New results on the importance of absorption in shaping the X-ray properties of AGN

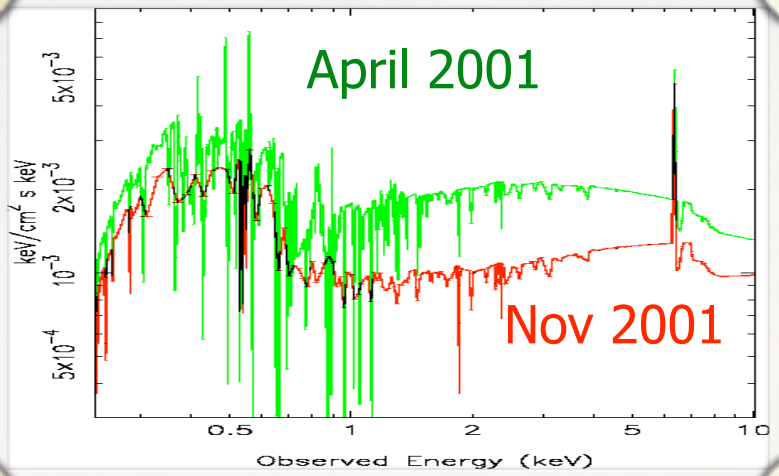
Jane Turner

Collaborators:
Lance Miller
(Oxford)
James Reeves
(Keele)
Steve Kraemer
(CUA)

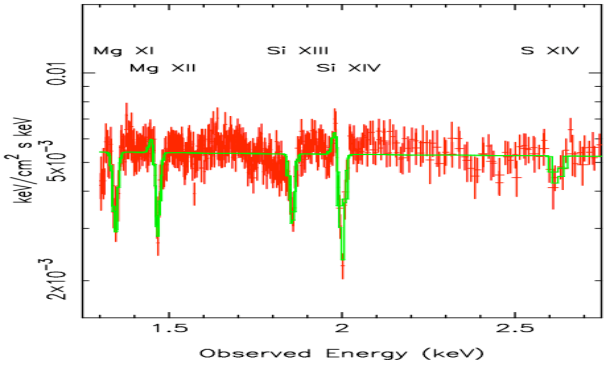
UMBC
AN HONORS UNIVERSITY IN MARYLAND

National Aeronautics
and Space Administration

NGC 3516



XMM, Turner et al. 2005

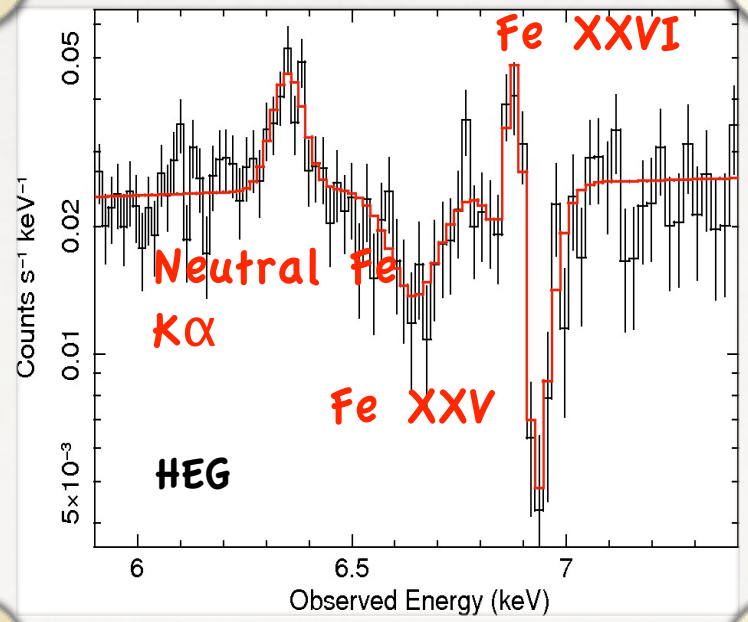


Turner et al. 2008

Long known to have multiple, variable layers of ionized gas

$N_{H1} \sim 6 \times 10^{21} cm^{-2}$ $\log \xi 1 \sim -0.5$; $N_{H2} \sim 10^{22} cm^{-2}$ $\log \xi 2 \sim 3$

