

# A variable-density absorption event in NGC 3227 mapped with *Suzaku* and *Swift*

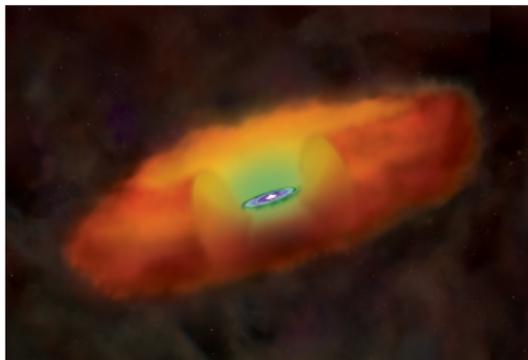
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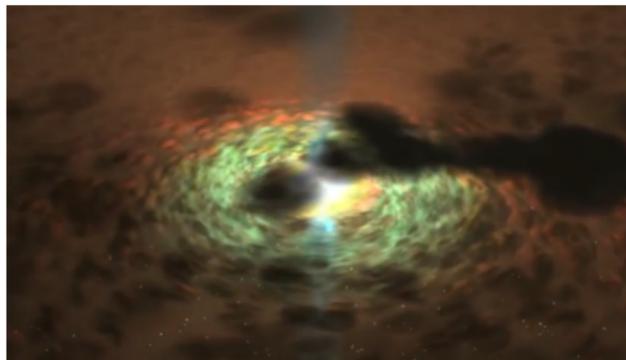




Objective: Morphology of circumnuclear gas



Urry & Padovani (1995)

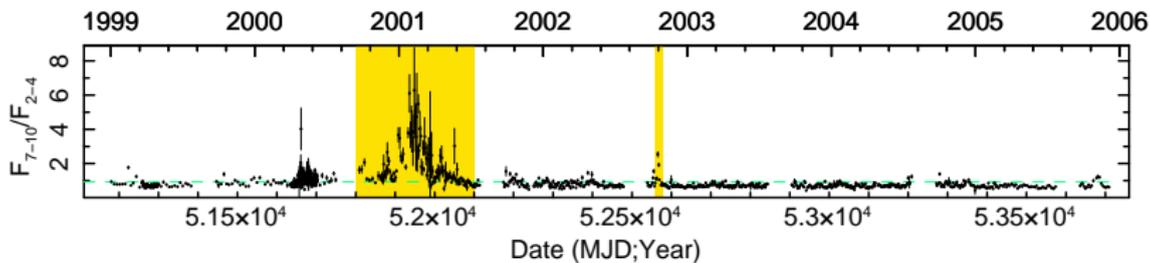


Nenkova et al., 2008

- ▶ Continuous structures? Discrete clumps/clouds? Both?
- ▶ Trace geometry/density of structures that transit the line of sight
- ▶ Method: X-ray variability study
- ▶ clumpy torus supported by IR-spectroscopy

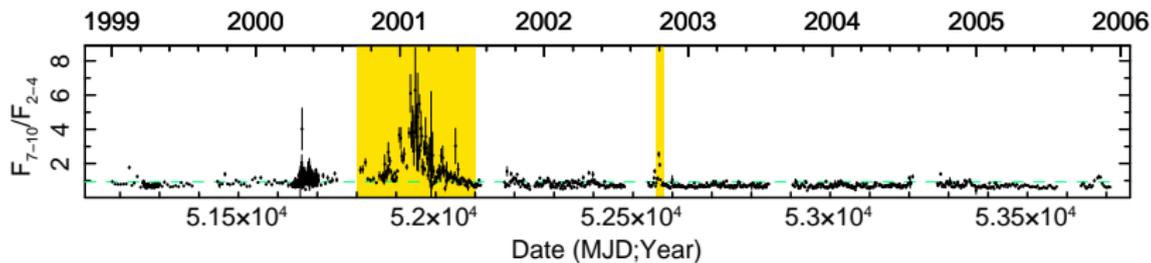
- ▶ Time scales from hours to years: evidence for clumpy tori, against homogeneous extended structures
- ▶ some events are **time-resolved**
- ▶ **short term ( $\sim 1$  d)**: Mrk 766 (Risaliti et al., 2011), "comets" in NGC 1365 (Risaliti et al., 2007, 2009), NGC 4388 (Elvis et al., 2004)
- ▶ **long term ( $\gtrsim 7$  d)**: Cen A (Rivers et al., 2011; Markowitz et al., 2014), NGC 3227 (Lamer et al., 2003), NGC 3783 (Markowitz et al., 2014)
- ▶  $\Delta N_{\text{H}} \sim 10^{22-24} \text{ cm}^{-2}$ ,  $\Delta$ Covering Fraction
- ▶ absorbers span a range from the "Broad Line Region" (lt-days – lt-weeks from SMBH) to the inner dusty torus

