X-Rays in AGN Outflows – MCG-6-30-15 multicomponents

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Outline

- PART I - Absorption Measure Distribution analysis – From The Reduced Spectra to Observing Thermal Instabilities
- PART II – MCG -6-30-15 Multi components
- Conclusions

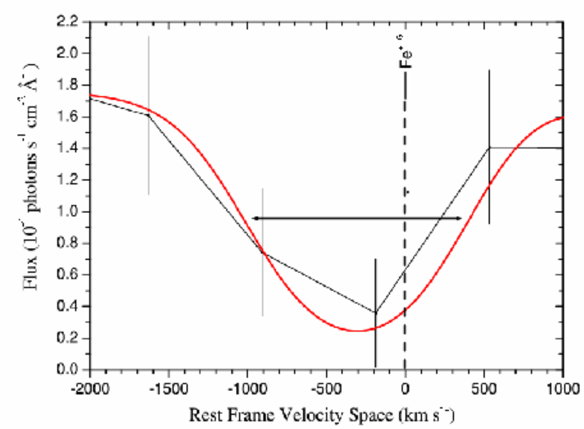
PART I : The Data

Outflow Model : Method

- Determine continuum
- Identify absorption lines; determine outflow and broadening velocity
- Obtain column densities from data of each individual ion by fitting all its lines
- Reconstruct the Absorption Measure Distribution (as a function of ξ)

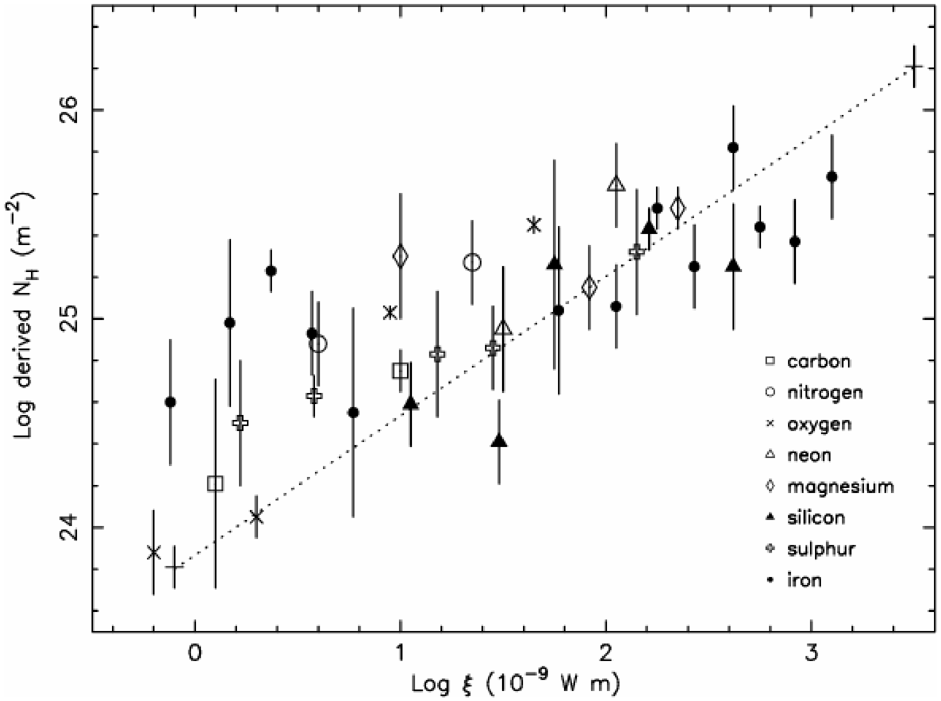
$$(\xi = \frac{L}{n_e R^2})$$

IRAS 13349+2438 line profile of Fe^{+16} resonance at 15 Å (in black) and model in red. Fitting the broadening (width) and outflow (shift) velocity.

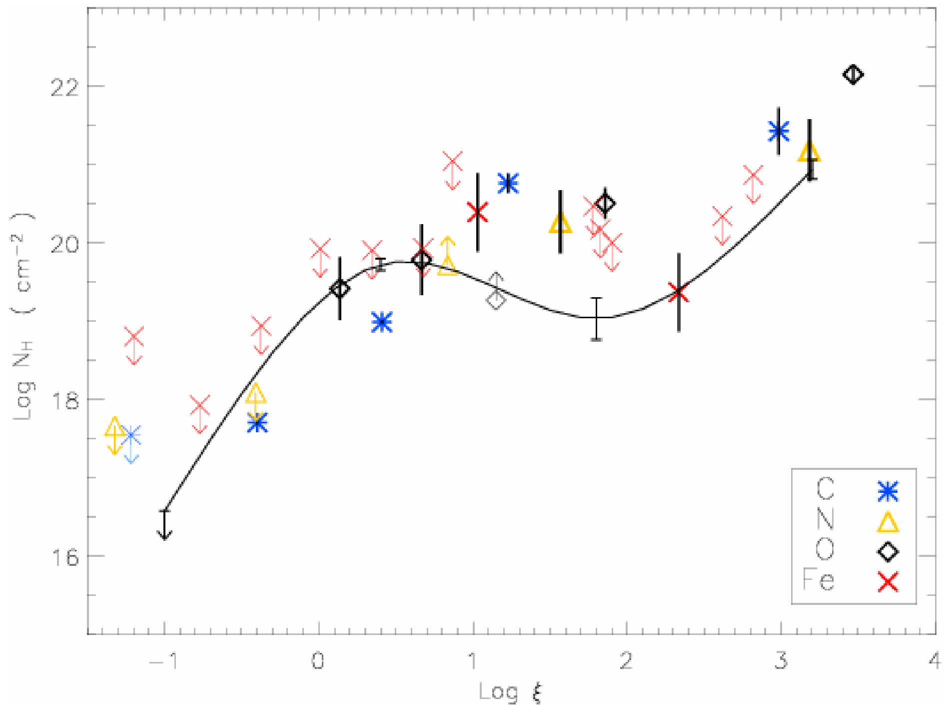


Previous works

Steenbrugge et al. 2005



Costantini et al. 2007



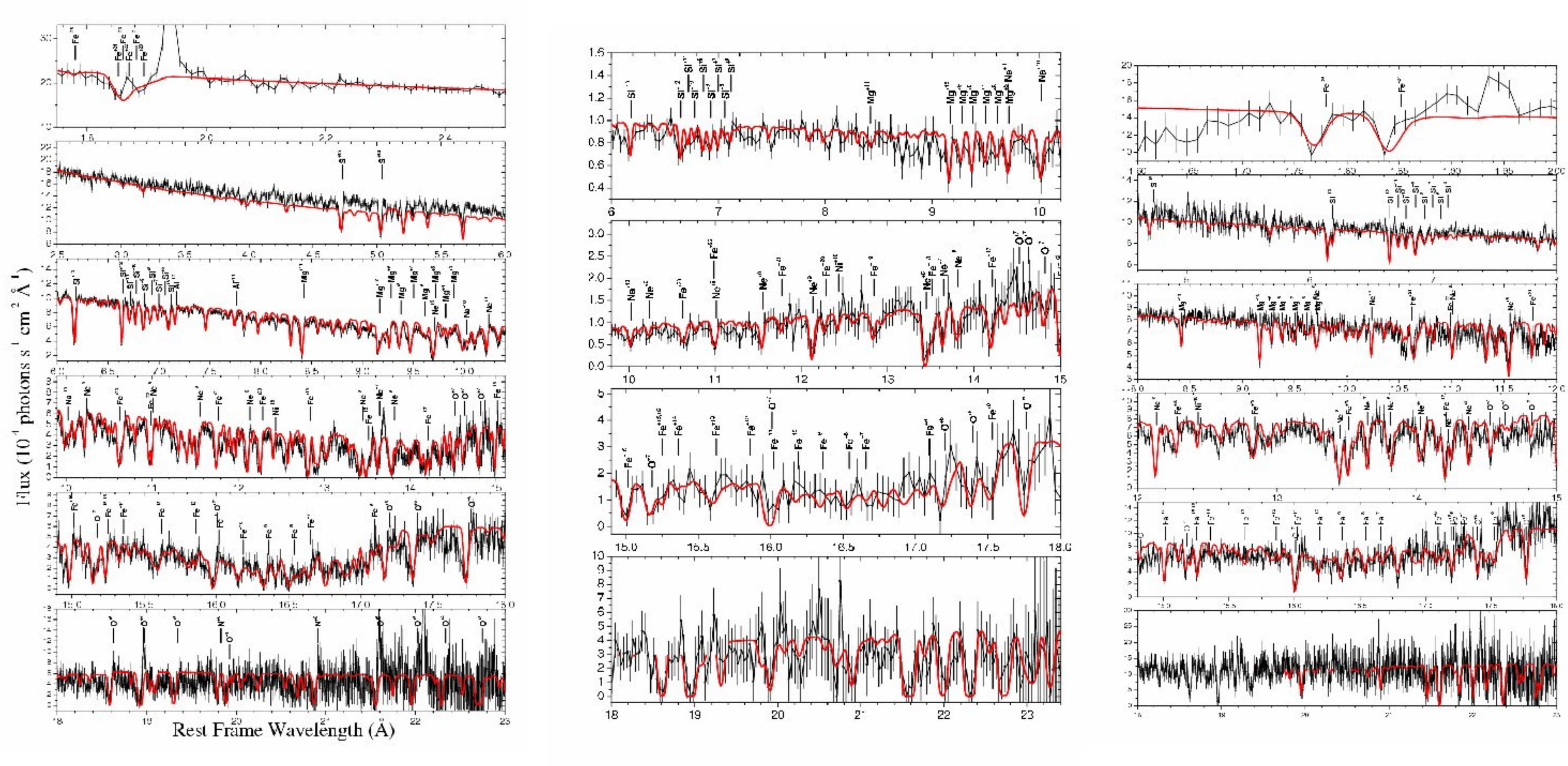
Absorption Measure Distribution , A New Method (analogous to emission measure distribution)

