The unique Suzaku discovery of variability in the Compton-thick absorber in NGC 4945

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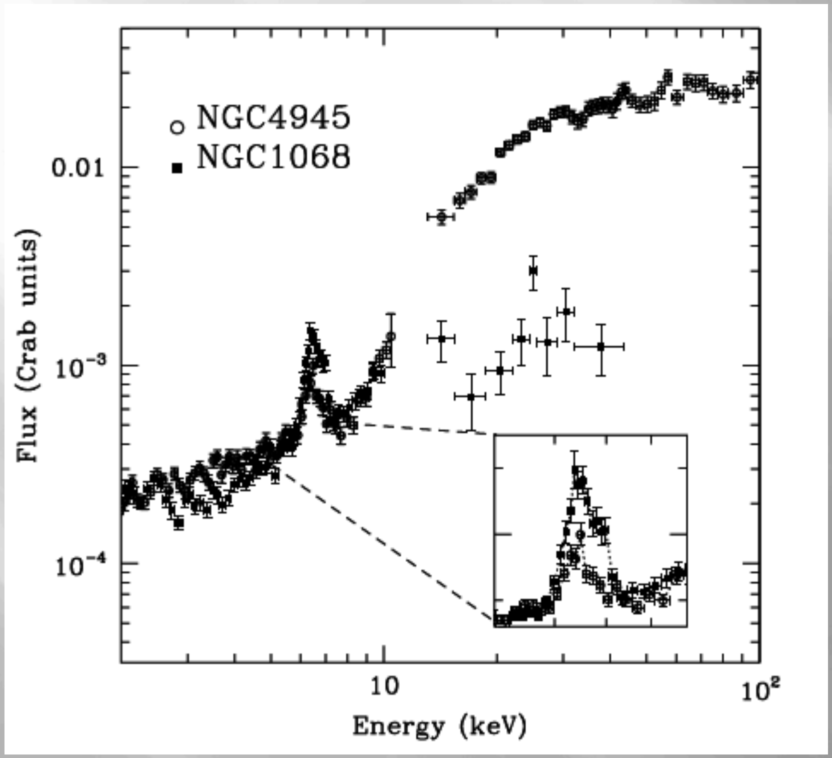
Introduction

NGC 4945 is a nearby (3.7 Mpc), almost edge-on, spiral galaxy.
It is the brightest Sy 2 galaxy and the brightest radio-quiet AGN of the 100 keV sky after NGC 4151 (Done et al, 1996)

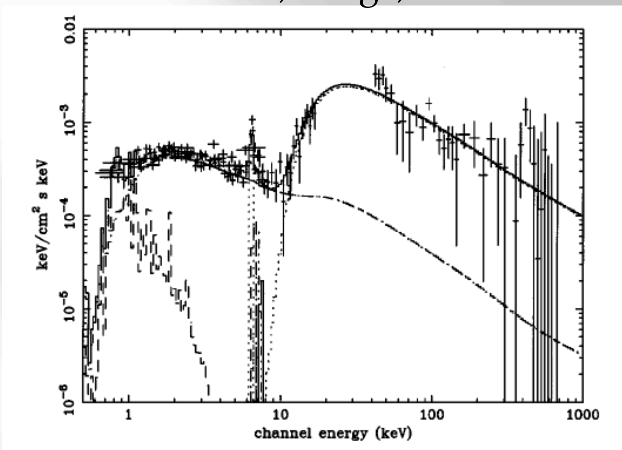


Guainazzi et al., 2000

Previous studies revealed the extreme absorbing column density of N_H~4 x 10^{24} cm^{-2} in the source.
It completely blocks the primary nuclear emission
below 8-10 keV and the nucleus can only be directly seen in higher
energy ranges (>10 keV).

