The X-ray Corona:

a Switch for the Broad Line Region?

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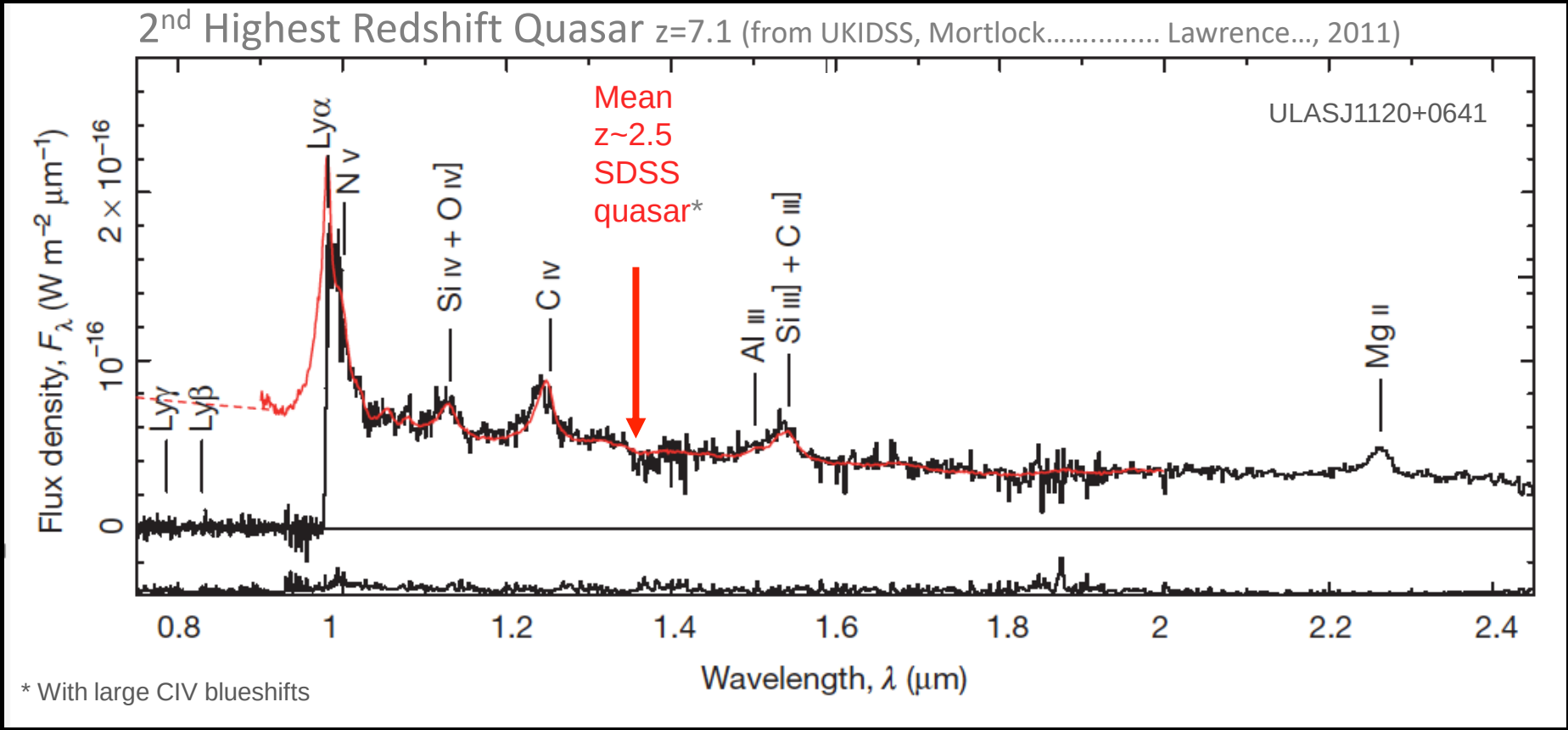
Broad Emission Lines are robust

invariant with redshift, luminosity

must be hard to switch off

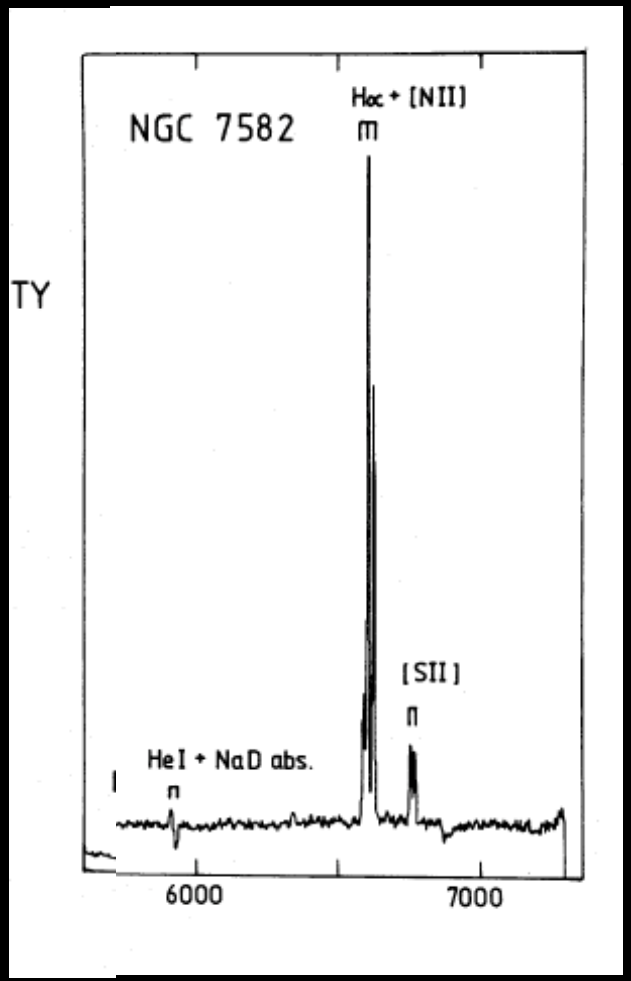


* With large CIV blueshifts

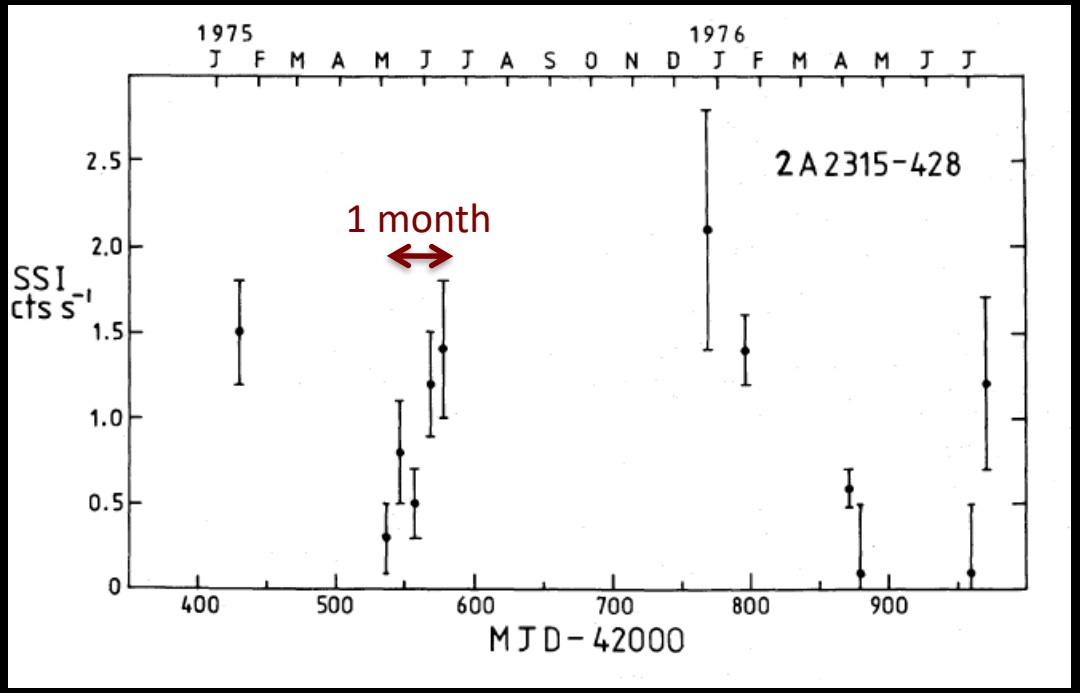
Need True Type 2s: NGC 7582

How do we turn off the BLR?

