Warm absorber (WA) in AGNs and its effect on broad Fe line

T. P. Adhikari, PhD - I
Nicolaus Copernicus Astronomical Center, Warsaw

Collaborators : Dr. hab. Agata Rozanska (Supervisor)
Dr. Malgorzata Sobolewska, Prof. Bozena Czerny

29 August 2014, FERO meeting, Krakow

Goal

- Structure of the WA (thermal structure , physical conditions) in AGNs: mrk 509

- Comparing the results from photoionization codes : TITAN (Dumont et al. 2000), CLOUDY 13.03 (Ferland et al. 2013)

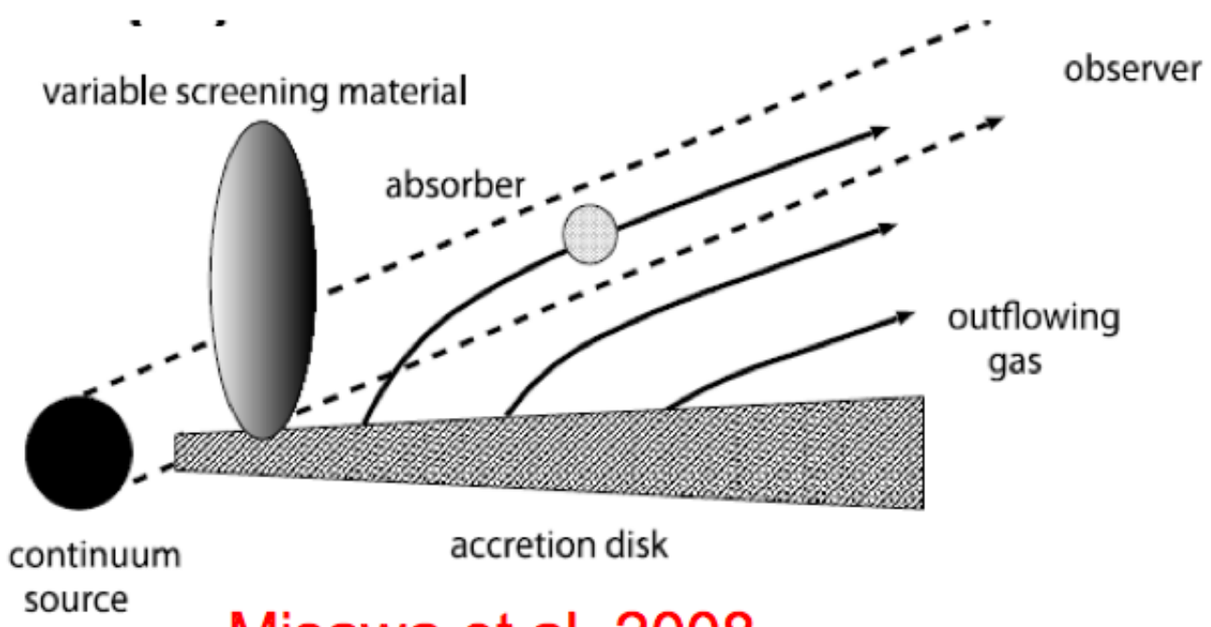
- Influence of WA on relativistically broadened Fe line profile

Warm Absorber

Halpern 1984 : Sy1 MR 2251-178

EXOSAT, ROSAT, GINGA,
ASCA, Beppo-SAX

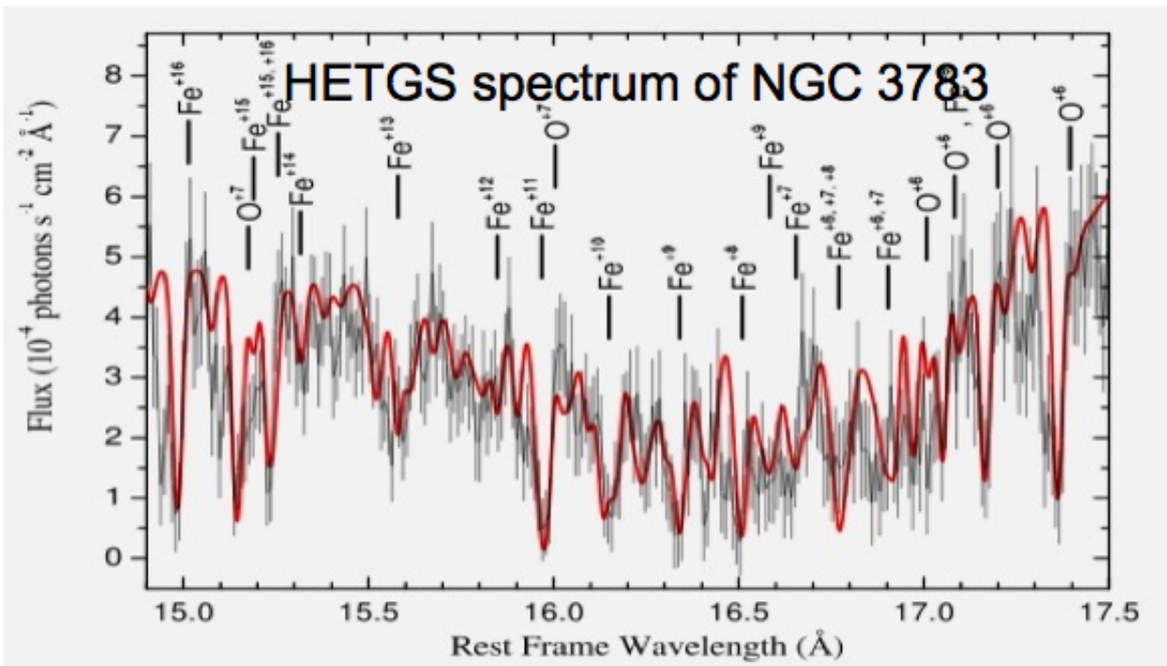
Nandra & Pounds (1992, 1994),
Reynolds (1997), George (1998)



Misawa et al. 2008

Chandra and XMM Newton

NGC 3783 (Krongold et al. 2003),
NGC 7469 (Blustin et al. 2002, 2003),
MCG-6-30-15 (Turner et al. 2004),
TonS180 (Rozanska et al. 2004)



Holczer et al. 2005

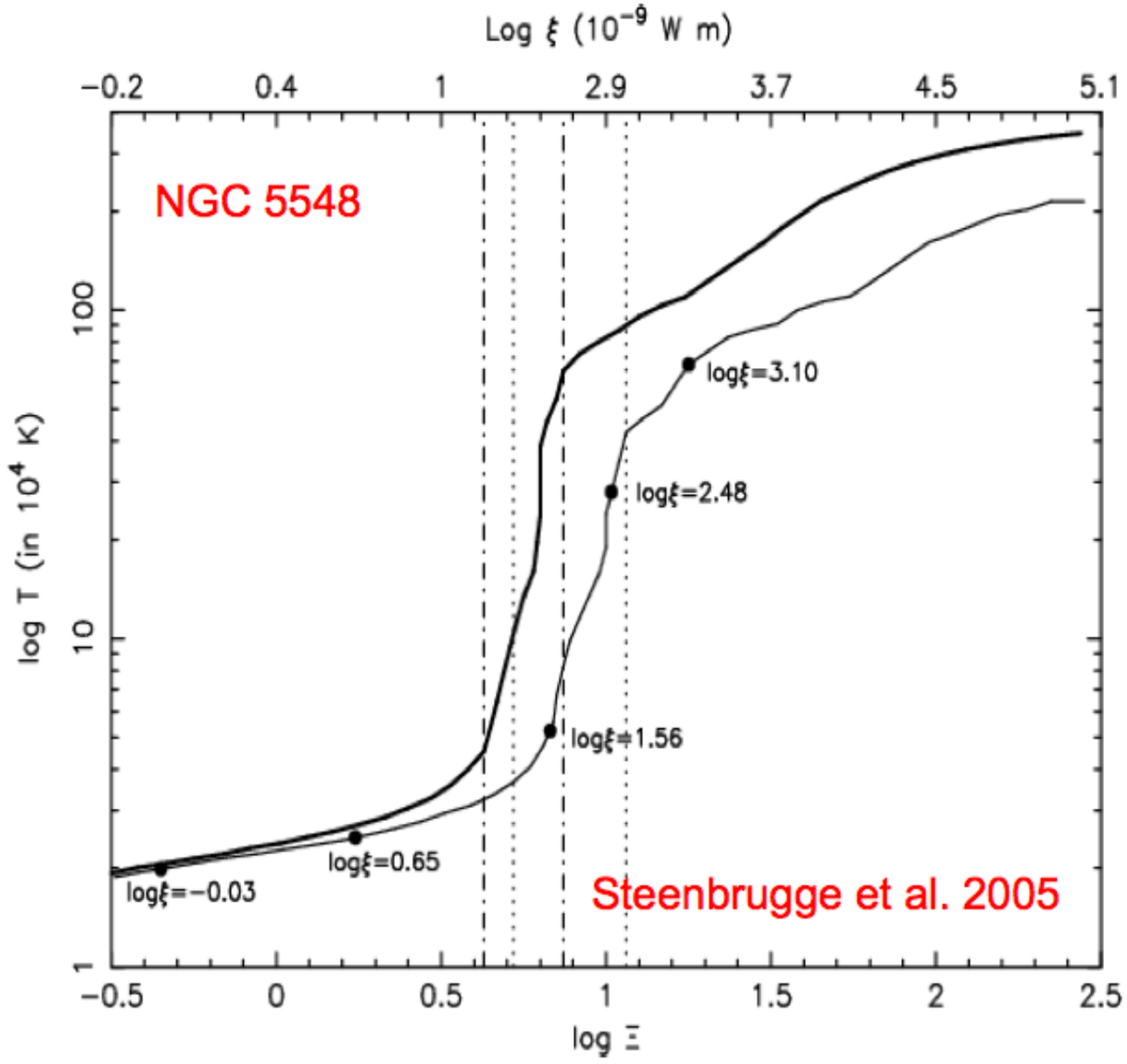
Physical Properties of WA

log xi ~ 0 - 2 erg s^{-1} cm

N_H ~ 10^{20} – 10^{22} cm^{-2}

absorption lines blue shifted indicating the outflow velocities of WA ~ 100-1000 km s^{-1}