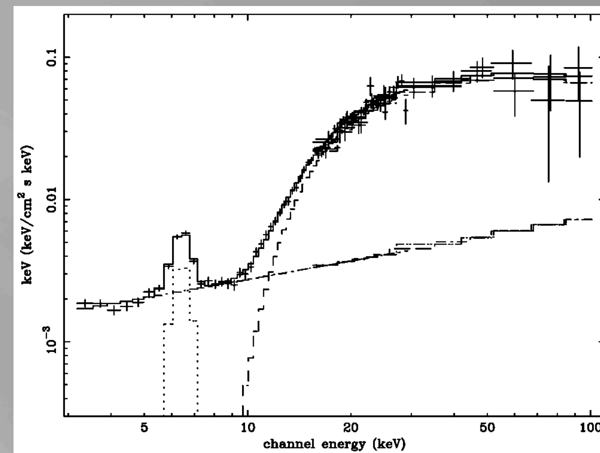
Brief history of the source: the importance of being a Sy2

ASCA, Ginga, OSSE



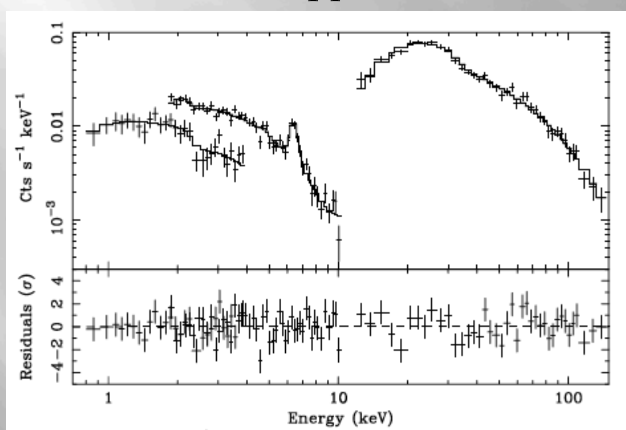
Done et al, 1996

RXTE



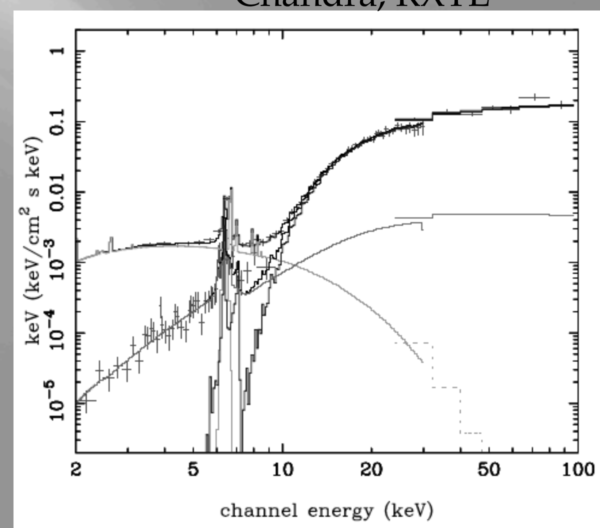
Madejski et al, 2000

BeppoSAX



Guainazzi et al., 2000

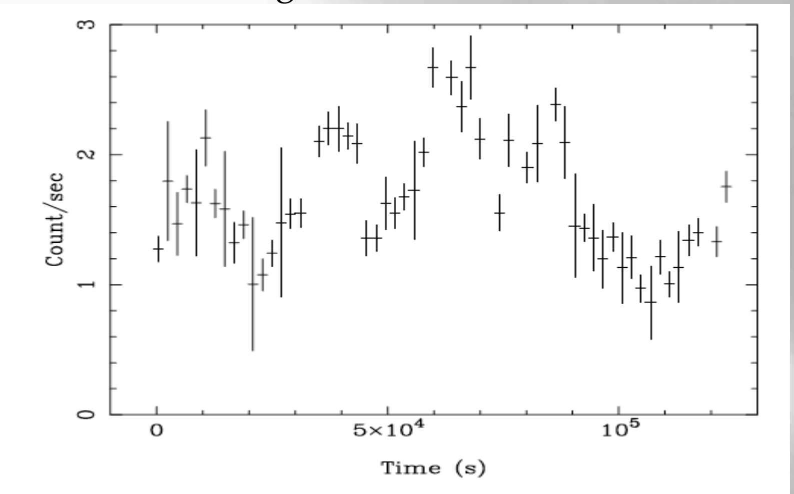
Chandra, RXTE



Done et al, 2003

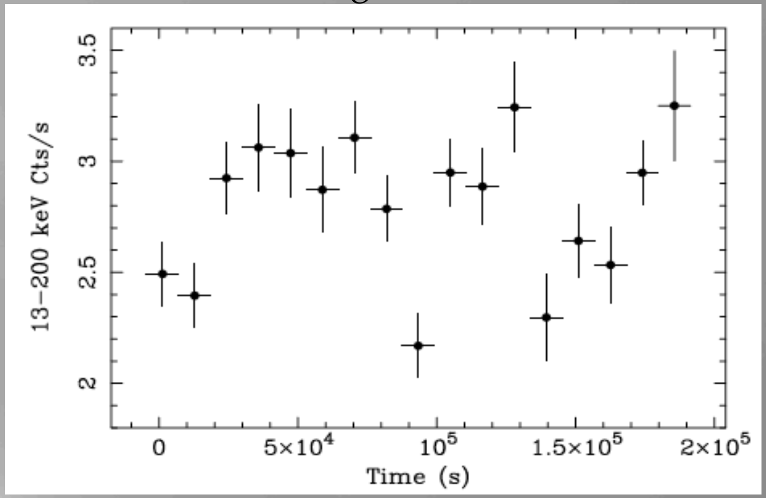
High-energy variability

PCA 8–30 keV light curve binned in 4096 s intervals.