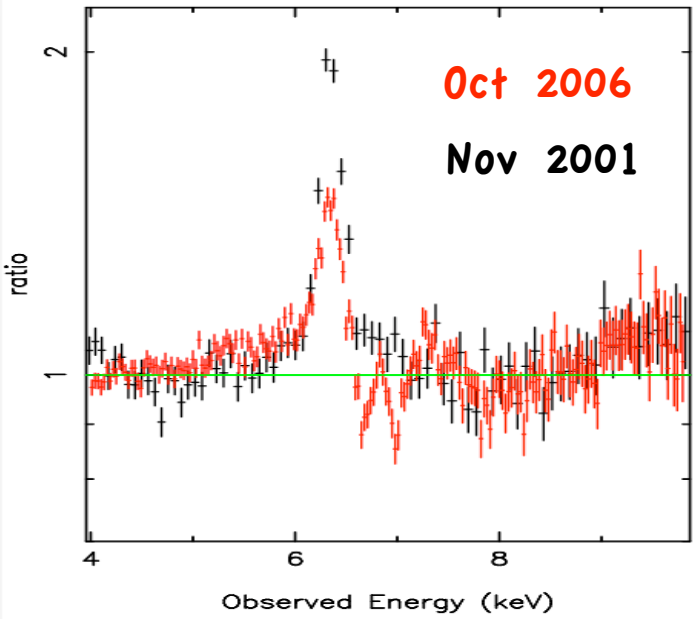
High N_H/ξ component isolated



Abs^n lines Fe XXV, XXVI

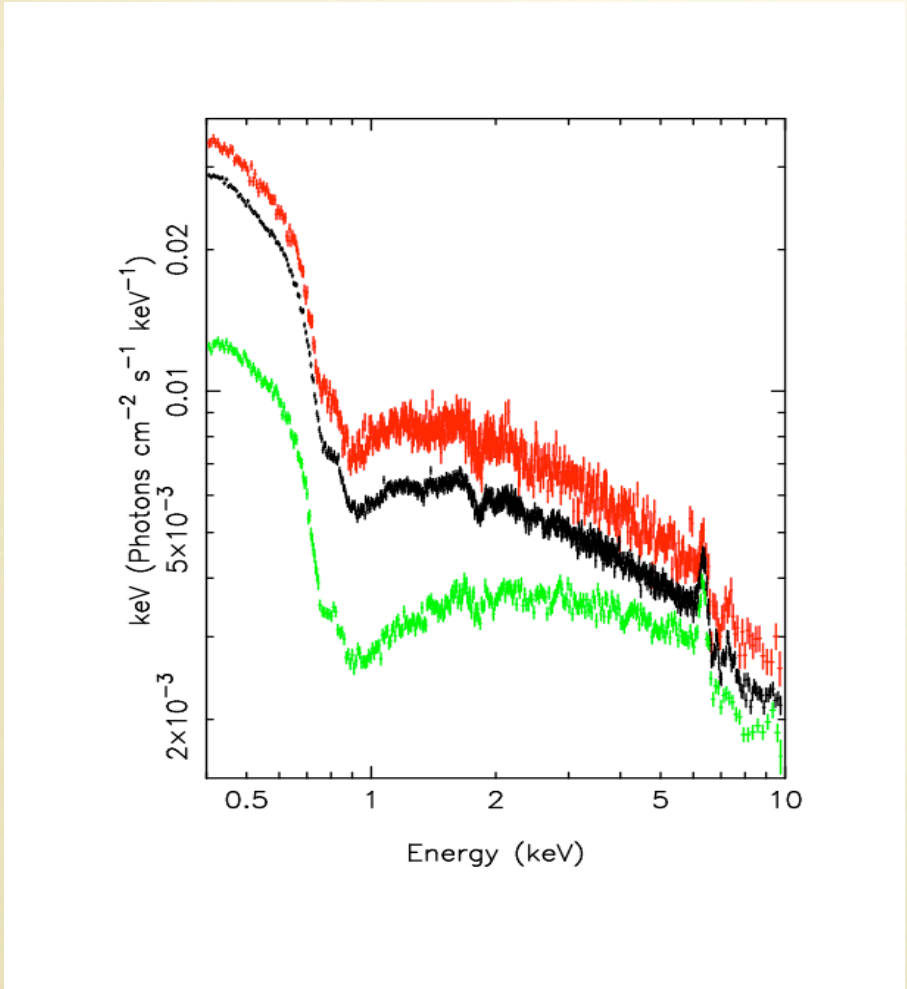
V ~ 1000 km/s outflow

$N_H > 5 \times 10^{23}$ cm^{-2} log ξ ~4.3



Observed energies rules out local (z=0) origin

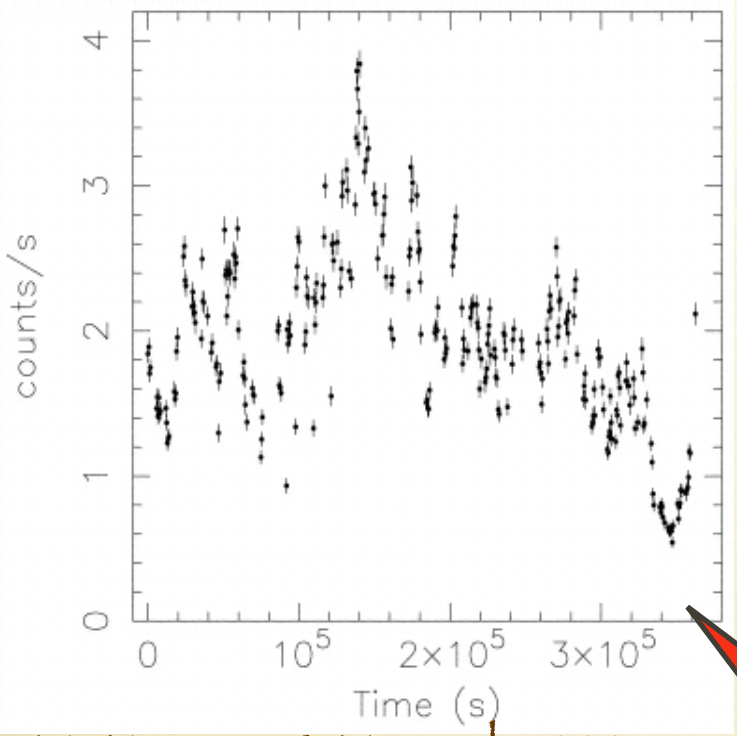
