X-ray absorber in the outflow of active galactic nucleus Mrk 509

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Active galactic nuclei (AGN)

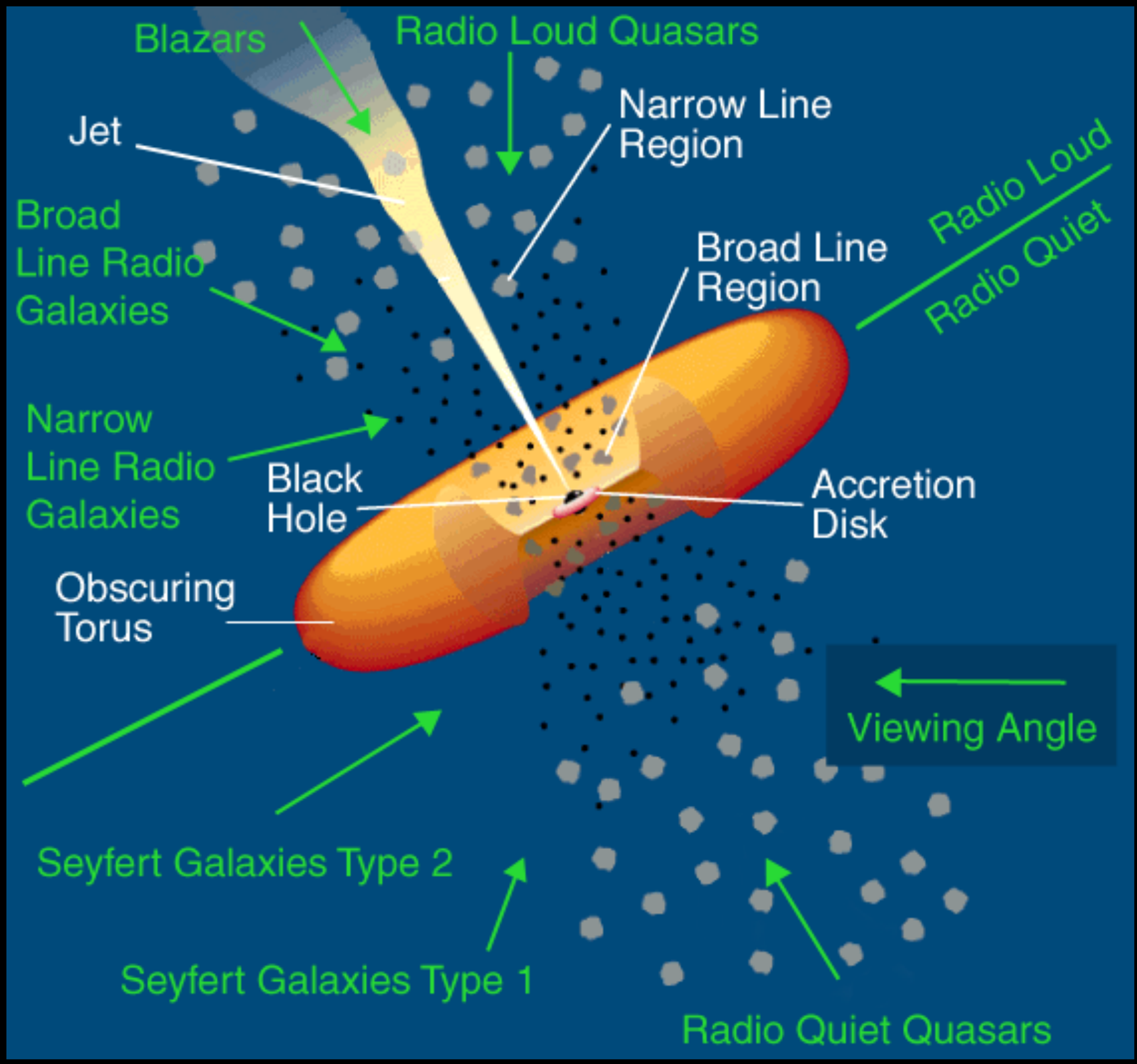
✦ Compact region at the centre of a galaxy

Credit:NASA Chandra X-ray center

✦ Supermassive (several millions to several billions times Sun's mass) black hole (SMBH) at the centre