NO broad Hα



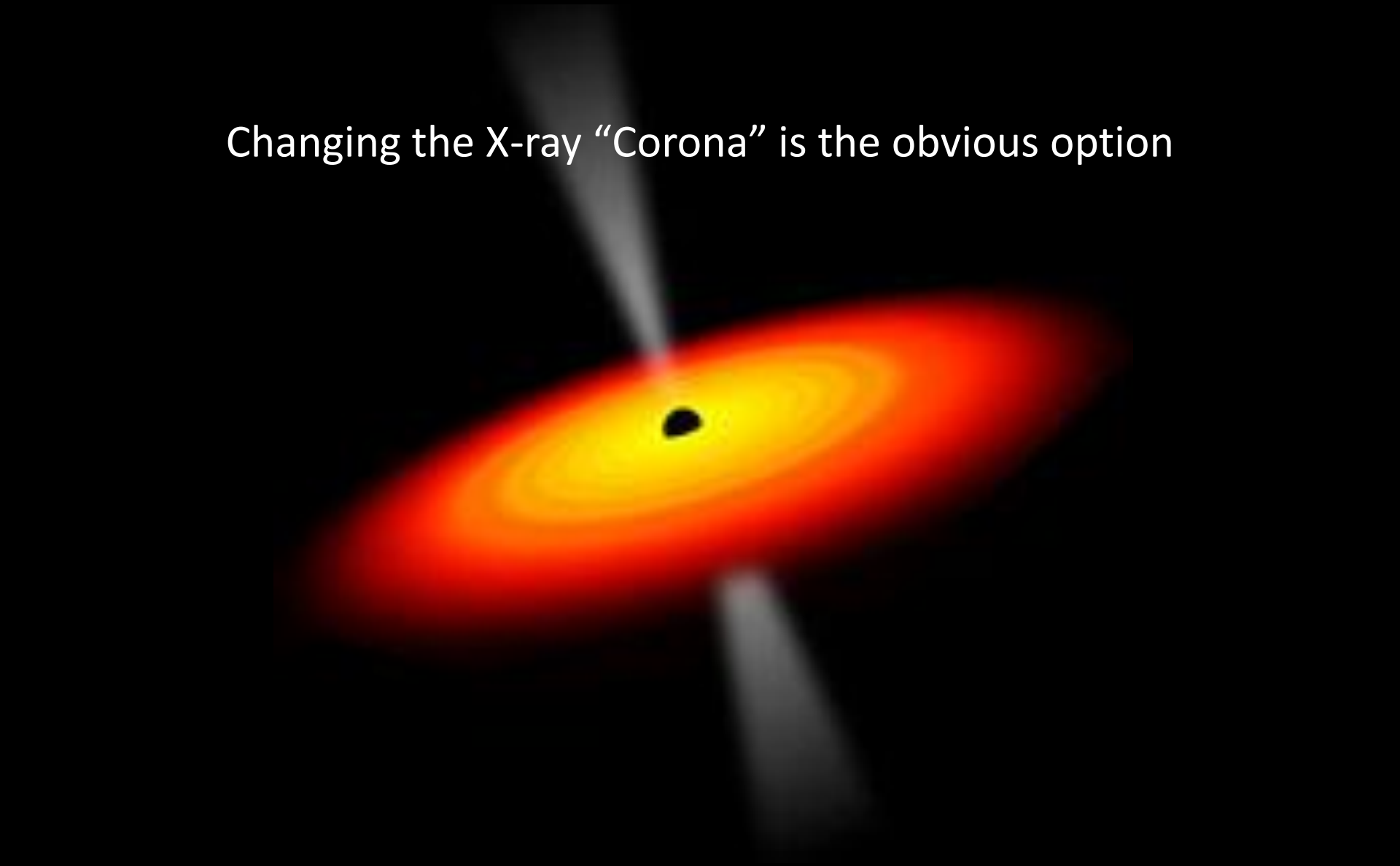
Highly X-ray Variable



Ward, Wilson, Penston, Elvis, Maccacaro, & Tritton 1978

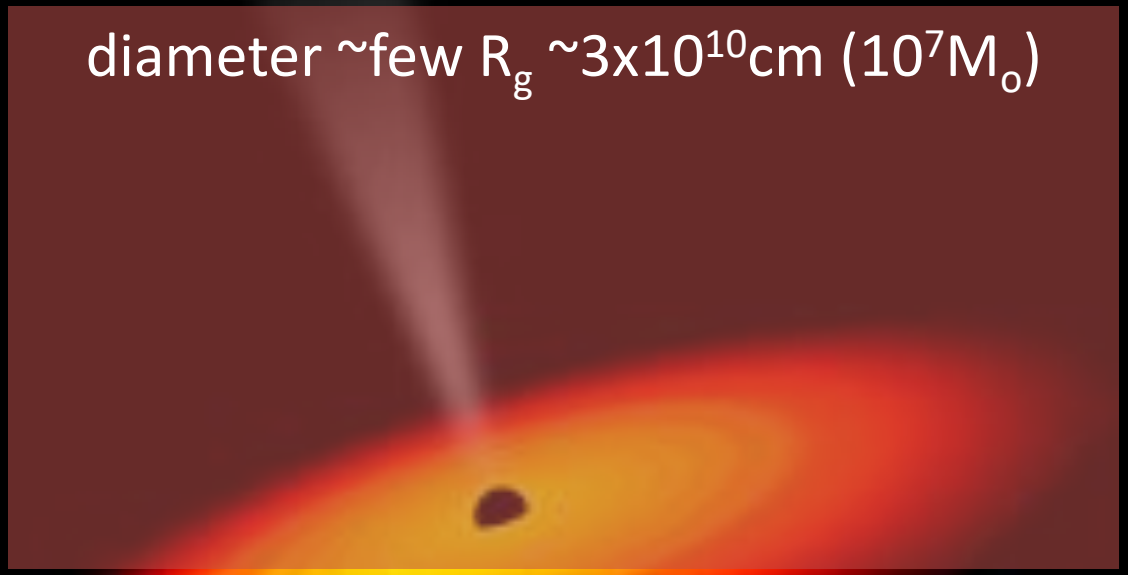
Can we switch off the broad lines without changing the UV?