- Improvement on multi-component models
- AMD – Absorption Measure Distribution – is the gas column-density (N_H) distribution in ionization parameter ξ :

AMD

$$N_{ion} = A_z \int f_{ion}(\xi)\left(\frac{\partial N_H(\xi)}{\partial \xi}\right) d\xi$$

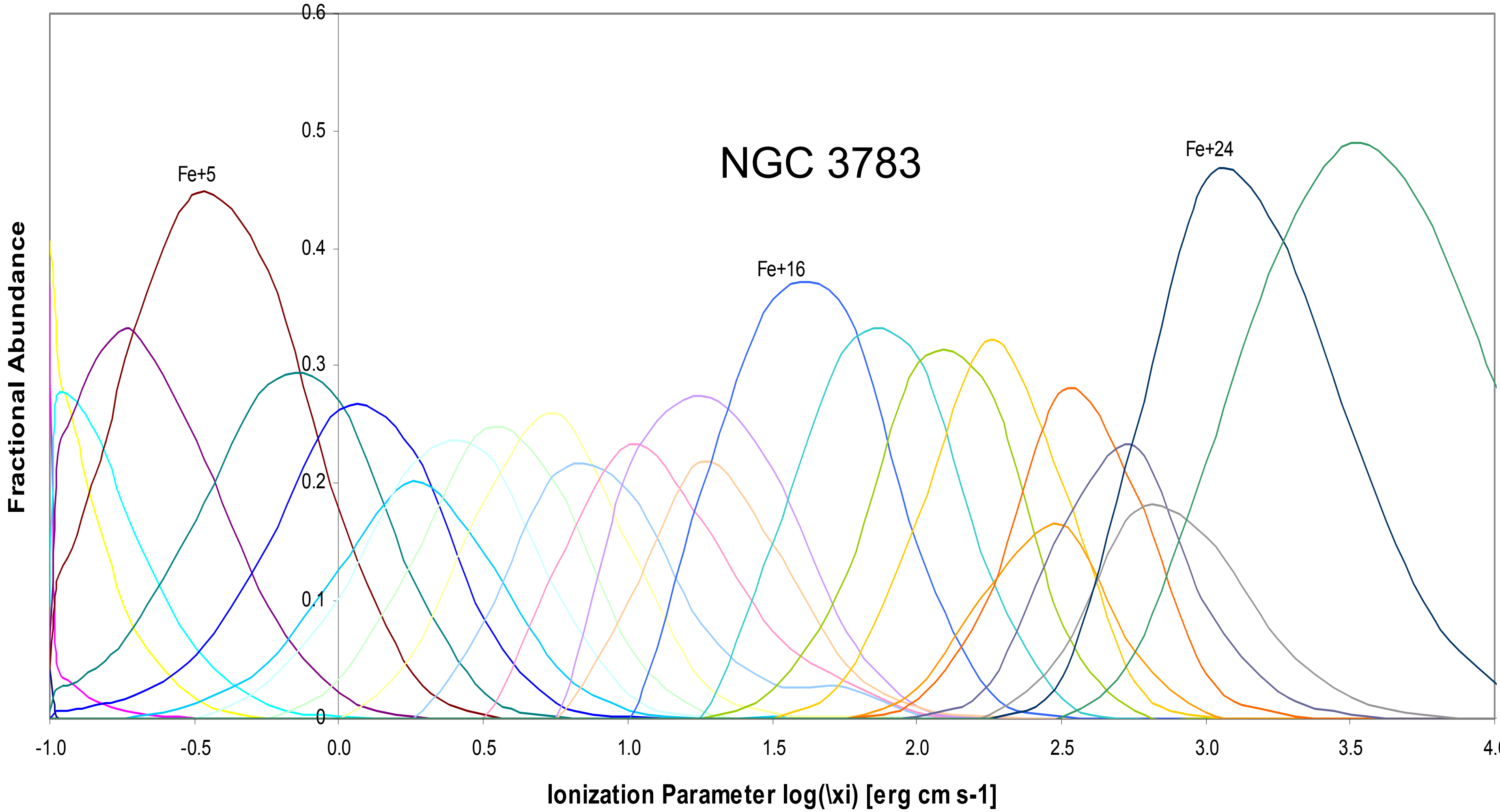
Measuring N_{ion} from HETG data



NGC 3783 (left panel), IRAS 13349+2438 (middle panel), and MCG -6-30-15 (right panel).

spectra in black, model in red.