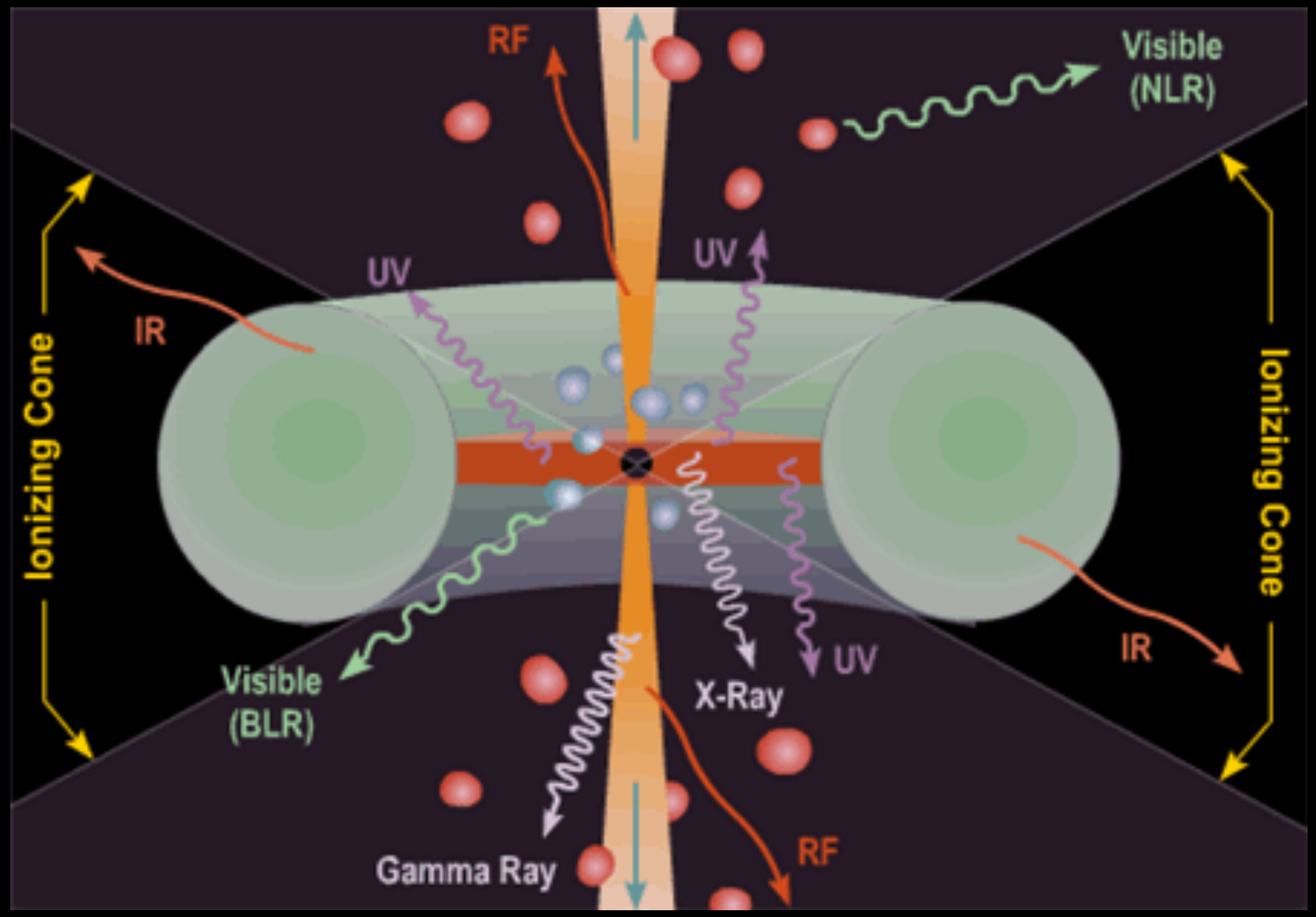
✦ Radiation powered by accretion of mass on to the SMBH

