The X-ray/UV absorber in NGC 4593

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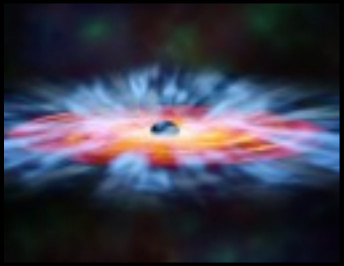
Black Hole Universe 2012, Bamberg, Germany

SRON
Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research

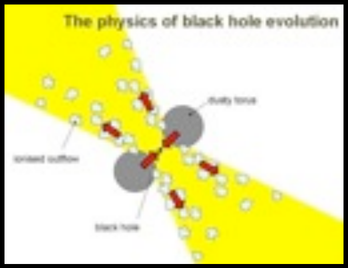
Cosmic Feedback mechanisms



1. Radiation
   - Huge bolometric output
   - Geometry of the nucleus matters
   - Heating, ionizing, accelerating…

2. Relativistic jets
   - Carry mass, energy, momentum
   - Source of high-energy cosmic rays?

3. Non-relativistic winds (outflows)
   - Probably ubiquitous
   - Important for coevolution of SMBH and host galaxy
   - Kinetic energy and mass outflow rates uncertain



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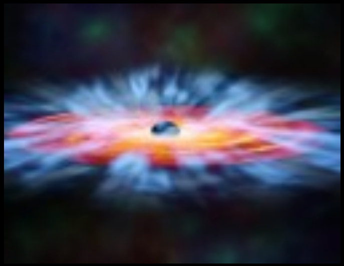

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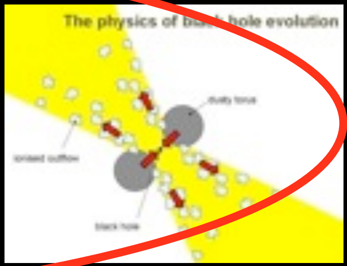
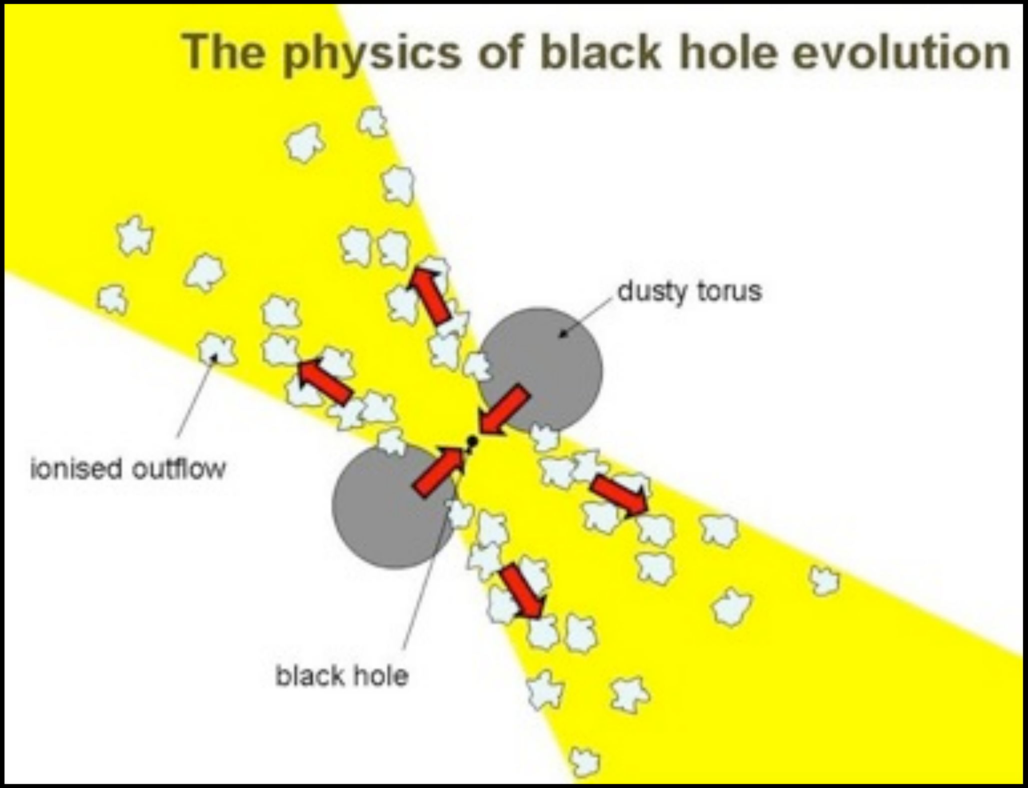


Outflows: the Warm Absorber



Ionized gas: wide range of ionization phases

$$\xi = L / nR^2$$

Absorption troughs in the soft X-ray spectrum

Blue-shifted features: outflows

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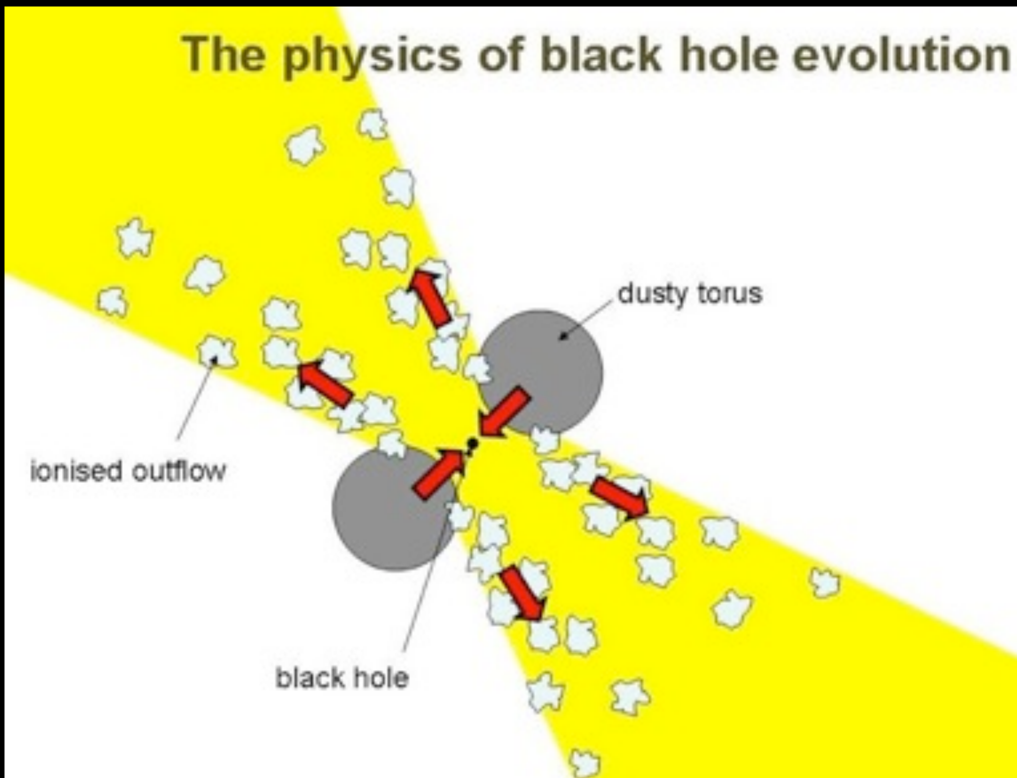

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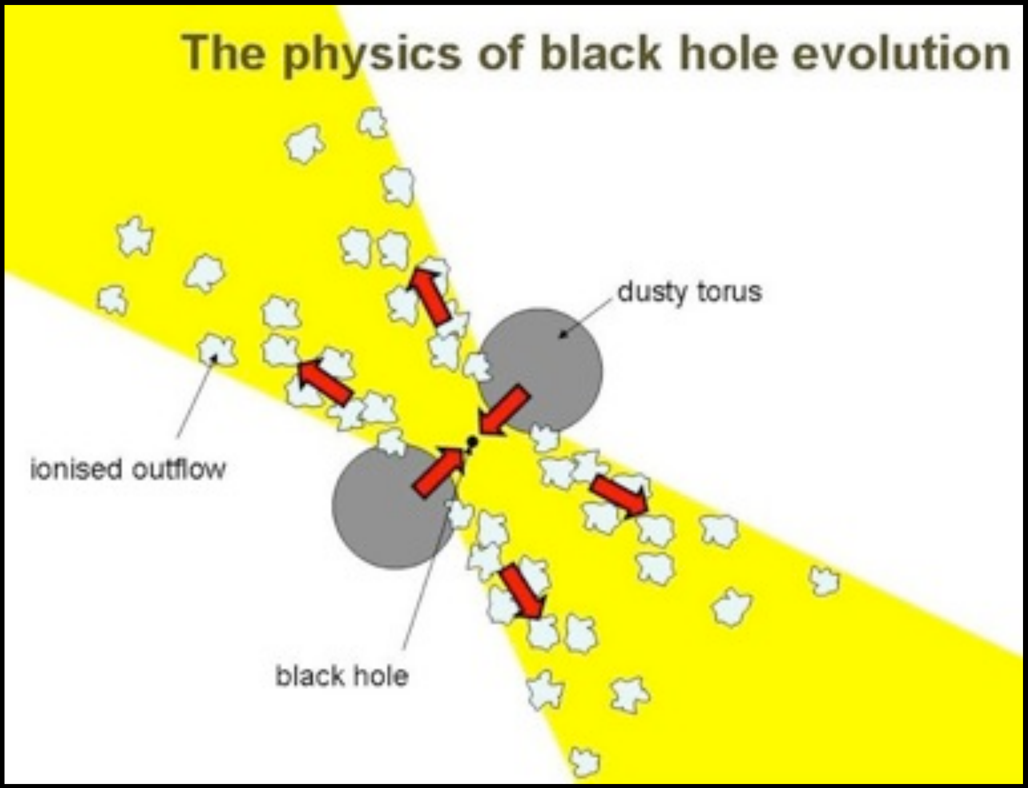

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Degenerate!