Done et al, 2003

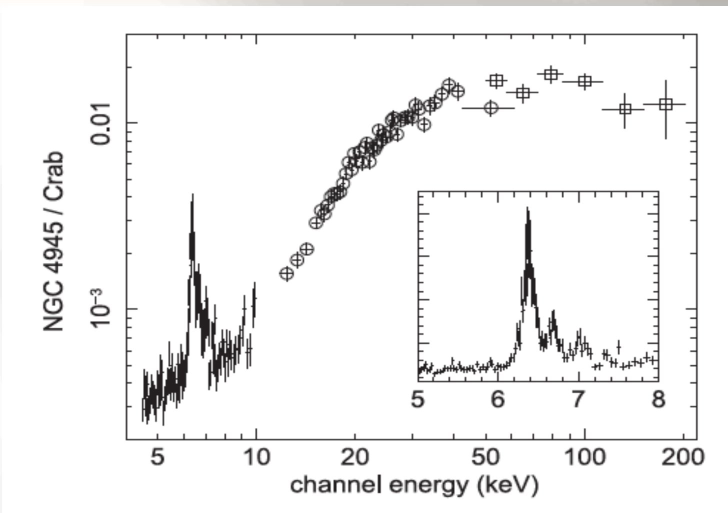
The binning time is 11520 ks



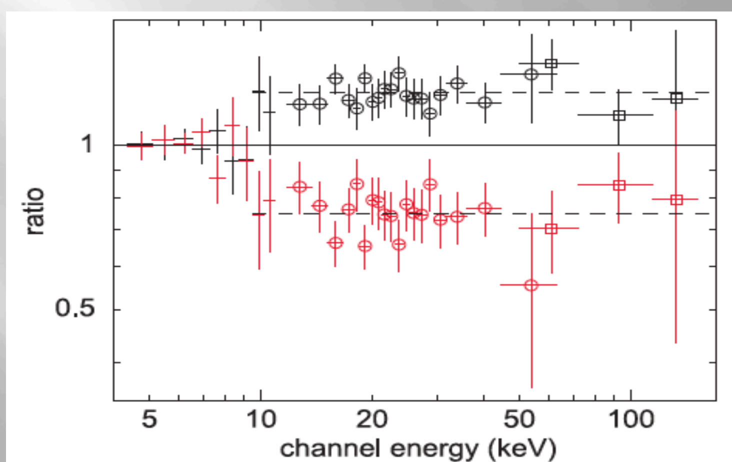
Guainazzi et al., 2000

Clear variation in the primary emission

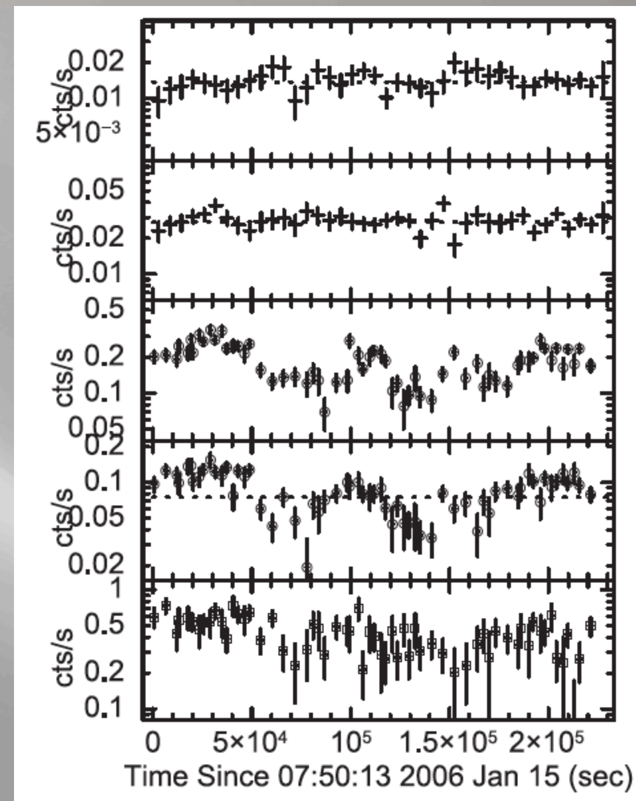