Unified model of AGN

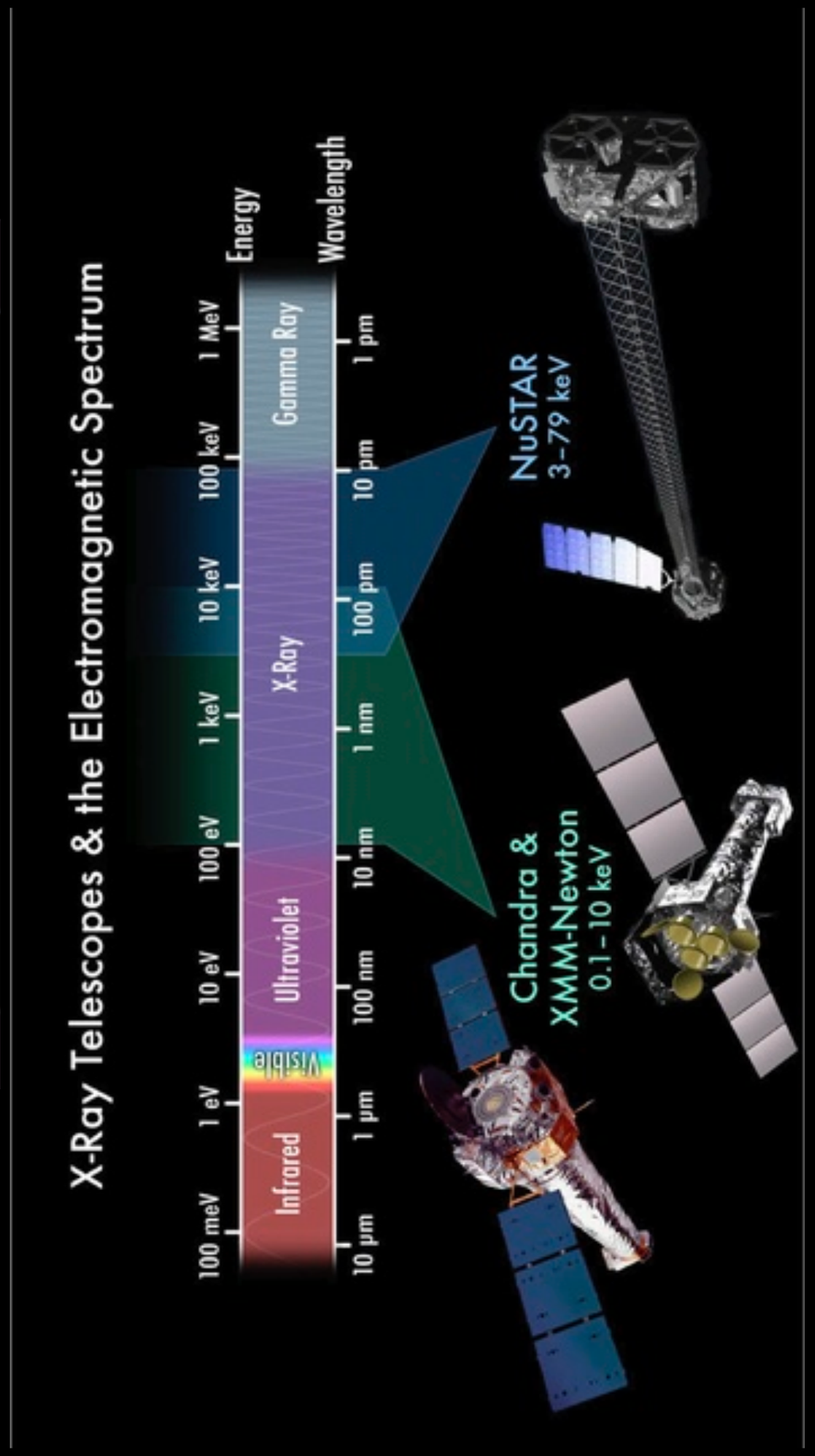


Credit:Pierre Auger Observatory

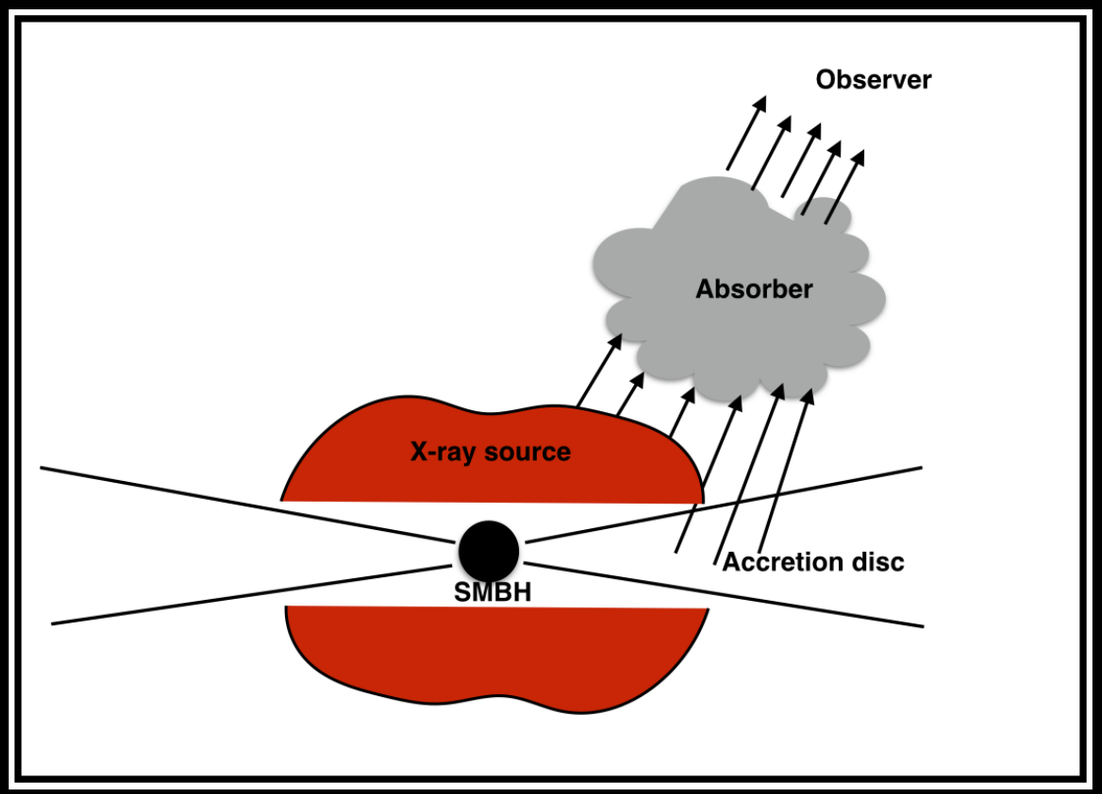
Radiation from AGN



Credit:Brooks/Cole Thomson Learning

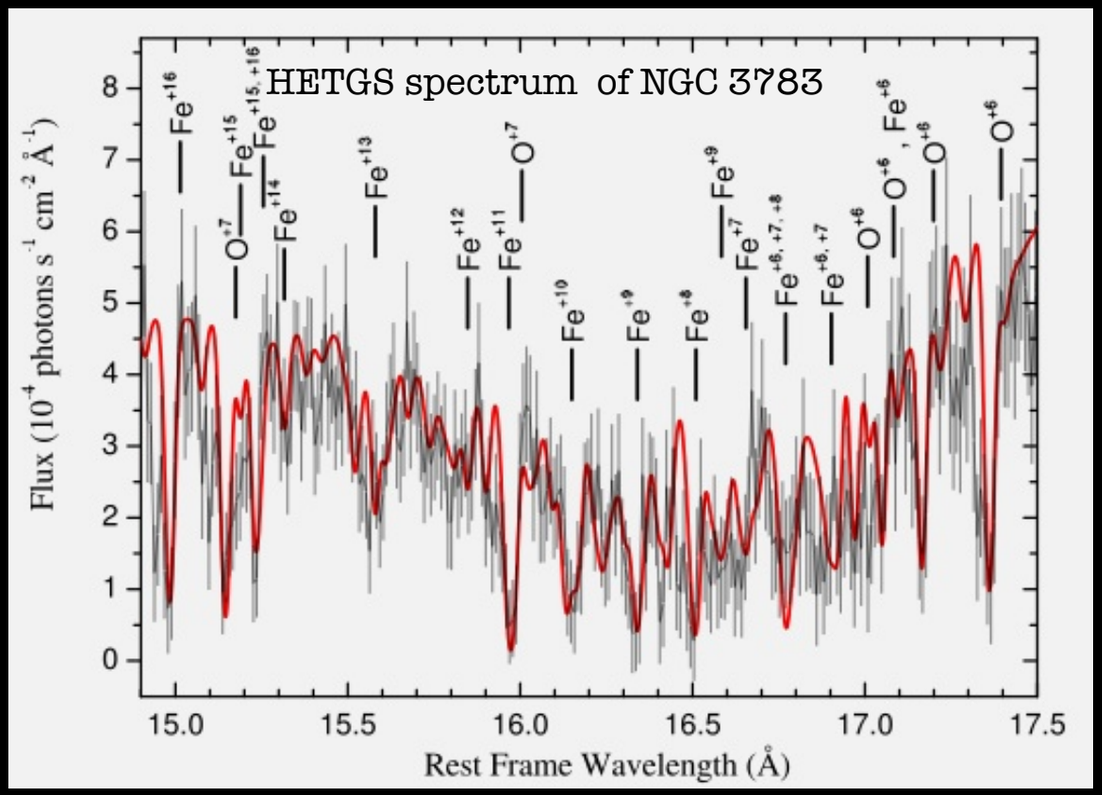


Outflowing warm absorber (WA) in AGN