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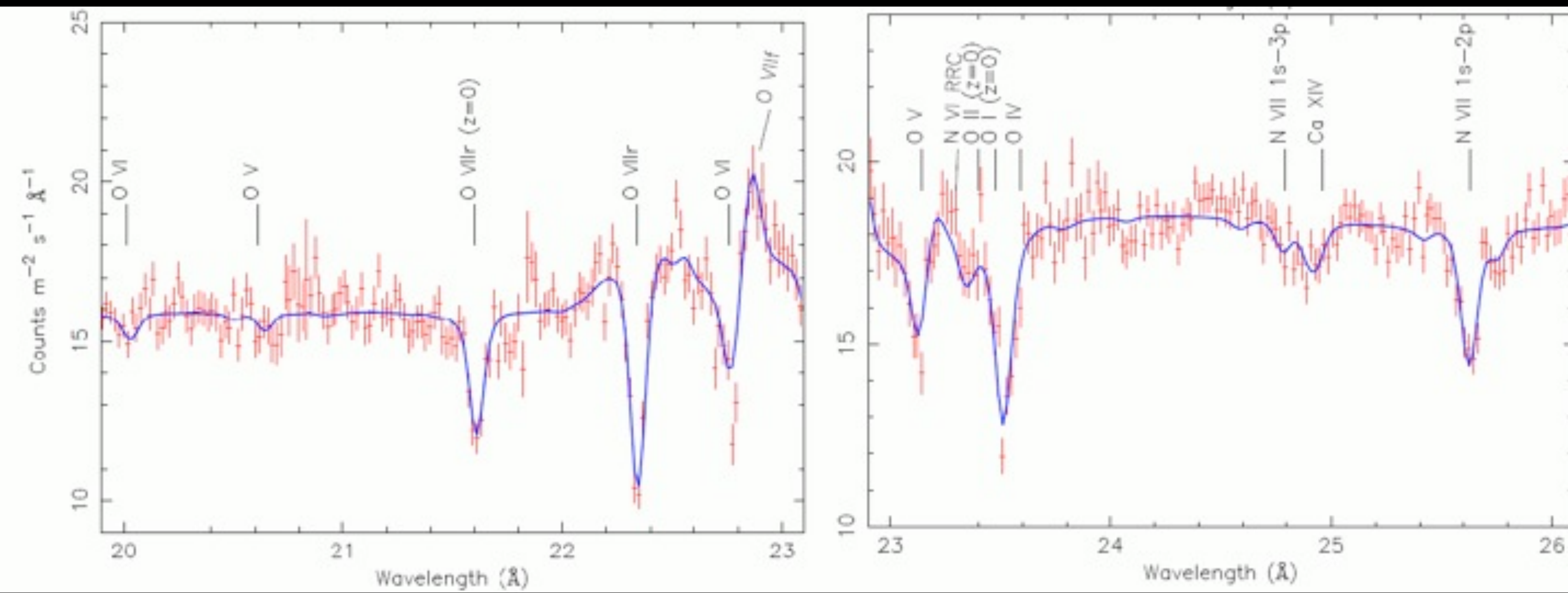

600 ks XMM-Newton RGS Mrk 509

Detmers et al. (2011)

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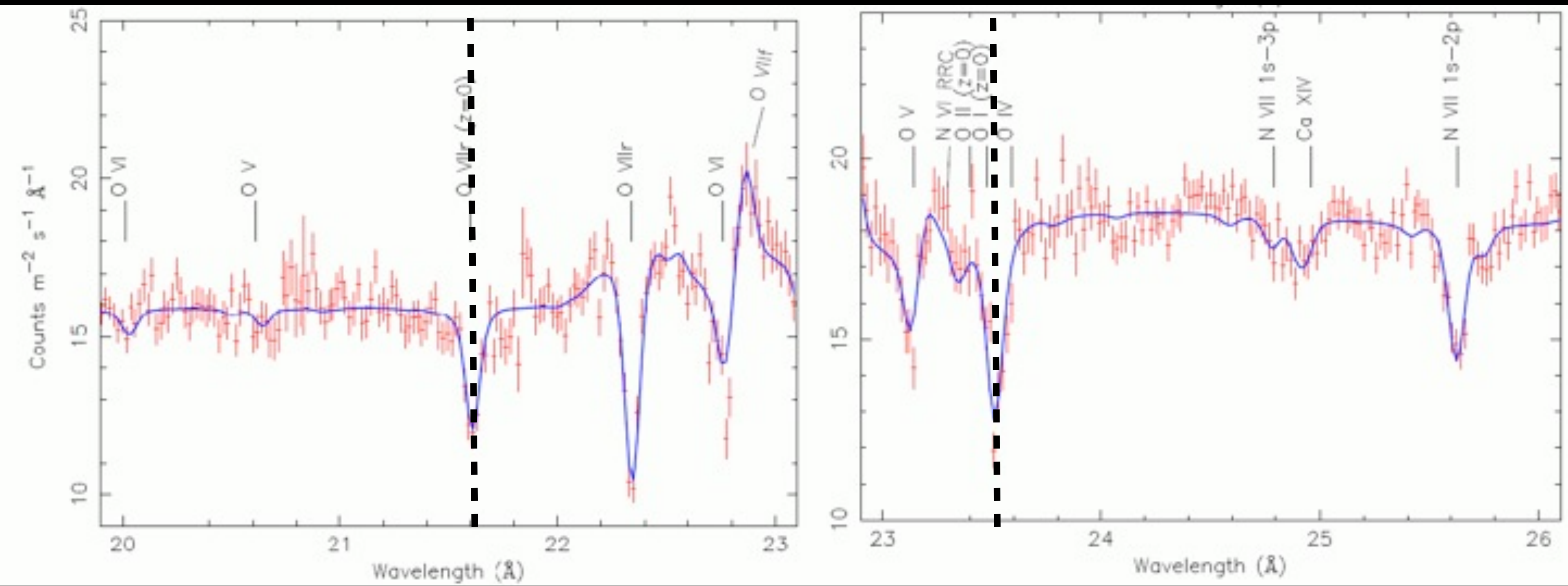

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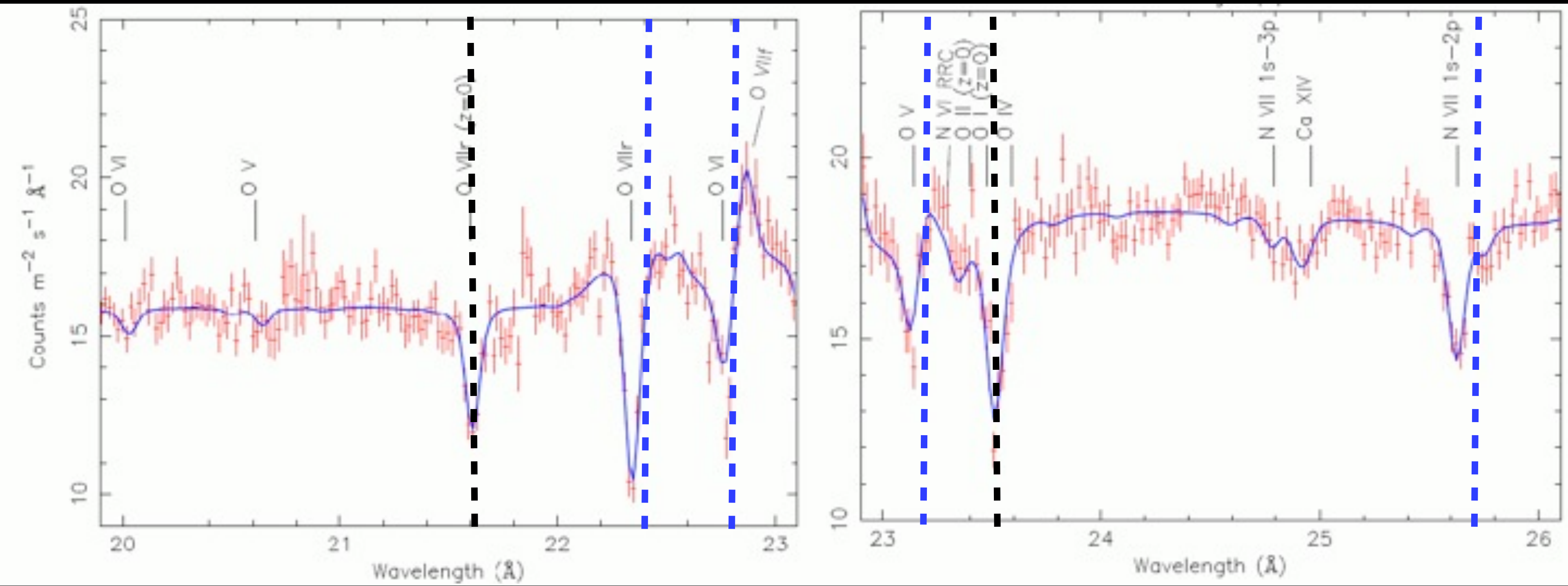