Iron ion fractional abundances



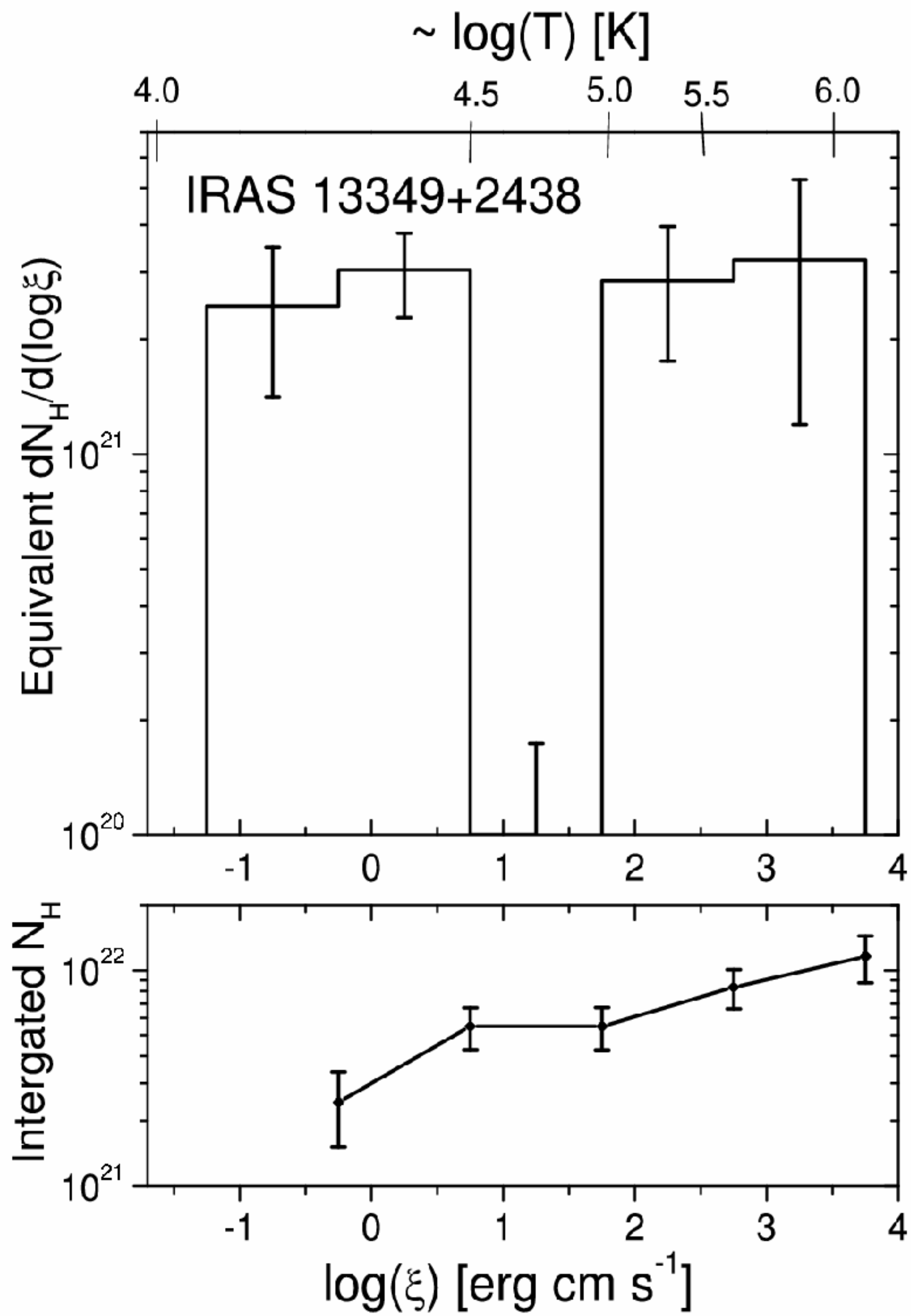
Iron ion's relative abundances for NGC 3783 using XSTAR (Kallman & Krolik 1995)

AMD of IRAS 13349+2438.

The lower panel is the integrated column density.

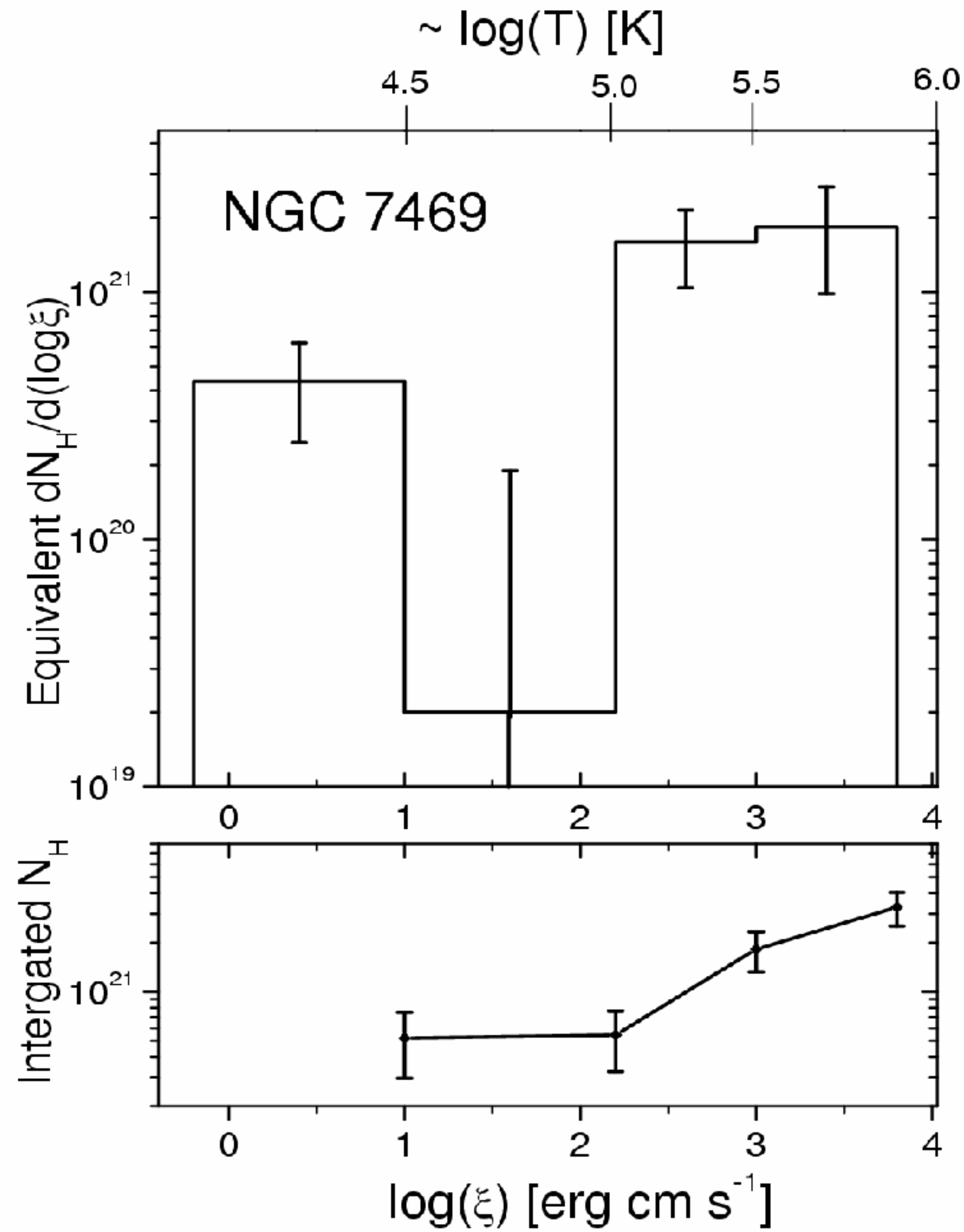
For IRAS 13349+2438 $N_H \sim 10^{22}$ cm^{-2} .

$$N_{ion} = A_z \int f_{ion}(\xi) \left(\frac{\partial N_H(\xi)}{\partial \xi} \right) d\xi$$