- Signature of absorber: absorption lines in the spectrum

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



Holczer et al. 2005

- Origin largely debated: several mechanisms proposed

- Large uncertainties in the location

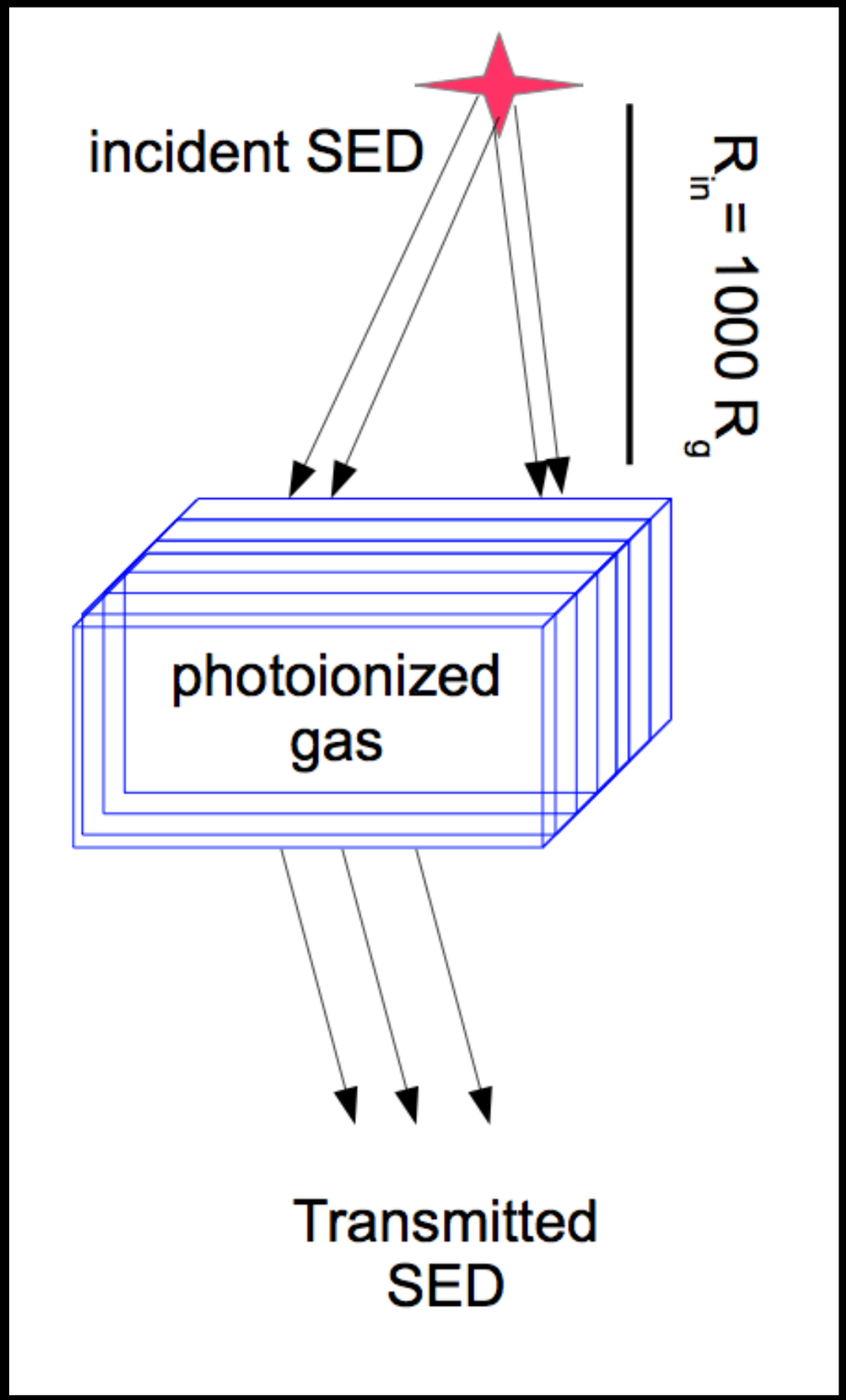
Why model photoionised gas ?

