AGN structure from X-ray Absorption variability

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Ubiquitous Variability of $N_H$ in Seyfert Galaxies

$N_H$ variable in 23/25 sources

Timescales from months to years

Clumpy absorber
Sub-parsec distance

Risaliti, Elvis & Nicastro 2002
NGC 1365: The best laboratory to investigate the absorber in obscured AGN

Hard X-ray observations:

- ASCA (1995) 40 ks
- BeppoSAX (1997) 30 ks
- Chandra (Dec 2002) 15 ks
- XMM 1 (Jan 2003) 17 ks
- XMM 2 (Jan 2003) 10 ks
- XMM 3 (Aug 2003) 15 ks
- XMM 4 (Jan 2004) 60 ks
- XMM 5 (Aug 2004) 60 ks
- Chandra (Apr 06) 6x15 ks
- XMM 6 (May 07) 4.5 days
- Suzaku (Jan 08) 4 days
Two methods:

1. Campaigns of snapshot observations within ~a few days
Two methods:

2. Analysis of HR light curves in long observations
Goals:

1. Finding more sources with eclipses in ~hours-days

2. Measuring the physical properties of the clouds
1. Finding more sources with eclipses in ~hours-days

- **NGC 4388**: $\Delta N_H \sim 2 \times 10^{23} \text{ cm}^{-2}$, $\Delta T \sim 15$ hours

- **NGC 4151**: $\Delta N_H \sim 10^{23} \text{ cm}^{-2}$, $\Delta T \sim 2$ days

- **UGC 4203**: $\Delta N_H \sim 3 \times 10^{23} \text{ cm}^{-2}$, $\Delta T < 15$ days

- **NGC 7582**: $\Delta N_H \sim 10^{23} \text{ cm}^{-2}$, $\Delta T \sim 20$ hours

(Bianchi et al. 2009)
Eclipses of the X-ray source are COMMON in nearby AGN

$\Delta N_H \sim 10^{23} - 10^{24} \text{ cm}^{-2}$

General results:

$V > 10^3 \text{ km/s}$

$D \sim 10^{13} \text{ cm}$

$n \sim 10^{10} - 10^{11} \text{ cm}^{-2}$

X-ray absorber = BLR clouds
2. Properties of the absorbing (BLR) clouds:

Time-resolved analysis of the Suzaku observation of NGC 1365

$10^{22}$ $>10^{23}$
Properties of the absorbing clouds: XMM long look of Mrk 766
Mkn 766
1st orbit

- Possible cometary structure
- Different cloud velocity
Properties of the absorbing clouds: XMM long look of Mrk 766

![Graph showing properties of absorbing clouds](image)
Mkn 766 - 2nd orbit

Flux

HR

$N_H$

C.F.

$10^{22}$

$>10^{23}$