Changing the X-ray “Corona” is the obvious option



Elvis 2012 arXiv:1201.3520

X-ray “Corona” is a dense hot plasma



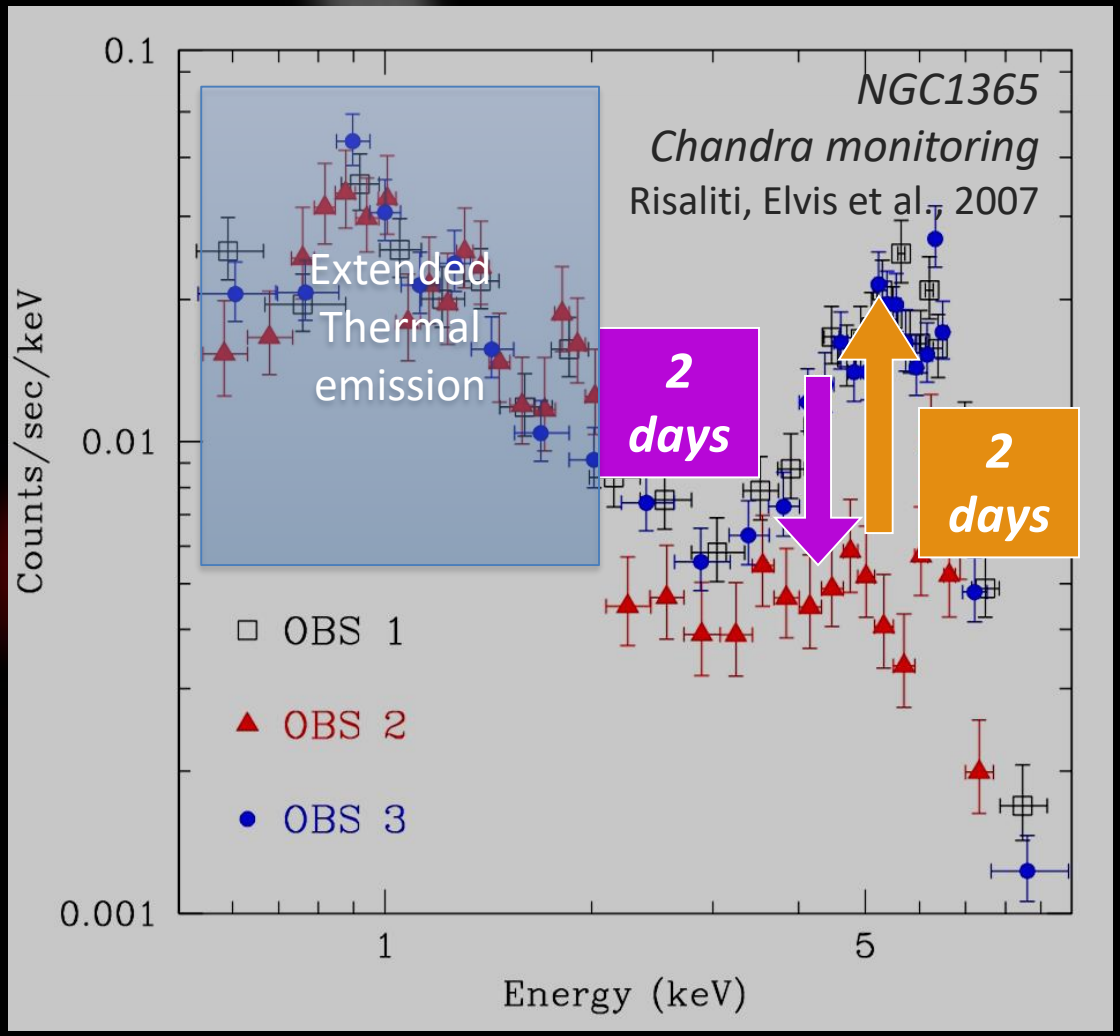
Eclipses

X-ray corona eclipses

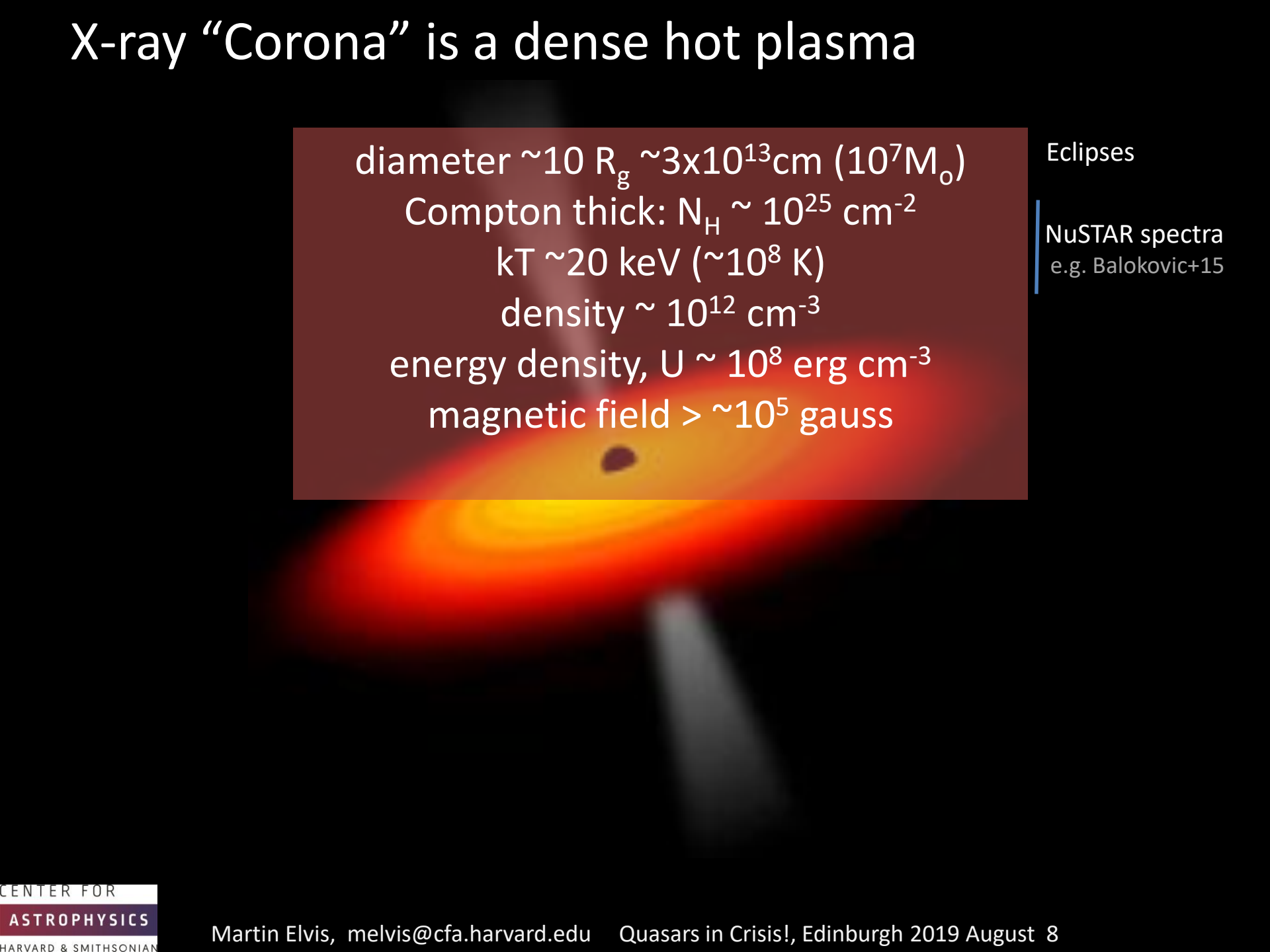
$D \sim 10\ R_g$ @ $M_{bh} = 3.10^7\ M_{sol}$

common
Torricelli-Ciamponi et al. 2014

consistent with BLR clouds
Pietrini et al., 2019



X-ray “Corona” is a dense hot plasma



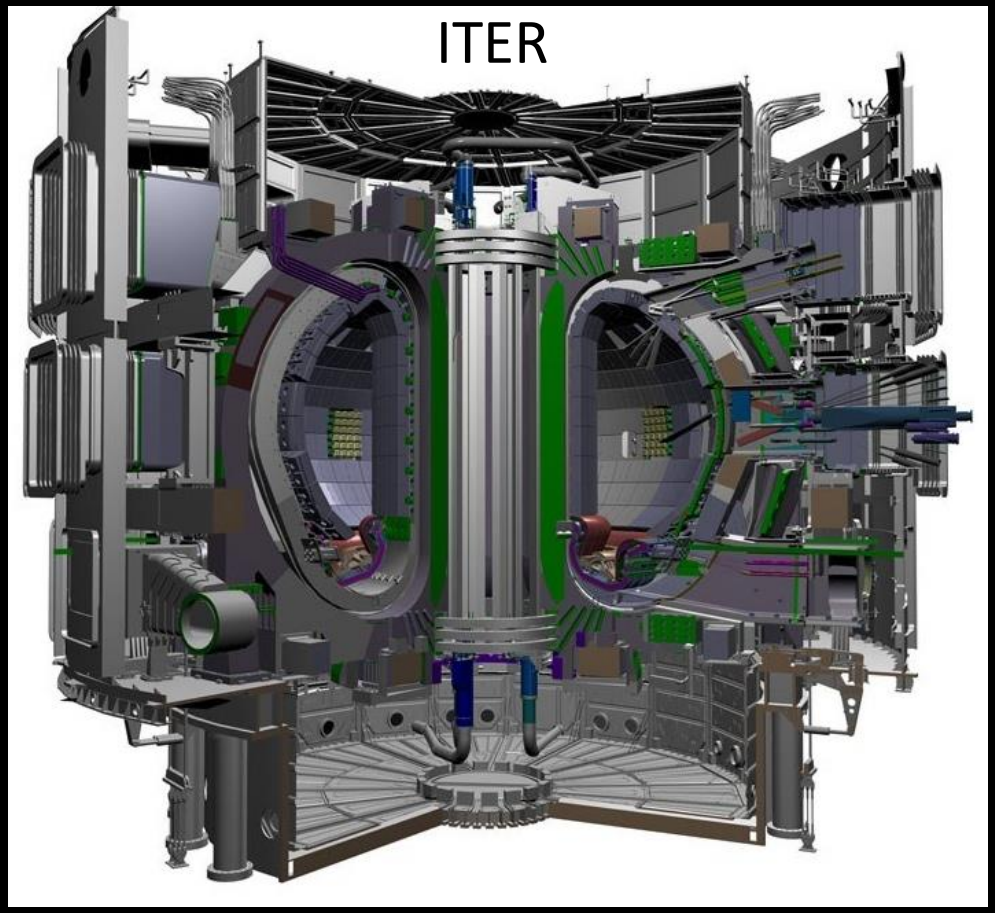
diameter ~10 R_g ~3×10^{13}cm ($10^7 M_o$)
Compton thick: $N_H \sim 10^{25}$ cm^{-2}
kT ~20 keV (~10^8 K)
density ~ 10^{12} cm^{-3}
energy density, U ~ 10^8 erg cm^{-3}
magnetic field > ~10^5 gauss