# NGC 3227 – past eclipses

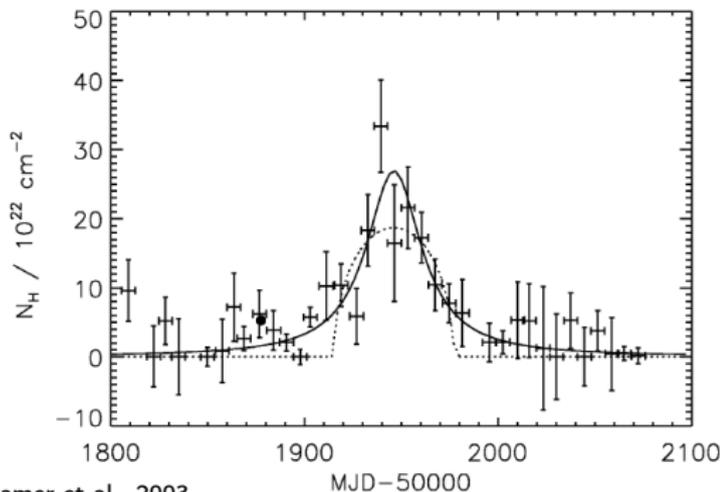


6.9 years of *RXTE* monitoring; Markowitz, Krumpe, & Nikutta (2014)

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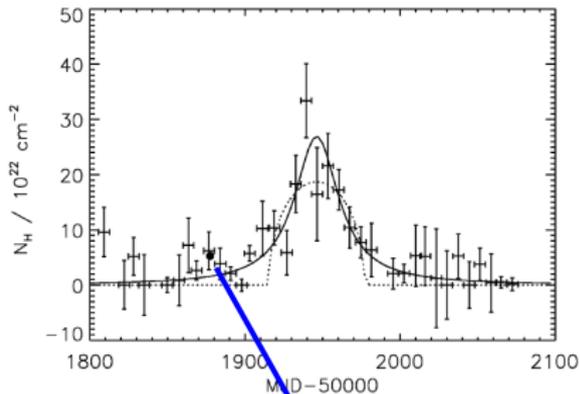


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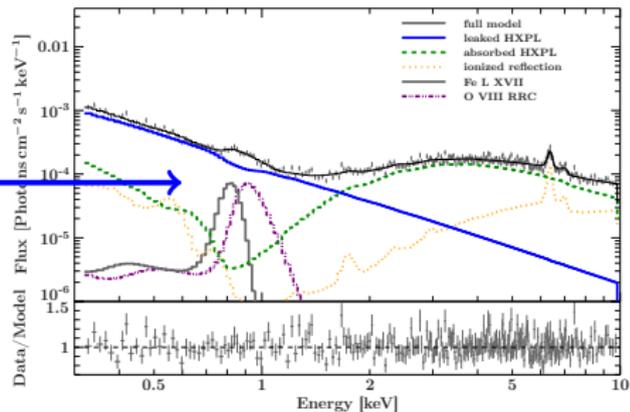
Lamer et al., 2003

# NGC 3227 – past eclipses



dominant, variable absorber:  $\log \xi \sim -0.3$

2000/1

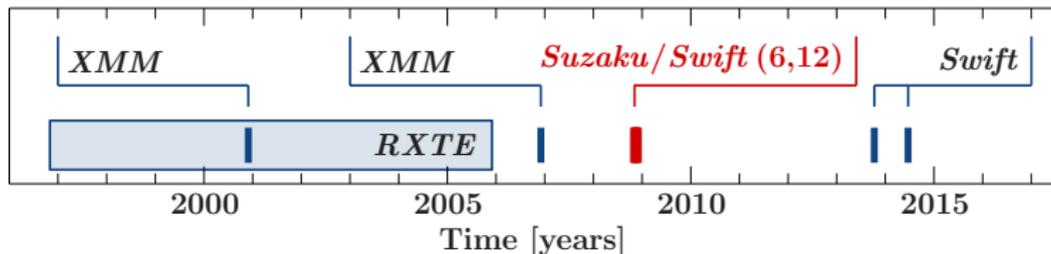


2008 campaign: simul. fit to

- ▶ **6 *Suzaku*** obs. (weekly spaced)  
energy range: 0.5–25 keV
- ▶ **10 *Swift*** obs. (two adjacent ones weekly spaced)  
wavelength/energy range: 1928–5468 Å (UVOT),  
0.5–10 keV (XRT)

