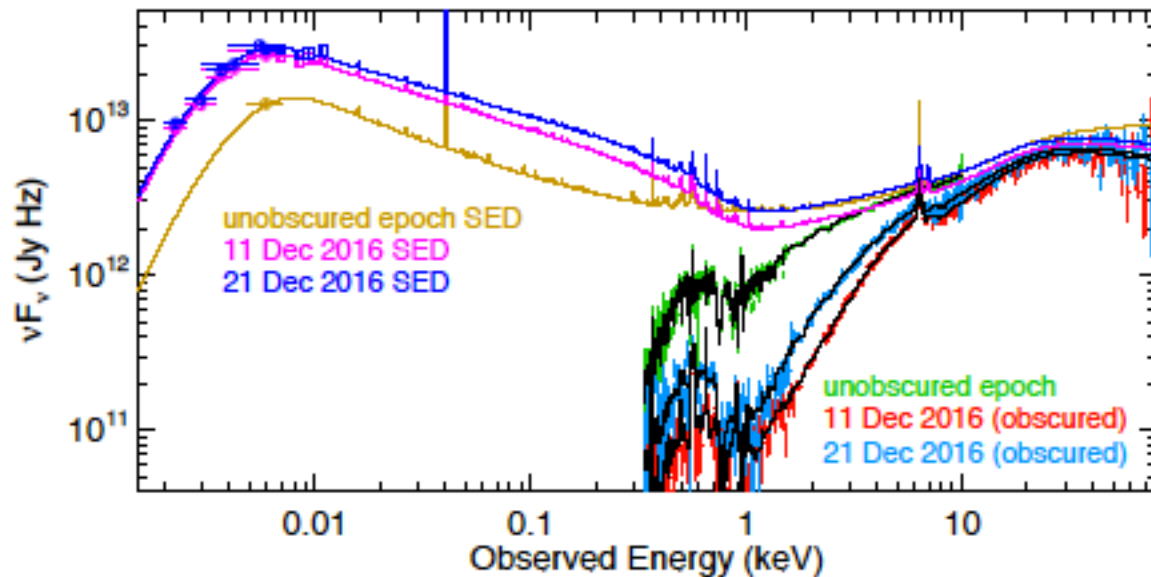
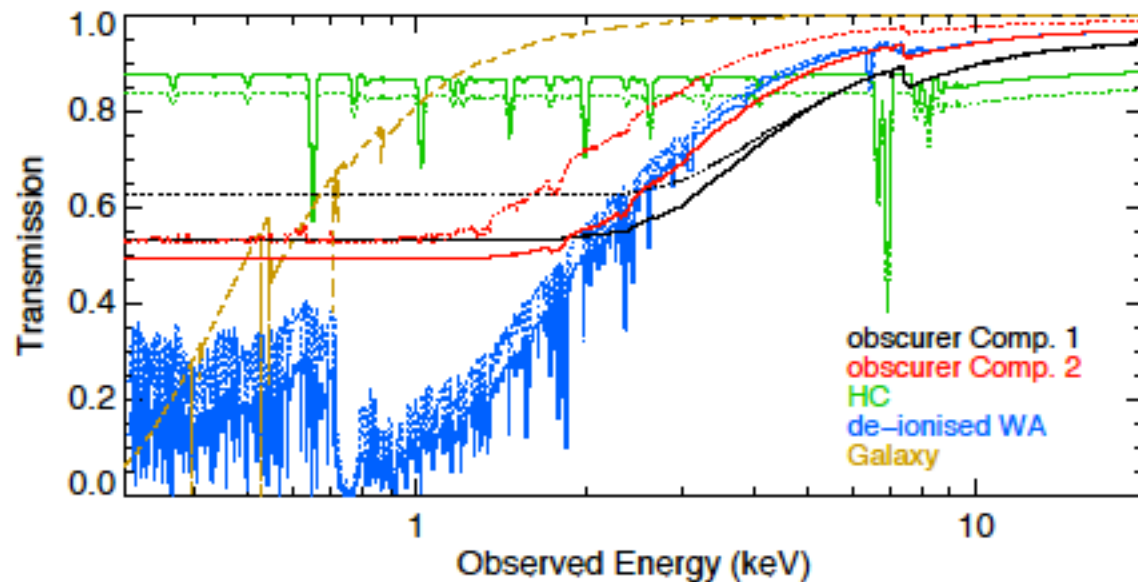