Eclipses

NuSTAR spectra
e.g. Balokovic+15

X-ray "Corona" is similar to a Tokamak

Tokamaks are notoriously unstable



AGN Corona
T ~10^8 K
N_e ~10^{12} cm^{-3}
B > 10^5 gauss

ITER
T ~10^8 K
N_e ~10^{15} cm^{-3}
B ~ 10^5 gauss

X-ray “Corona” is a dense hot plasma

sound crossing time: $\tau_s \sim 2 \times 10^5$ s

expected to be highly unstable

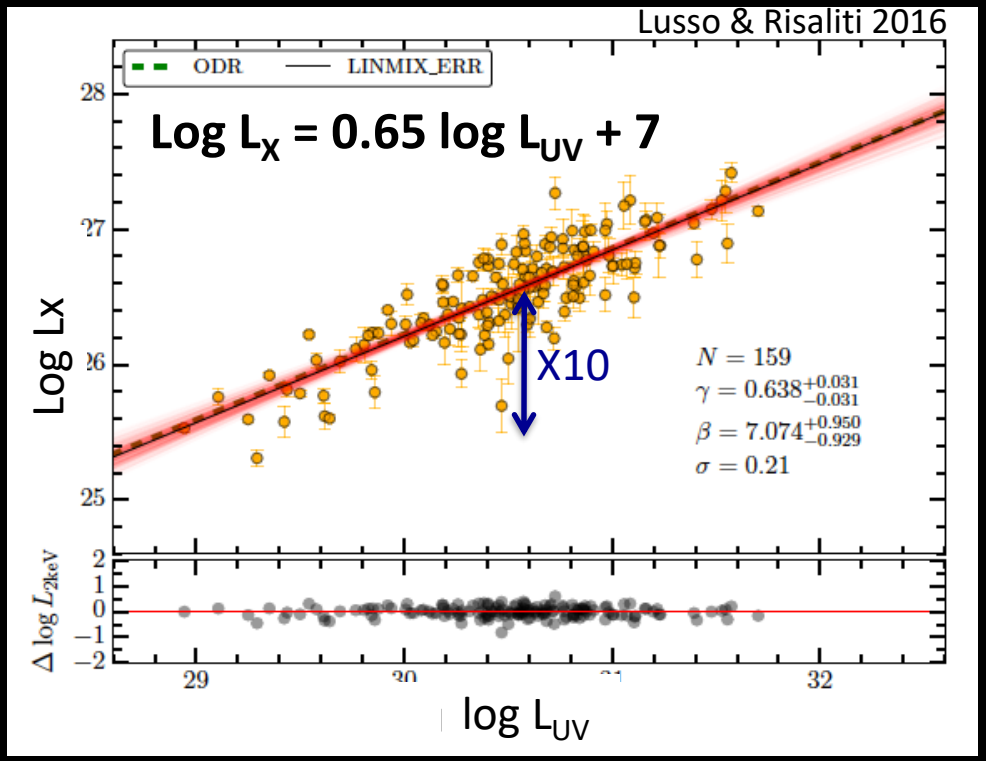
diameter ~10 R_g ~3×10^{13}cm ($10^7 M_o$)
Compton thick: $N_H \sim 10^{25}$ cm^{-2}
kT ~20 keV (~10^8 K)
density ~ 10^{12} cm^{-3}
energy density, U ~ 10^8 erg cm^{-3}
magnetic field > ~10^5 gauss

yet X-ray/UV ratio is remarkably stable

could rare instabilities of the corona switch off the BLR?

N = 159, outliers possible

type-changing quasars are 1:~1000



scatter ~0.15 dex
includes: orientation
+ non-simultaneity
→intrinsic scatter tiny

X-ray Corona is not

"added to taste"

non-Linear

BLR as clouds in a multi-phase medium

small clouds in pressure equilibrium with the Warm Absorber

THE ASTROPHYSICAL JOURNAL, 249:422–442, 1981 October 15

TWO-PHASE MODELS OF QUASAR EMISSION LINE REGIONS

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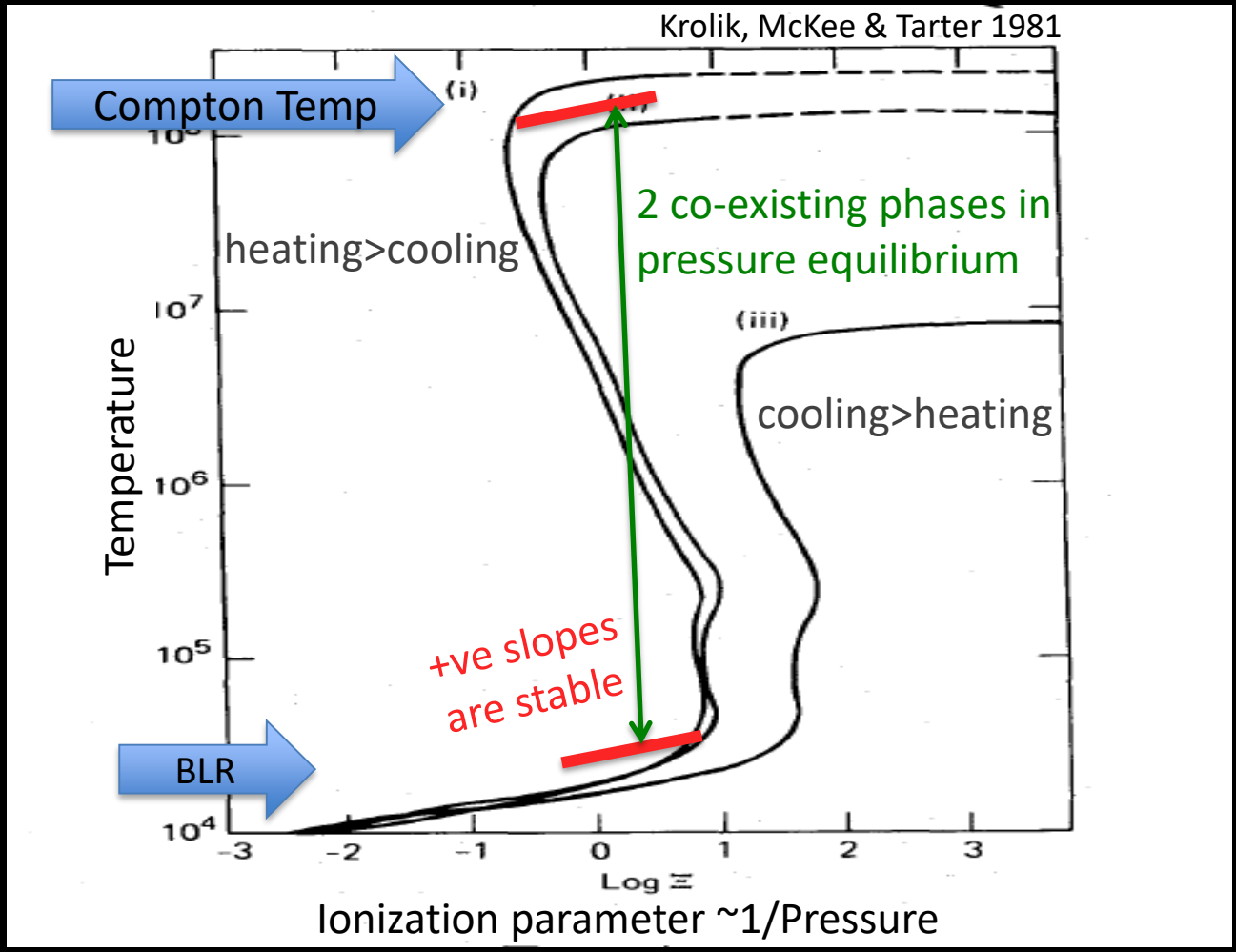
Received 1980 November 17; accepted 1981 April 14

BLR clouds in a multi-phase medium

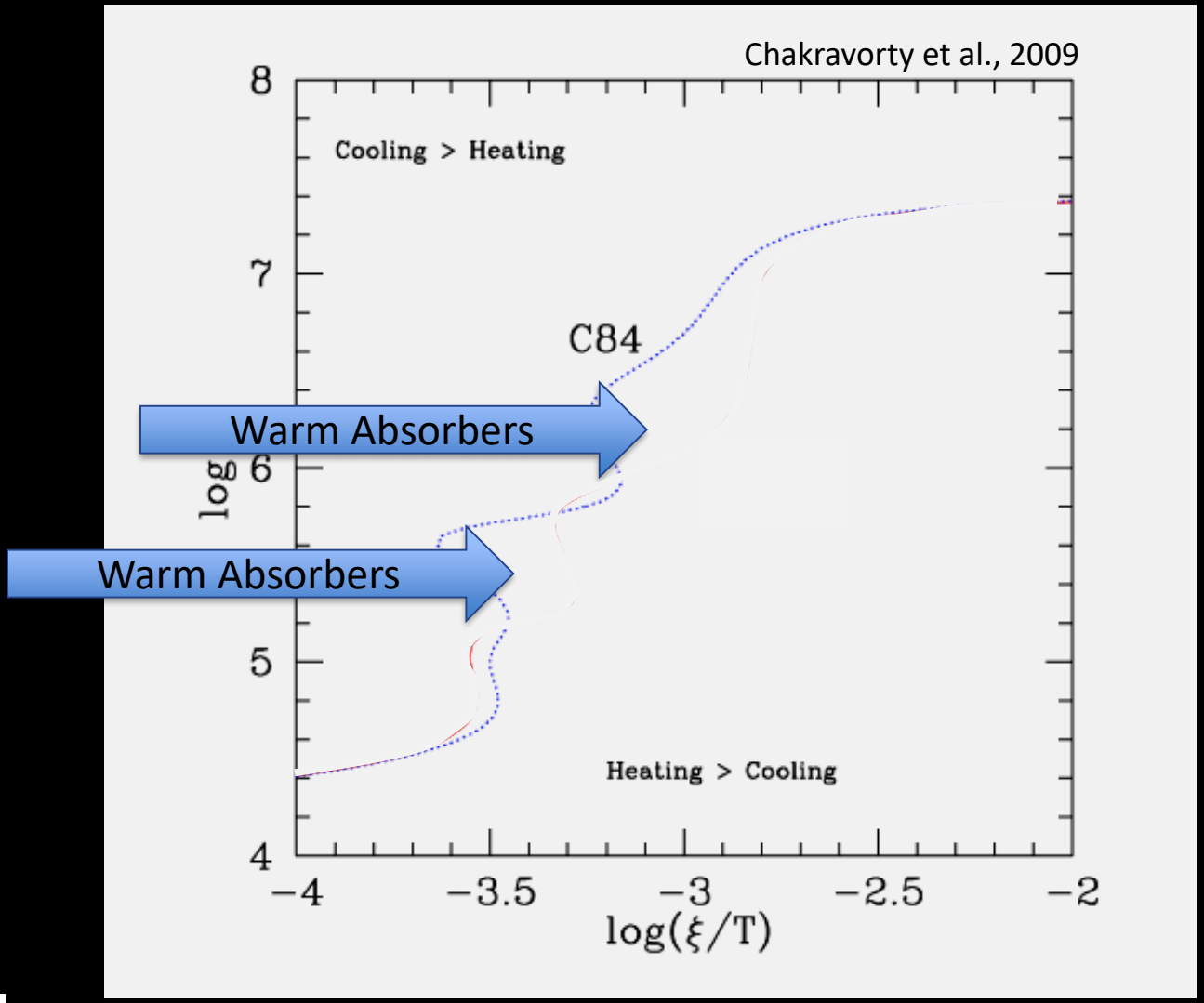
small clouds in pressure equilibrium with a hotter phase