significant uncertainties on the exact location: few pc to few kpc



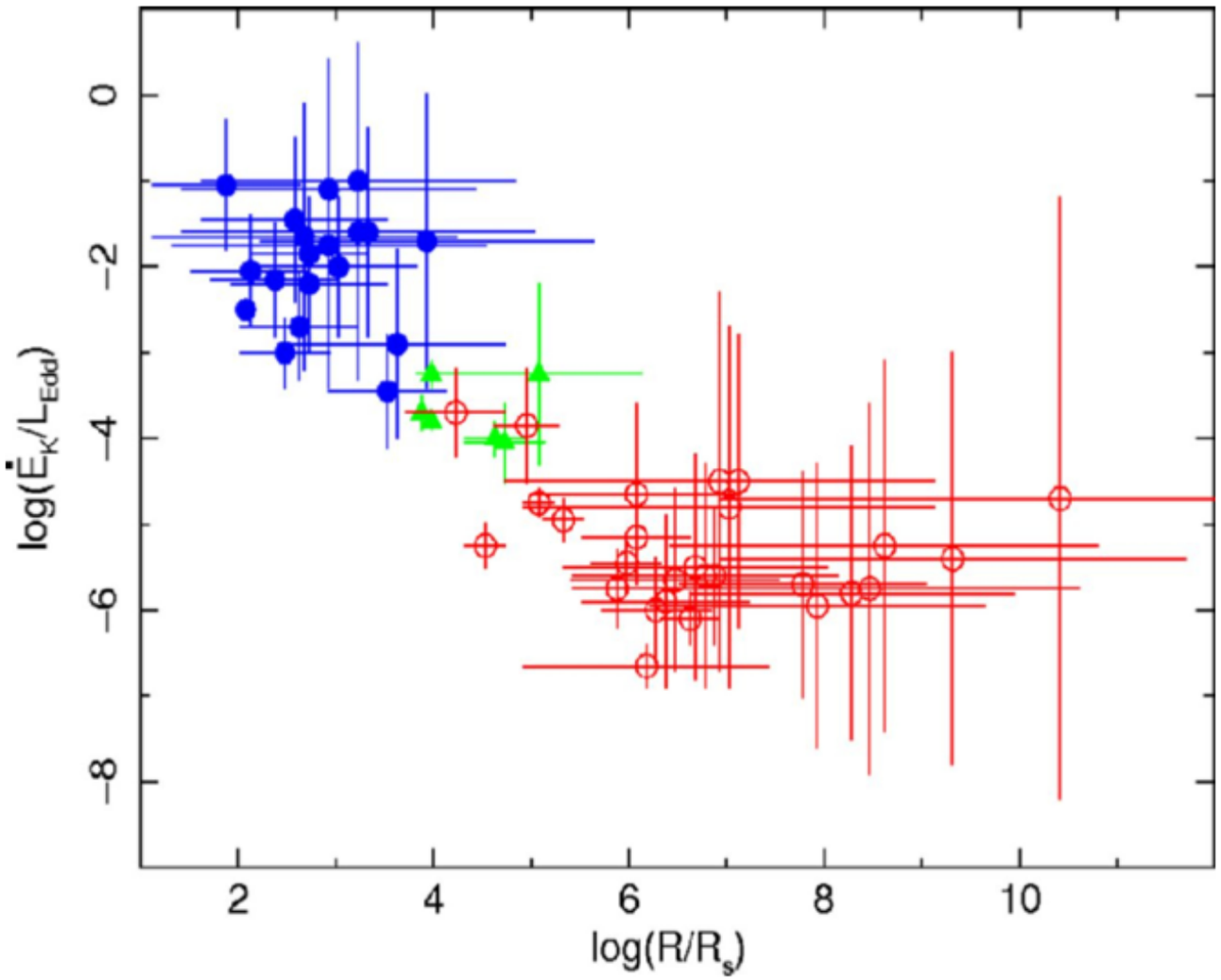
Origin: largely debated, diverse suggestions

gas evaporated off the torus (Krolik & Kriss 1995)

evaporation of blotted stars (Netzer 1996)

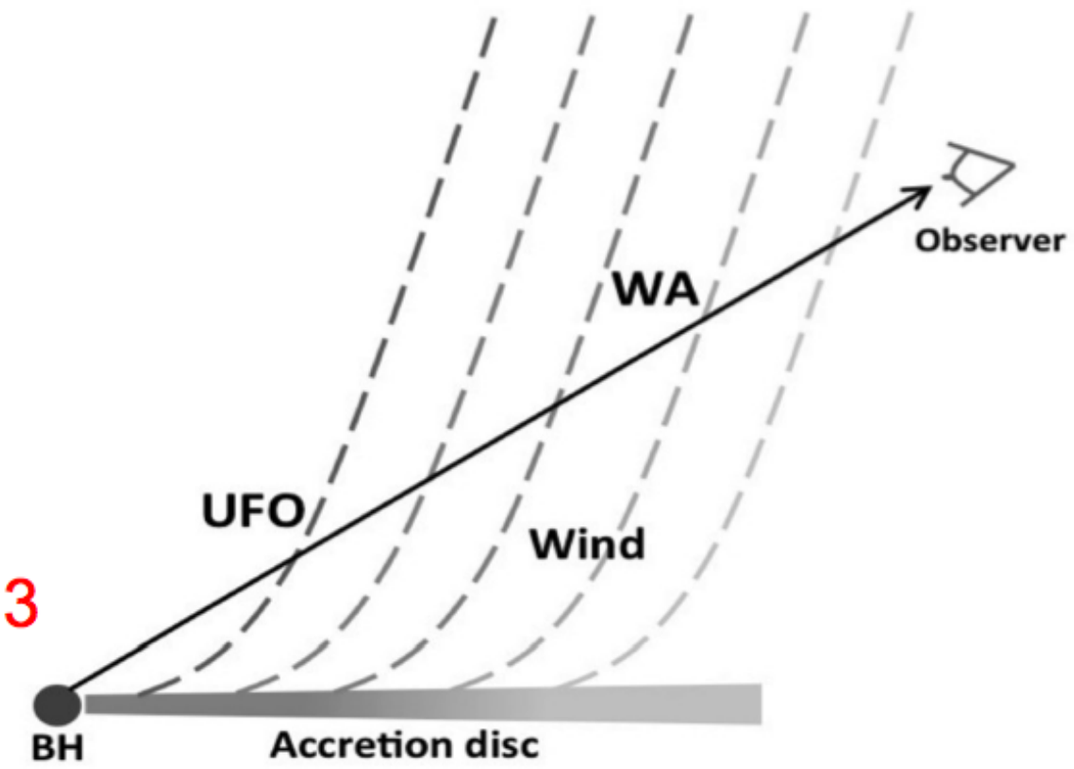
Wind driven off the accretion disk (Elvis 2000, Bottorff et al. 2000)

Unification of X-ray Winds



Intrinsically distinct or different manifestation of the same phenomenon (Fukumura et al. 2010, Kazanas et al. 2012, Reynolds 2012)