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NGC 4593

1. Nearby Seyfert 1 galaxy
   - $z = 0.009$
   - L(1-1000 Ryd) = 1.4×10^{43} erg/s

2. Confirmed presence of intrinsic WA
   - Steenbrugge+03; McKernan+03

3. Confirmed presence of UV absorber
   - Ebrero+12, in prep.

4. Slow variability
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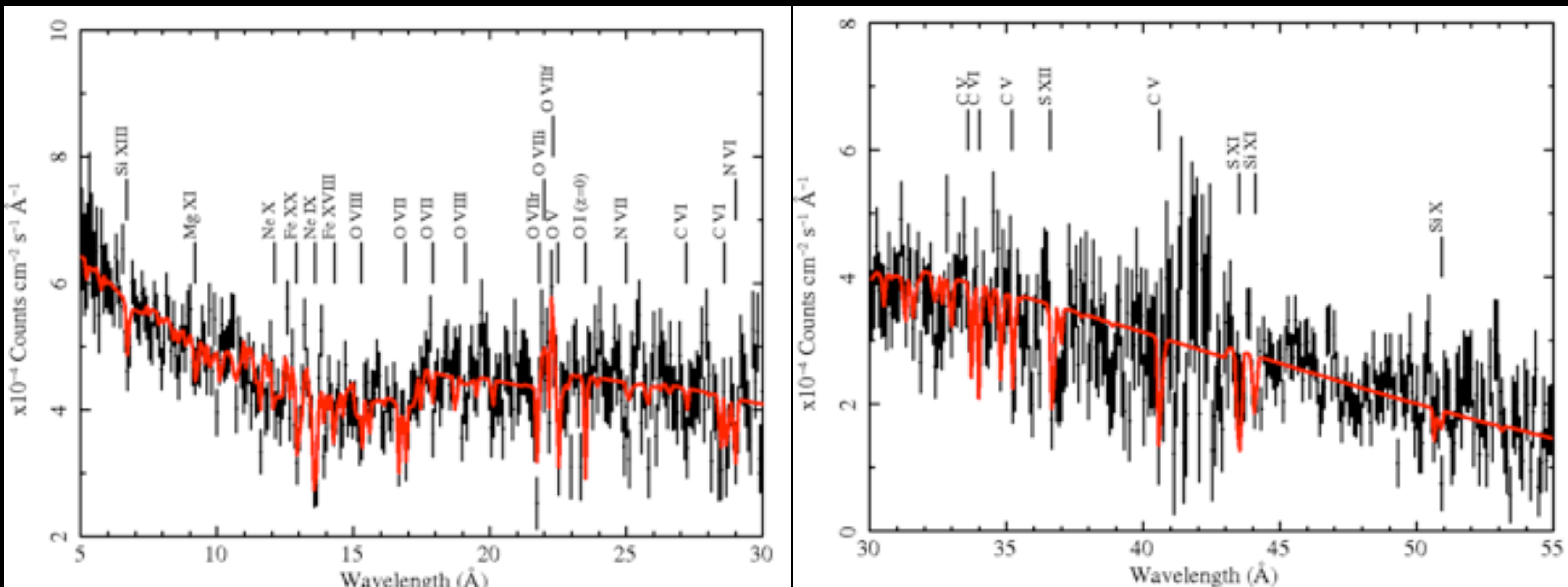
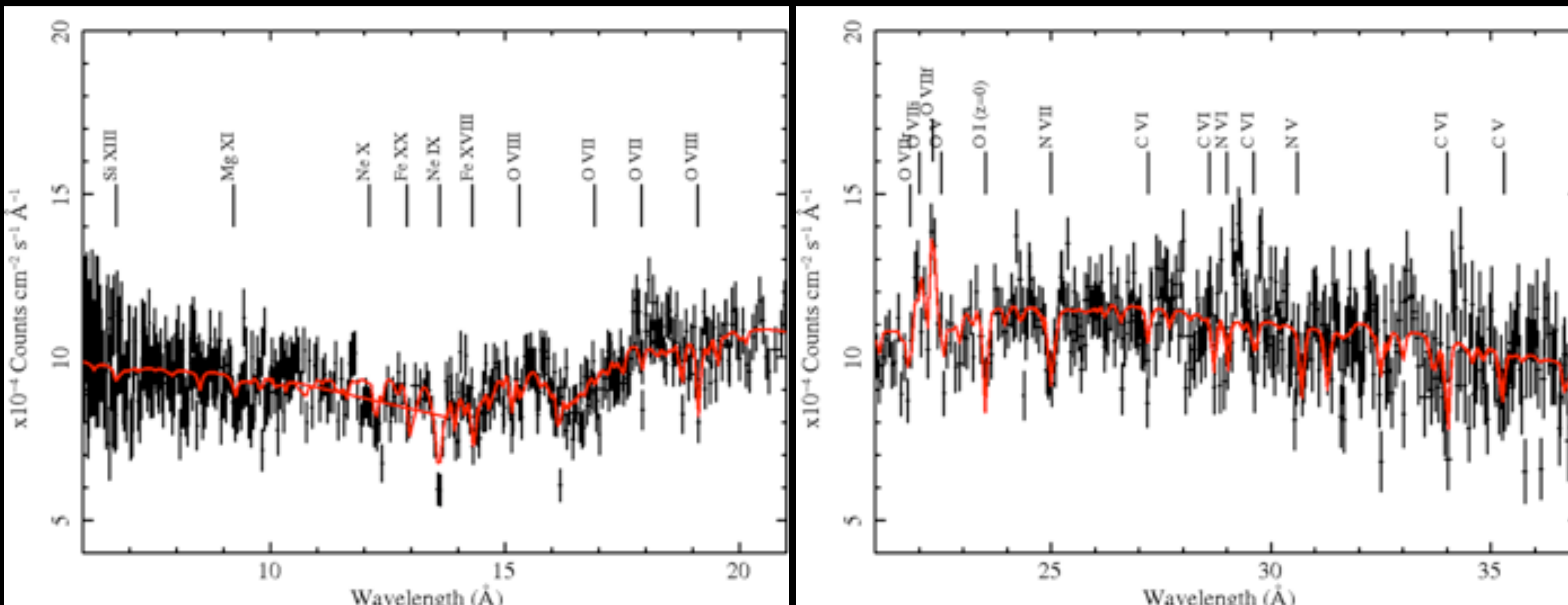
X-ray absorption in NGC 4593

Chandra LETGS, 160 ks (Ebrero+12, in preparation)



X-ray absorption in NGC 4593

XMM-Newton RGS, 86 ks (Ebrero+12, in preparation)



Is the X-ray absorption variable?

X-ray warm absorber

	RGS (2002)			LETGS (2011)		
Comp	log ξ (erg cm s^{-1})	log N_H (cm^{-2})	v_{out} (km s^{-1})	log ξ (erg cm s^{-1})	log N_H (cm^{-2})	v_{out} (km s^{-1})
A	1.0 ± 0.1	20.8 ± 0.1	-320 ± 100	0.4 ± 0.4	20.0 ± 0.5	-290 ± 200
B	2.6 ± 0.1	21.6 ± 0.1	-240 ± 60	2.4 ± 0.1	21.6 ± 0.1	-670 ± 120

Ionizing flux higher by ~50% in 2002, hints of variability in the WA parameters

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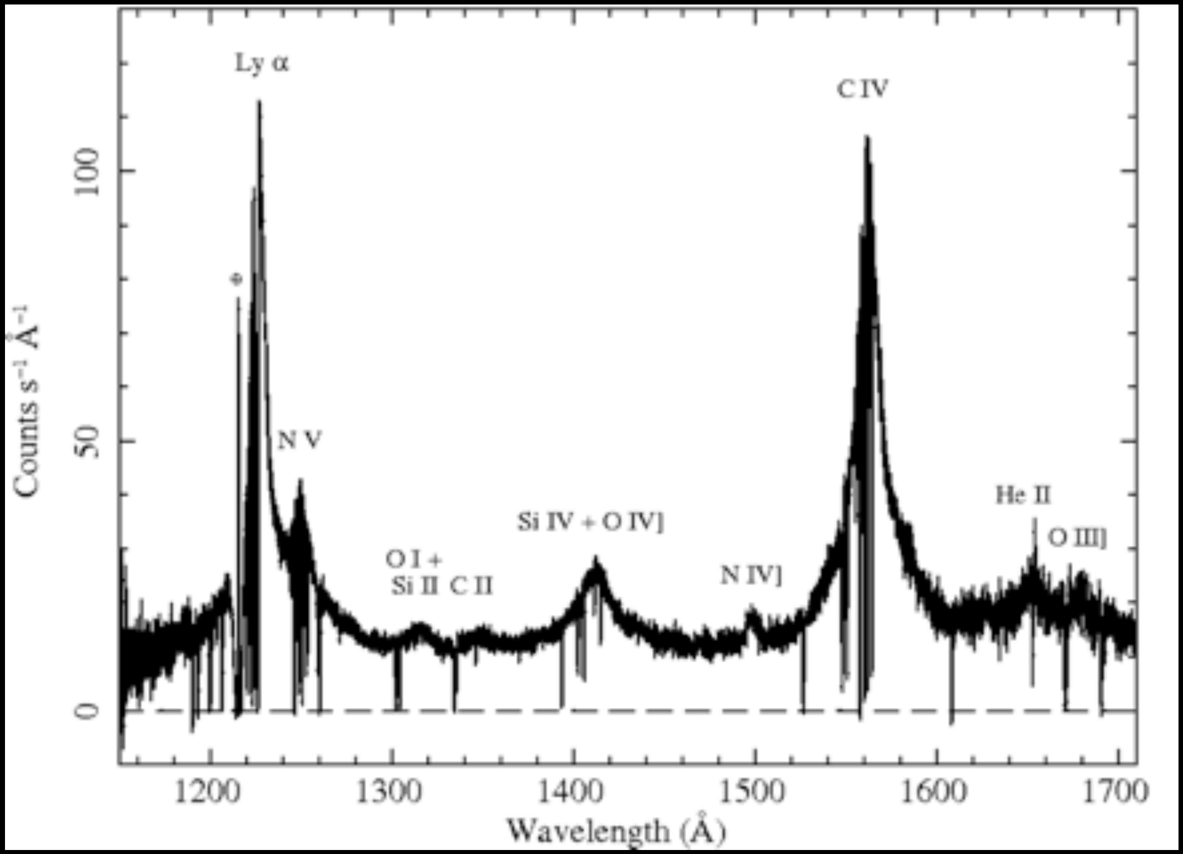
Constrain the location the component(s) via time-dependent recombination processes (Ebrero+12, in preparation).

UV absorption in NGC 4593



HST-STIS observation (2002)

4 orbits, E140M grating

Quasi-simultaneous with XMM-Newton

Unpublished data (!?)

Emission lines: Ly α, C IV, N V, Si IV

Foreground absorption: Several ISM components, Ly α IGM features

Intrinsic absorption: 9 kinematic components (blueshifted)