Covering Changes

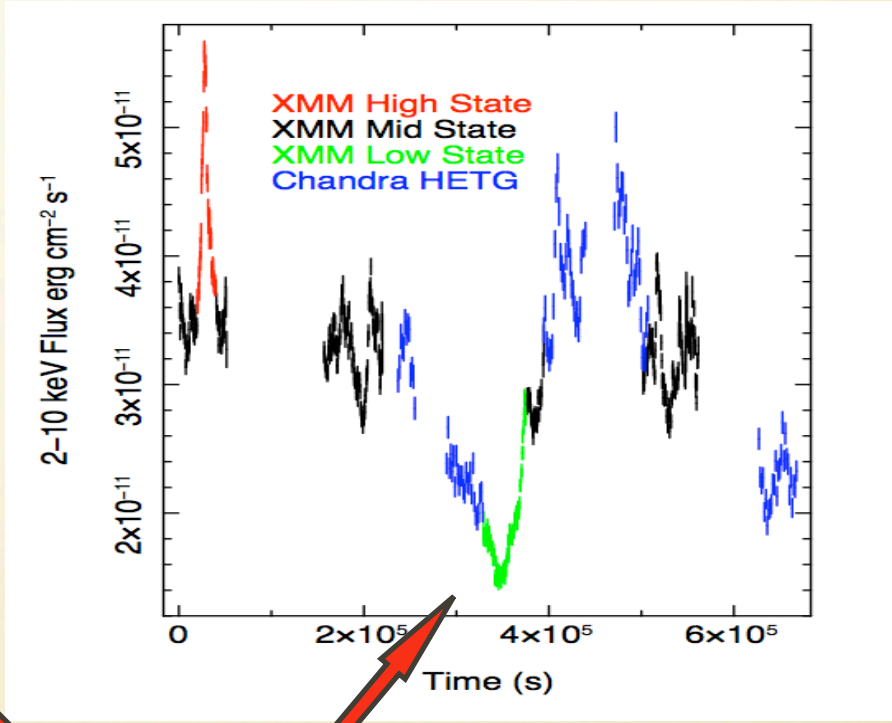


Spectral & most of flux variability - changes in covering of log ξ ~2 layer, 40%-60% in N_H ~10^{23} cm^{-2}

Covering variation also explains much of flux variability (cf NGC 4151 Puccetti et al 2007)