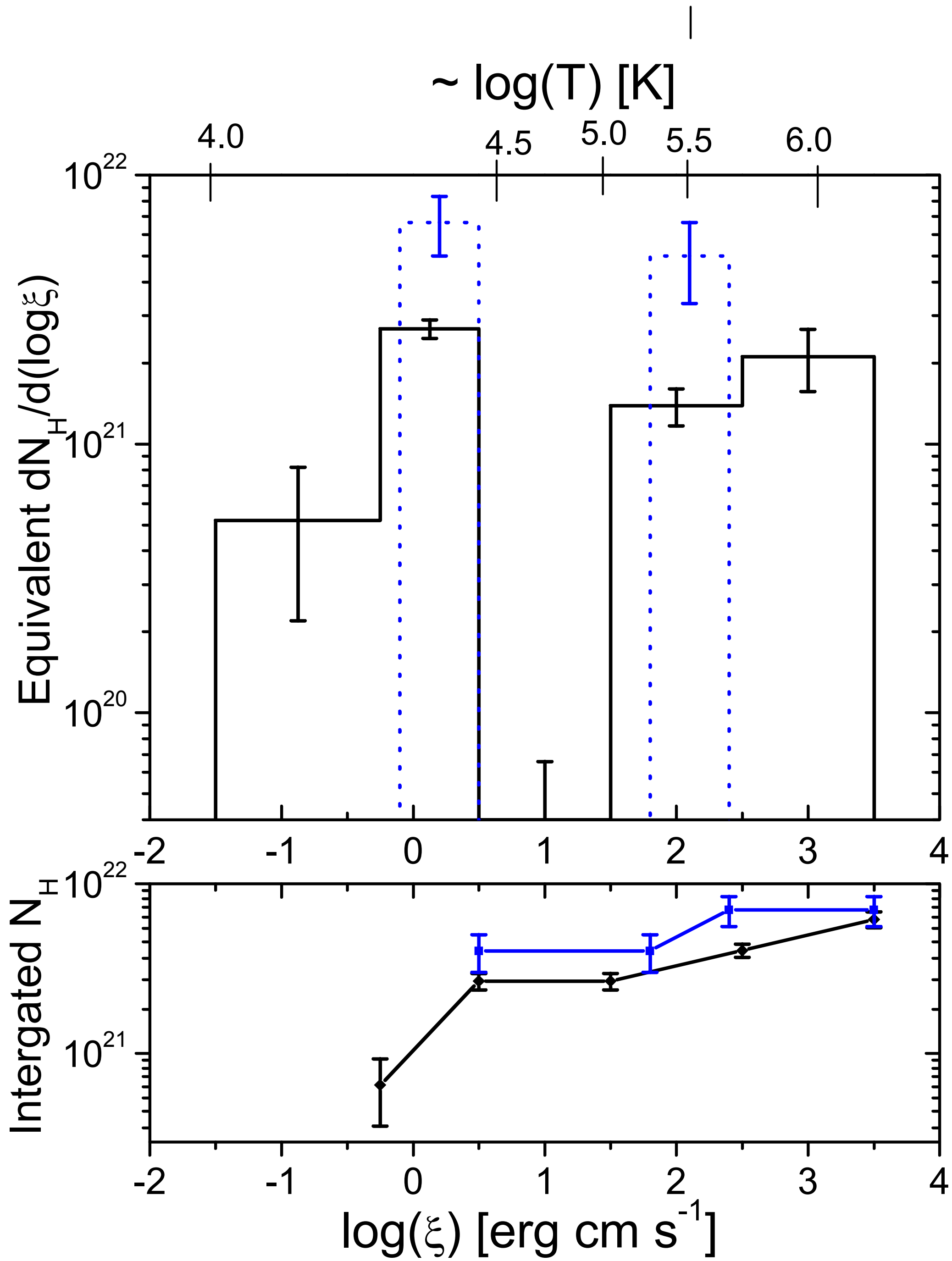
AMD of NGC 7469. (Blustin et al. 2007).

$N_H \sim 3\ 10^{21}\ cm^{-2}$.



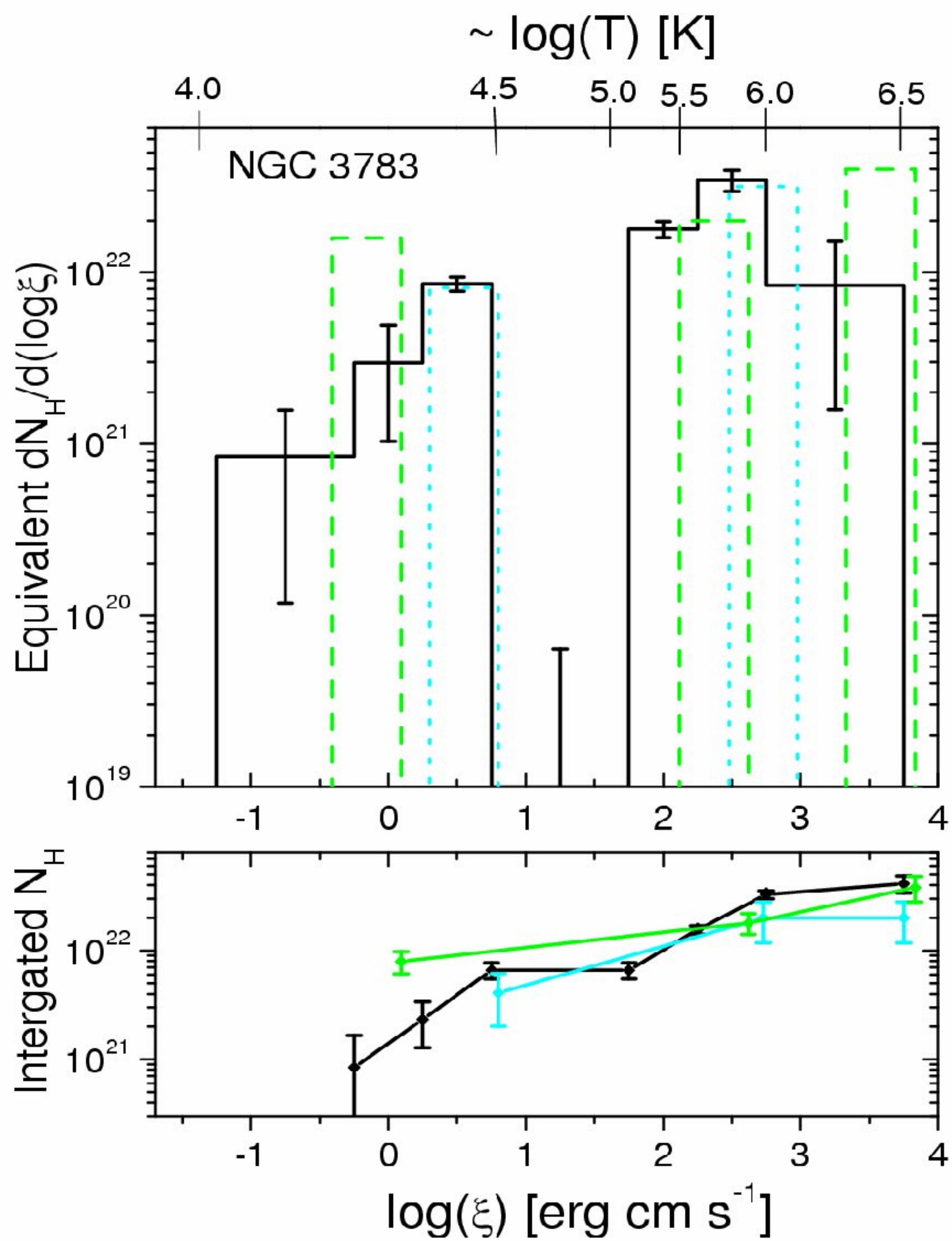
AMD of MCG -6-30-15.

MCG -6-30-15 have total column density around 7×10^{21} cm^{-2}. Blue dotted lines represent the model of McKernan et al. 07

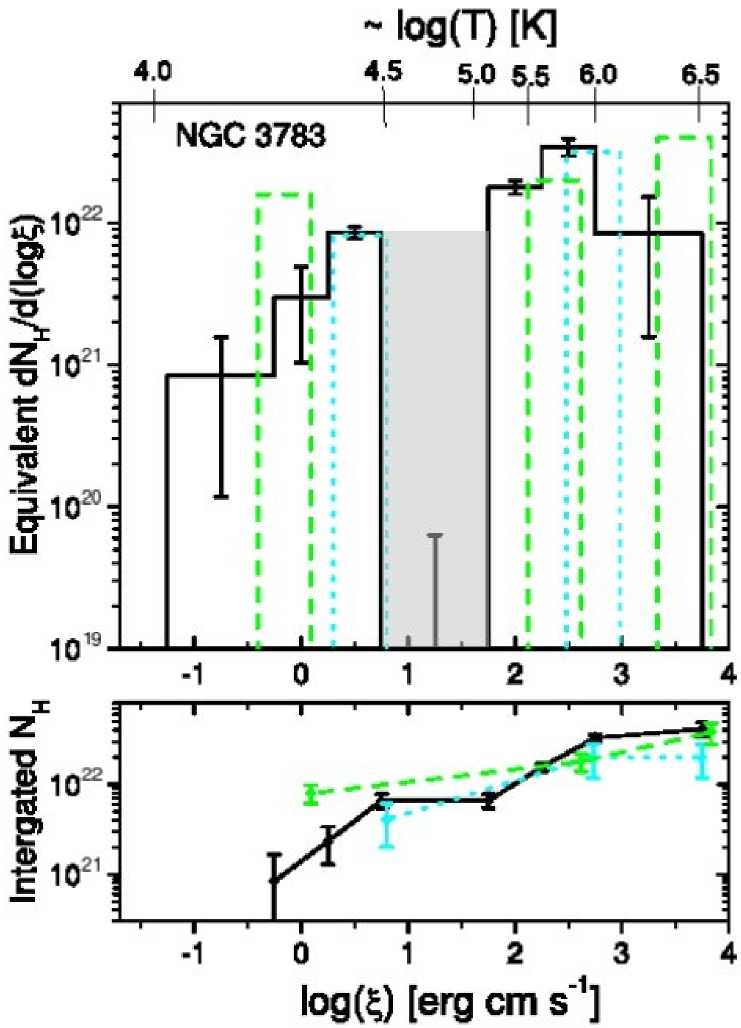


AMD of NGC 3783. The cyan bins in NGC 3783 are the Krongold et al. model (with a bin width) and the green bins Netzer et al. model .