New high-ionisation component



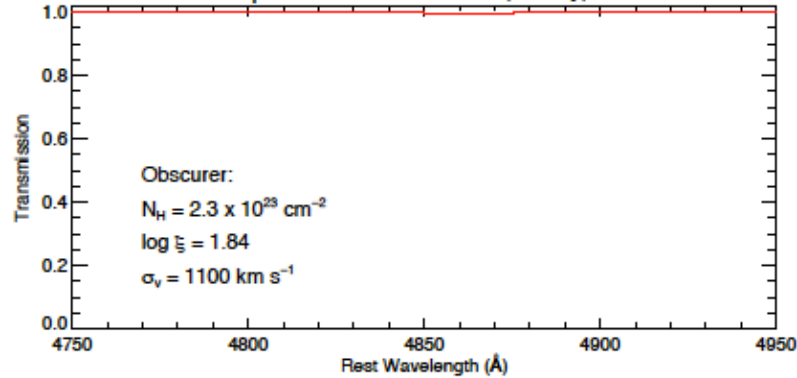
Complex modeling

- Need model with *48 components*
- Includes 16 *pion* components, all stacked and influencing each other
 - 2 for the emission lines
 - 11 for the WA (different ν , ξ)
 - 3 for the obscurer
- 19 free parameters (L/ξ is fixed)
- Fit: optical to hard X-ray spectrum
- *80 s* calculation time per full model allows interactive fitting
- Forthcoming paper: Mehdipour et al. 2017 (submitted to A&A Letters)

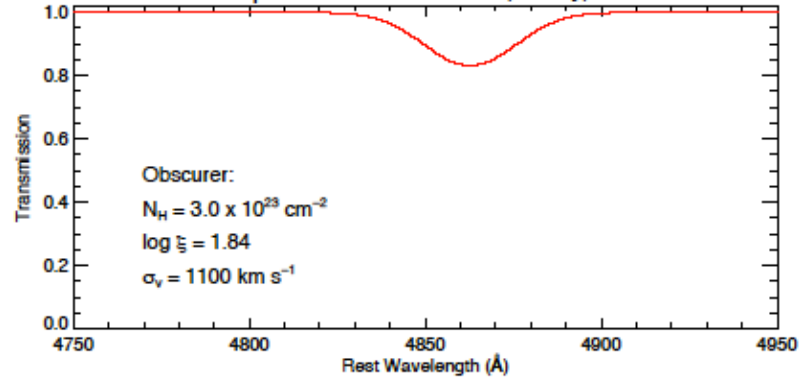


Balmer line absorption?

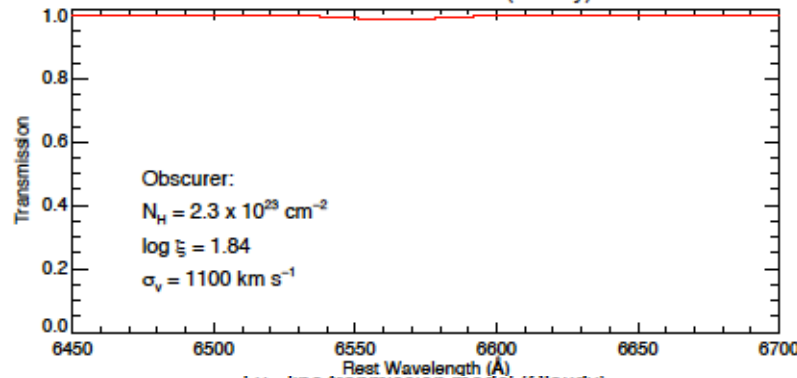
H β line transmission model (Cloudy)