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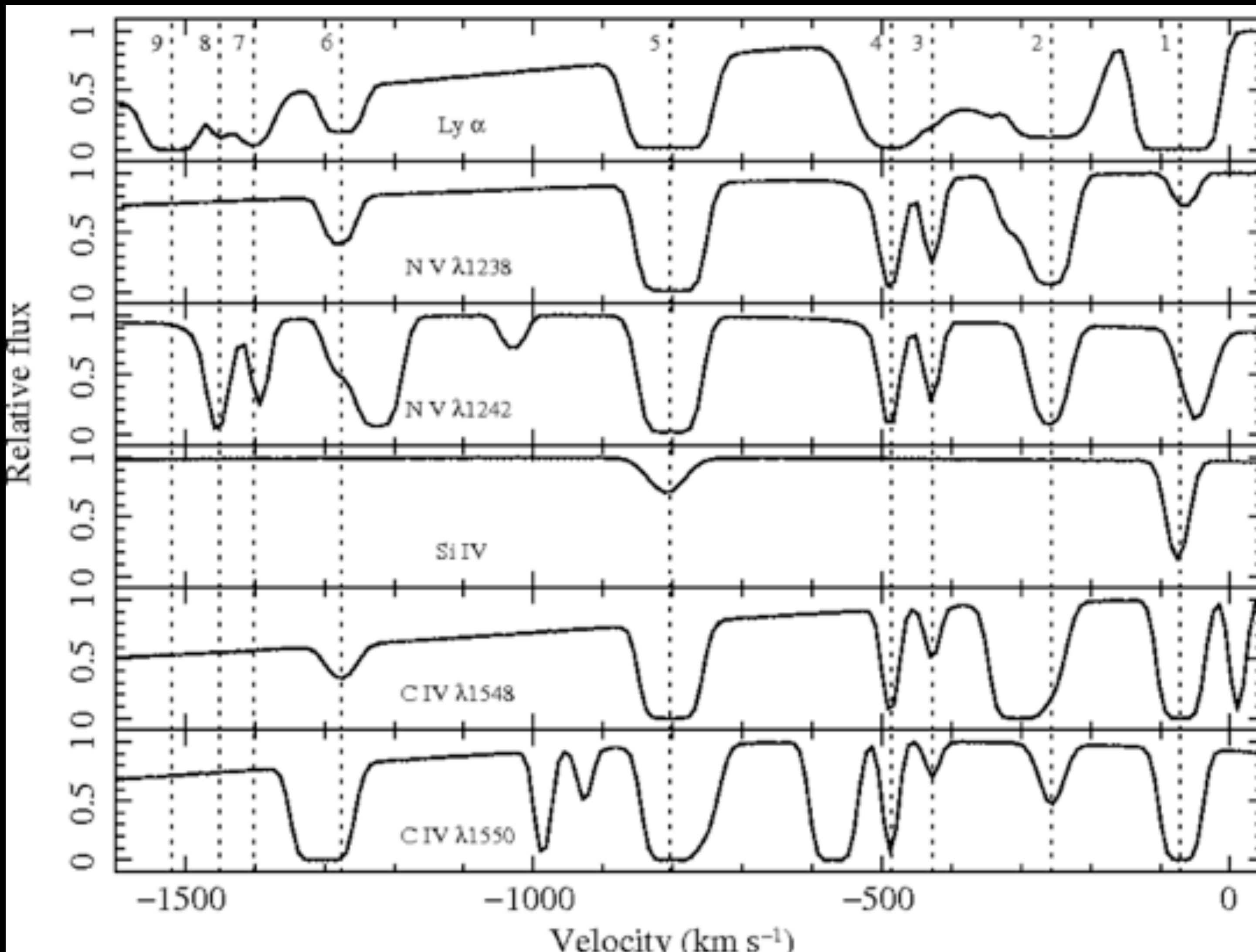

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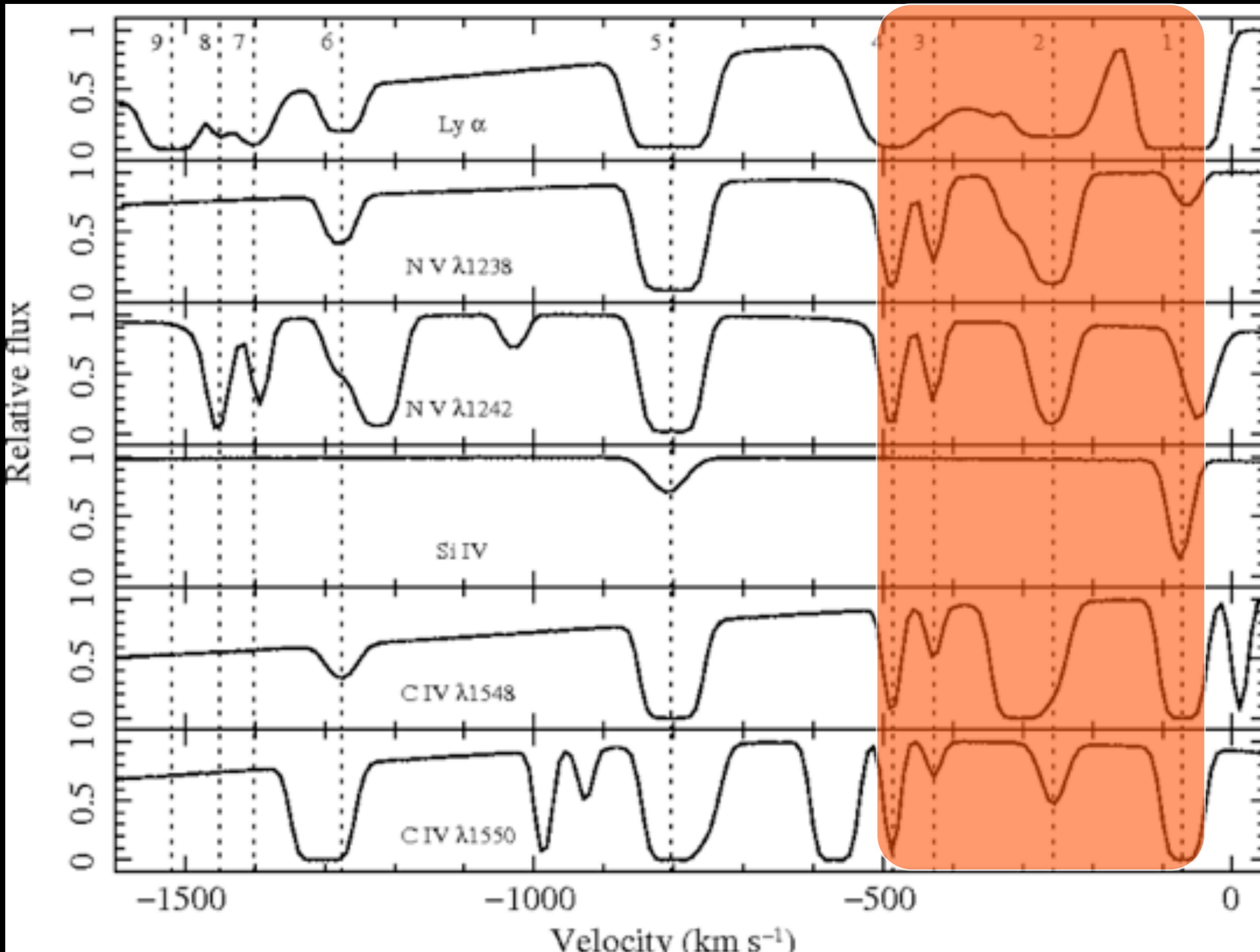

Structure of the X-ray/UV absorber

Fit UV absorber in the same manner as the X-ray absorber

Transmission of a slab of material where all the N_{ion} are linked through a photoionization balance model (CLOUDY)

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The same gas is likely producing the UV and low ionization X-ray absorption

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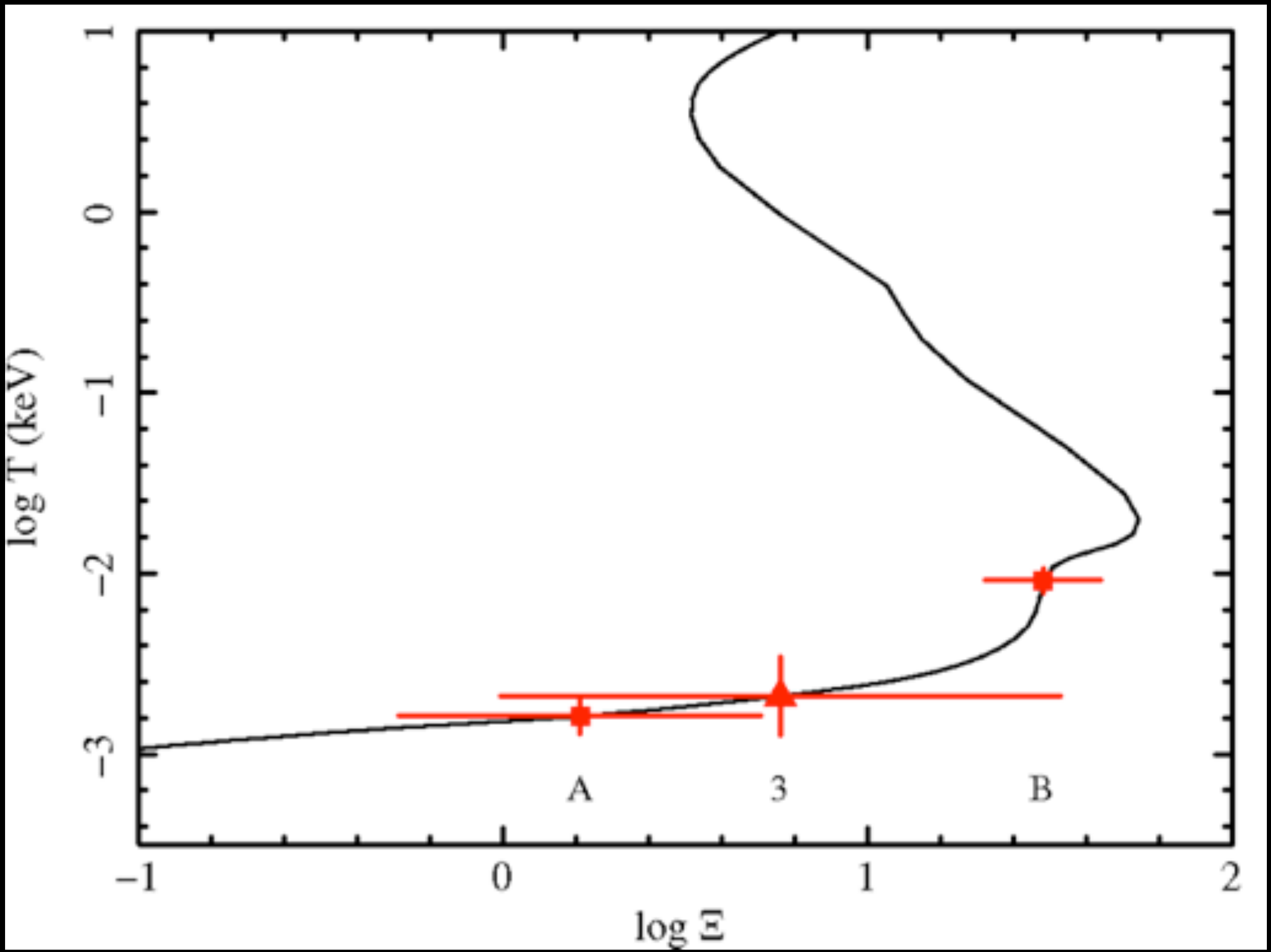