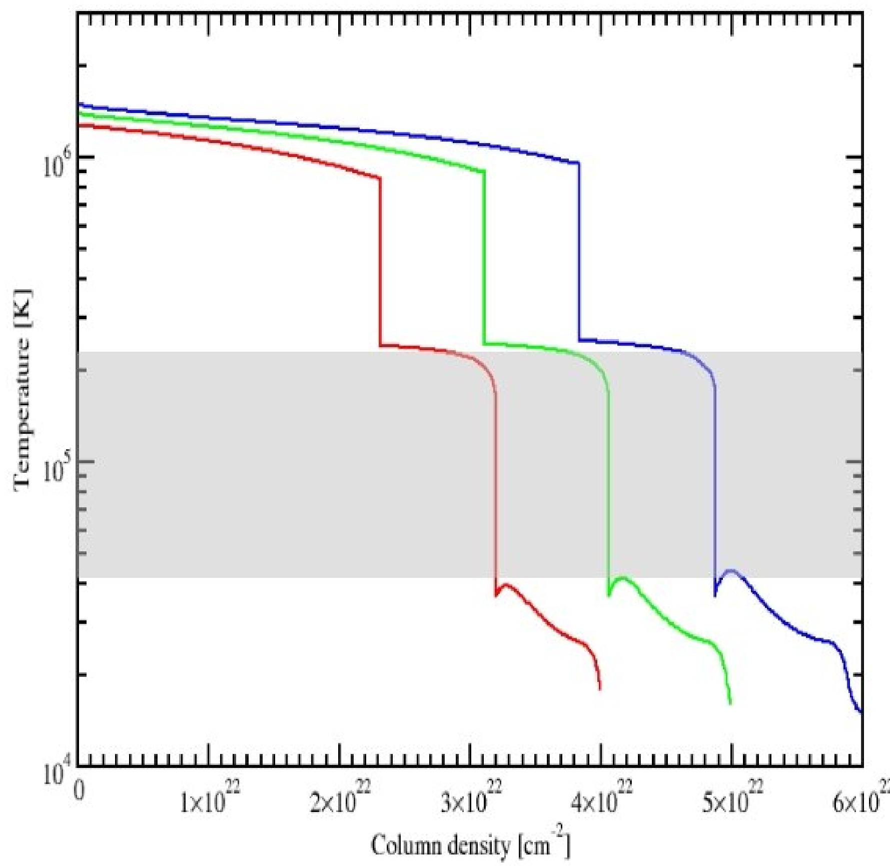
$N_H \sim 4\ 10^{22}\ cm^{-2}$.