✦ Constrain the physical properties (Z, n_H) of the absorber

✦ Constrain the unobservable emission in 1-15 Ryd in accretion disk and stars

✦ Useful in constraining the properties of central SMBH

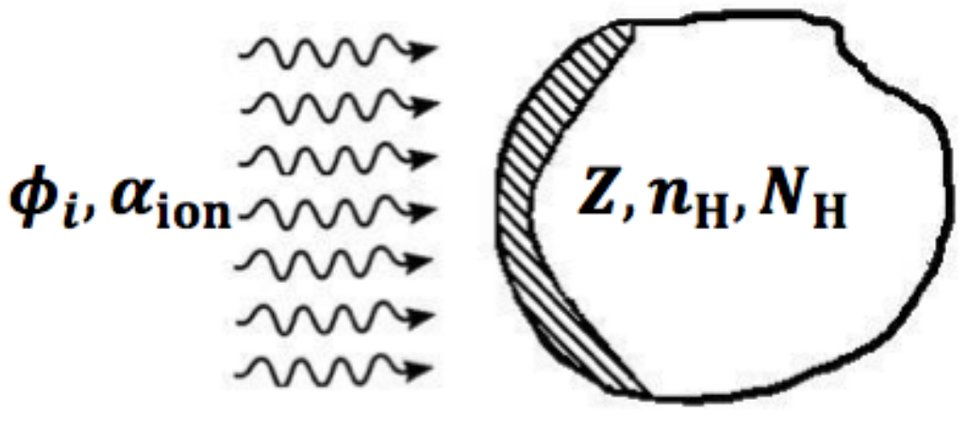
✦ Constrain the stellar feedback models



How to do it?