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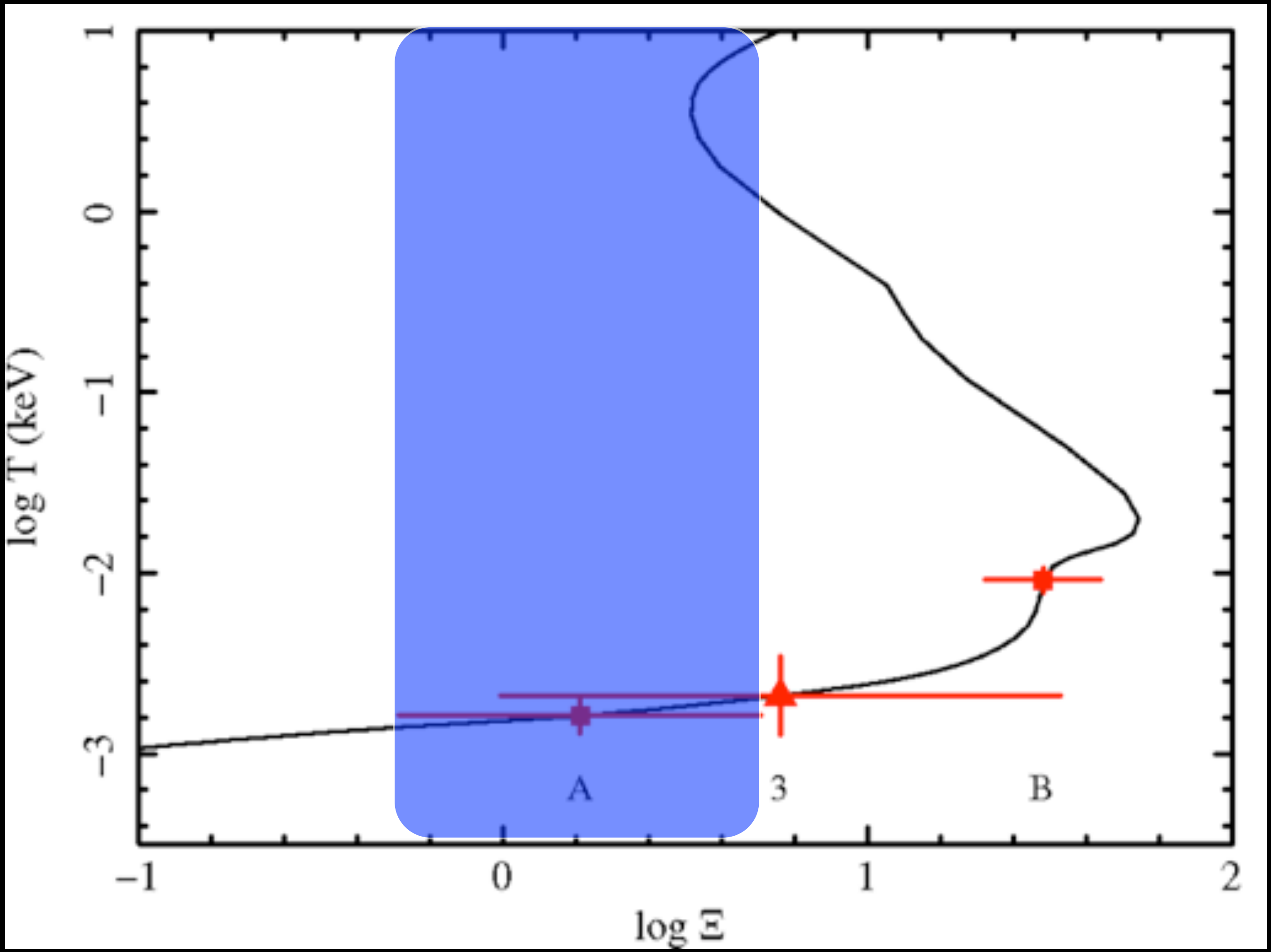

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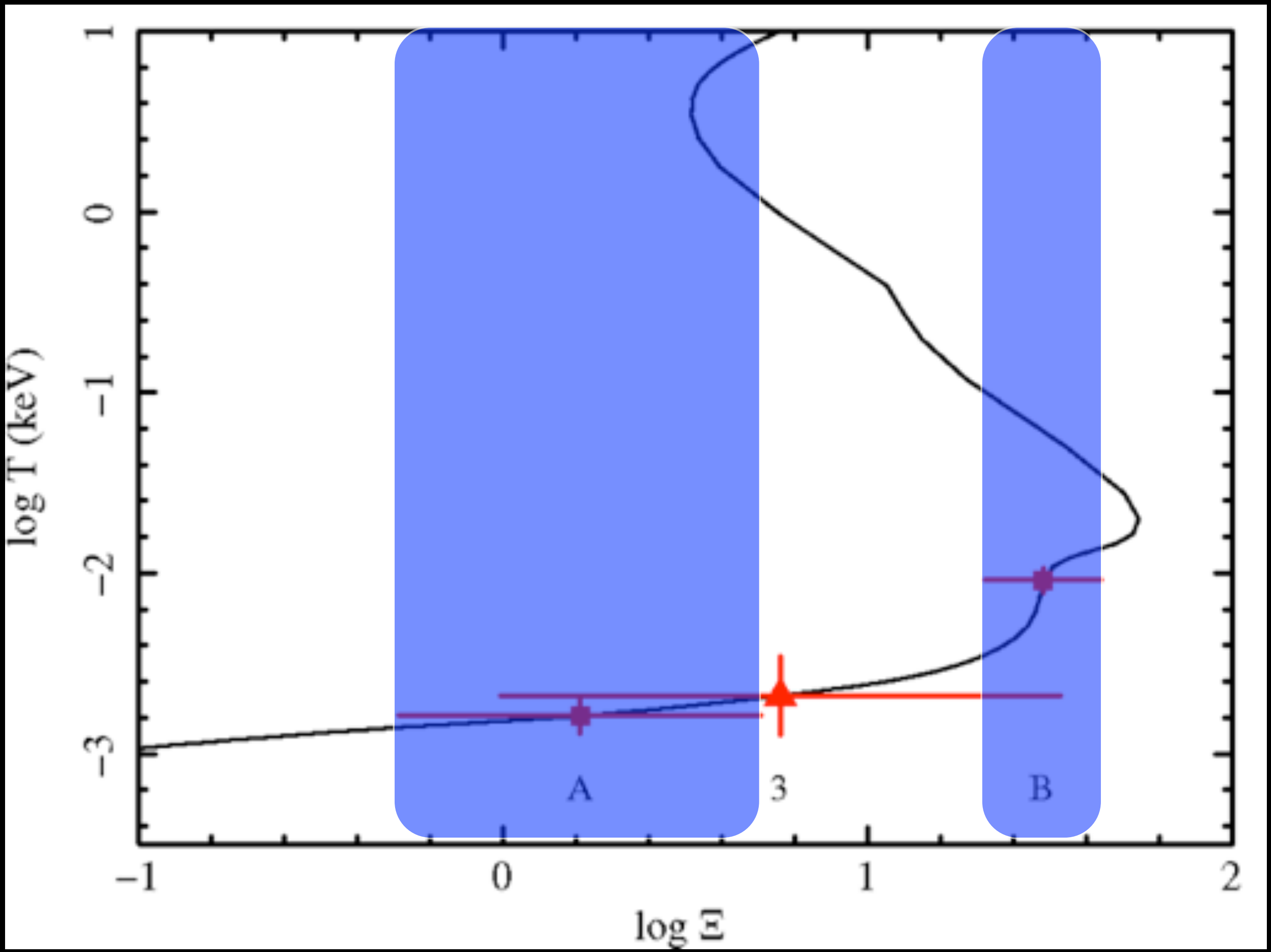

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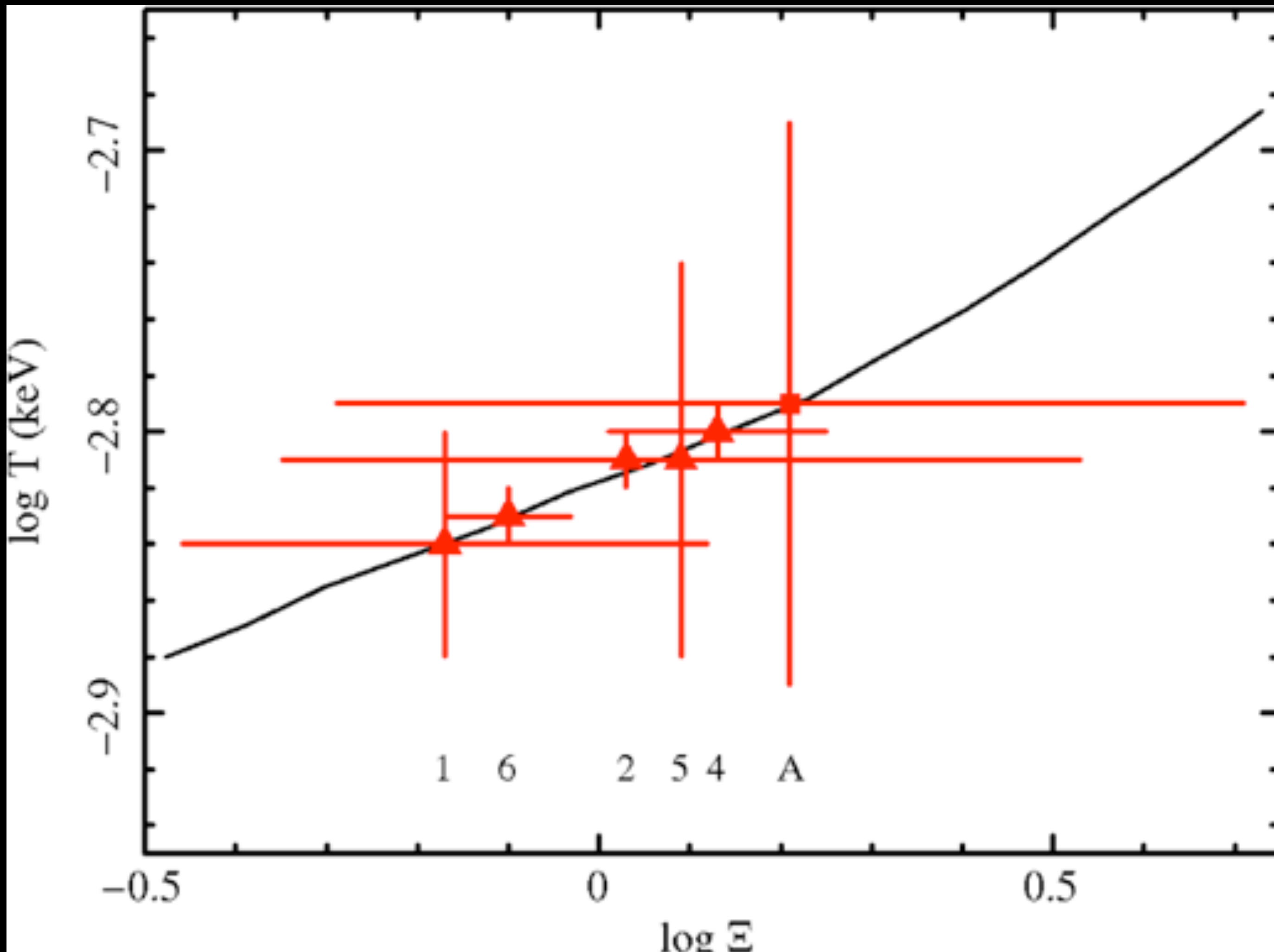