Spotting the thermal instability in NGC 3783

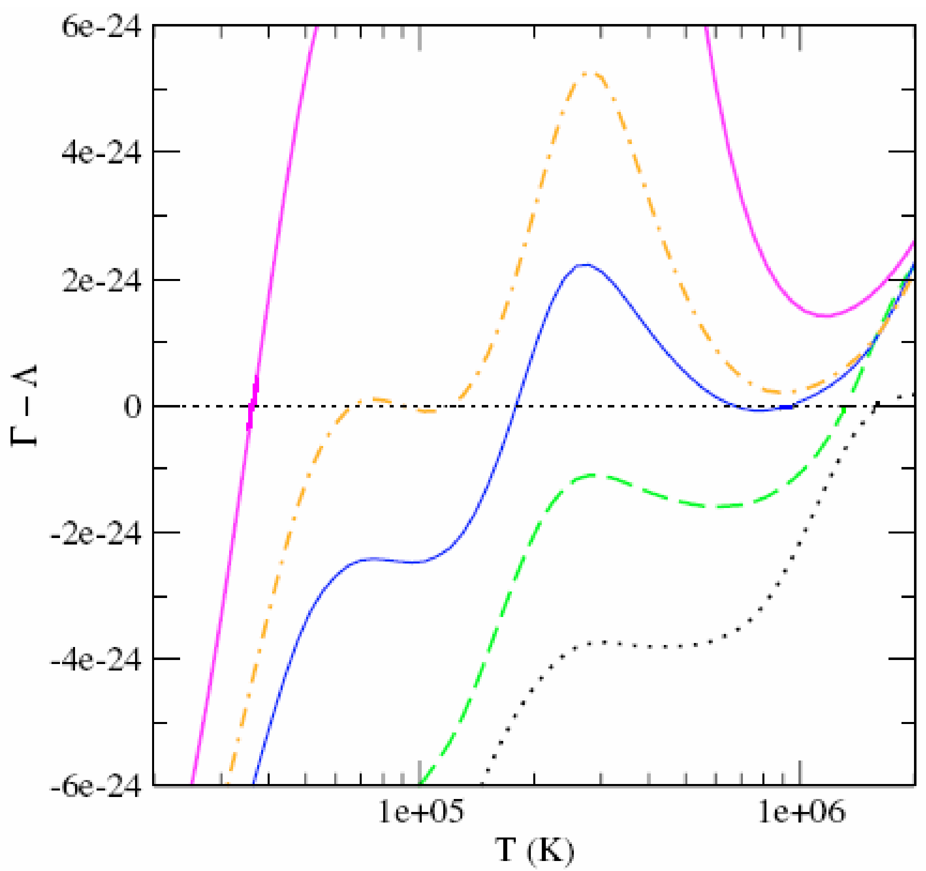


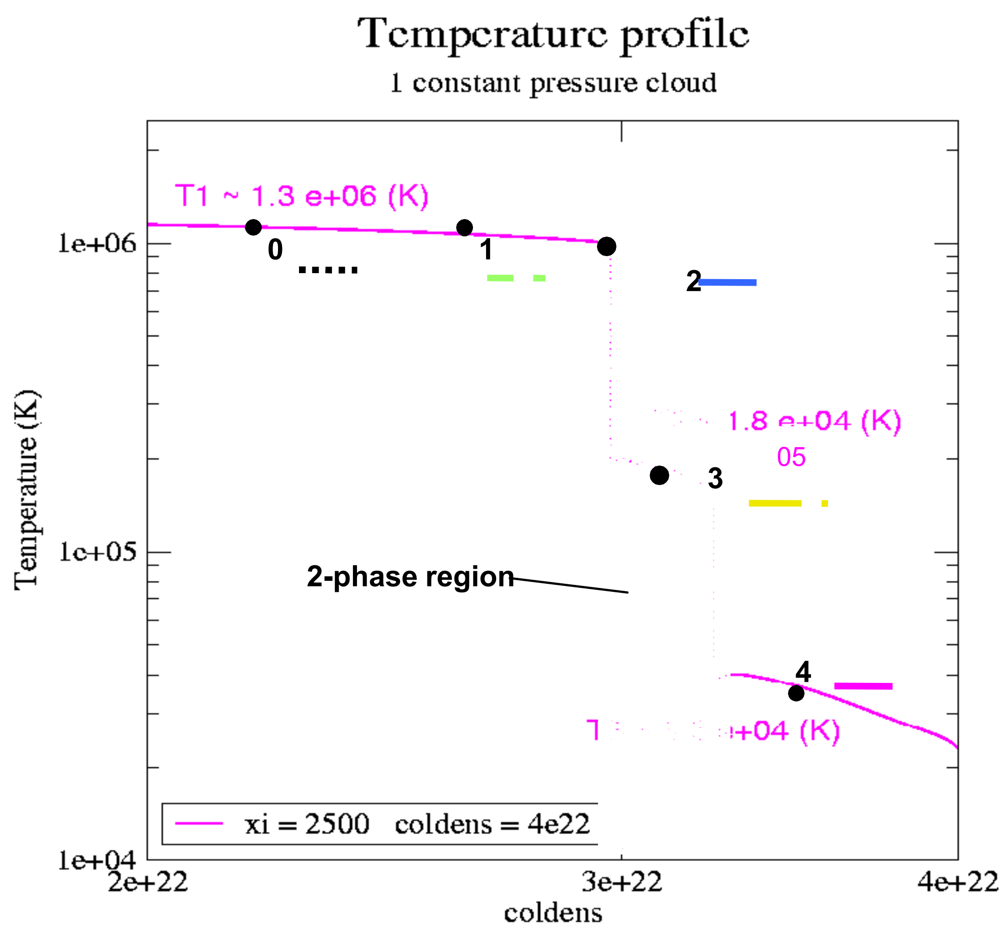
AMD model, Holczer et al. 2007



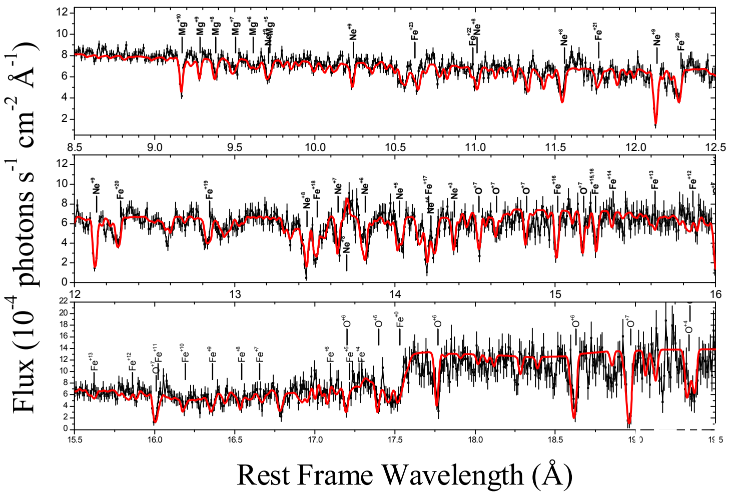
constant pressure model

The net cooling function Λ
Thermal stability criterion: $\left(\frac{\partial \Lambda}{\partial T}\right)_{P_{gas}} > 0$