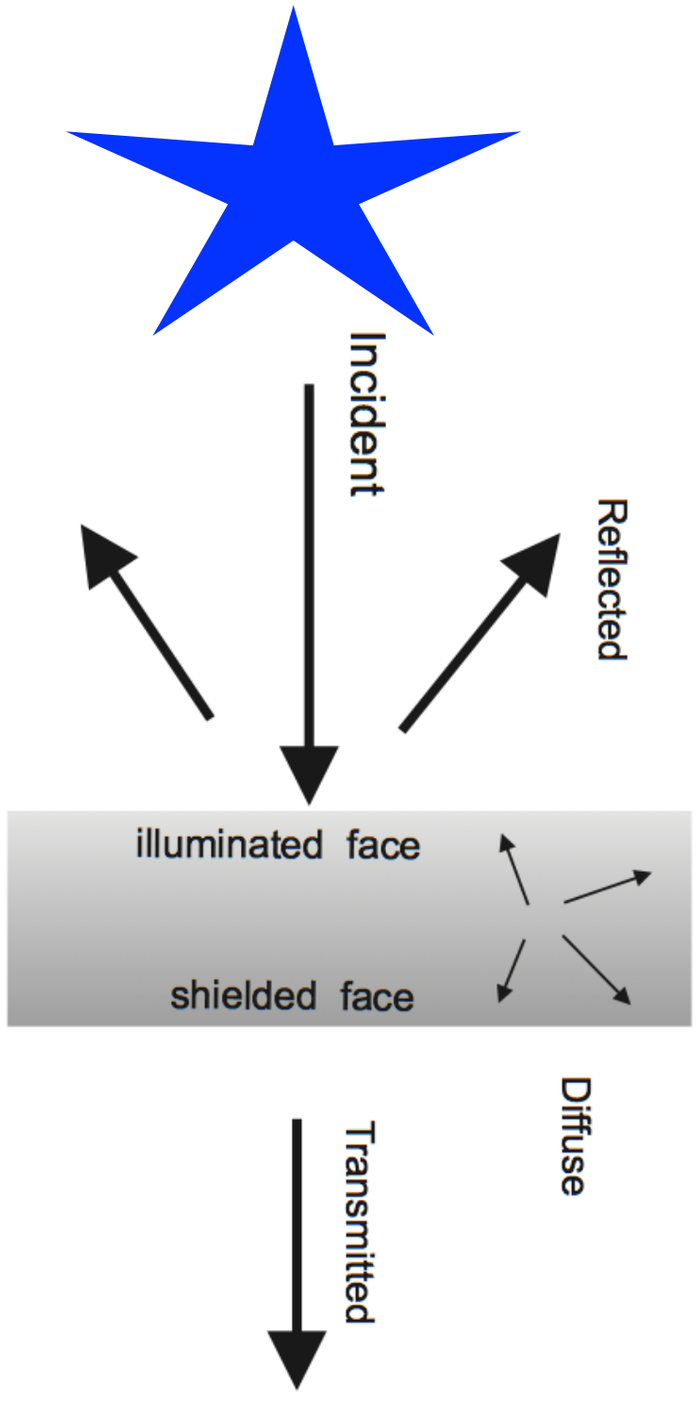
Tombesi et al. 2013



Photoionization Modelling

CLOUDY and TITAN : to compute the photoionization in non LTE plasma in many different astrophysical situations.

Physical parameters are computed simultaneously solving the ionisation equations, thermal equations, equations of statistical equilibrium, pressure equilibrium equations and radiation transfer equations.



Photoionization modelling can also be used for estimating the distance to the WA from the central source