Occultation events in MCG-6-30-15 & NGC 3516



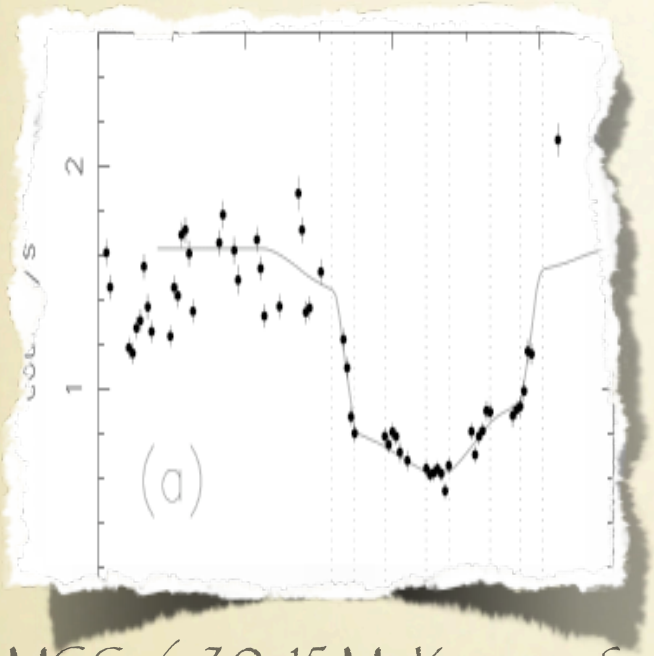


McKernan & Yaqoob 1998

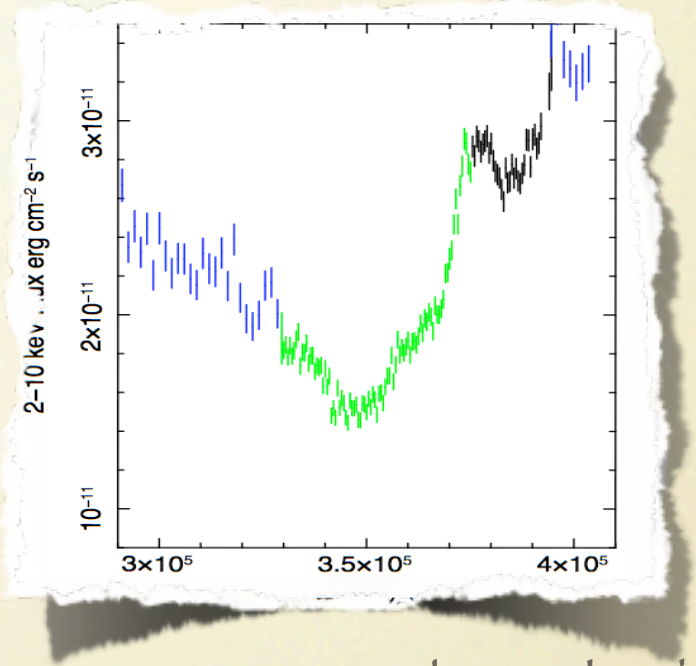
Occultation by optically-thick cloud explains flux and spectral variability in target low state, including Fe emission line