Parameters
1. Spectral shape (α_{ion})
2. Ionizing photon flux ϕ_i (or $U \equiv \frac{\phi_i}{n_{\mathrm{H}} c}$)
3. Gas density n_{H}
4. Metallicity Z
5. Column density N_{H}

Equations
1. Local Ionization Equilibrium
2. Local Temperature Equilibrium
3. Radiation Transfer

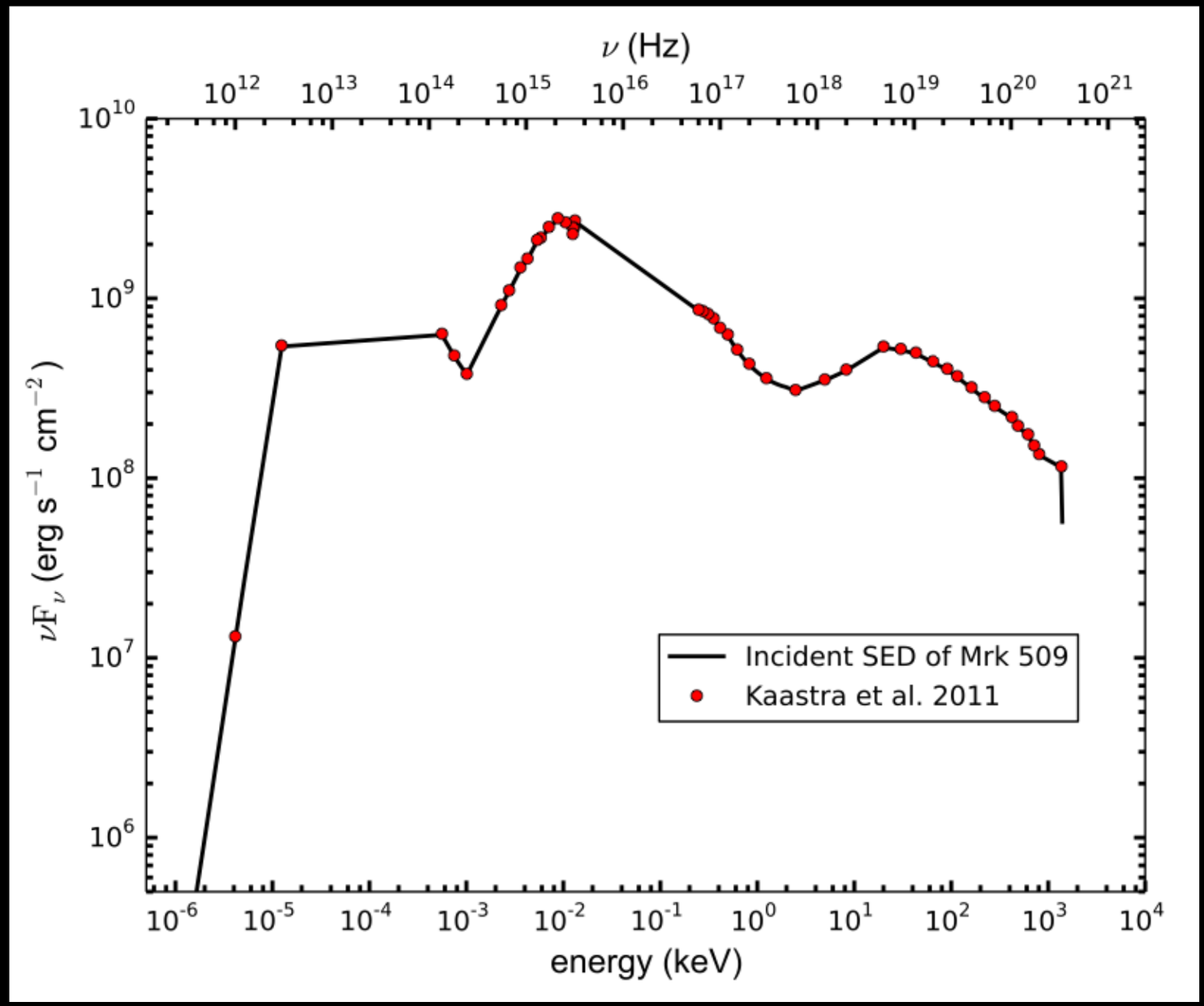


Result:
emission line / absorption line spectrum

Codes: CLOUDY, MAPPINGS, TITAN, XSTAR, ION, …

Spectral Energy Distribution of Mrk 509

- ✦ Ideal source for the study of WA
- ✦ Well constrained SED: observations combined from ground based and space based telescopes