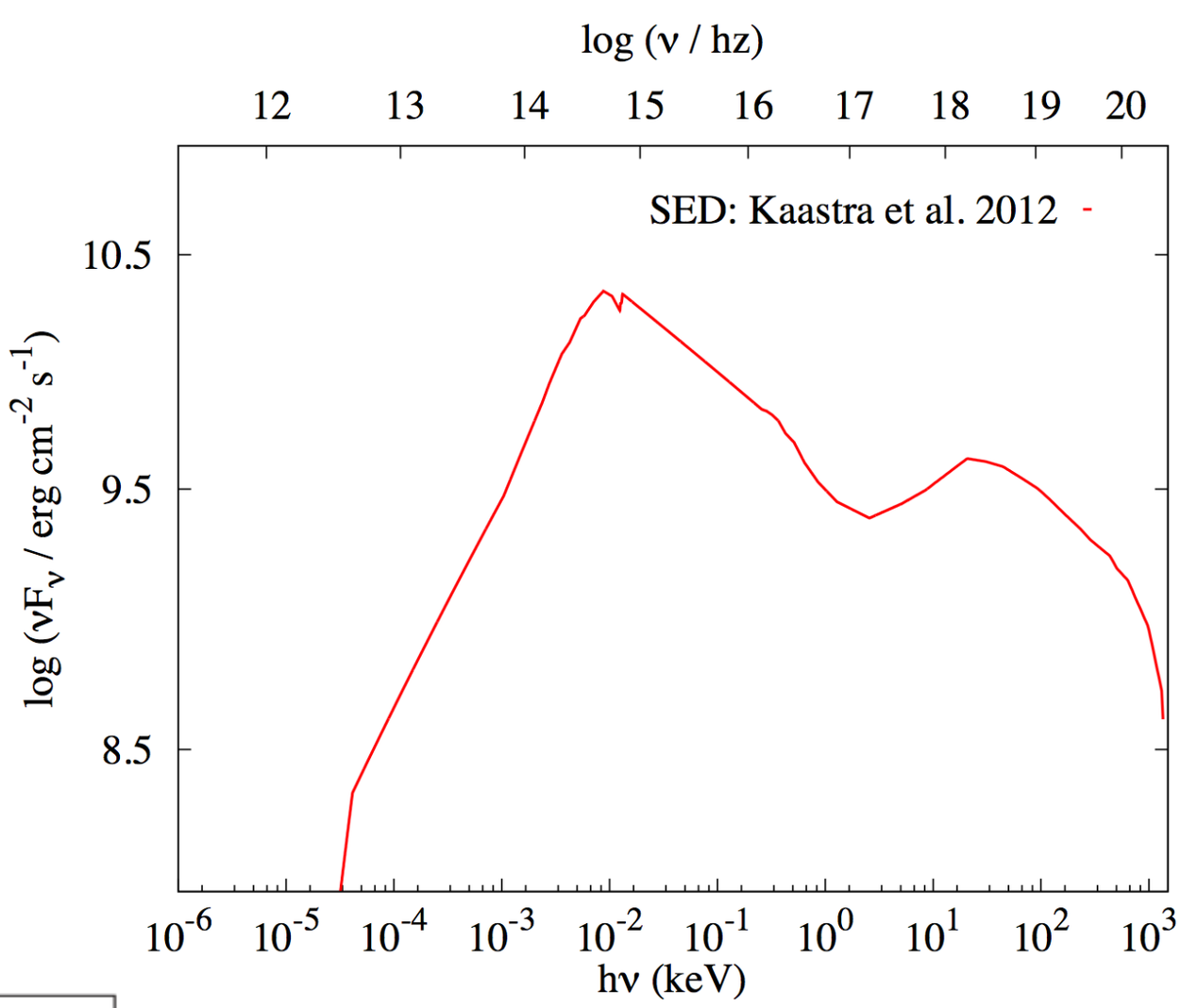
Rozanska et al. 2008

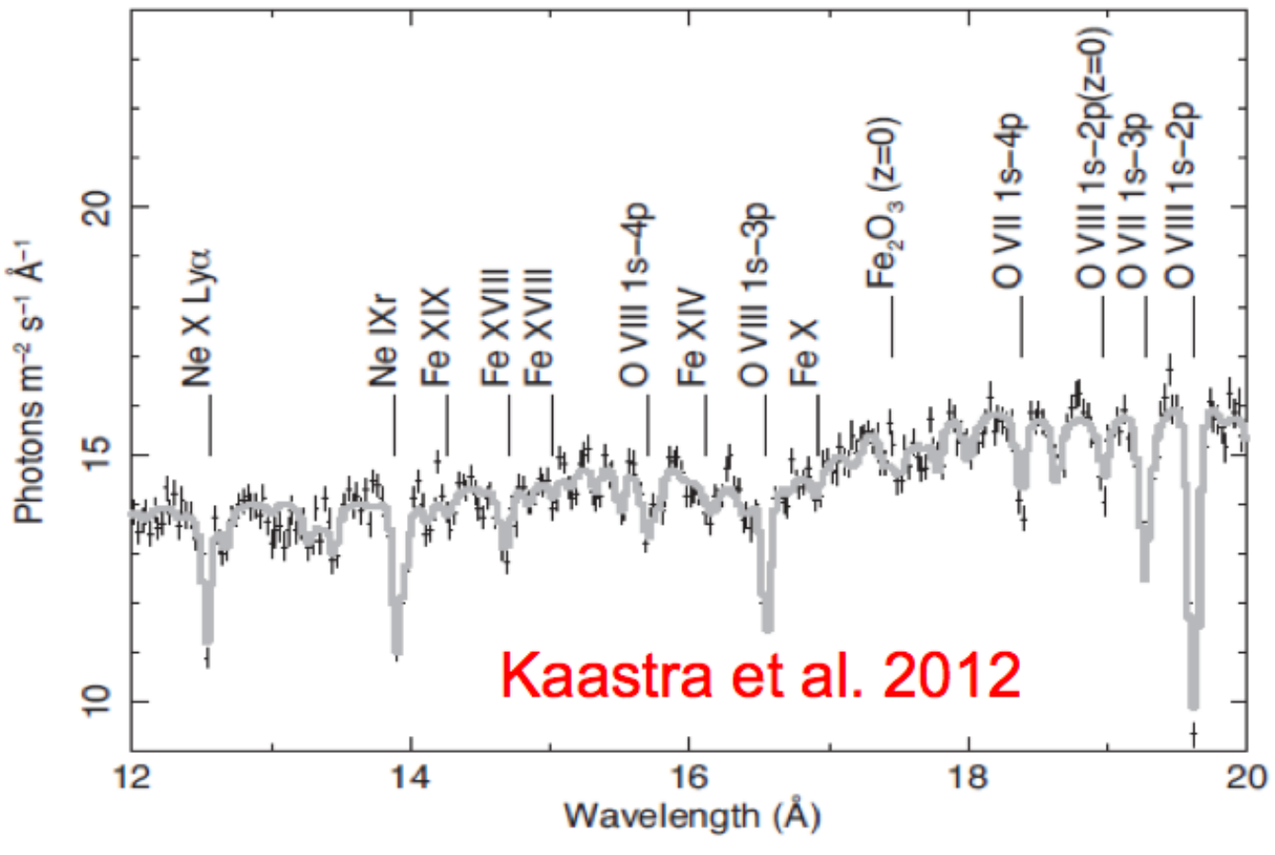
Mrk 509

$M_{BH} = 1.24 \times 10^8 M_{sun}$

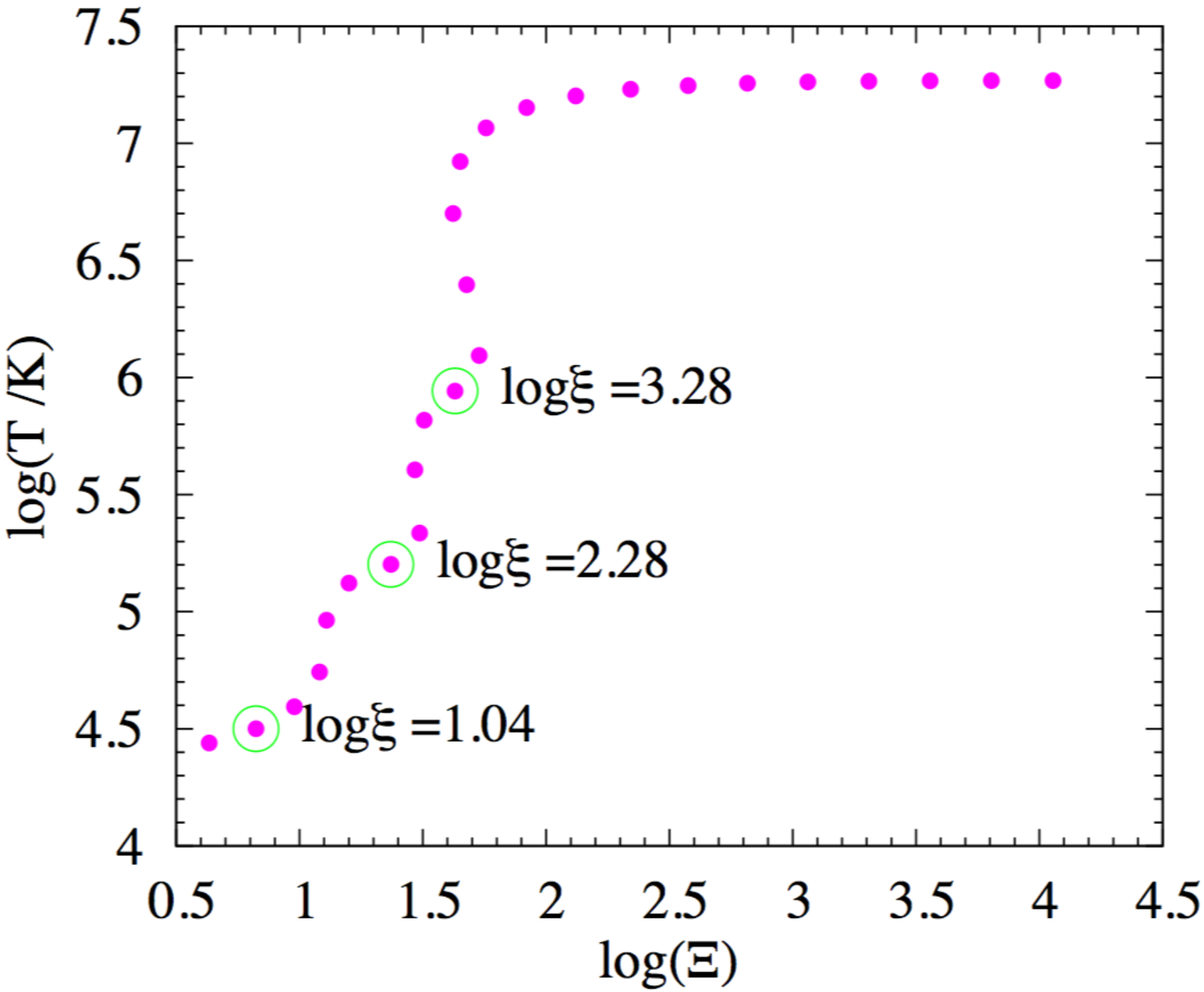
$L = 1.45 \times 10^{45}$ ergs/sec

Z=0.0343, distance = 147 Mpc





Grid of constant density clouds with densities ranging from 10^5 cm^{-3} to 10^{11} cm^{-3}



Constant Pressure Cloud

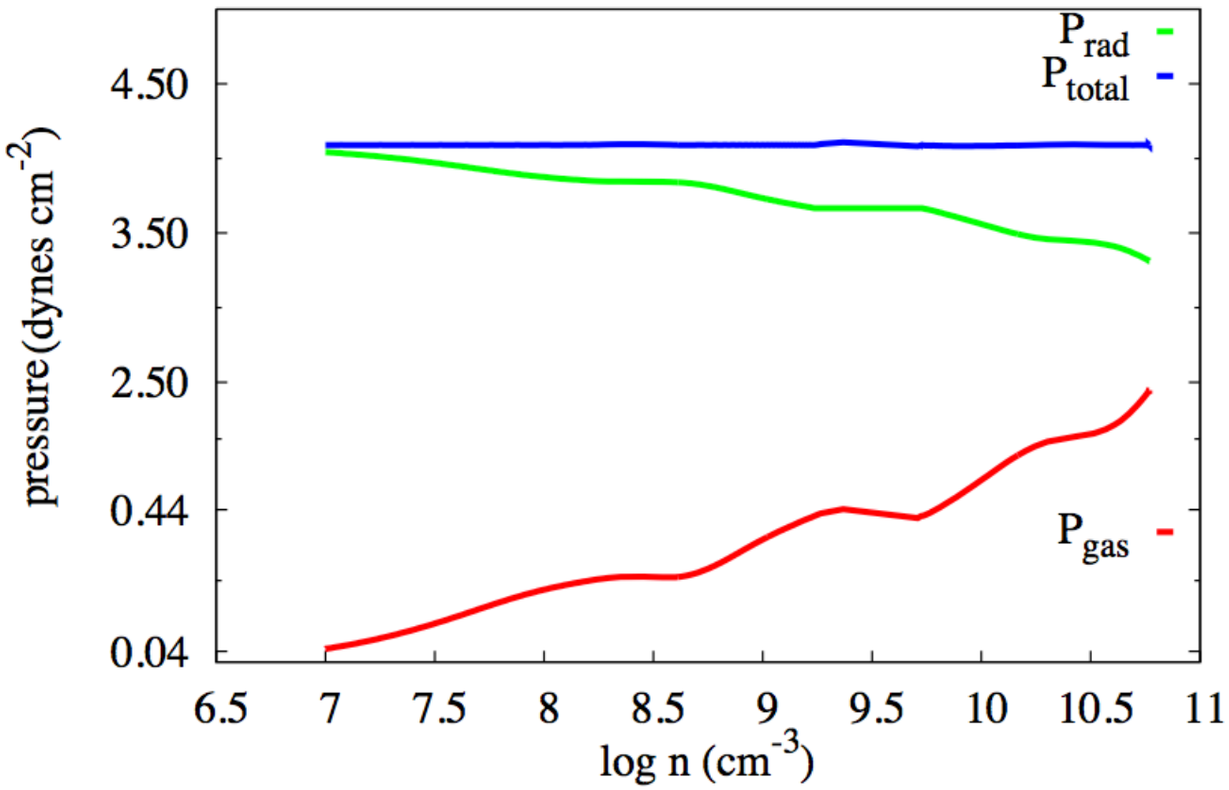
Cloud parameters same for the both codes CLOUDY and TITAN