Updated atomic physics since early ‘80s change the stable phases

creates new stable regions

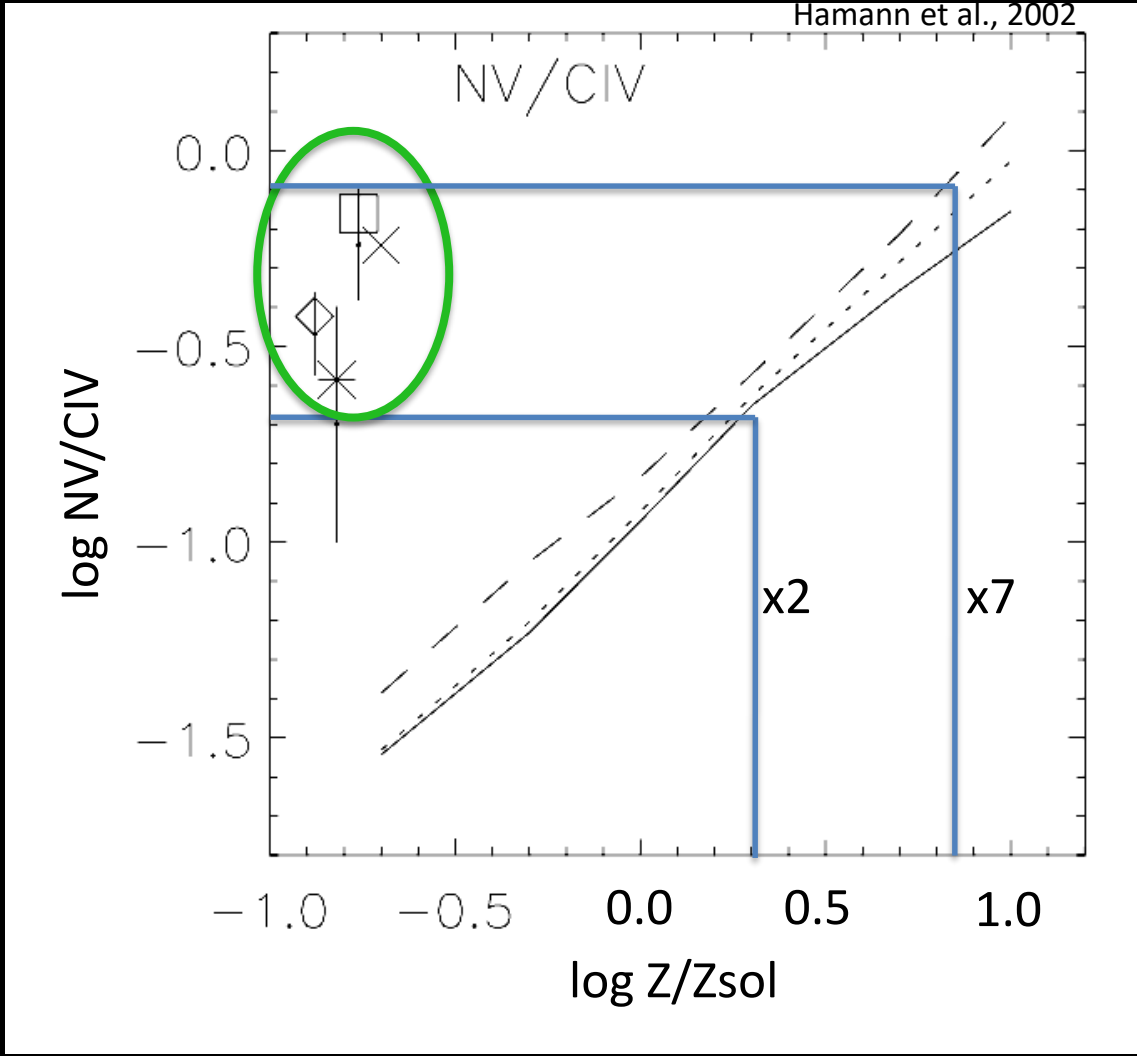
eliminates most multi-phase regions



super-Solar abundances are normal in AGN

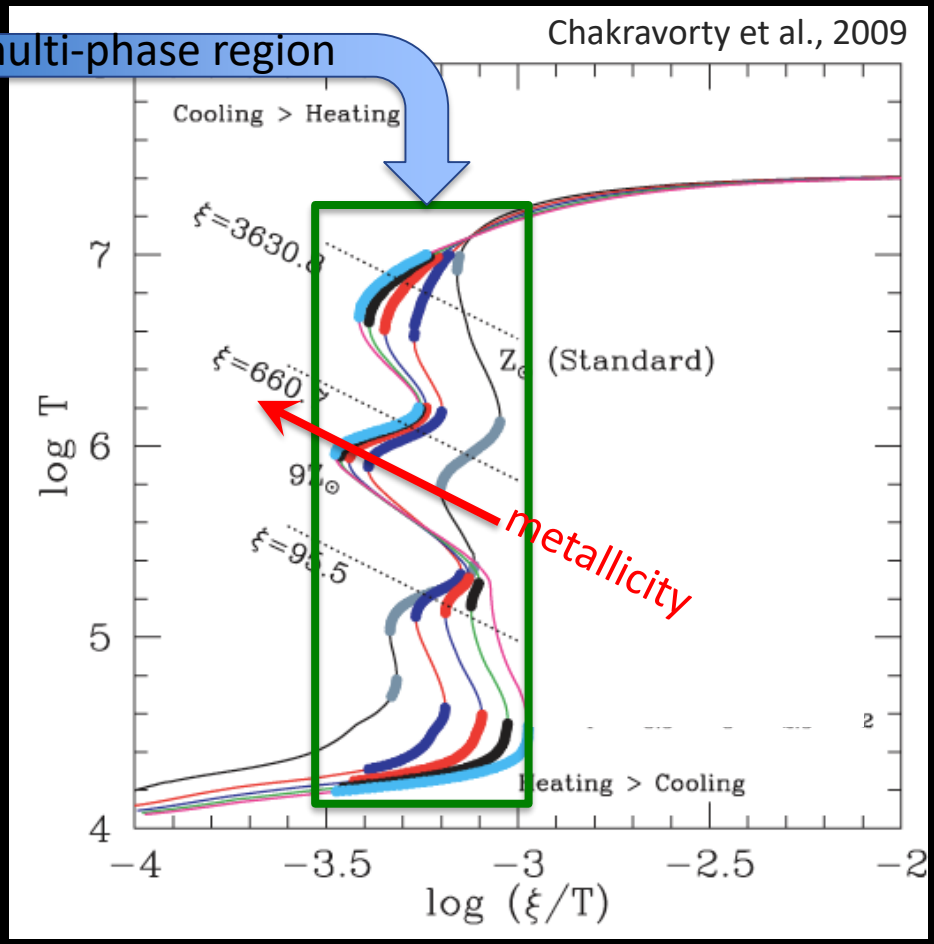
Hamann & Ferland 1999 ARAA

Z/Z_{sol}~2-7



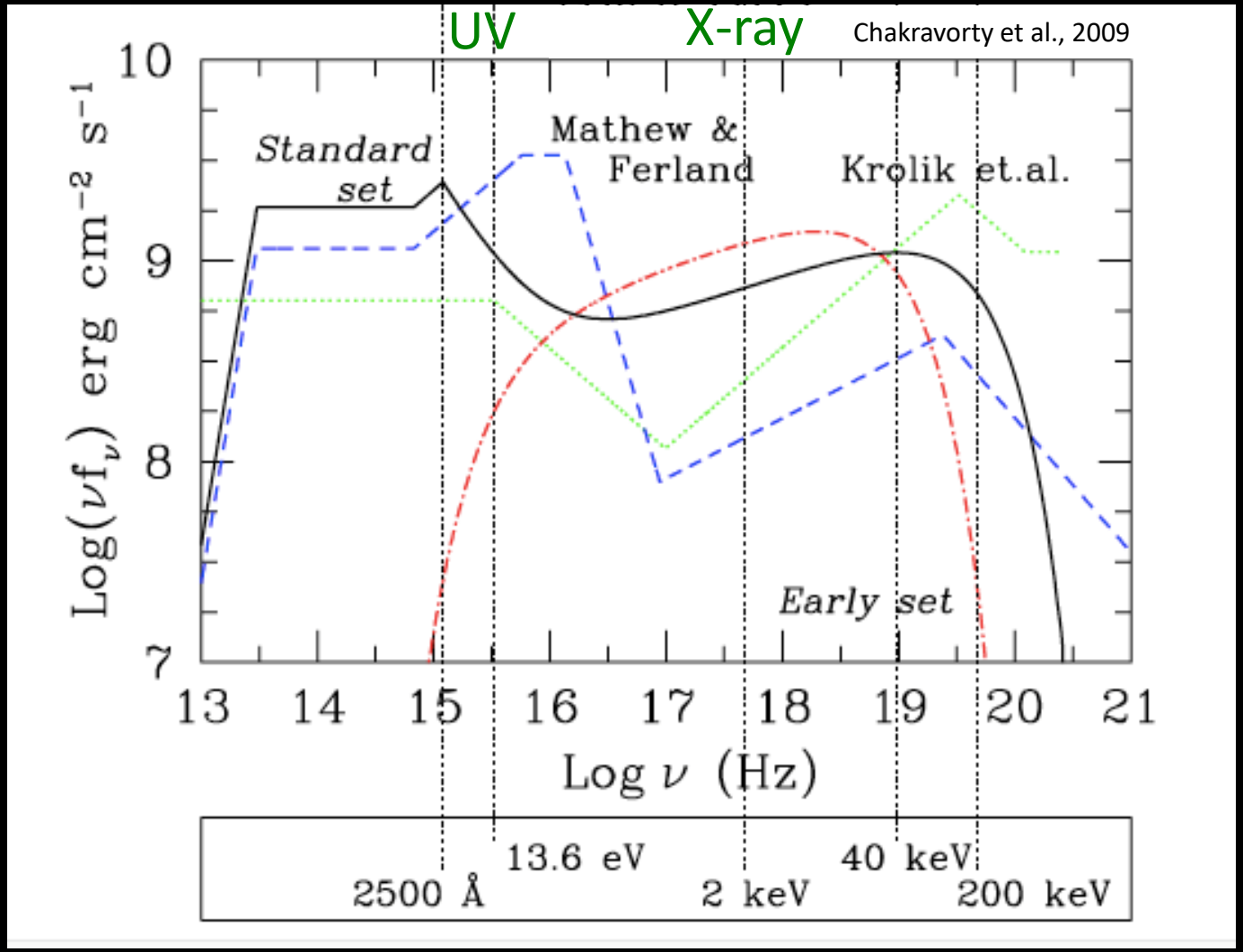