The perfect X-ray laboratory for Suzaku instruments



Itoh et al, 2008



Itoh et al, 2008



6.25–6.52 keV

6.50–9.00 keV

12–25 keV

25–50 keV

52–114 keV

Itoh et al, 2008

230 ks observation

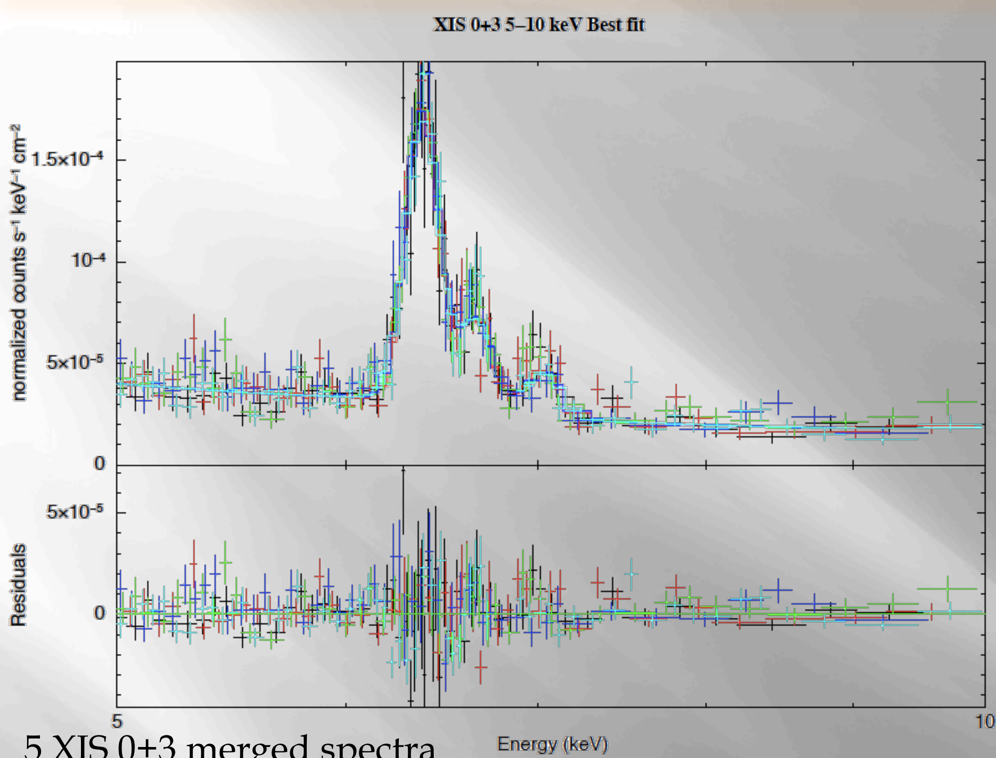
Excellent detection in the XIS, HXD-PIN, HXD-GSO