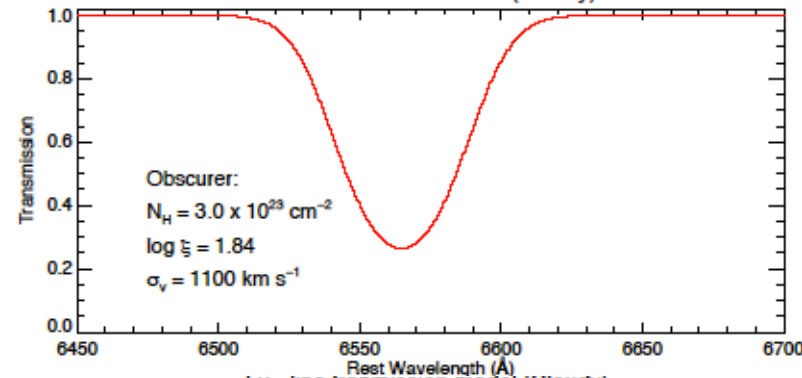
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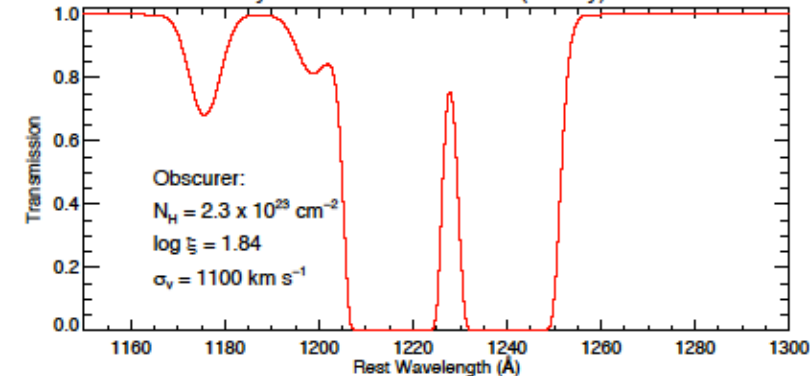
H α line transmission model (Cloudy)



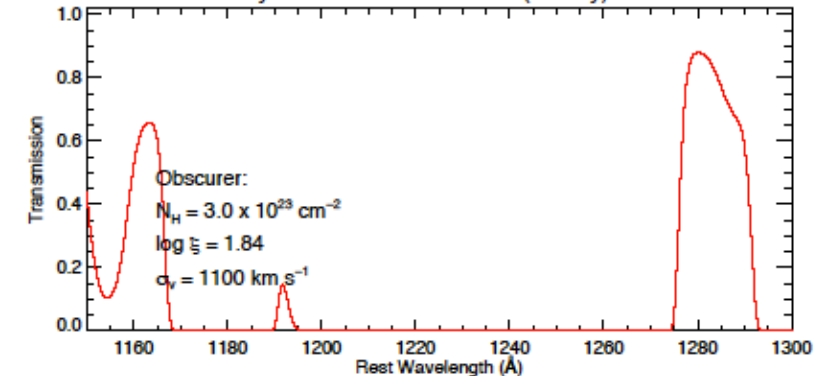
H α line transmission model (Cloudy)