Deep dips - eclipse type events ?

Flat Bottomed Dips



MCG-6-30-15 McKernan & Yaqoob '98 - dip shape from inhomogeneities in emitter



NGC 3516 Turner et al '08- dip shape - inhomogeneities in emitter or absorber

$d_{cloud} \sim 3 \times 10^{13} v_4$ cm ~ R_s

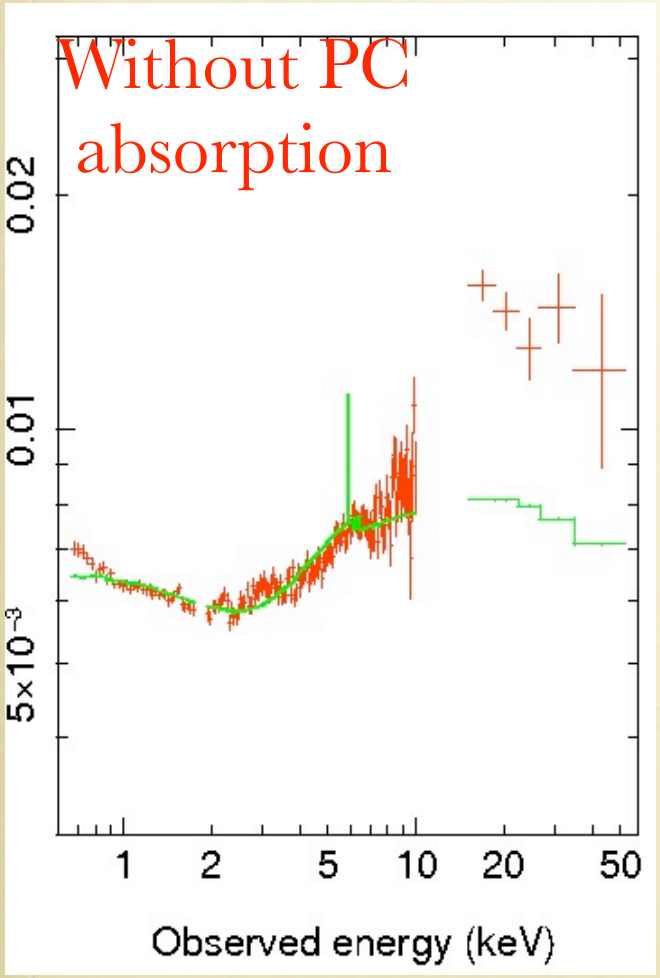
Dip shape hard to explain in light-bending model?