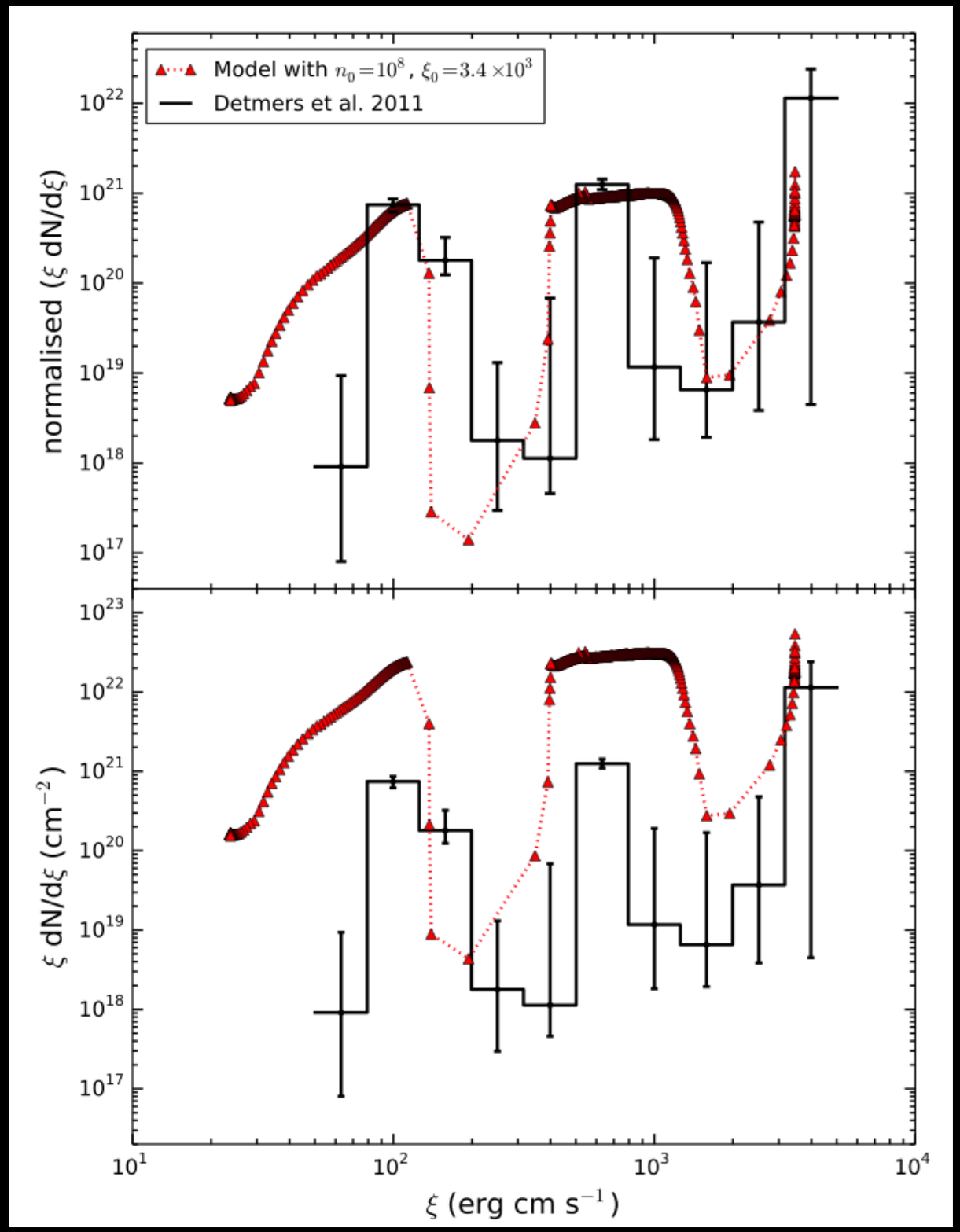
Adhikari et al. 2015, ApJ , 815, 83

Absorption measure distribution (AMD)

- ✦ First strong indication that the absorber in AGN exists under constant pressure

- ✦ Observed AMD shape is reproduced with single slab of plane parallel absorber with density ~ 10^8 cm^{-3} in pressure equilibrium