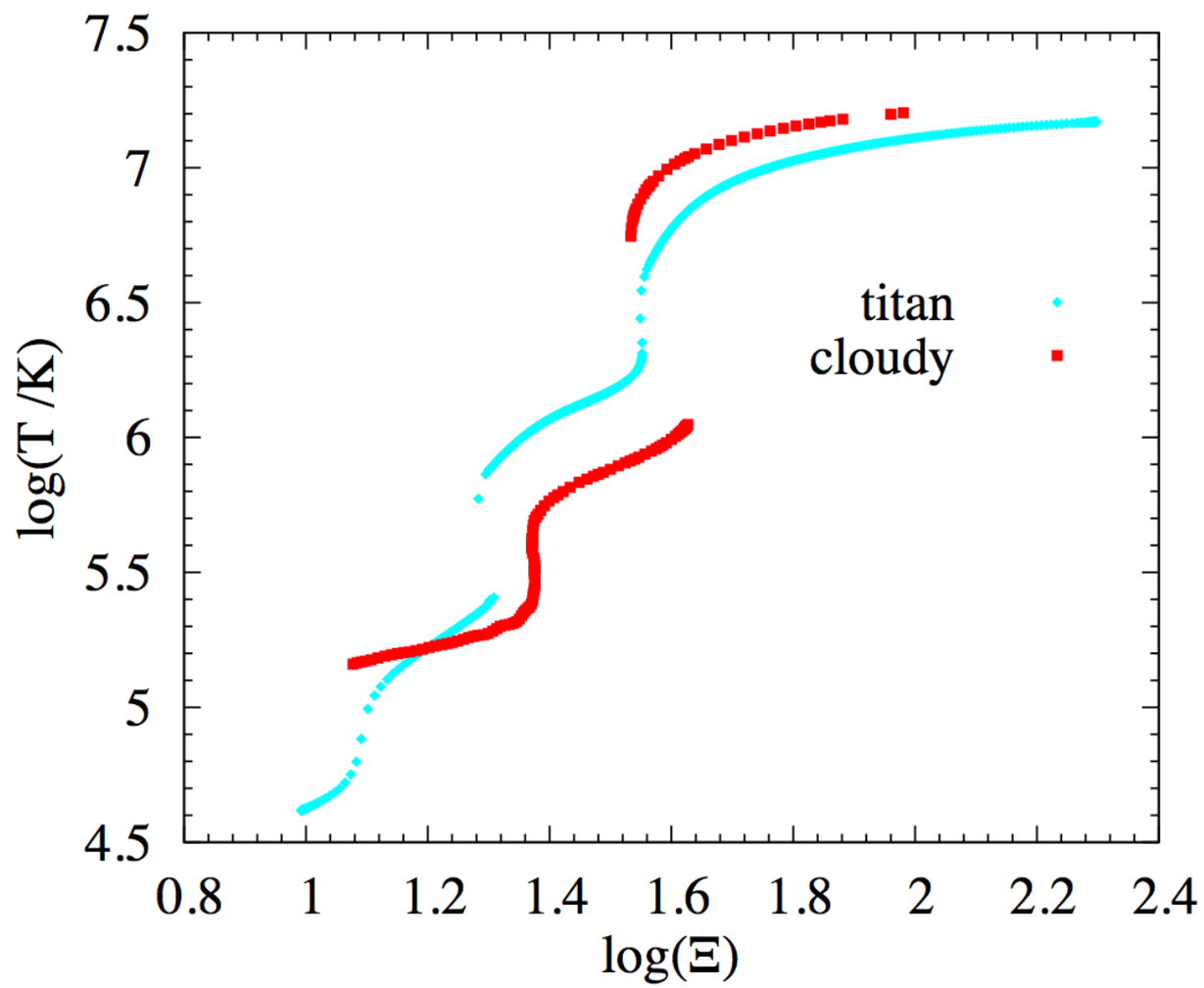
- log (xi /erg s^{-1} $cm^{-1)}$ = 4.89
- $n_0 = 10^7\ cm^{-3}$
- $N_H = 1.5 \times 10^{23}\ cm^{-2}$

- The abundances are set to solar and the geometry of the cloud is plane parallel in both codes.

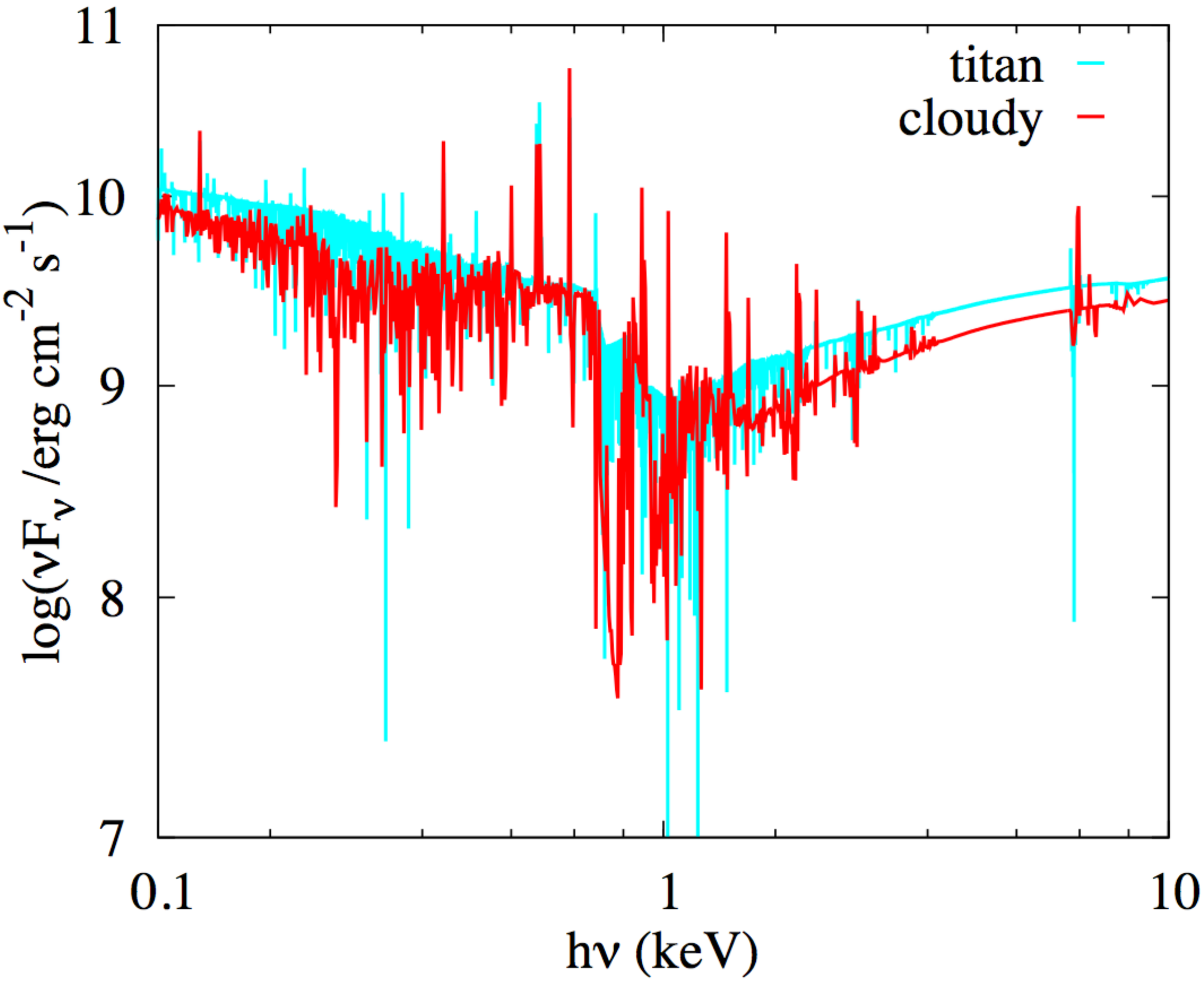
- The incident spectrum is assumed to incident normally on the cloud