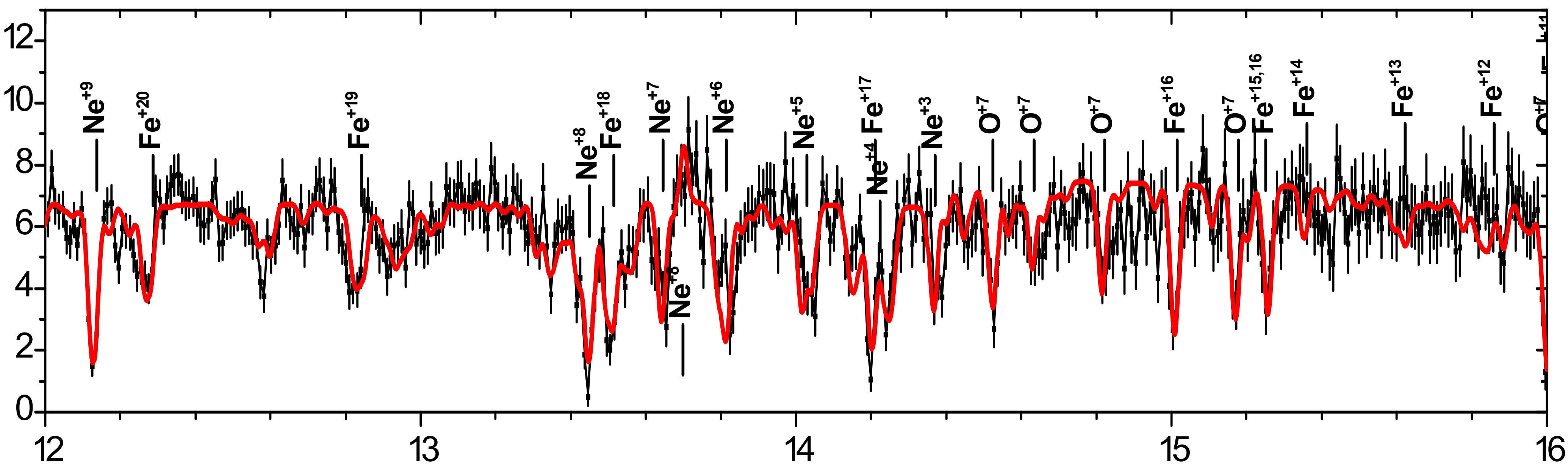




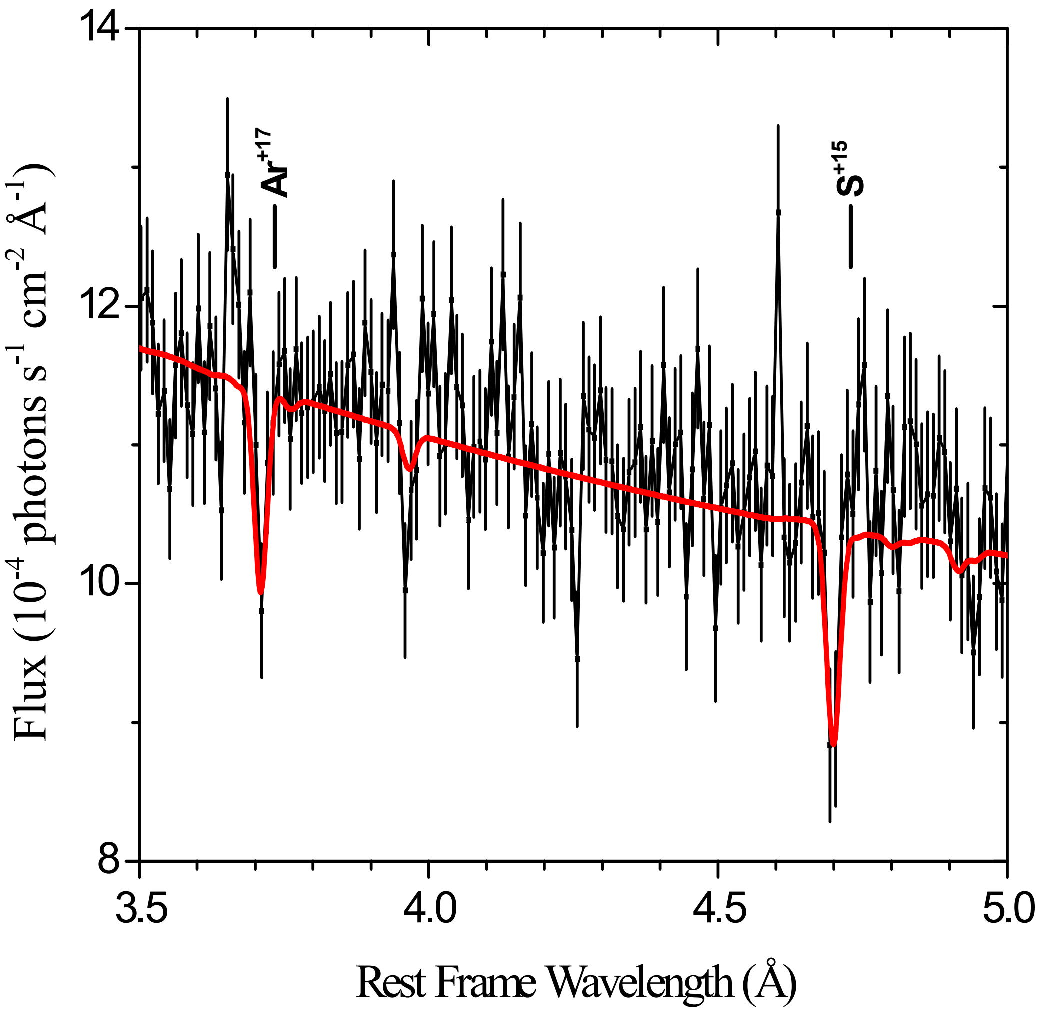
PART II – MCG -6-30-15 Multi-components

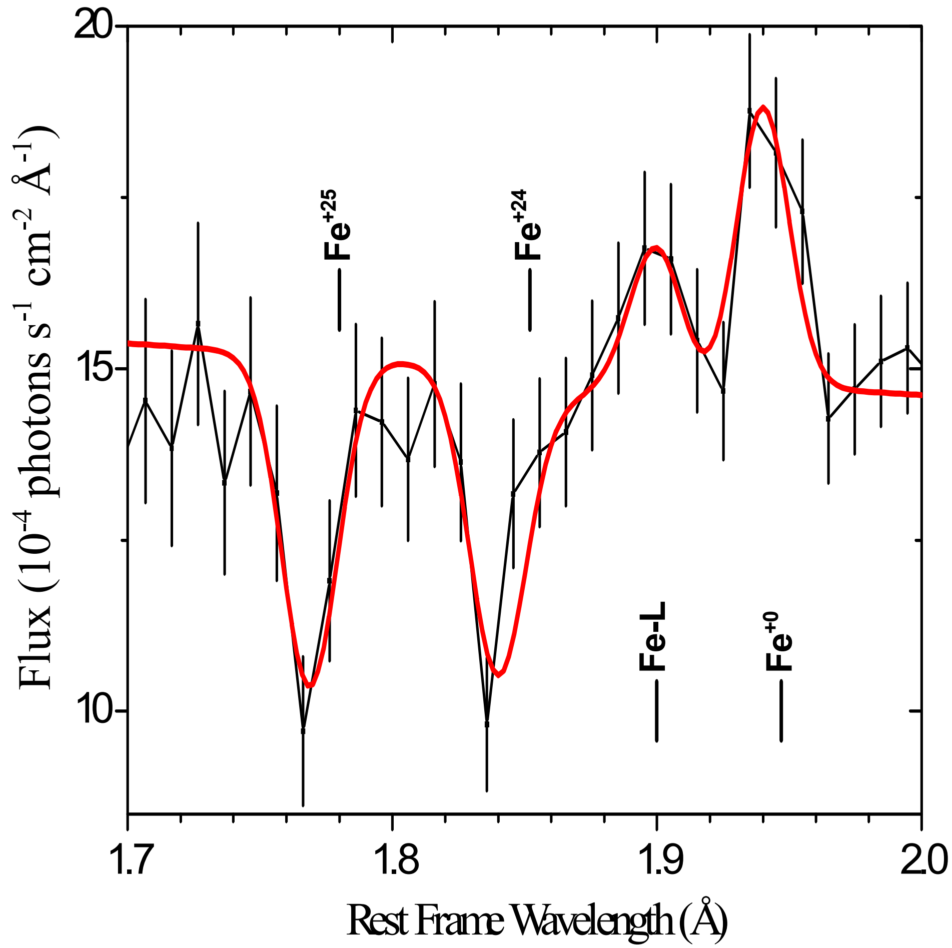


We confirm a "slow" outflow velocity of -100 km s-1 and turbulent velocity of 100km s^{-1} (Sako et al. 2003, Lee et al. 2001)

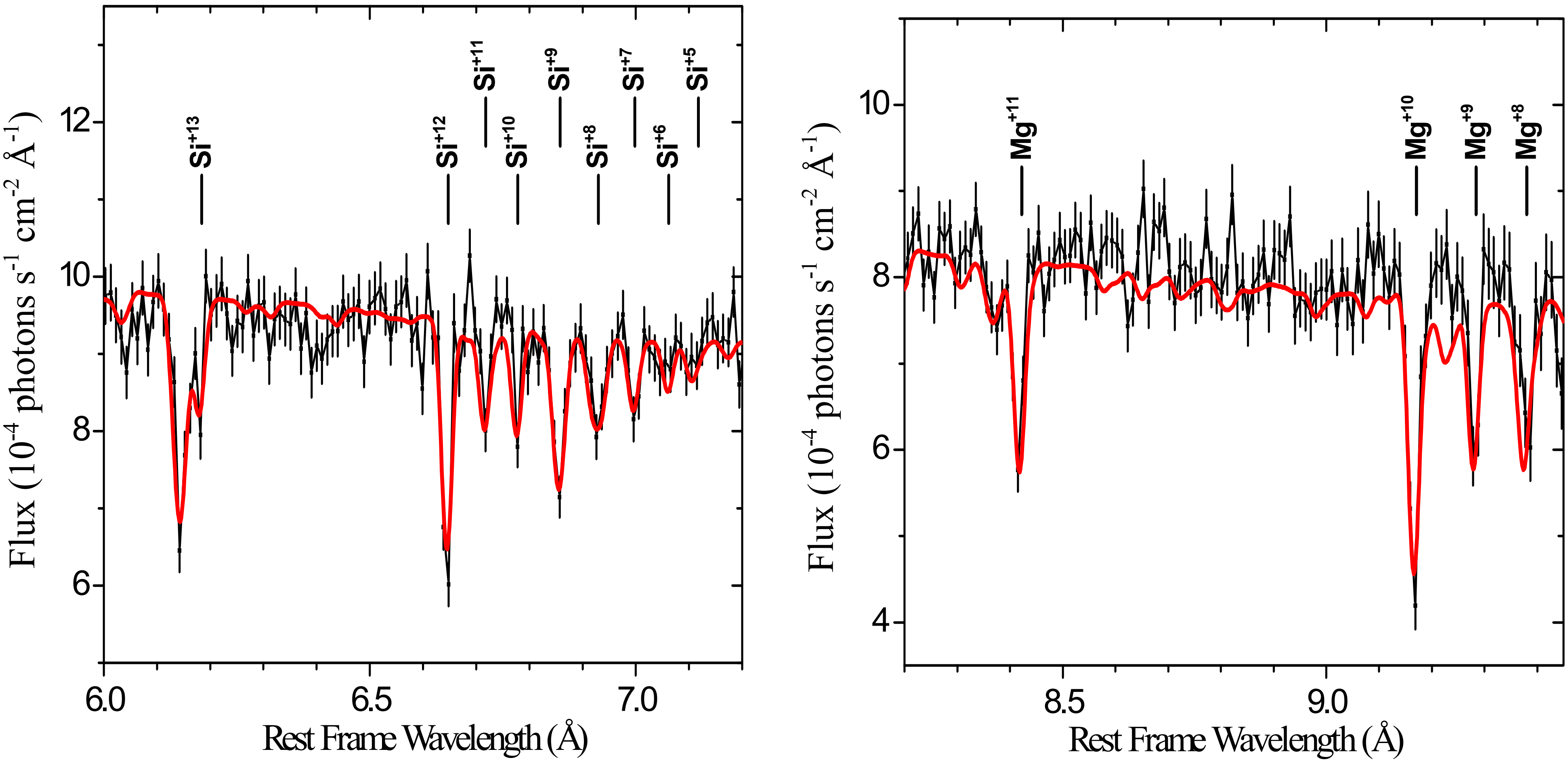


We confirm a fast component with outflow velocity of -1900 km s^{-1} and turbulent velocity of 500 km s^{-1} (Sako et al. 2003, Young et al. 2005)