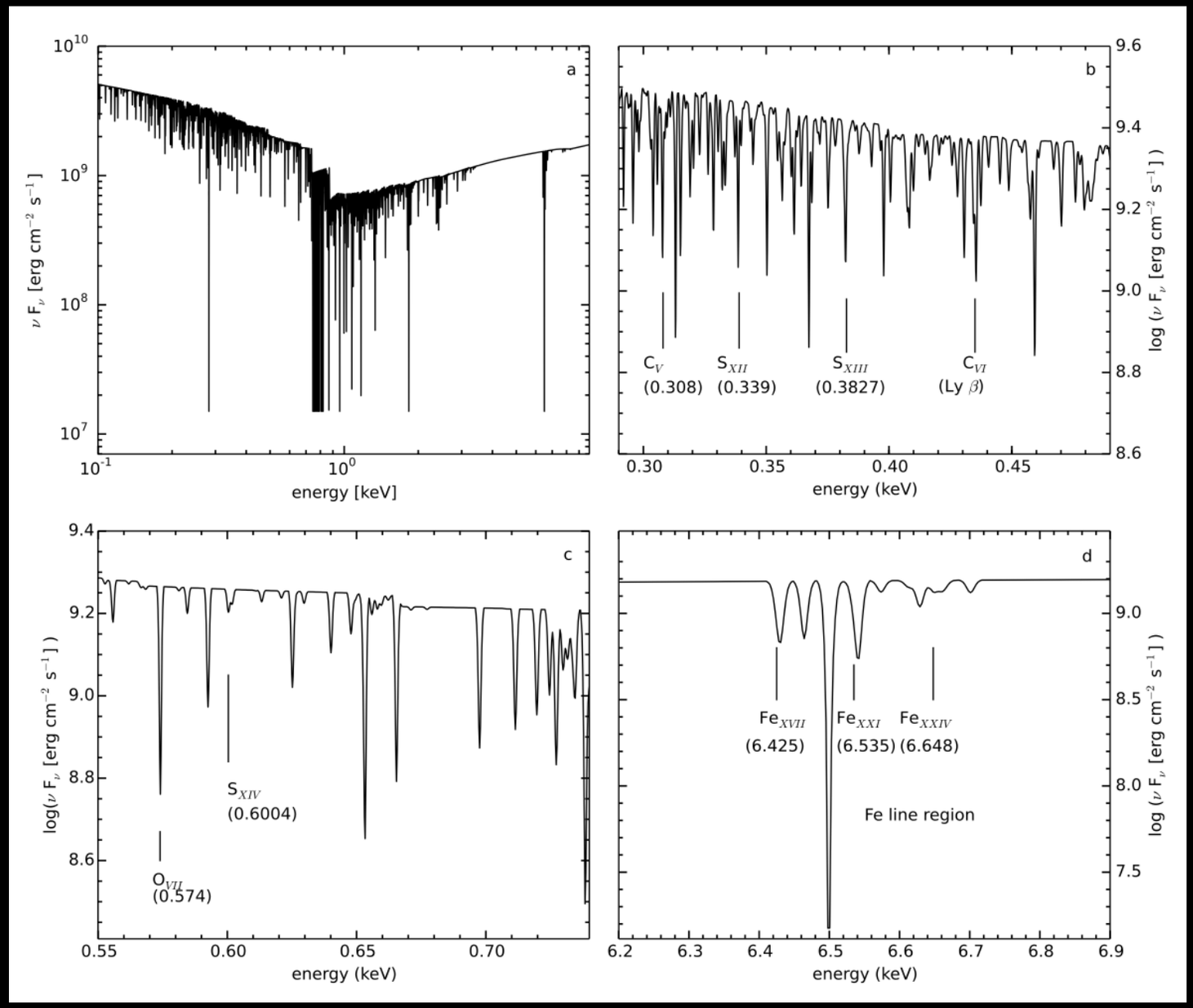
- ✦ Regions of thermal instabilities are interpreted as the discontinuities seen in the AMD



Adhikari et al. 2015, ApJ, 815, 83

Transmitted spectrum

- ✦ Absorber under constant pressure shows absorption lines corresponding to ions of several ionisation degrees
- ✦ Significant absorption around 6.4 keV



Adhikari et al. 2016, PTA proceedings

Summary

- ✦ We showed that the warm absorber in Mrk 509 is a single plane parallel slab of ionised gas in constant total pressure

- ✦ The shape of the AMD computed from our simulation agrees fully with that derived from the observation

- ✦ The spectrum transmitted through an absorber shows absorption lines corresponding to ions with large range of ionisation parameters

THANK YOU

European Space Agency headquarter , Madrid Spain