super-Solar abundances are normal in AGN

create large multi-phase regions



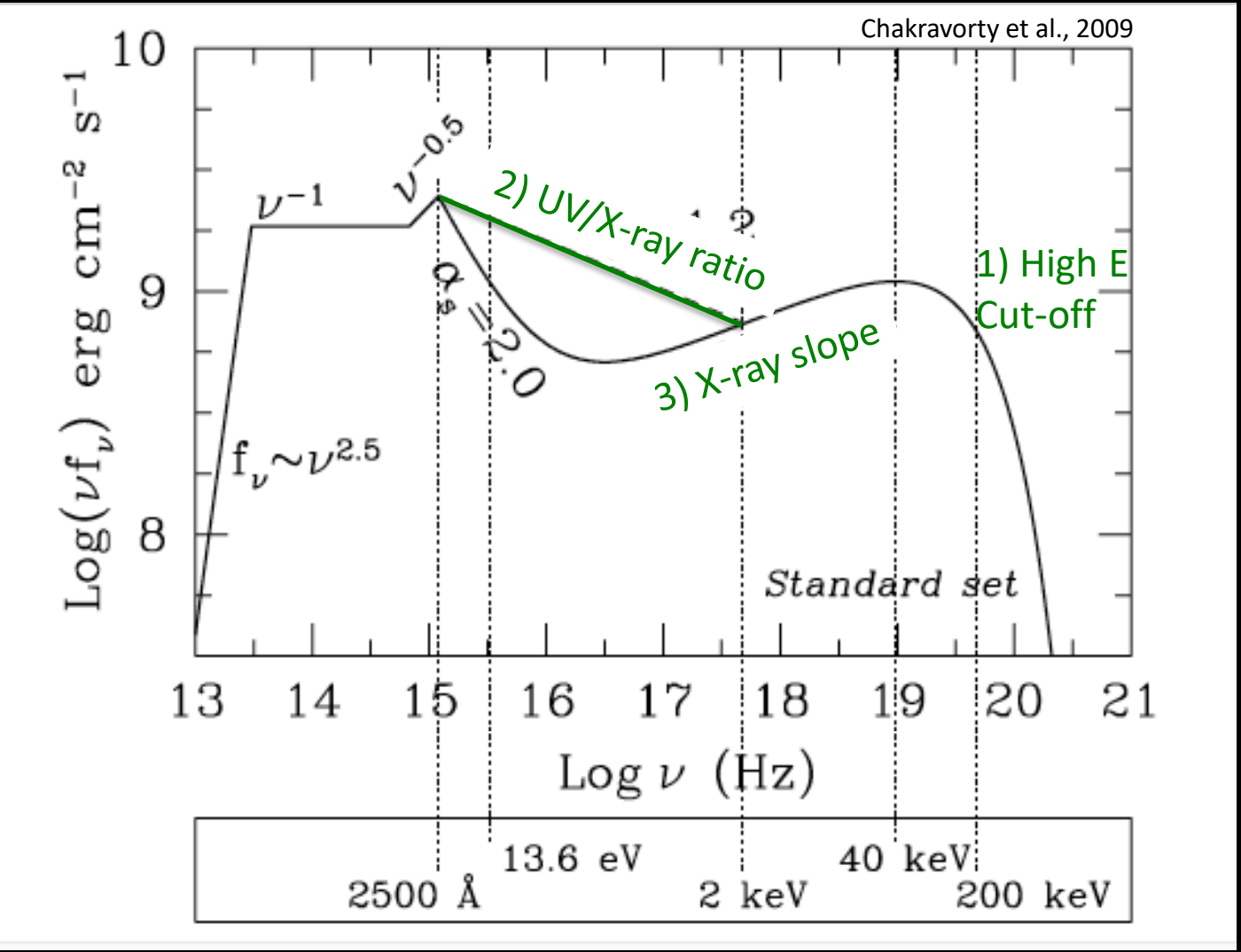
shape of SED changes stable phases

could SED changes induce a sudden loss of the BLR?



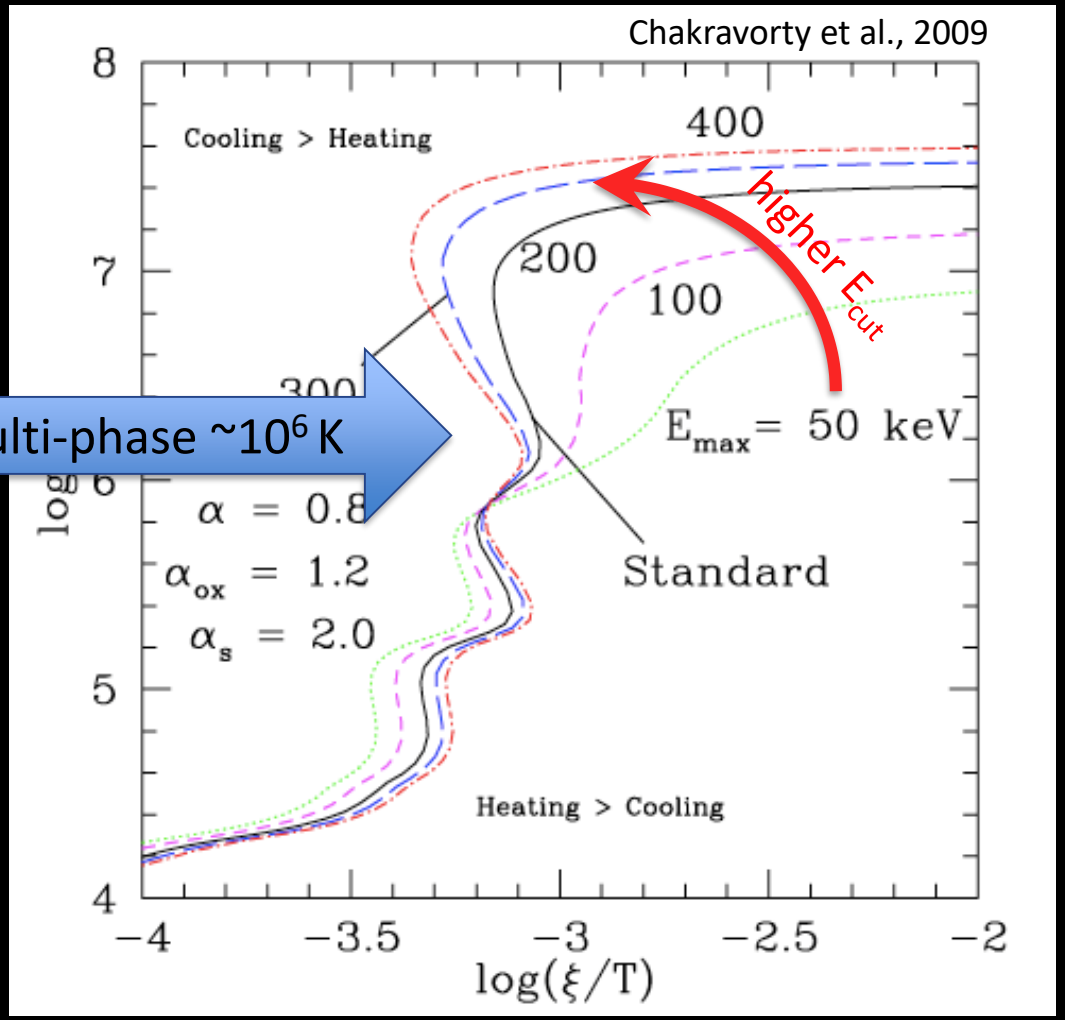
3 SED X-ray related parameters

could change fast



1) higher E_{cut}

10^4 K stable region unchanged → no effect on BLR?