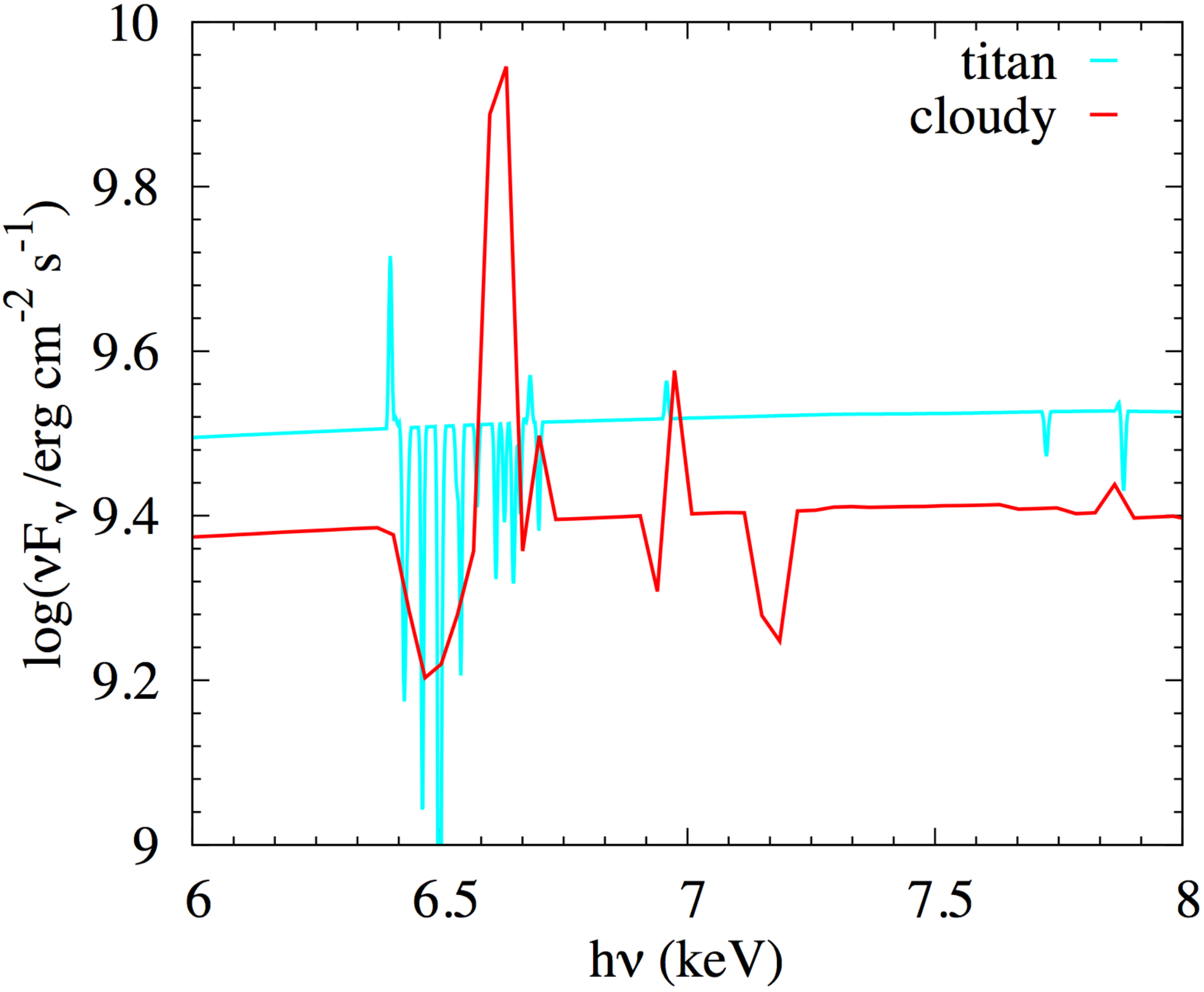
Structure of Constant Pressure Cloud



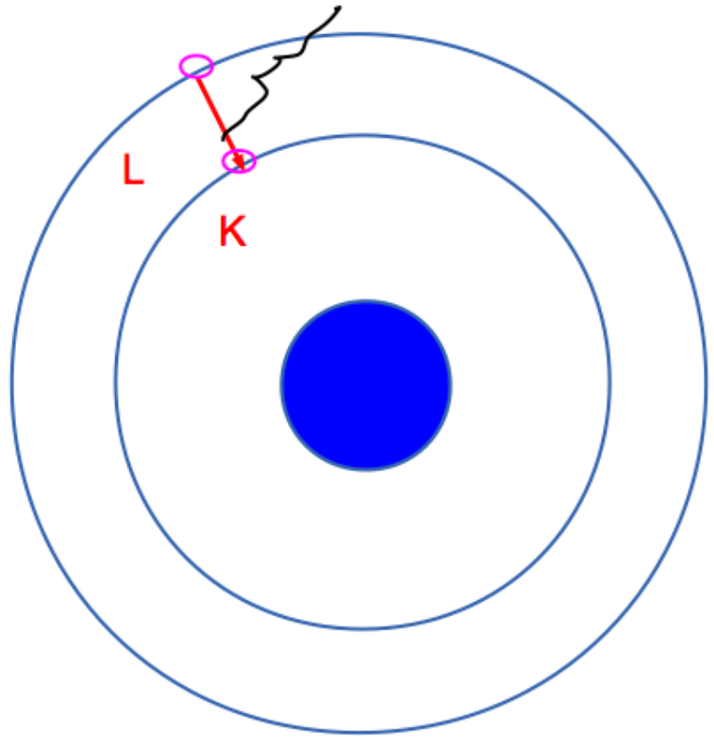


Transmitted spectrum




titan
cloudy
10
9.8
9.6
9.4
9.2
9
log(νF_ν /erg cm^-2 s^-1)
6
6.5
7
7.5
8
hν (keV)

Fe line in AGNs



- Neutral Iron line:

K shell electron absorbs photon > 7.1 keV and an electron from L shell jumps to K shell emitting 6.4 keV photon. There are two possibilities: either the photon leaves the atom (33%) or is reabsorbed by the outer shell electron and ejected later (Auger effect, 66%)

- Highly Ionised Iron line:

fewer photons are absorbed by outer shell electrons, lowering the Auger effect. The fluorescent yield is high: radiation is absorbed at one wavelength and immediately re-radiated at different wavelength.

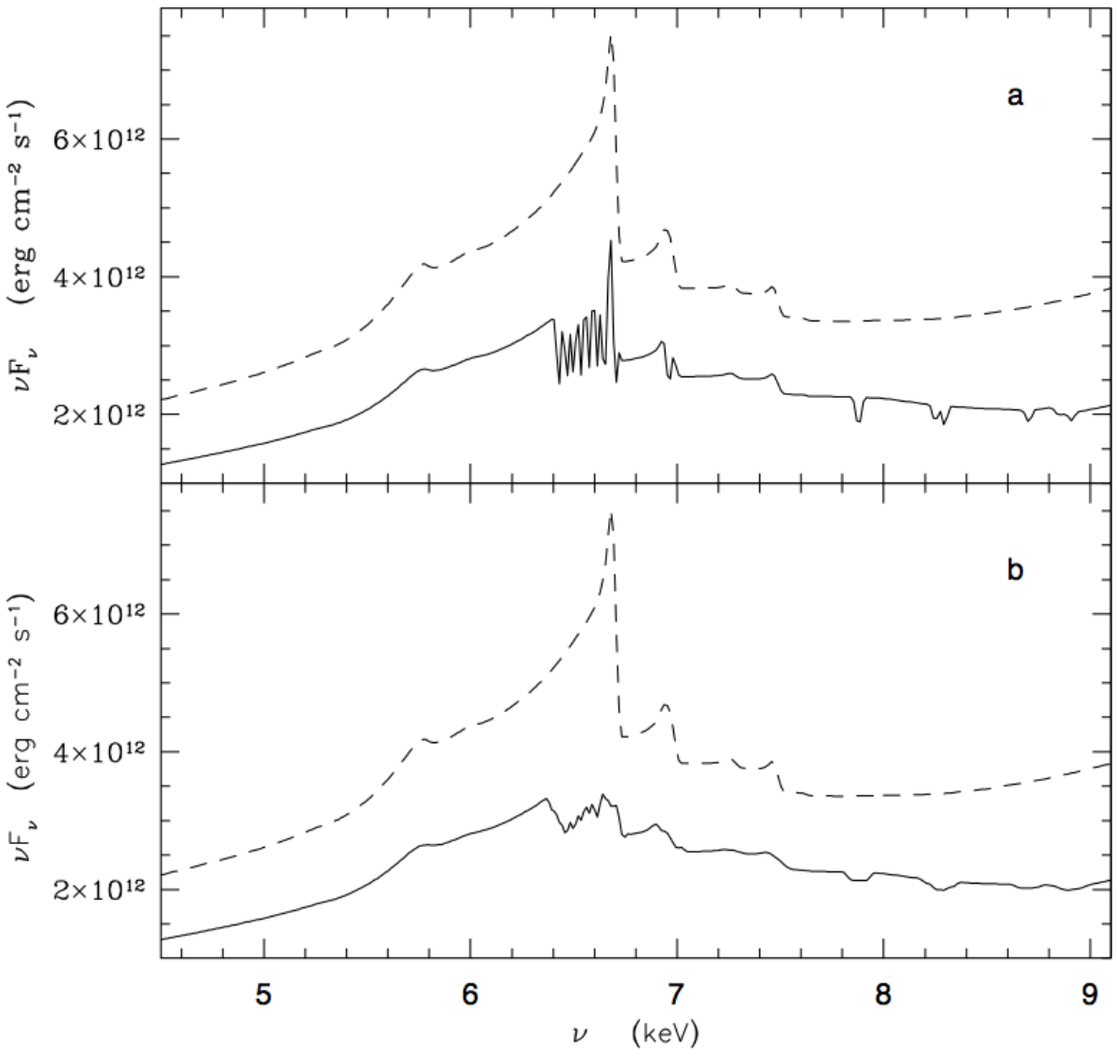
Why Fe line is important?

- Innermost region of AGNs
- Black hole mass, spin, accretion disk structure, ionisation states

Very important in probing AGNs !!

