X-ray winds from AGN and their role in the evolution of galaxies

Horizon 2020

AstroFIt2/MSCA

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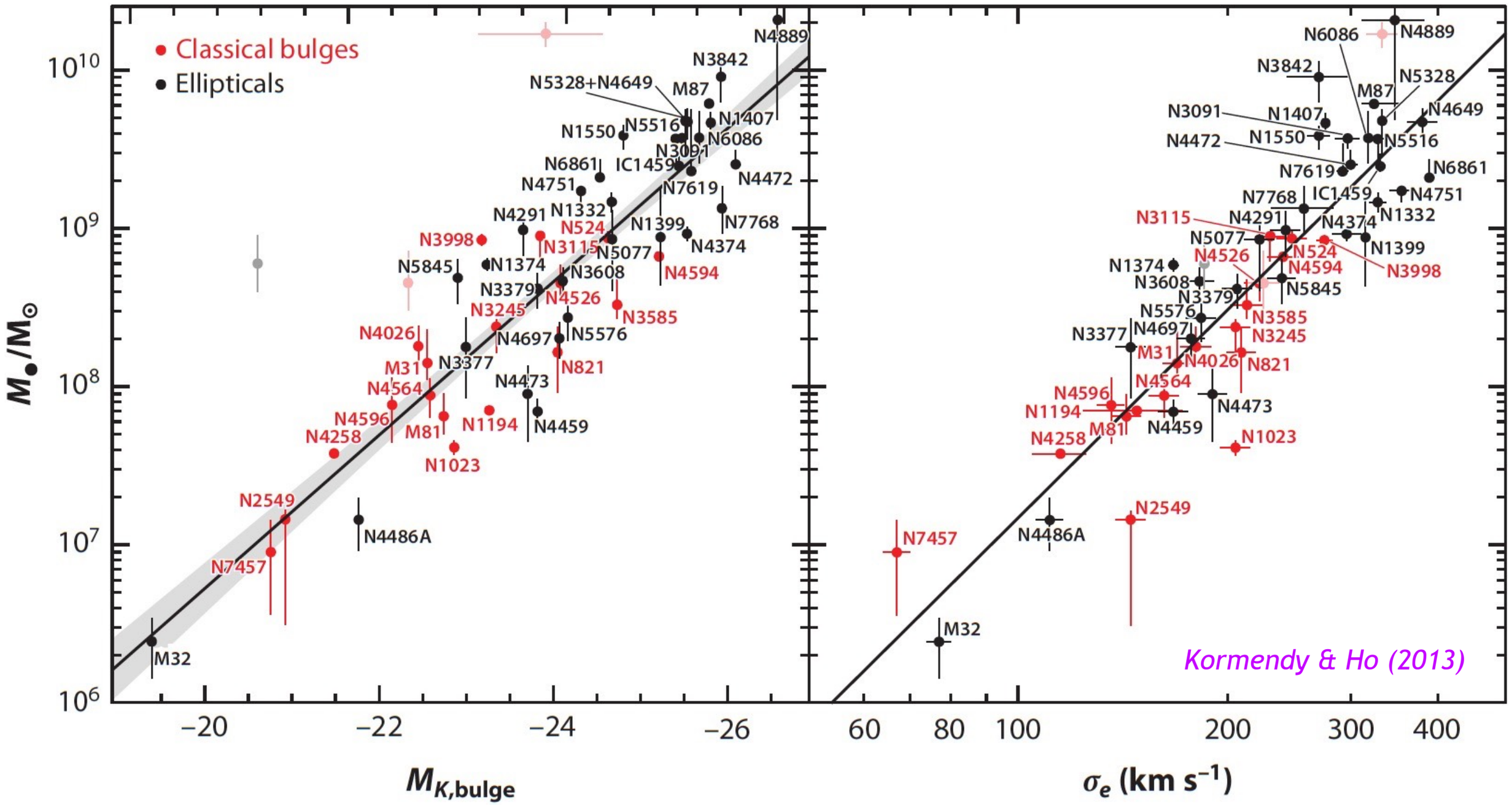
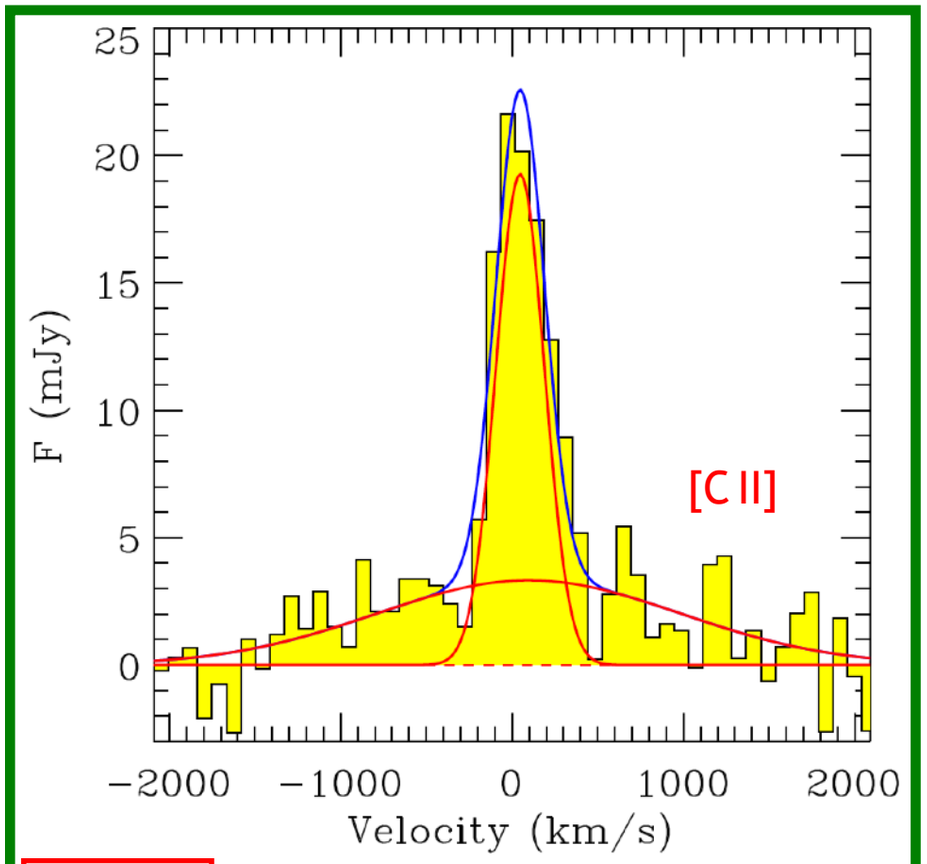
SMBHs and their host galaxies