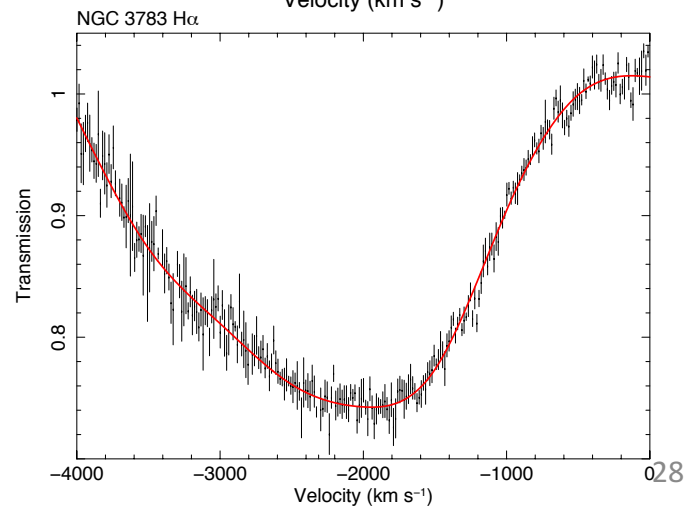
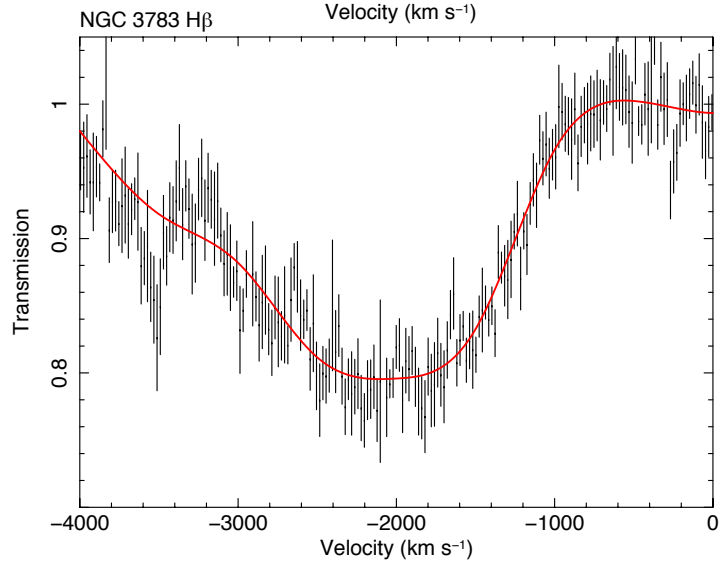
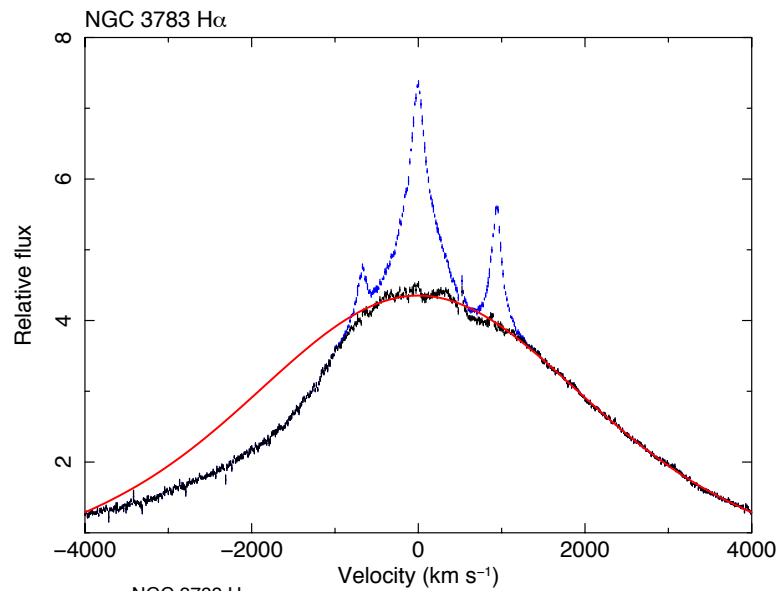
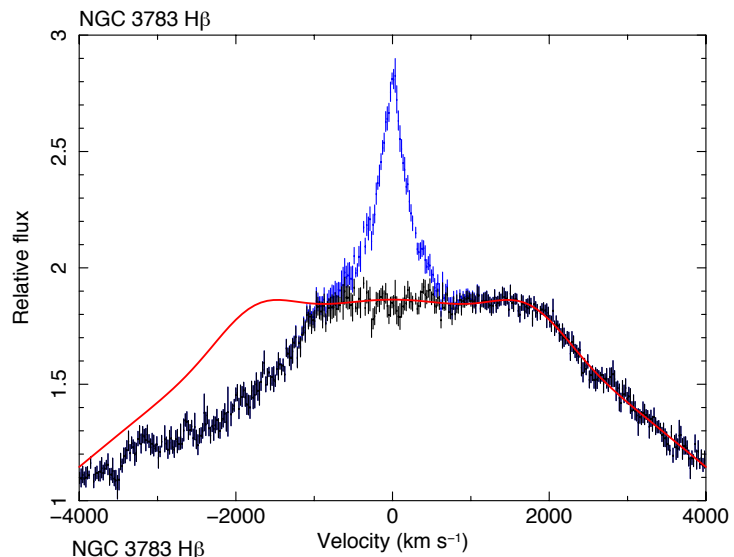