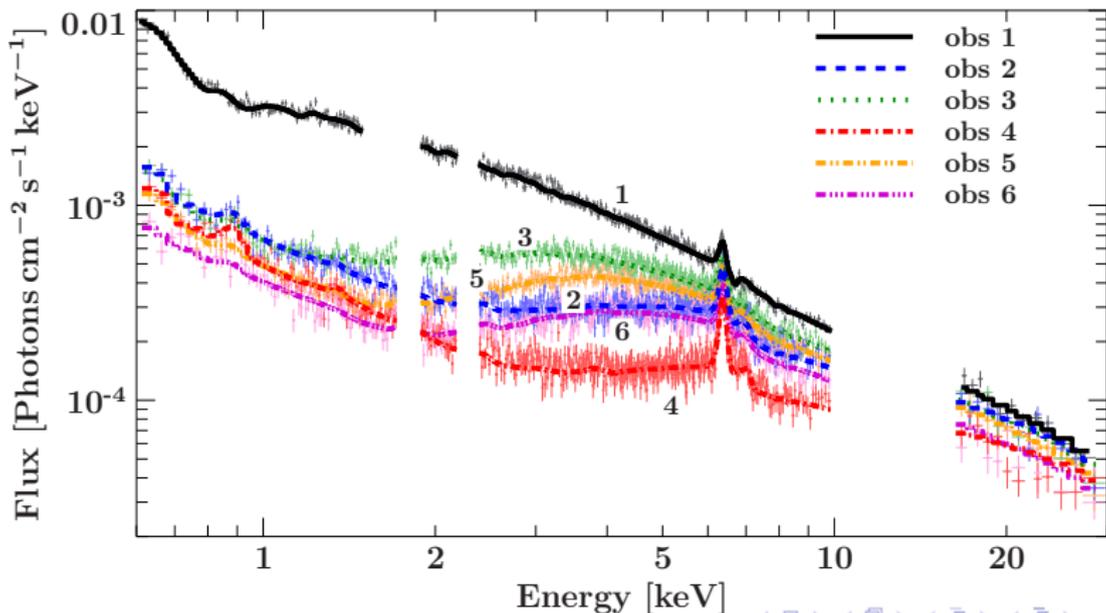
Re-visit *XMM-Newton* obs. from 2000/1 (Lamer et al., 2003) and  
2006 (Markowitz et al, 2009)

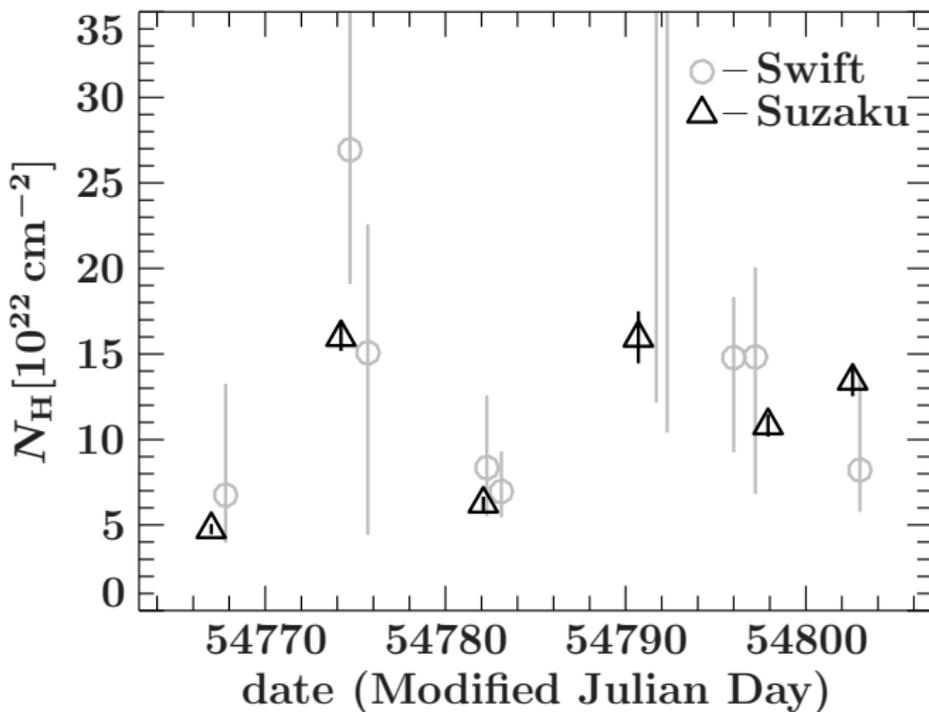
Compare recent *Swift* obs. from 2013/4



3 absorbers ( $\log \xi \sim -0.39, 1.1, 3.4$ ) motivated by Markowitz et al., 2009  
 variability: intermediately ionized, partial covering absorber