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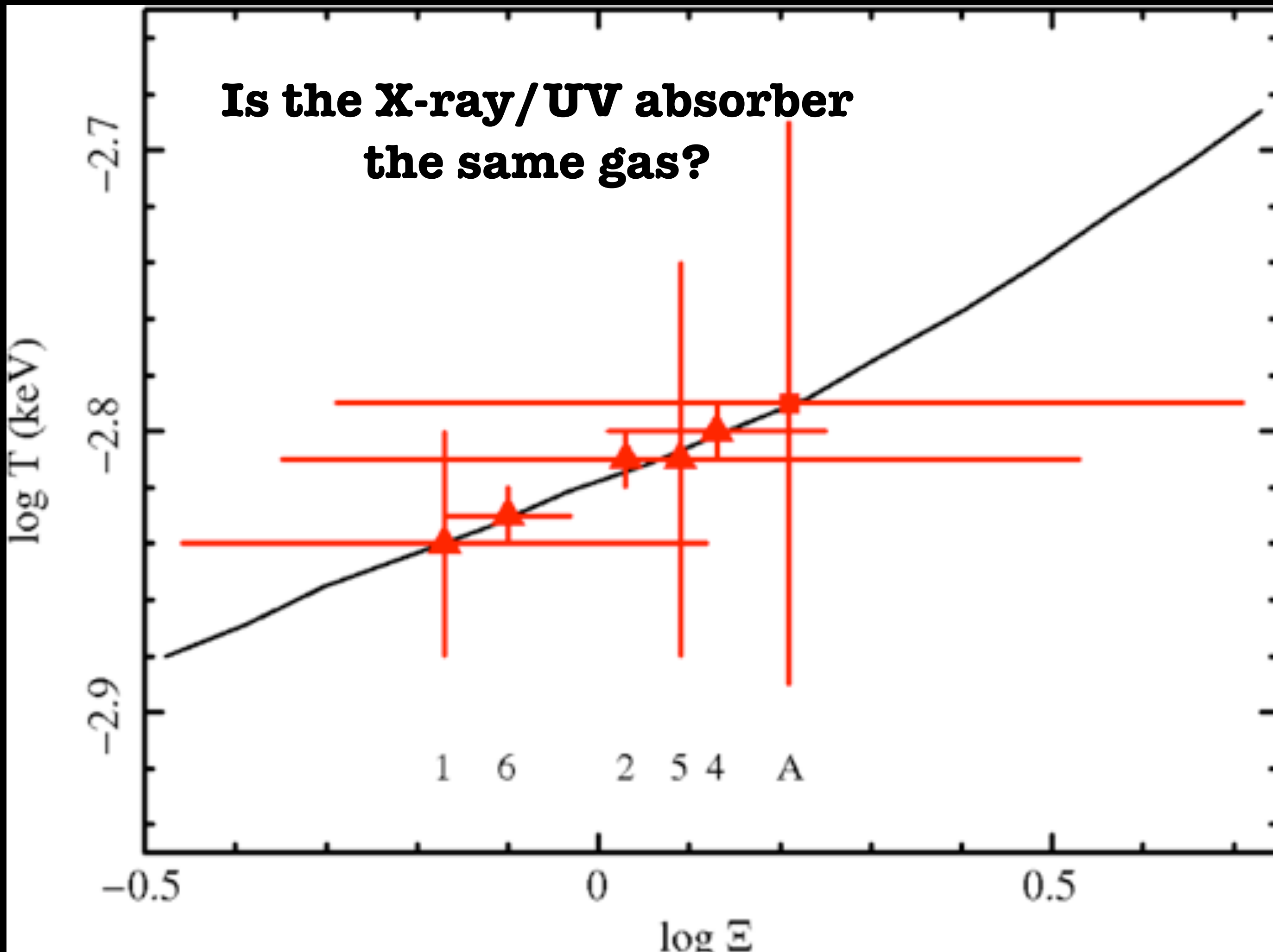

Estimating the location...

Can be done using dynamical arguments and some reasonable assumptions

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Total mass outflow rate ~ 0.01 $M_\odot\ yr^{-1}$

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$L_K \sim 0.0002\%\ L_{bol}$

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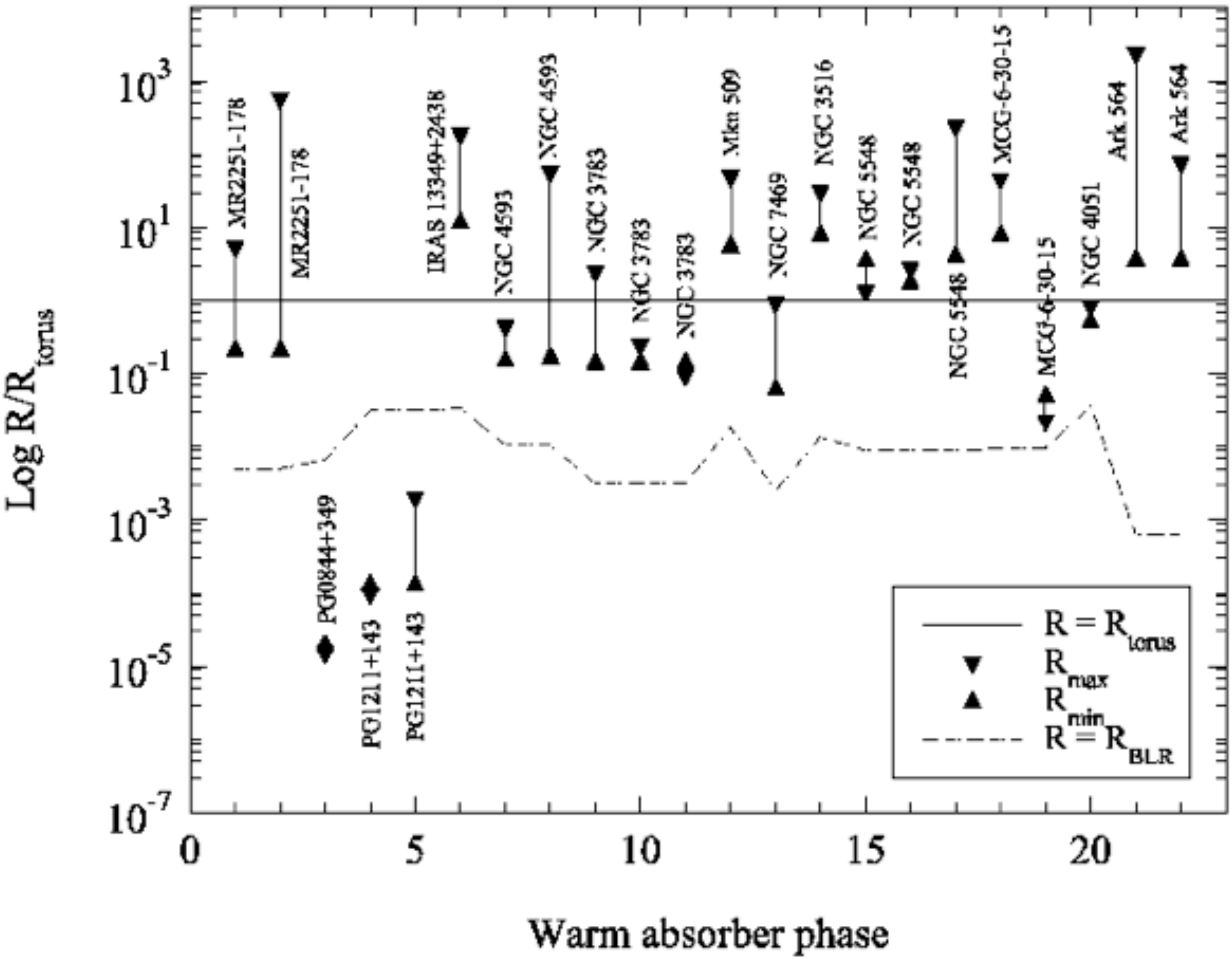
Feedback models show that between 0.5% (Hopkins & Elvis 2010) and 5% (Di Matteo+05) must be fed back to the medium to alter the ISM

Blustin et al. (2005)



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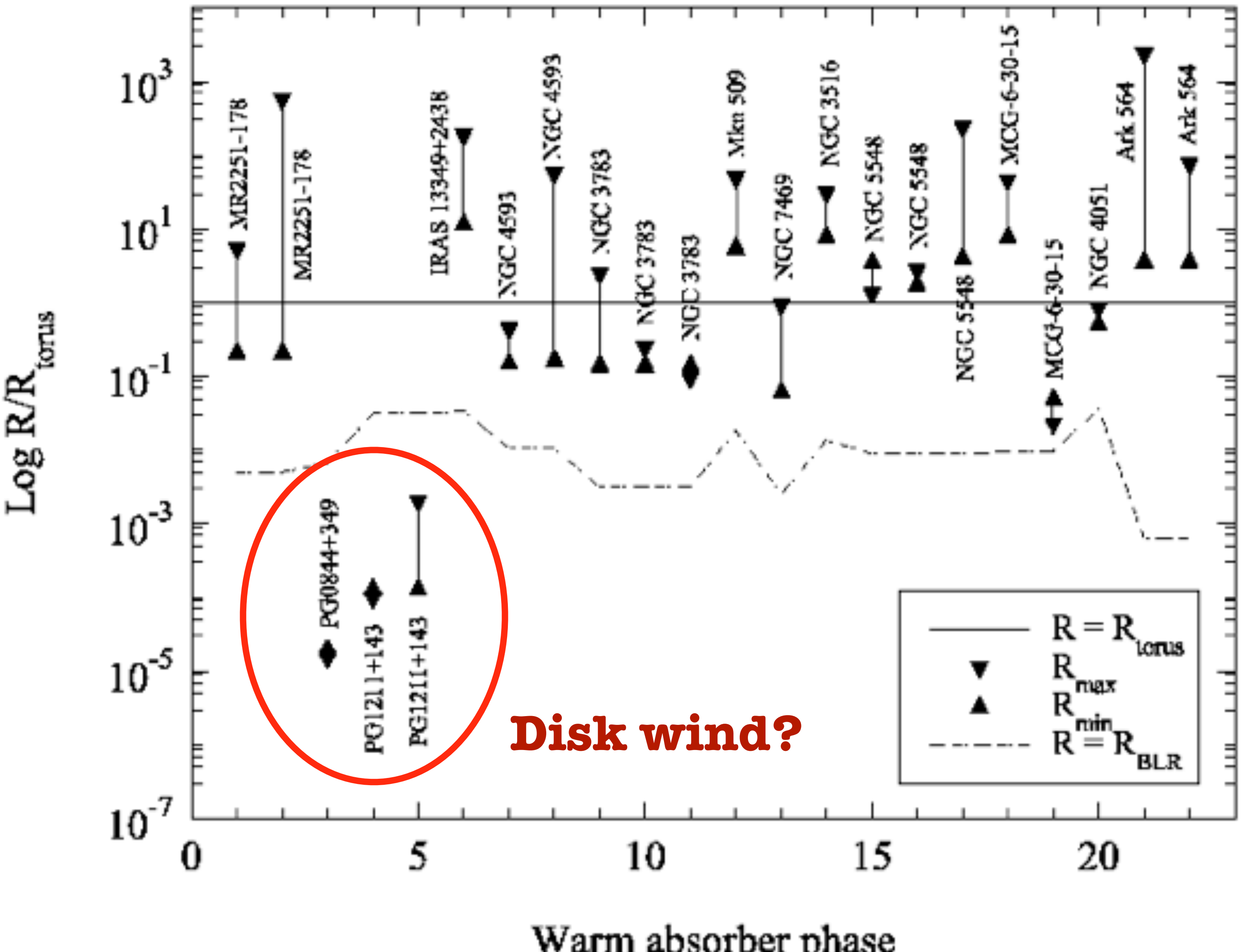