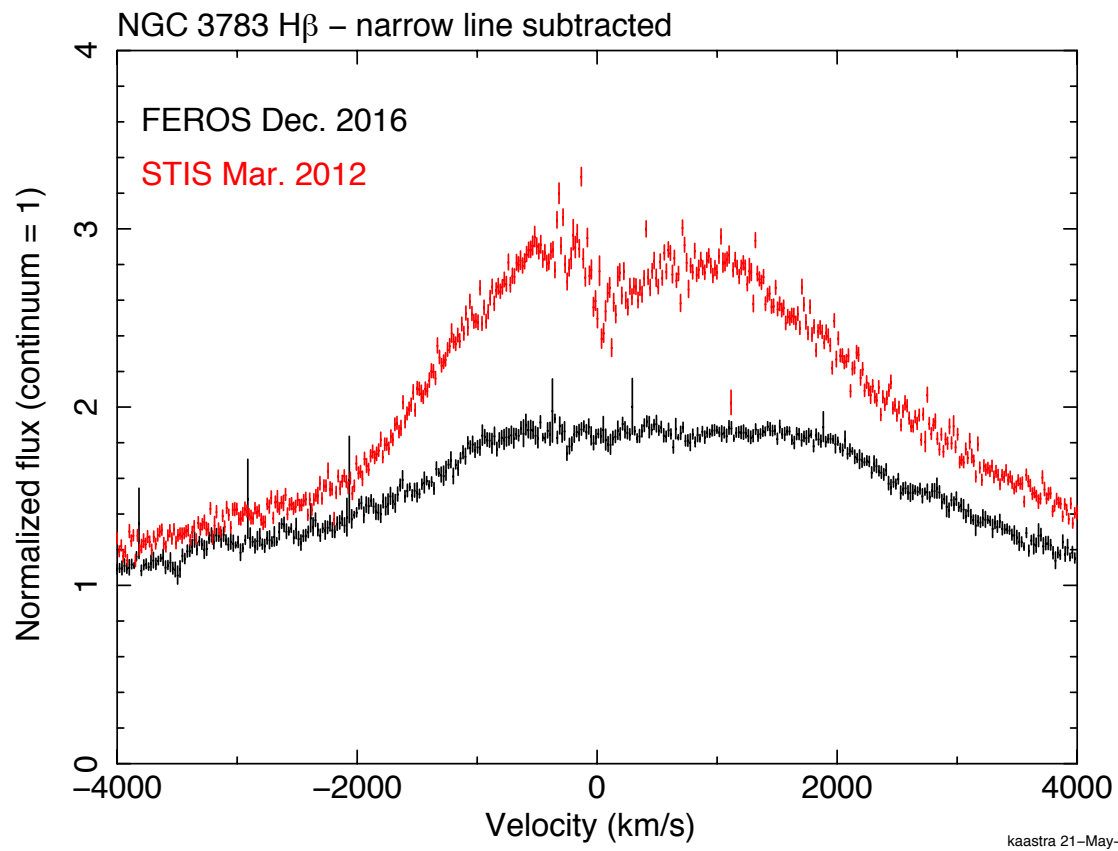
Ly α line transmission model (Cloudy)



Ly α line transmission model (Cloudy)







Comparison between sources

Comparison of sources

	NGC 5548	NGC 985	Mrk 335	NGC 3783
Components	2	1	?	3
N_H (10^{26} m^{-2})	1 & 10	2	?	20 & 5 & 2
$\log \xi$	-1 & <-2	-1	?	-1.8 & -1.8 & 3.7
F_{cov} (X-ray)	0.86 & 0.30	0.92	?	0.4 & 0.5 & 1
UV Center (km/s)	-1000 (up to -6000)	-6000	-6500	-1900 & -1900 & -2300
UV FWHM	3000	1400	750	2500 & 2500 & 6000
UV depth	40%	25%	15%	30 %
Duration	> 6 years continuous	> 18 month??	Frequently, month?	1 month

Questions

- what is the difference between obscuration and an eclipse?
- What are the timescales for obscuration: weeks, years, centuries?
- where is the obscuring stream originally born and how?
- is there a connection between certain accretion disk behavior and the obscuration?
- What fraction of the AGN continuum is covered by the obscuration?