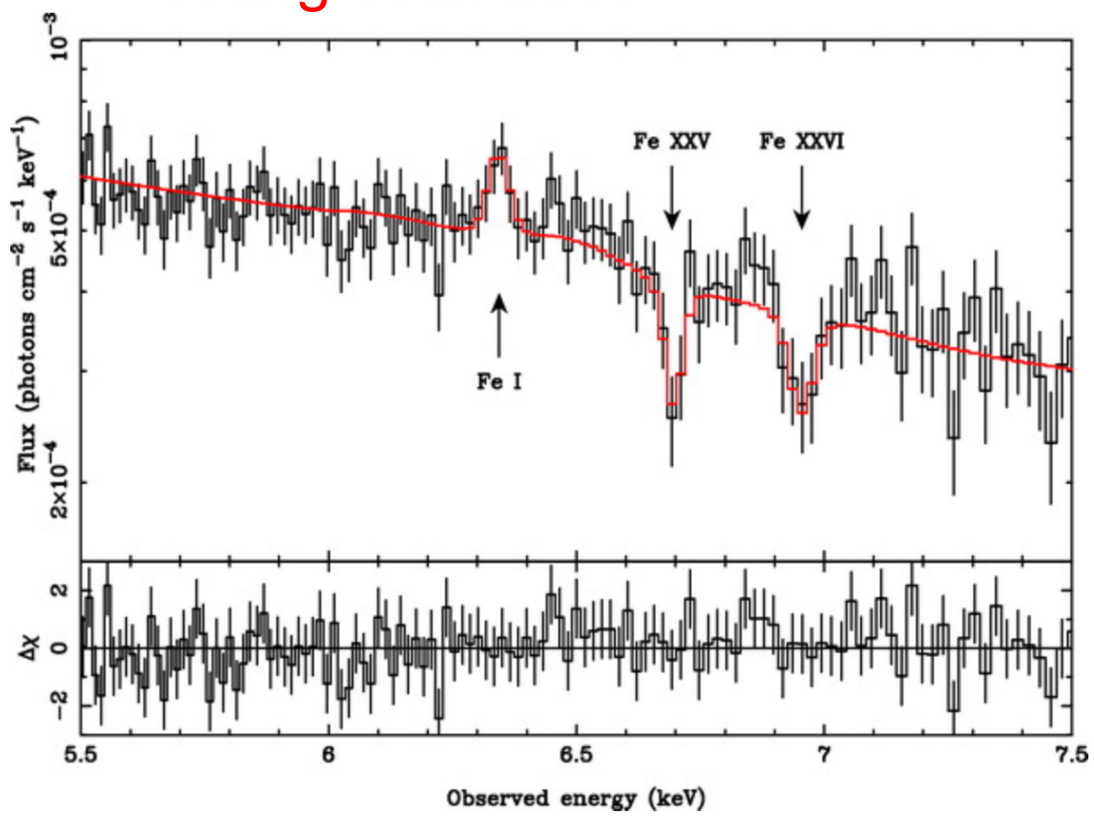
Does WA affect broad Fe line?

Significant opacity from X -r ray absorbers could effect broad line modelling.



Rozanska et al. 2006

Young et al. 2005



MCG-6-30-15, Chandra/HETG (500ks)

In the study of broad Fe line, the effect of absorption should be accounted

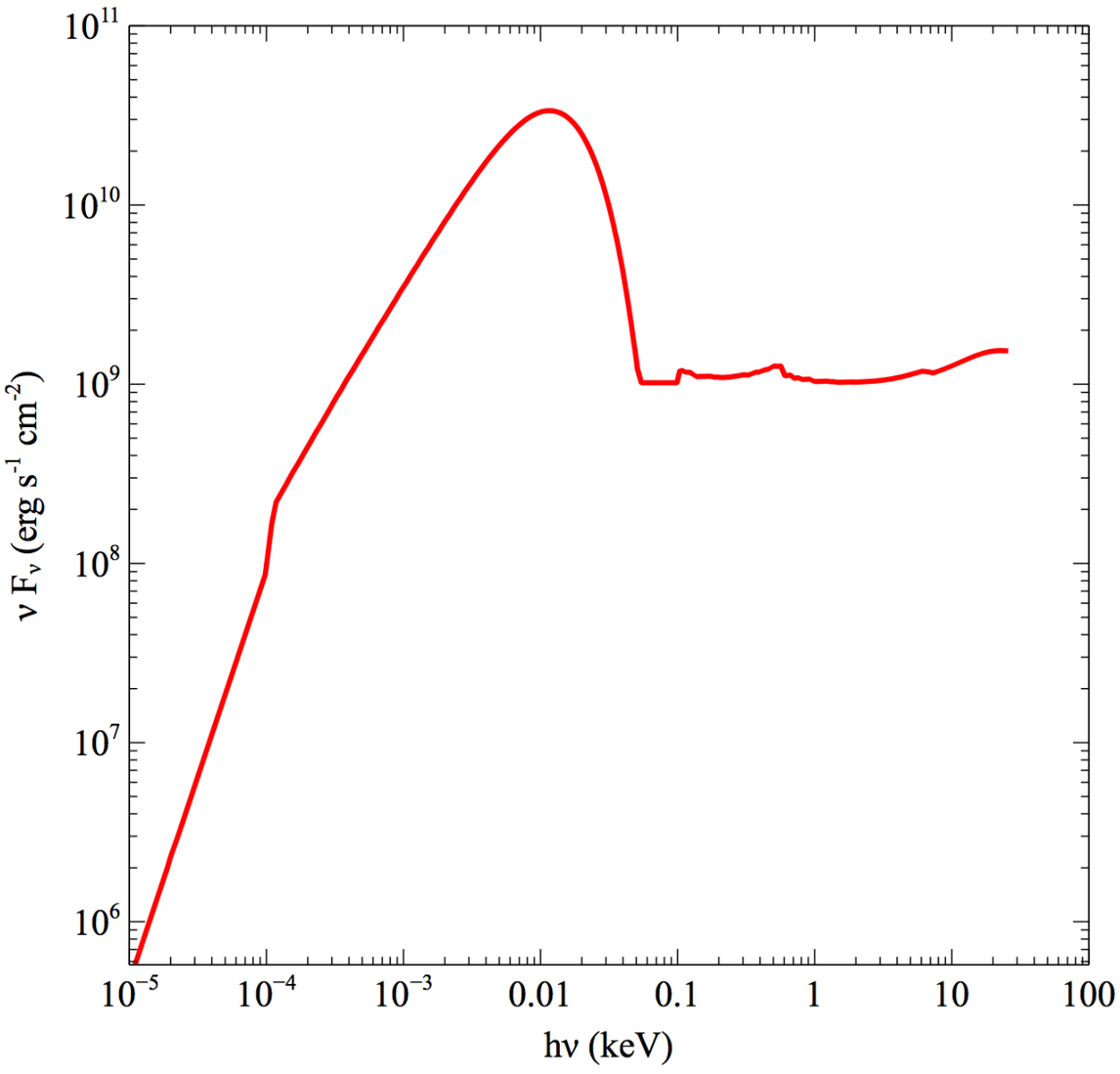
If it does, how much?