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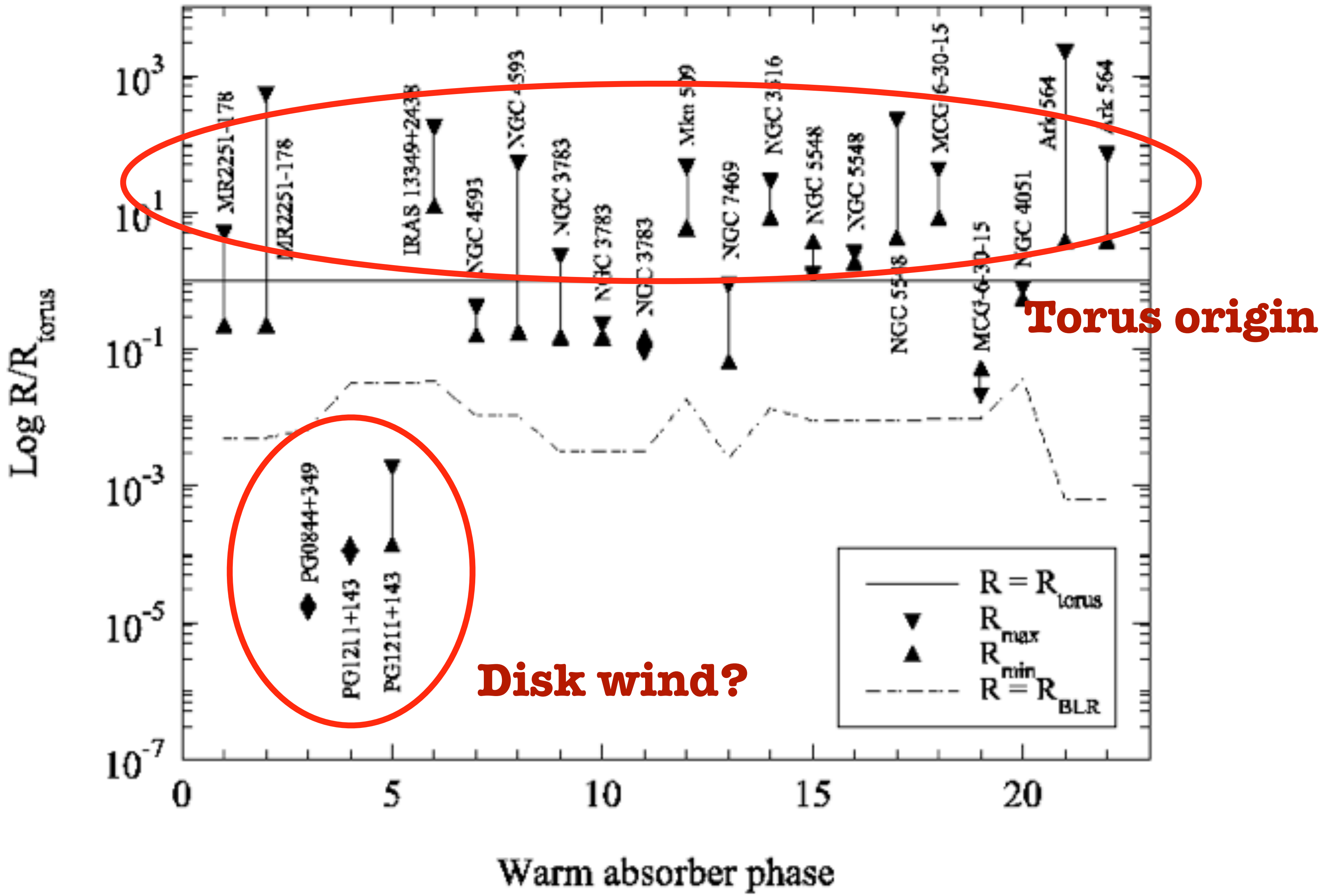

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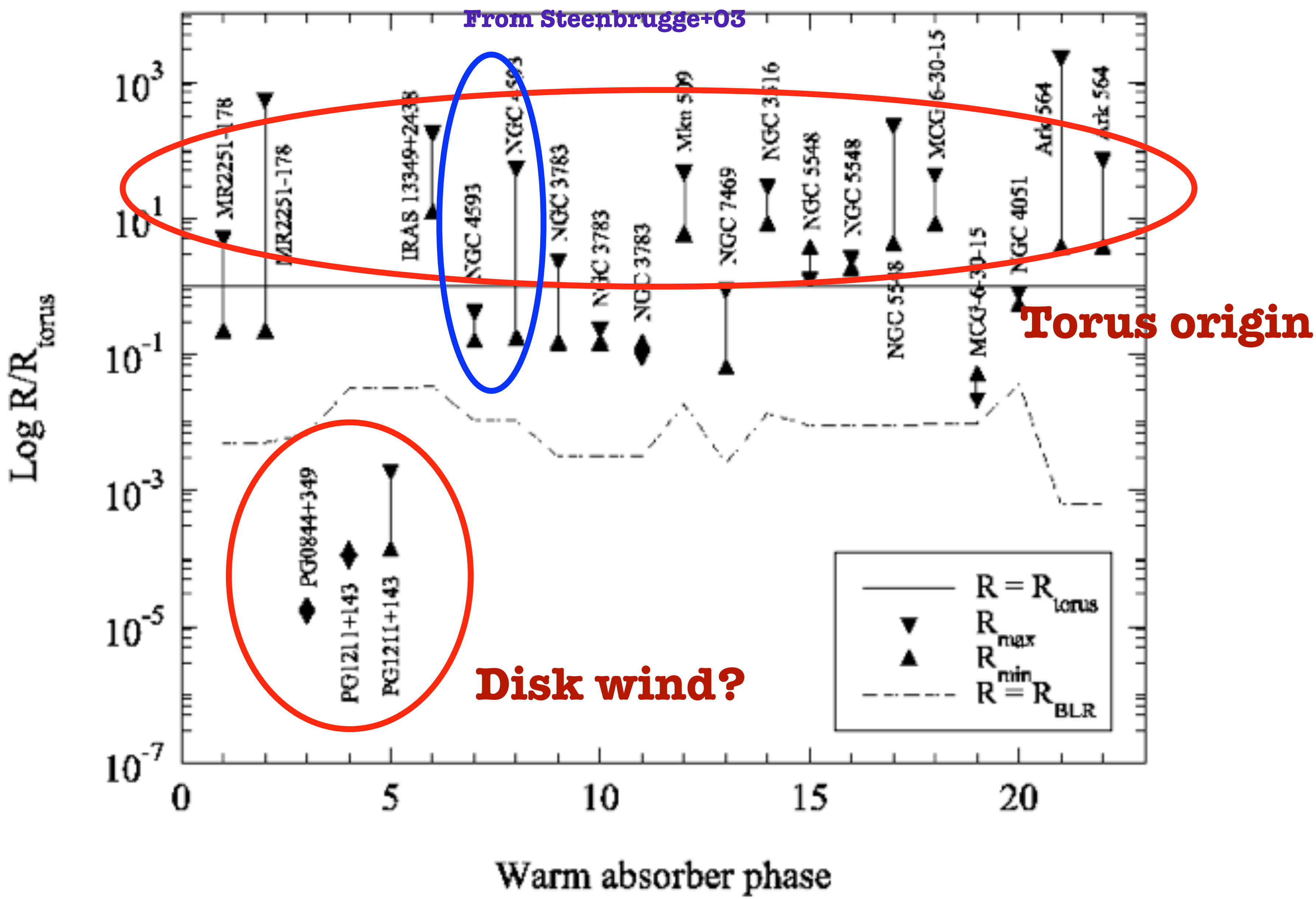