Slow to Fast wind Transition

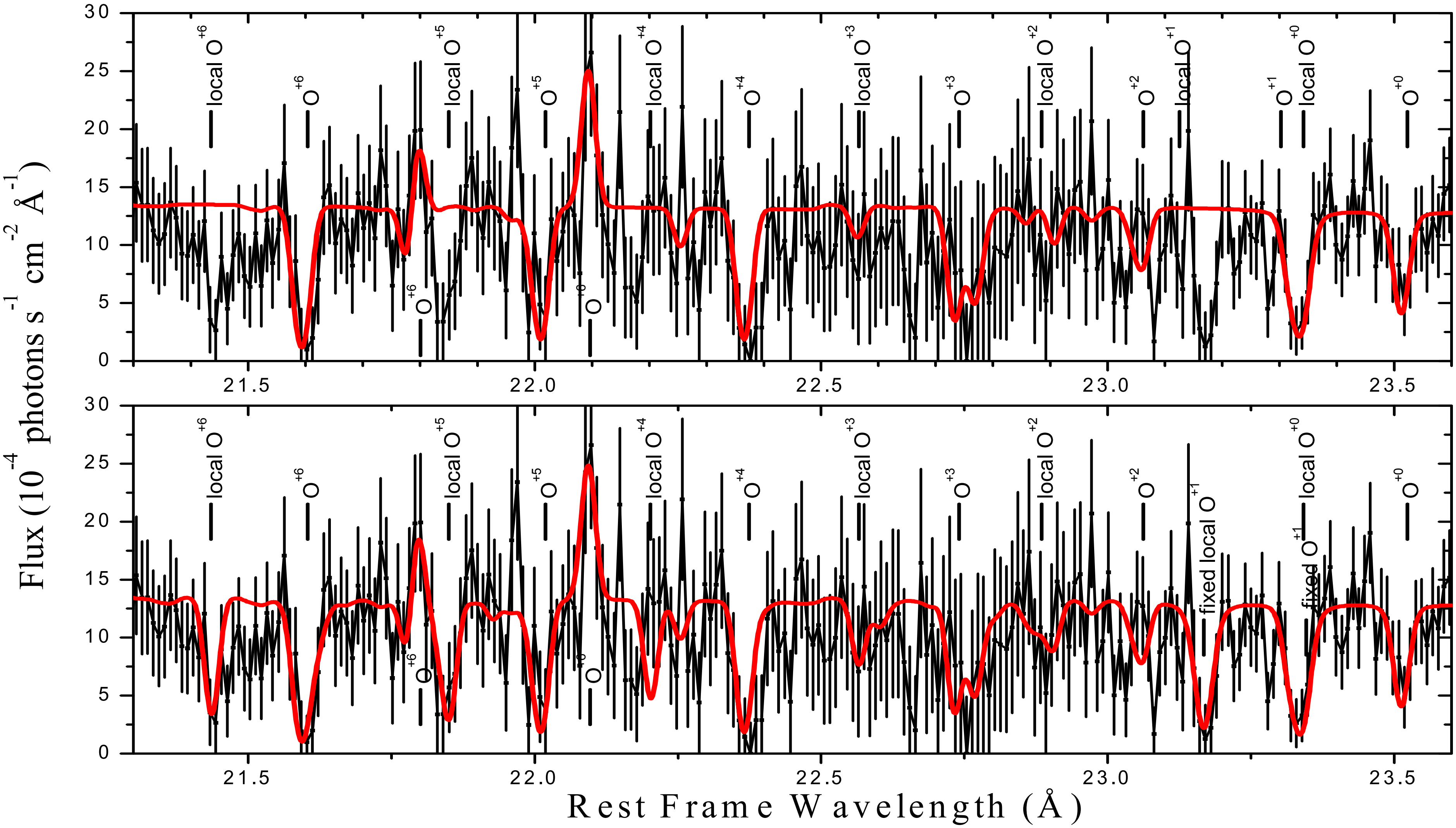


Why OI - OVII lines are **NOT** part of the fast wind:

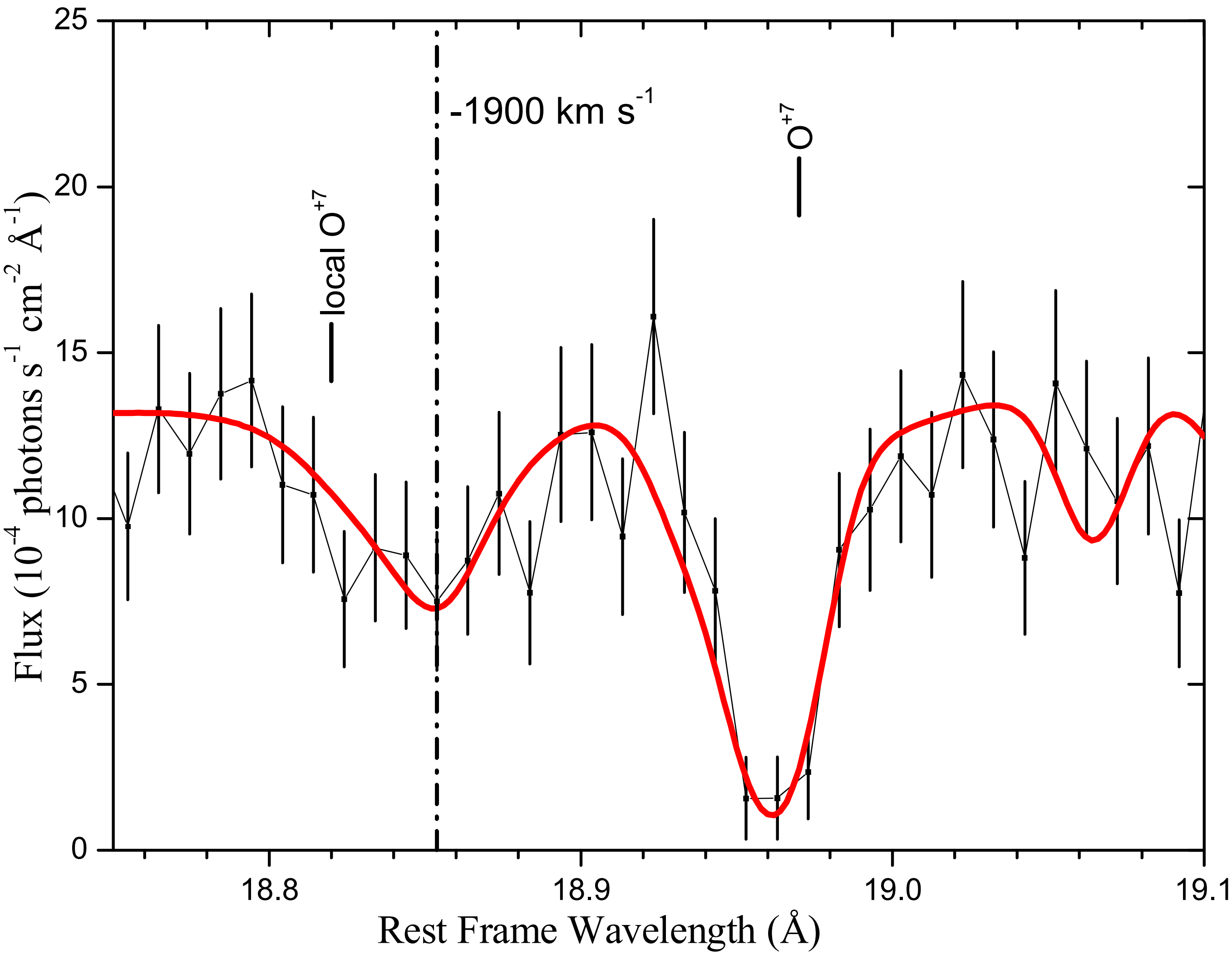
We find only high ionization parameter ions (logξ=3.82)

We find that the oxygen lines have lower turbulent broadening ~100km s^{-1}

The oxygen ions outflow velocity is not -1900 km s^{-1} but rather -2300 km s^{-1}



OVIII **IS** Part of the fast wind



Conclusions

- All outflows in the AGN's we've checked are missing gas at logT ~ 4.5 - 5 K
- We believe this is evidence for thermal instability in this region observed by the AMD method and calculated by TITAN
- We find two distinct outflow components in mcg-6-30-15
- Most of the oxygen lines do not have a high outflow velocity origin, but seem to have a local (z=0) origin