Variability in the high-energy spectrum found

Our 2010-2011 observational campaign

Five different 40 ks long snapshots to investigate variations
in the primary (>10keV, HXD-PIN, HXD-GSO) and
in the reflected continuum (< 10keV, XIS 0-1-3)

Results



5 XIS 0+3 merged spectra

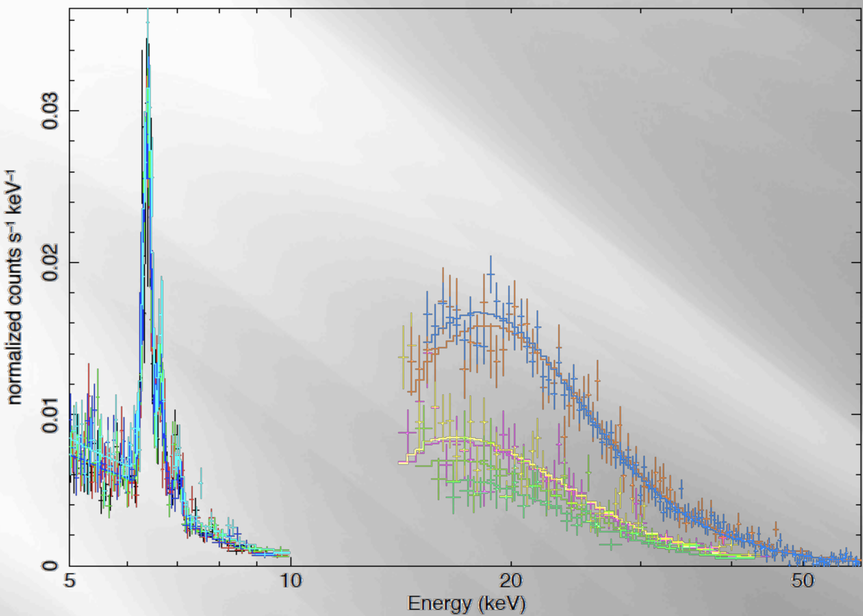
Emission lines from neutral and highly ionized material have been found (Fe I Kα, Fe I Kβ, Fe XXV Kα), in perfect agreement with the spectral analysis presented in Itoh et al, 2008.

Constant reflection from cold circumnuclear material in the 5 different observations:

$f_{\rm refl} < 0.7\ \%$

Small solid angle subtended to the nucleus, reflection and (possibly) extreme absorption do not originate within a parsec-scale region.

Results



There is a hint of a possible absorbing column density variation in the third set of data χ^2/ dof=821/705:

N_H → $6.8 \pm 0.6 \times 10^{24}$ cm^{-2}

N_H → $4.7 \pm 0.7 \times 10^{24}$ cm^{-2}

The high-energy data can be modeled in terms of a strongly absorbed power law (Γ=1.8, N_H=6.1±0.5 x 10^{24} cm^{-2}) χ^2/ dof=834/705

18-50 keV Fluxes:

Obs. 1 5.9±0.5 x 10^{-11} ergs cm^{-2} s^{-1}
Obs. 2 6.1±0.5 x 10^{-11} ergs cm^{-2} s^{-1}
Obs. 3 1.50±0.05 x 10^{-10} ergs cm^{-2} s^{-1}
Obs. 4 4.9±0.4 x 10^{-11} ergs cm^{-2} s^{-1}
Obs. 5 4.4±0.3 x 10^{-11} ergs cm^{-2} s^{-1}
2007 1.40±0.05 x 10^{-10} ergs cm^{-2} s^{-1}

~250-300% Flux increase/decrease in a timescale of 15-35 days

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Conclusions

For the first time Suzaku revealed a clear spectral variation in a Sy2 primary emission

Thanks to the striking constancy of the reflected part of the spectrum and
to the high-significance detection in the HXD-PIN,
the circumnuclear matter can be studied in great detail.

The possible variation in the absorbing column density would be the first
ever observed at high energies.
Chandra, Swift, XMM-Newton have never been able to reveal
changes of several 10^{24} cm^{-2} in Sy2 galaxies.

Suzaku, with his low and high-energy detectors, is the perfect
X-ray observatory to reveal the inner physics of strongly absorbed AGNs

In general, a broadband X-ray coverage is needed to obtain extensive constraints
on physical and geometrical structure of AGNs at the different scales