Radiative and mechanical *AGN feedback* in the form of galaxy-wide outflows is thought to regulate the SMBH growth and to control the star formation in the bulge

Evidence for AGN-driven outflows

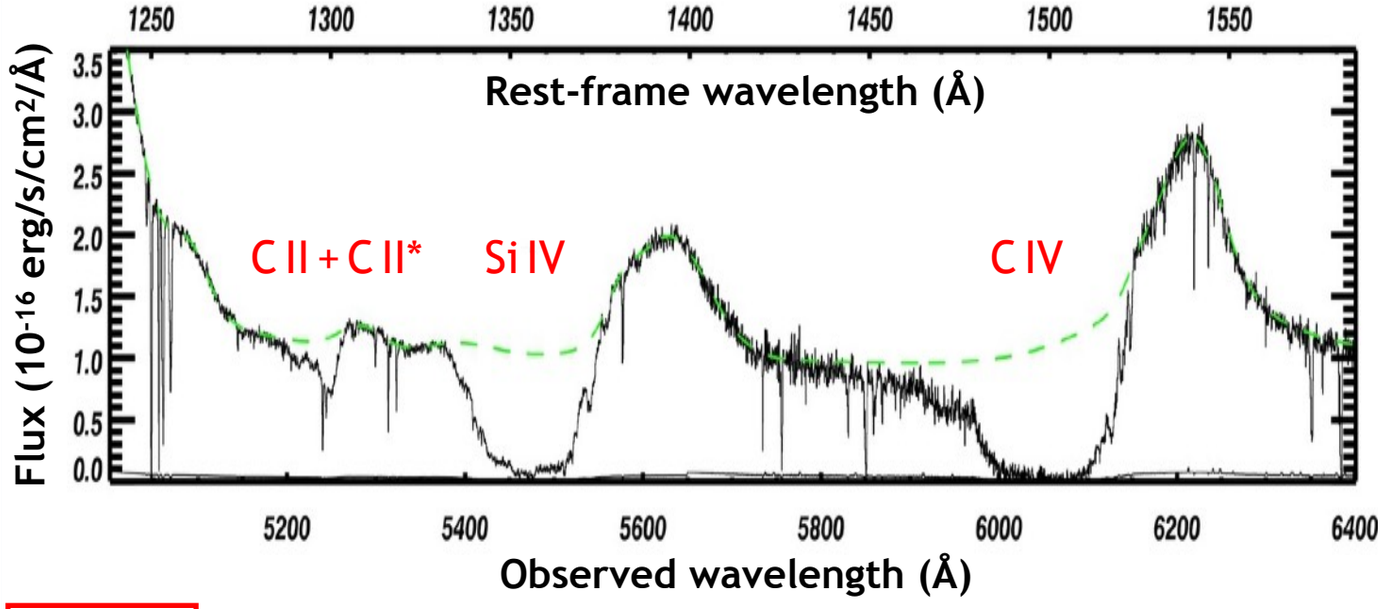


z = 6.41

Maiolino et al. (2012)

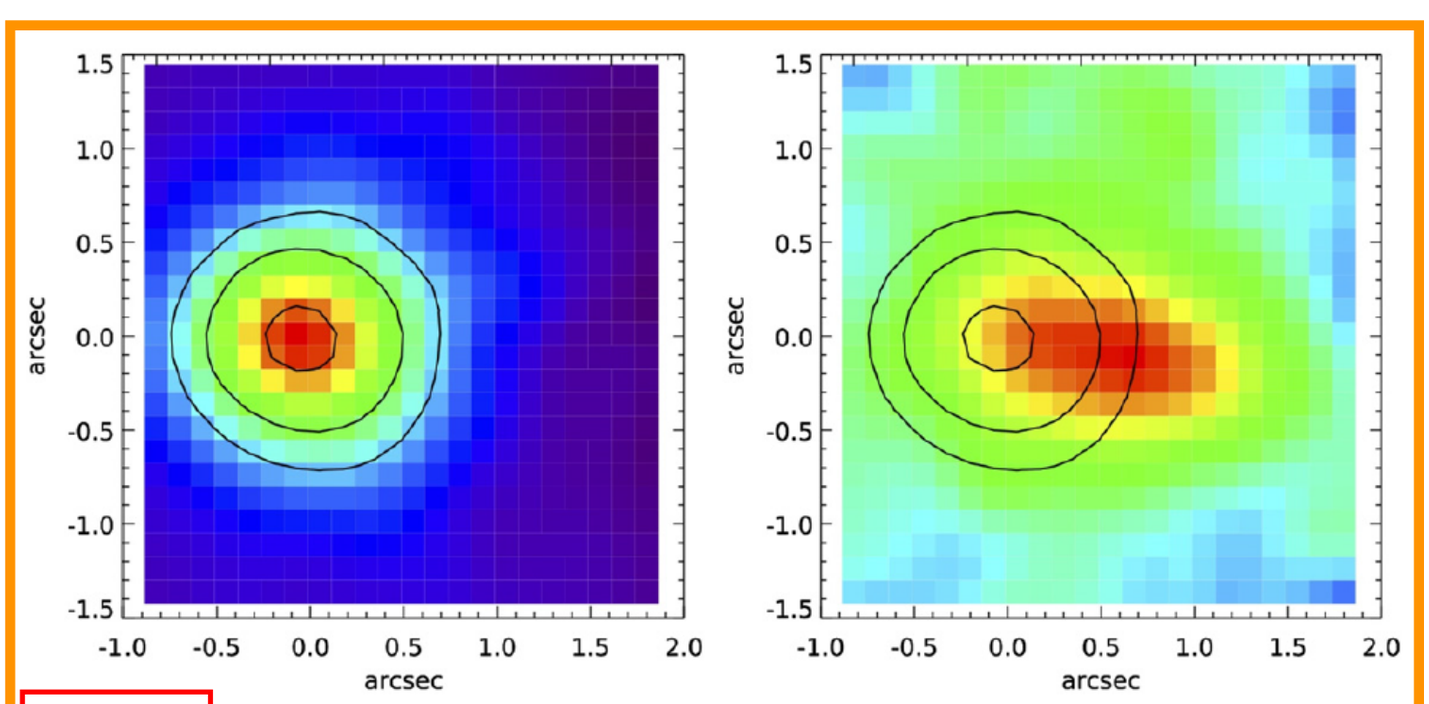
1 thousand is the typical number for **distance** (pc), **mass loss rate** (M_{SUN}/yr), and **outflow velocity** (km/s)