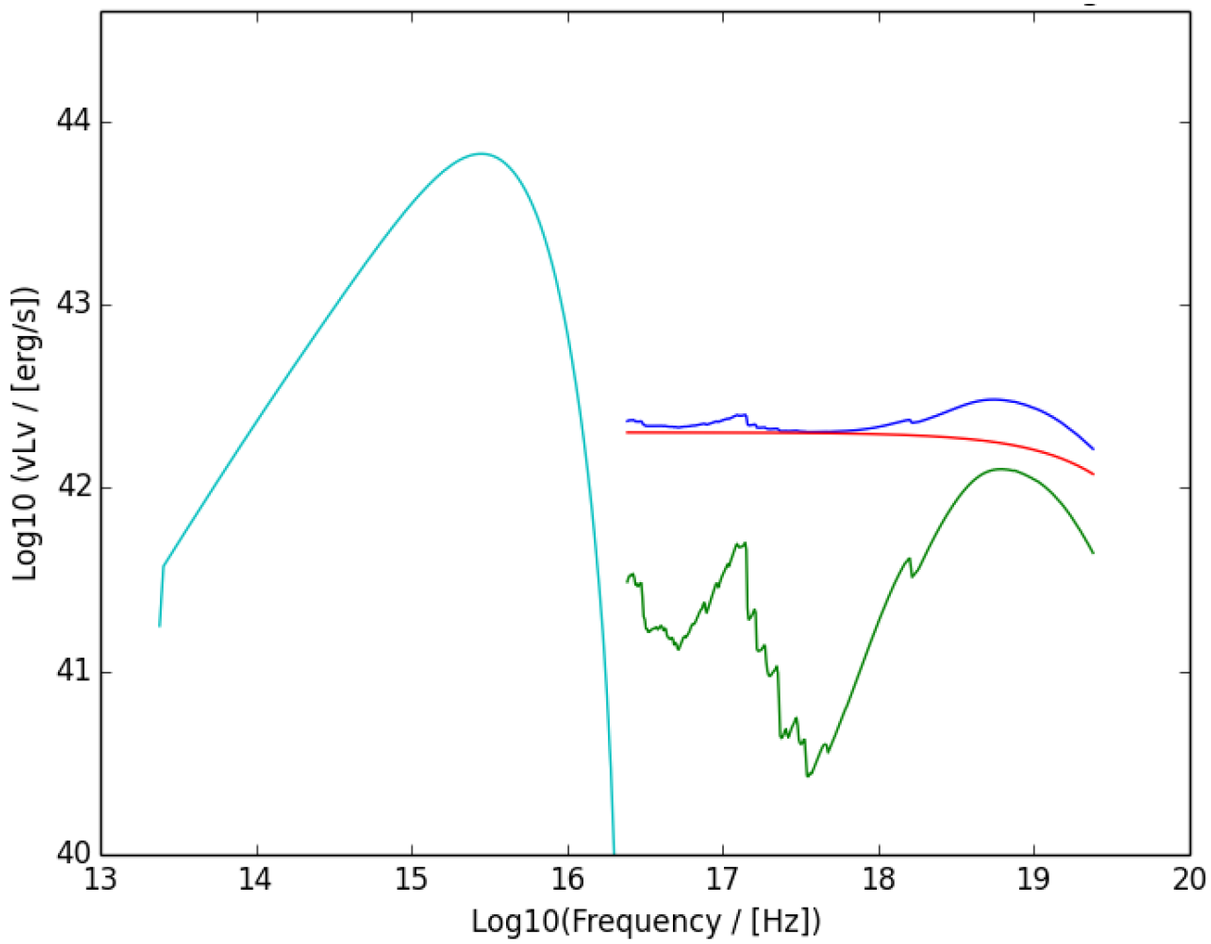
Incident SED

$M = 10^8\ M_{Sun}$ Cos i = 0.87

$\alpha_{ox} = 1.5$ a = 0.99

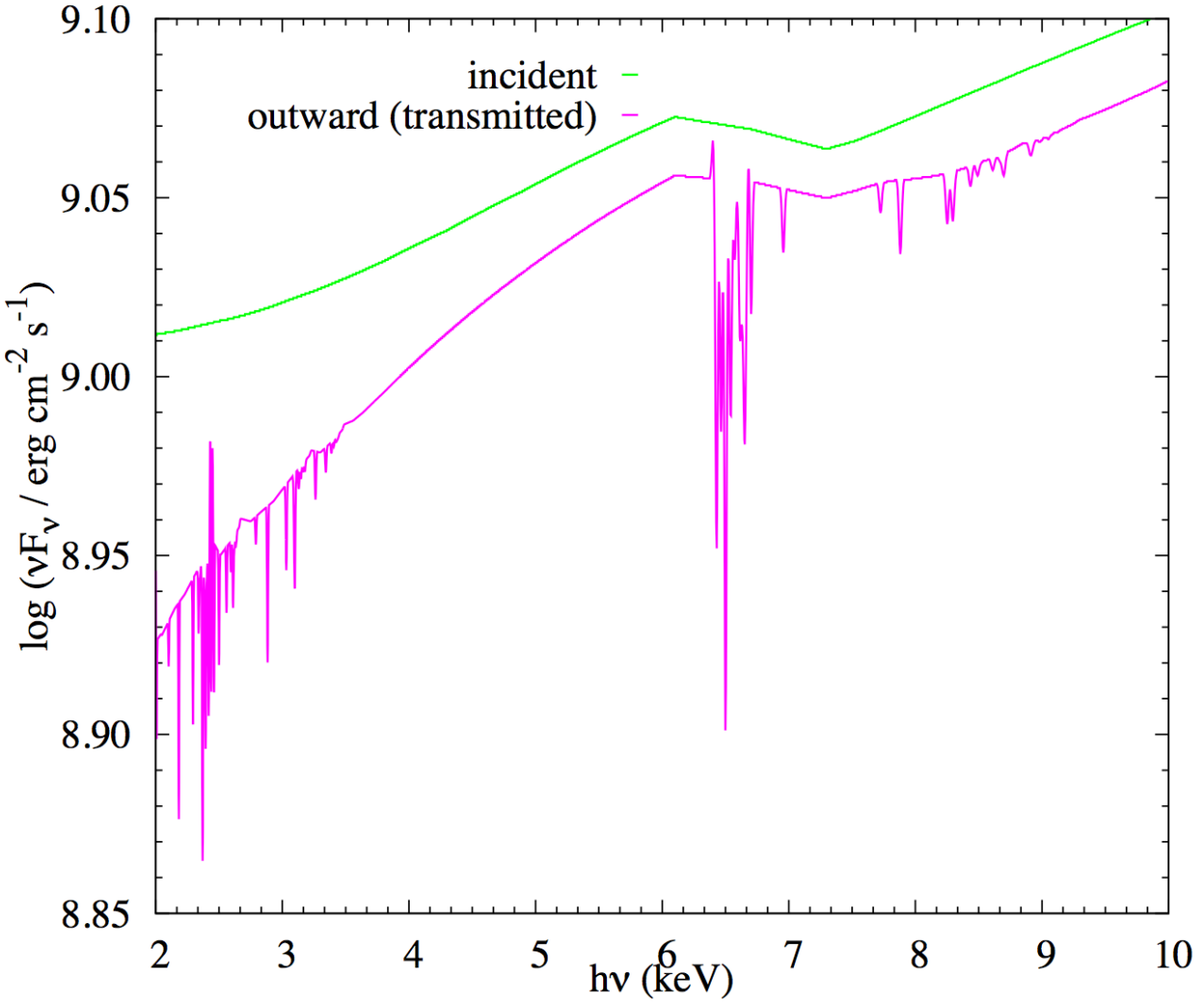
$L_{disc}/L_{Edd} = 0.01$

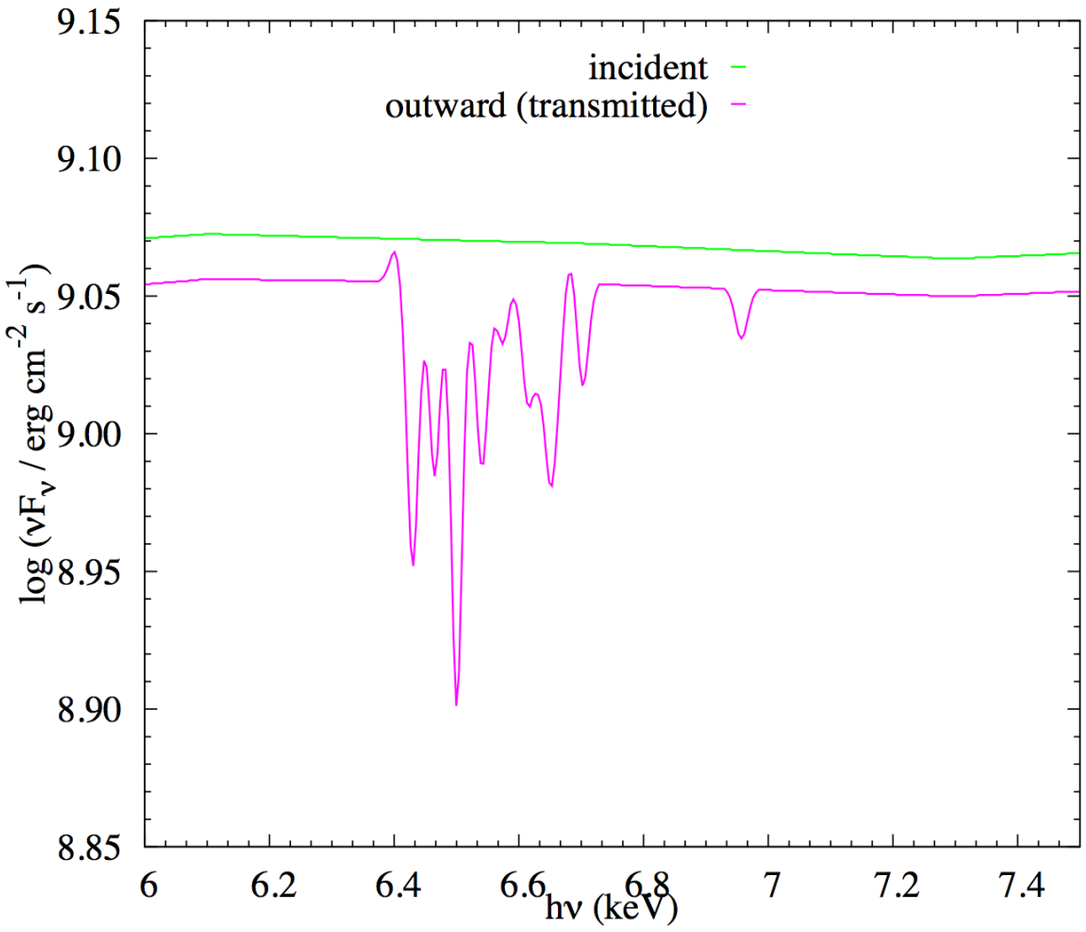




Absorbing cloud parameters:

- xi =10^5 erg s^{-1} cm^{-1}
- n_0 =10^7 cm^{-3}
- N_H = 5 ×10^{22} cm^{-2}





EW of Fe line: 129 eV

EW of absorption components : 44 eV

Its 34% !!

dziękuję

Thank You

धन्यवाद