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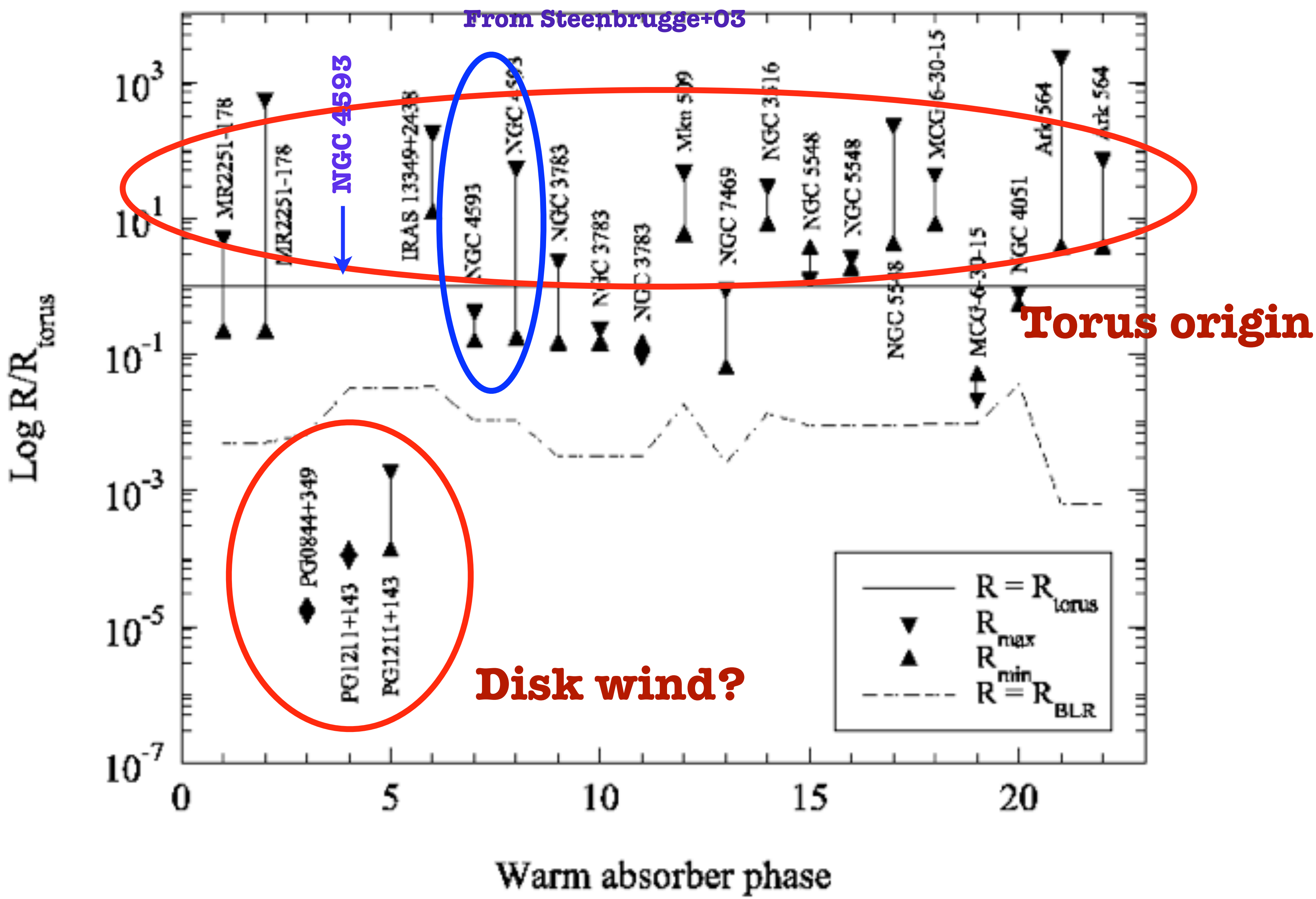

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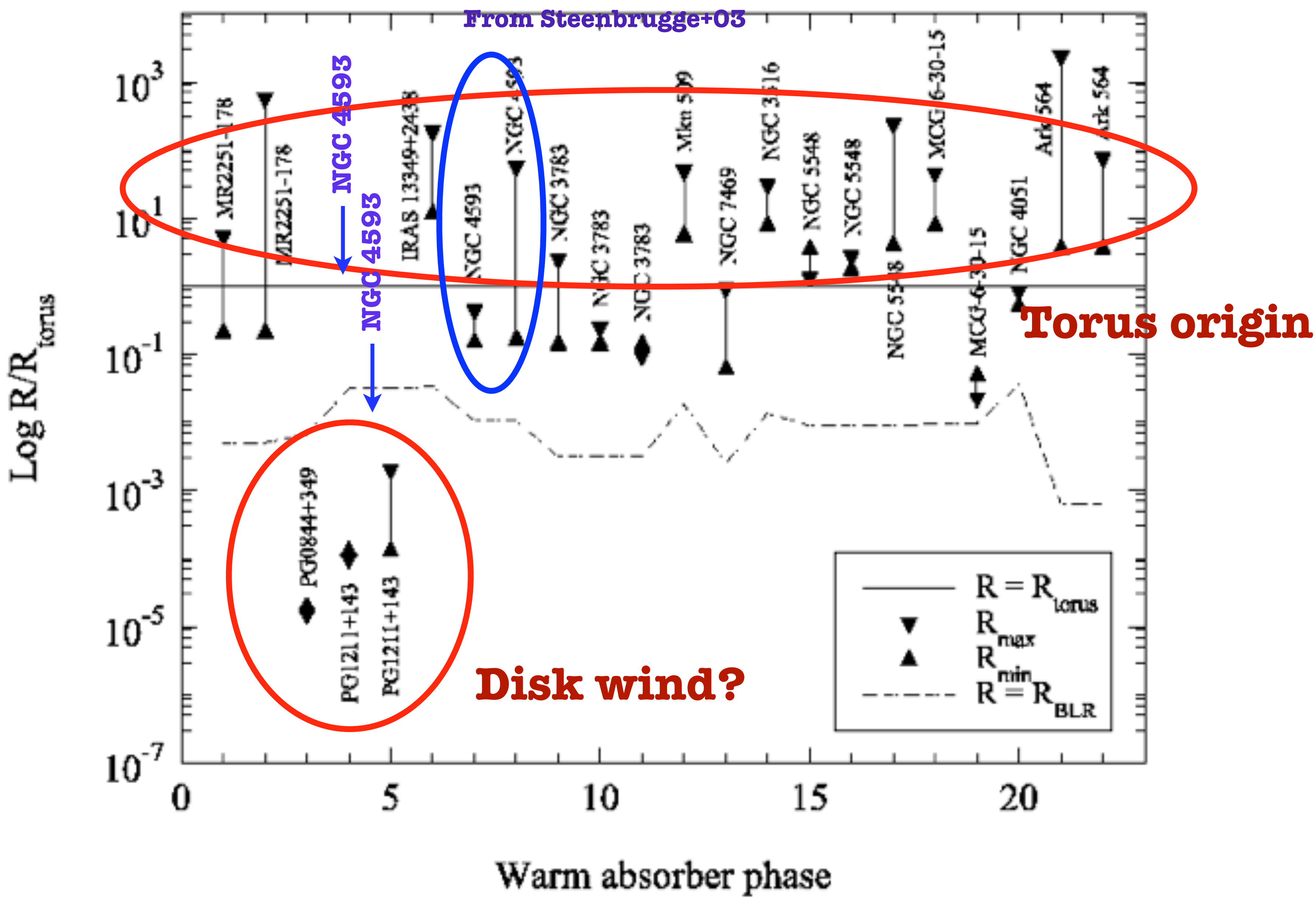

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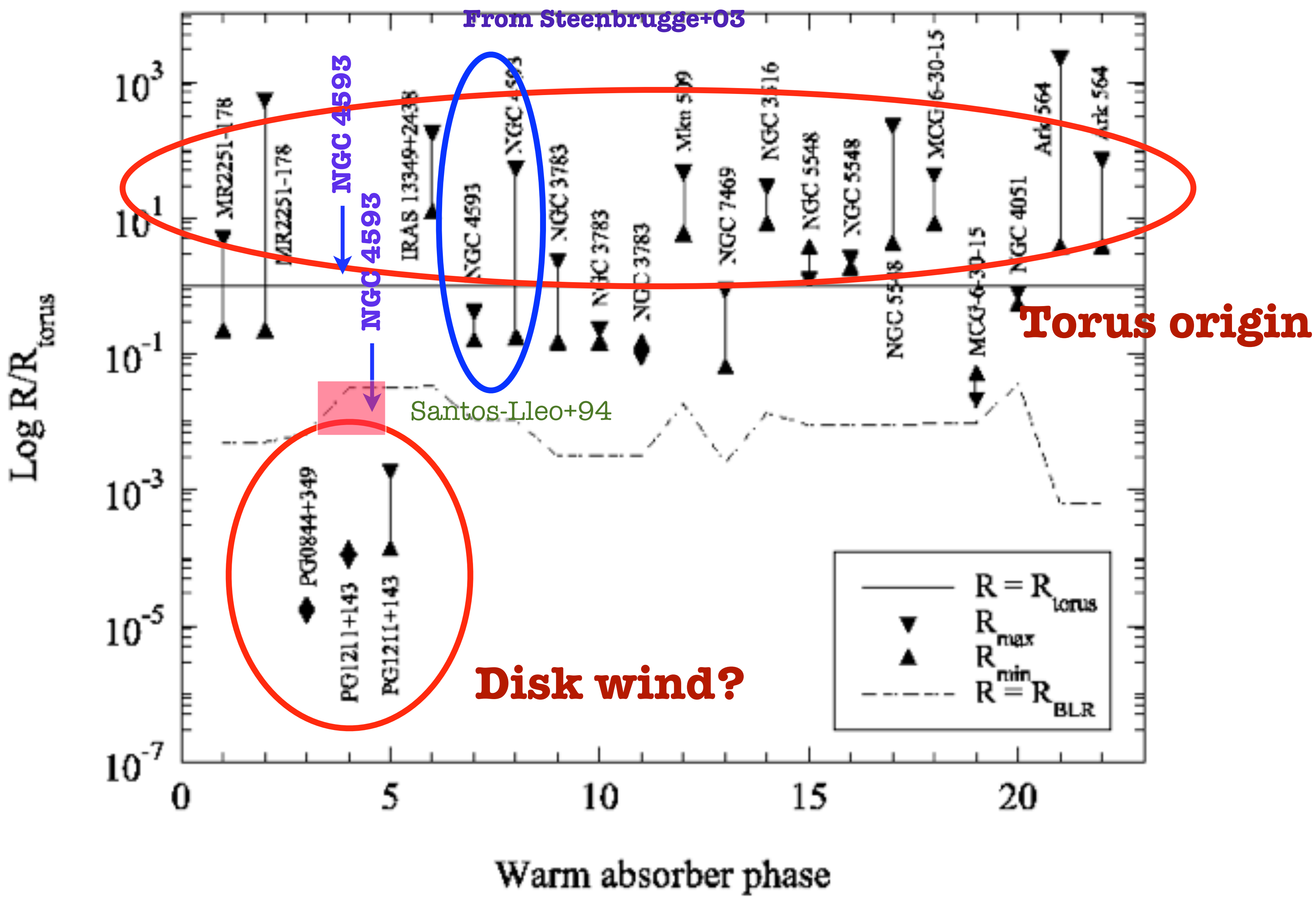

Summary

- NGC 4593 shows a **two-phase WA** in its X-ray spectra

- The low ionization component may be responding to **variations** in the incident ionizing flux

- **Nine kinematic** components are seen in the UV absorption spectrum

- At least 3 of them likely originate in the **same gas** that produces the low ionisation X-ray absorption

- This component is consistent with thermally driven winds from the **torus**, whereas the high ionization component is located at distances consistent with the **BLR**

- Their total contribution to AGN feedback processes is **negligible**