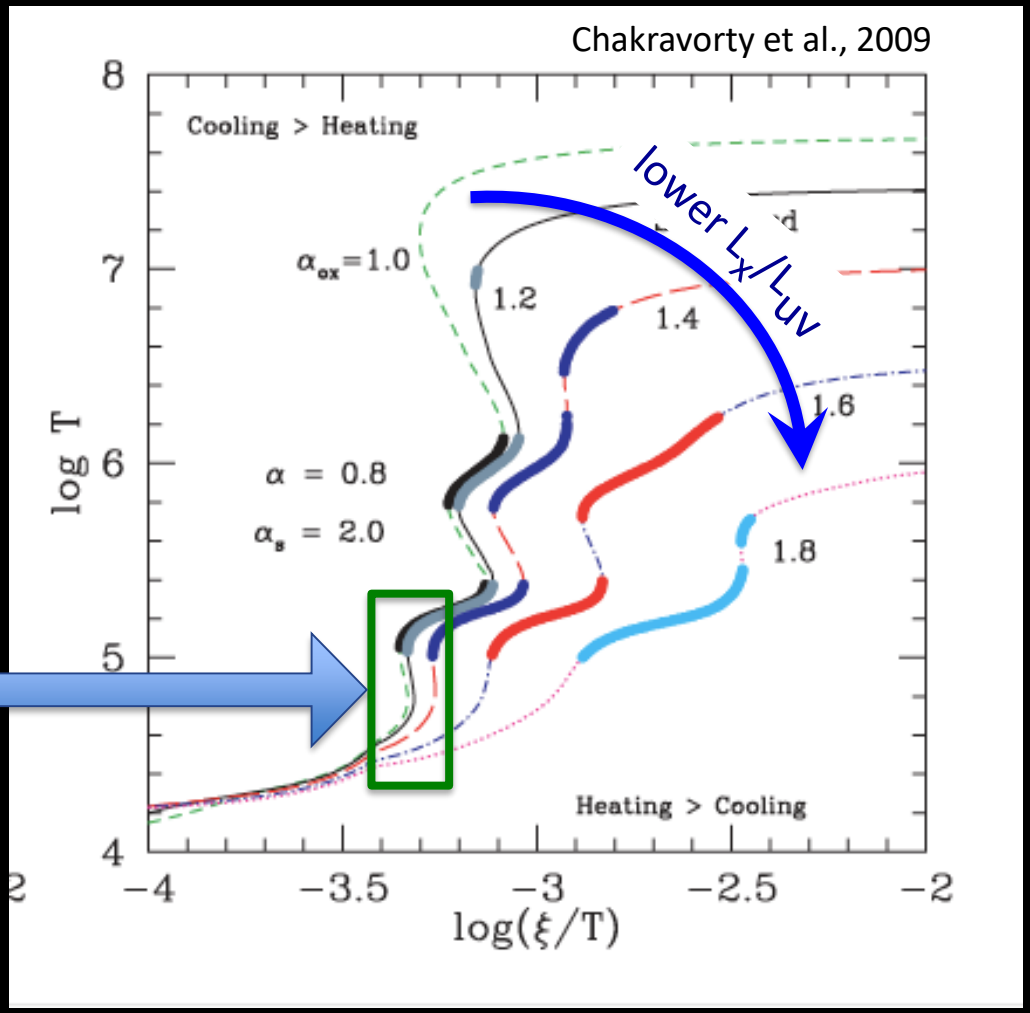


adds higher T multi-phase ~10^6 K

2) lower L_X/L_{UV}

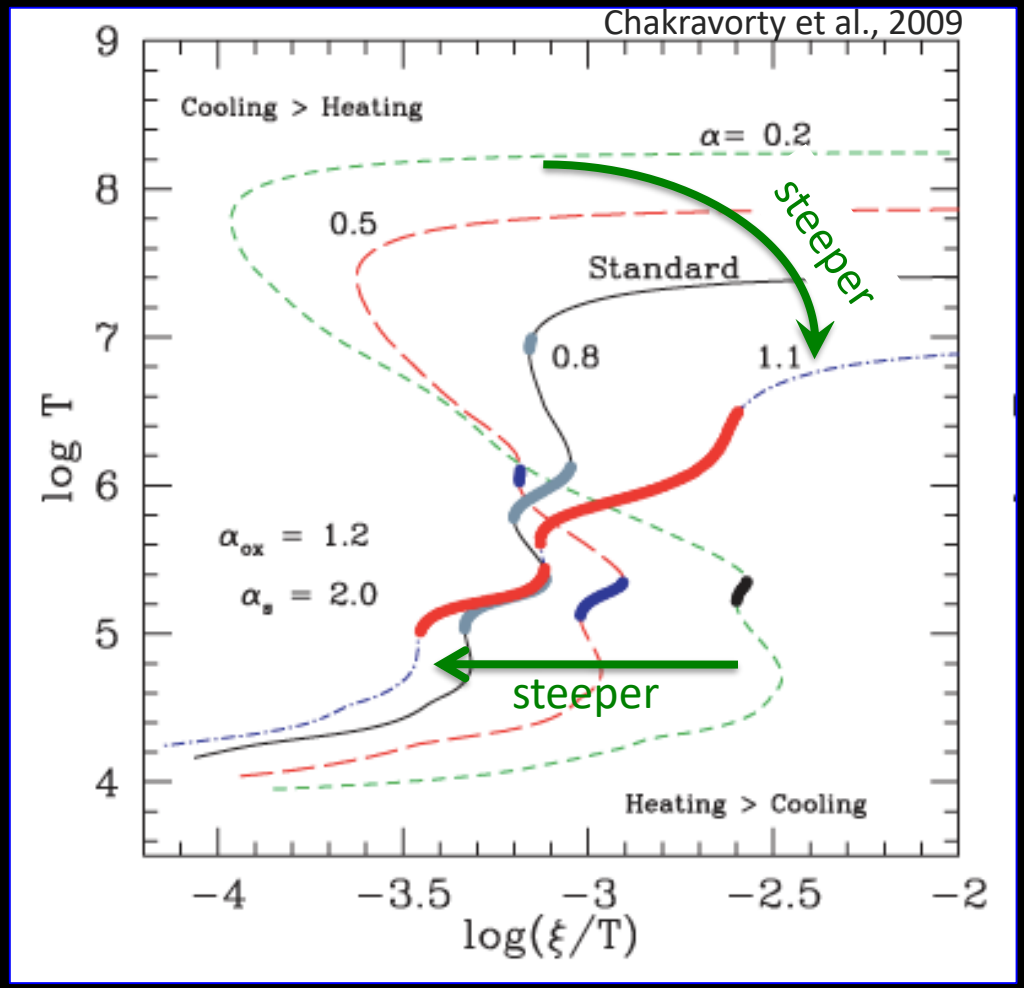
eliminates 2-phase region (Z/Z_o=1)

→ no BLR?



3) Steeper X-ray slope

→ multi-phase regions eliminated
no BLR?