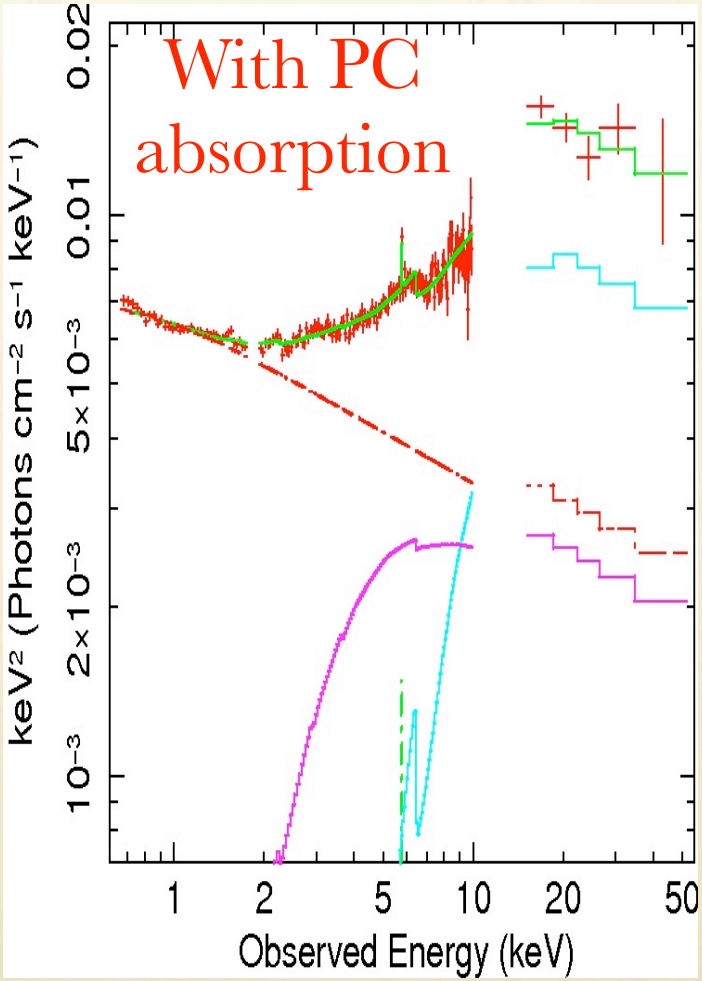
Effective resolution ~million greater than possible w/ current X-ray optics

Compton-thick absorbers in type 1 AGN

New evidence from Suzaku that partial-covering by Compton-thick gas is important

Compton-thick Absorber in Type 1 QSO, 1H 0419-577 (Turner et al. 2009, Ap J, resubmitted Feb)





Very strong hard excess in HXD.

Cannot be fit by reflection

$N_H > 10^{24}$ cm^{-2} covering >70% of emitter

$L_{bol} \sim 10^{47}$ erg/s

Located close to black hole (e.g. within BLR)

Signature of a thick disk wind?

Suzaku PIN Results

Flux above 10 keV generally stronger than expected from reflection models

MCG-6-30-15 R ~ 2-5 Ballantyne et al '03, Miniutti et al '07
NGC 4051 R ~ 7 Terashima et al 2008
Mrk 335 R ~ 2.8 Larsson et al 2008

1H 0419-577 & PDS 456 - fits require PC absorption
(see review Turner & Miller 2009, The Astronomy and Astrophysics Review: 17, 47; arXiv0902.0651

Covering Fractions

PDS 456 - more marked hard excess (lower S/N)

also c.f. variable covering by large columns in

Mrk 766	0-60% (Miller et al '07, Turner et al '07)
NGC 3516	30-70% (Turner PDS et al '08)
MCG-6-30-15	50-100% (Miller et al '08)

also 1H0557-385 (Longinotti et al '09)

Partial Covering

Covering fractions < 1 -> absorber structure on same scale as continuum source. If clouds exist far from continuum - probability issue.

More likely scenario - X-ray absorber exists close-in as part of a clumpy (equatorial?) disk wind containing structures on many size scales

Preferred plane -> chance of seeing absorption depends on opening angle of wind

1H0419-577 f~10%, can be explained by an equatorial wind with opening angle ~12°

Summary

- Variable covering absorber can explain spectral shape & flux variability in NGC 3516
- NGC 3516/MCG-6-30-15 light curves show dip events - favor absorption models - provide way to map AGN inner regions ahead of optics development
- A number of AGN have strong flux above 10 keV further favoring absorption models
- Physical explanation - disk winds - developing models look promising
- Need Astro-H/IXO to determine the level of contribution from various regions