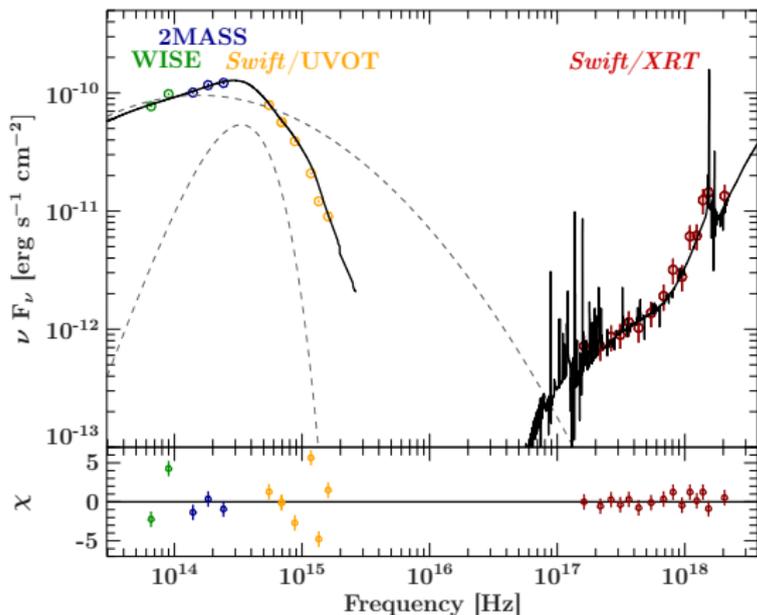
$$\log \xi \sim 1.1, f_{\text{cvt}} \sim 0.7-0.9, N_{\text{H}} \sim 5-16 \times 10^{22} \text{ cm}^{-2}$$



Unique resolved  $N_{\text{H}}$ -profile

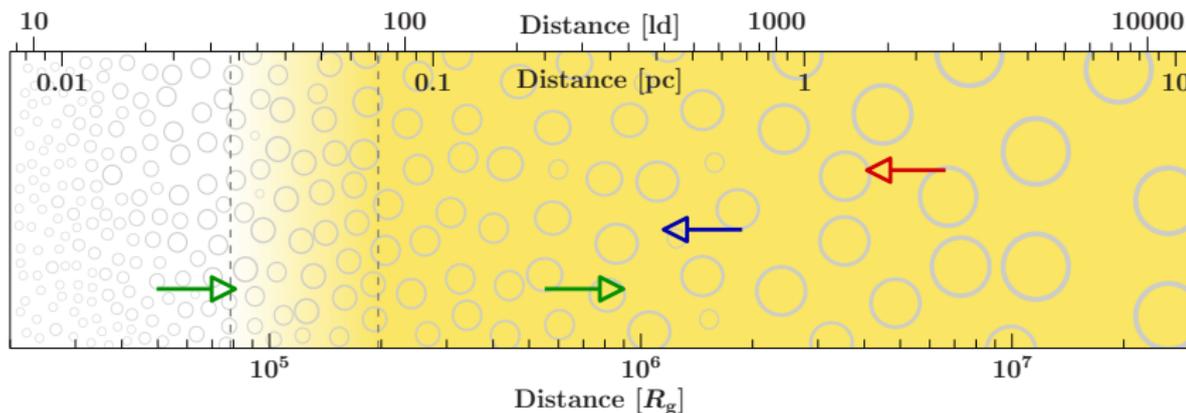
Reddening of UVOT data  $\rightarrow A_V \rightarrow N_H$  (Crenshaw et al. 2001; Nowak et al., 2012)

$$N_{H,X\text{-rays}} (\sim 10 \times 10^{22} \text{ cm}^{-2}) \gg N_{H,UV} (\sim 0.1 \times 10^{22} \text{ cm}^{-2})$$



$\rightarrow$  non-dusty absorber?  
 estimated distance range:  
 0.018–0.69 pc

- ▶ simul. fit of *Suzaku* and *Swift* spectra spanning 35 days
- ▶ applied complex ionized absorption: low, **intermediate**, high  $\xi$
- ▶  $\log \xi \sim 1.1$ ,  $f_{\text{cvt}} \sim 0.7\text{--}0.9$ ,  $N_{\text{H}} \sim 5\text{--}16 \times 10^{22} \text{ cm}^{-2}$
- ▶ MIR-X-ray SED: most likely dust-free absorber
- ▶ consistent with clumpy torus model
- ▶ morphology: likely a sheared, filamentary cloud launched from the disc
- ▶ NGC 3227: unique lab for studying absorbers across a range of distances from the SMBH



Geometrical considerations ( $\Delta R < N_{\text{H}}/n_{\text{H}}, \Delta R < R$ )

←  $R \leq L_{\text{ion}}/\xi N_{\text{H}}$

← photoionization equilibrium ( $t_{\text{rec}} \leq t_{\text{var}} = 7 \text{ d}$ )

(see also Reynolds & Fabian 1994)

← Orbiting spherical cloud on Keplerian orbits

(see also Lamer et al. 2003, Lohfink et al. 2012)

## Model composition for simultaneous fit