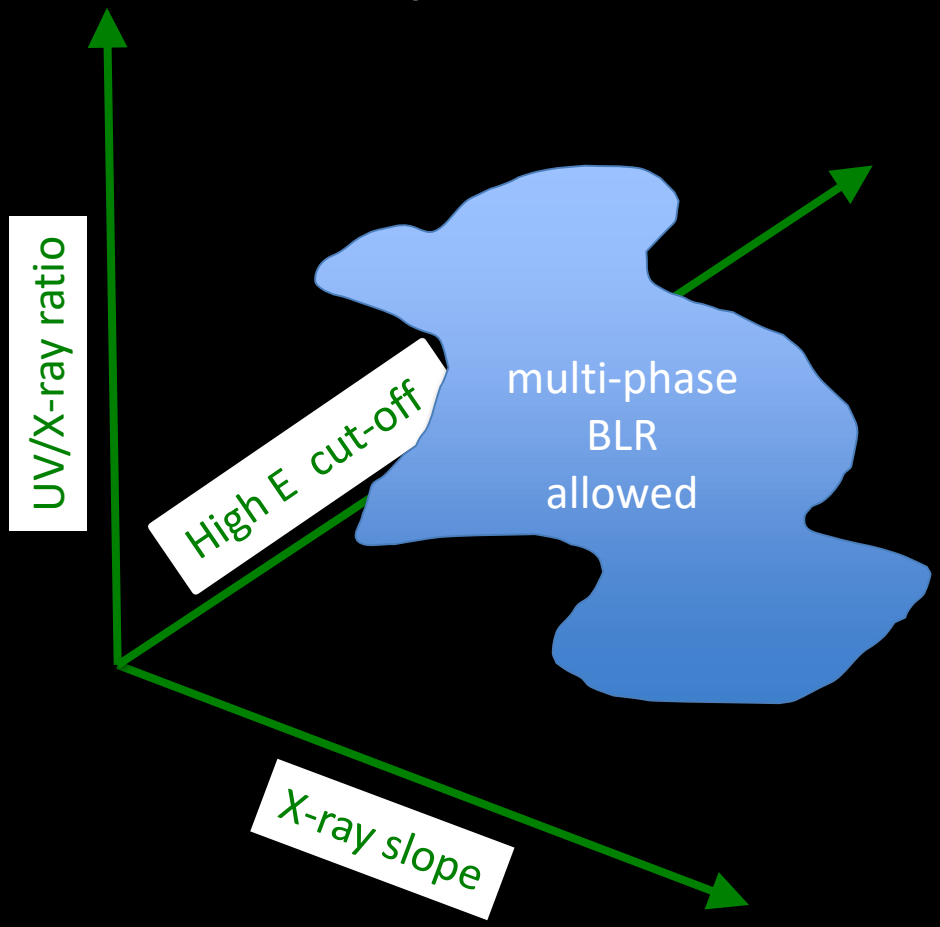


Coronal Changes could Switch off the BLR

restricted regions, but OK as rare

interesting but no slam-dunk

needs 3-D analysis + abundances



Obvious Questions

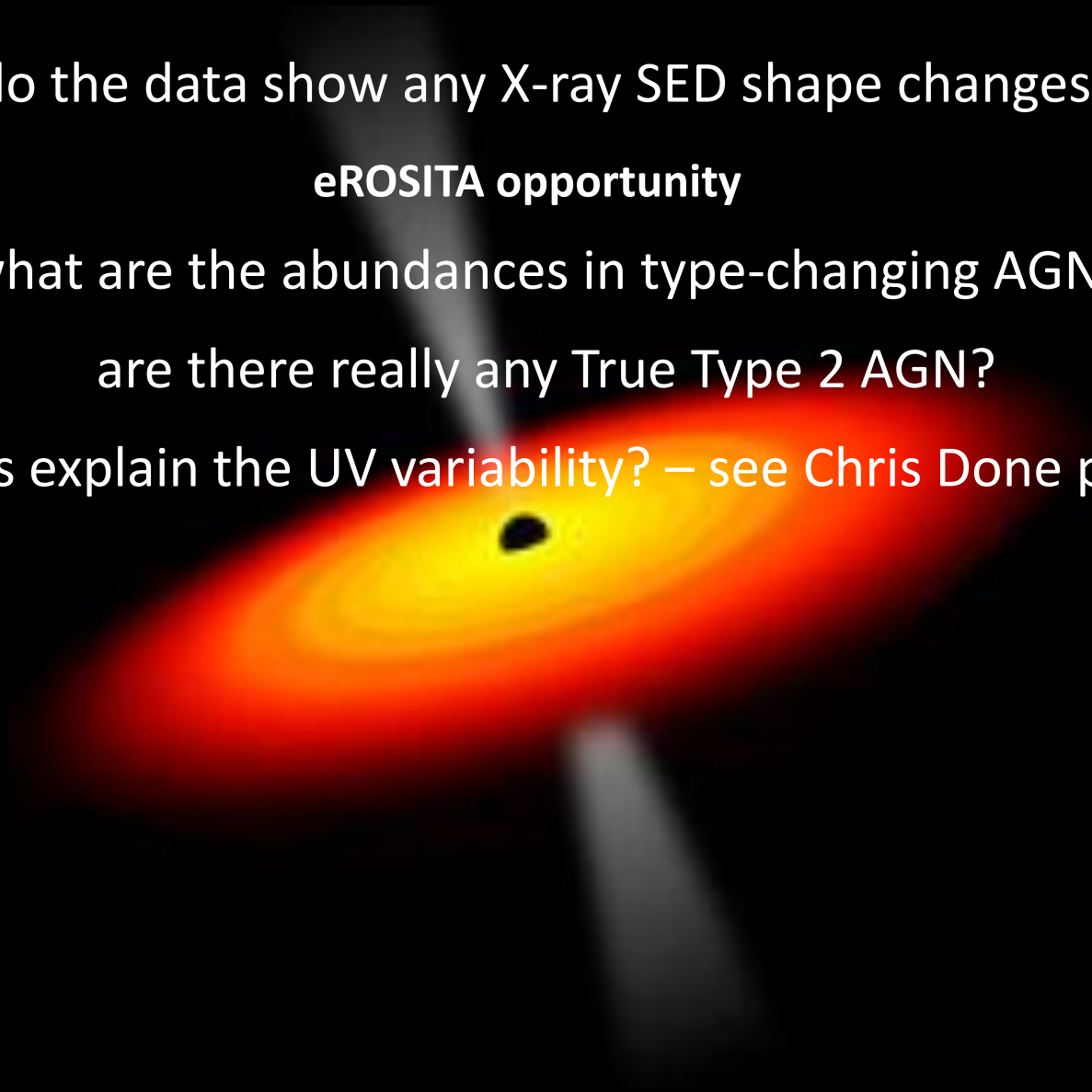
do the data show any X-ray SED shape changes?

eROSITA opportunity

what are the abundances in type-changing AGN?

are there really any True Type 2 AGN?

can this explain the UV variability? – see Chris Done poster !

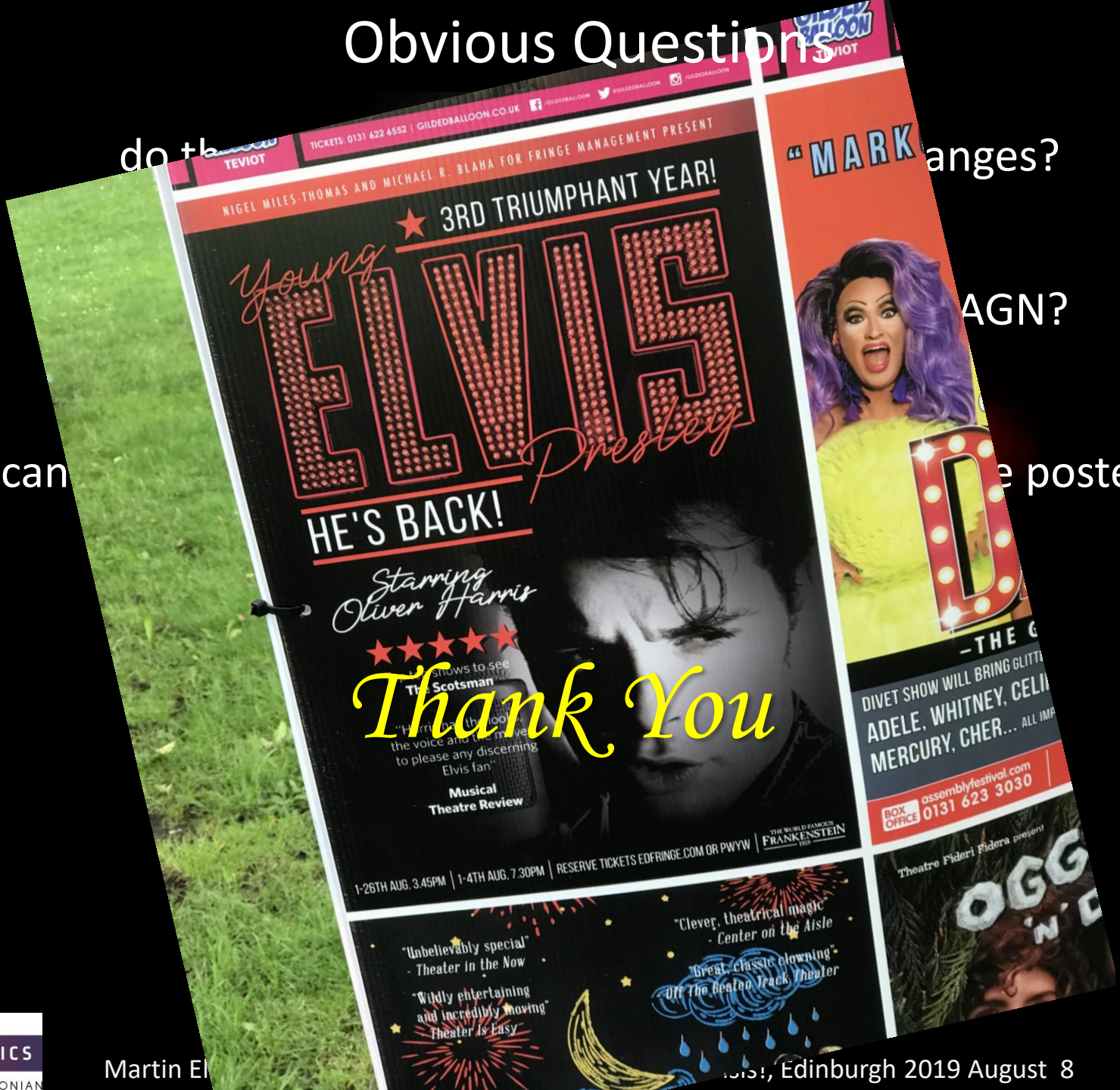


Obvious Questions

do th anges?

AGN?

can e poster !



Thank You