How are these winds launched?



z = 3.04

Borguet et al. (2013)



z = 1.59

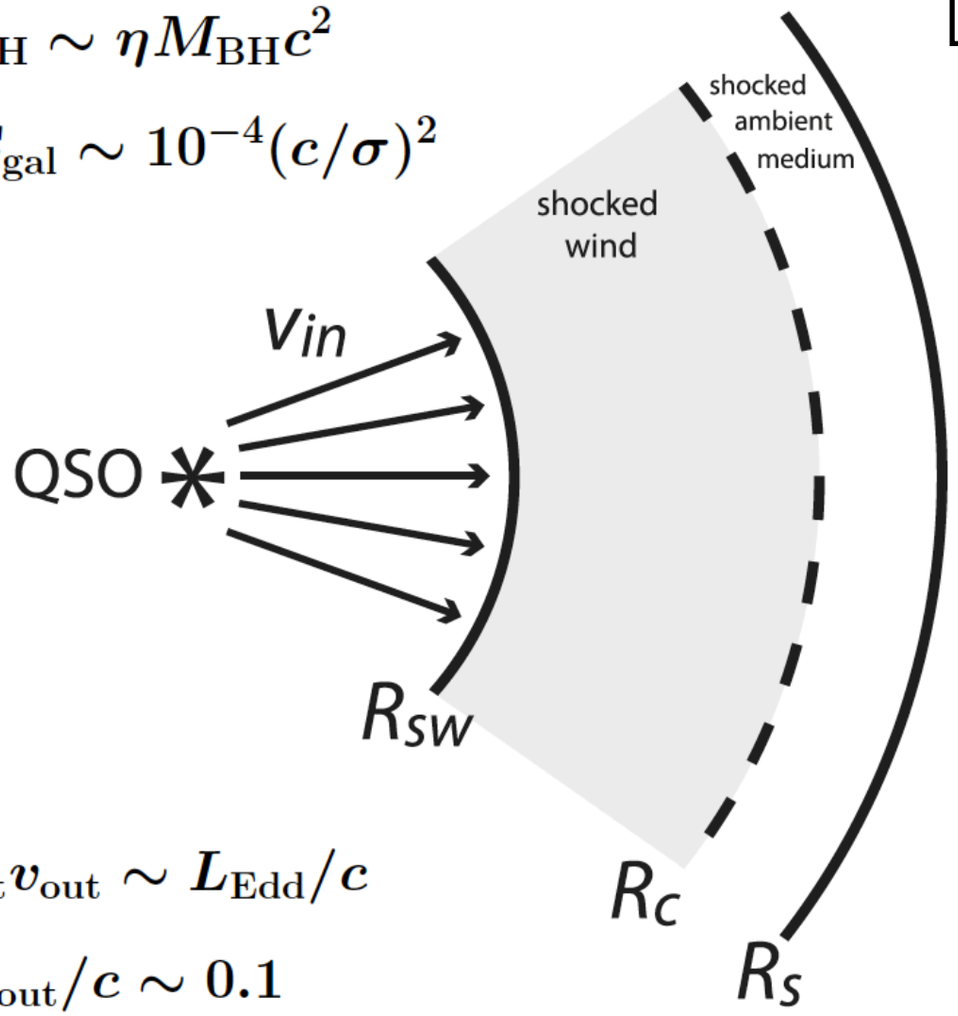
Cresci et al. (2015)

Ultra-fast X-ray outflows

$$E_{\rm gal} \sim M_{\rm gal}\sigma^2$$

$$E_{\rm BH} \sim \eta M_{\rm BH}c^2$$

$$E_{\rm BH}/E_{\rm gal} \sim 10^{-4}(c/\sigma)^2$$

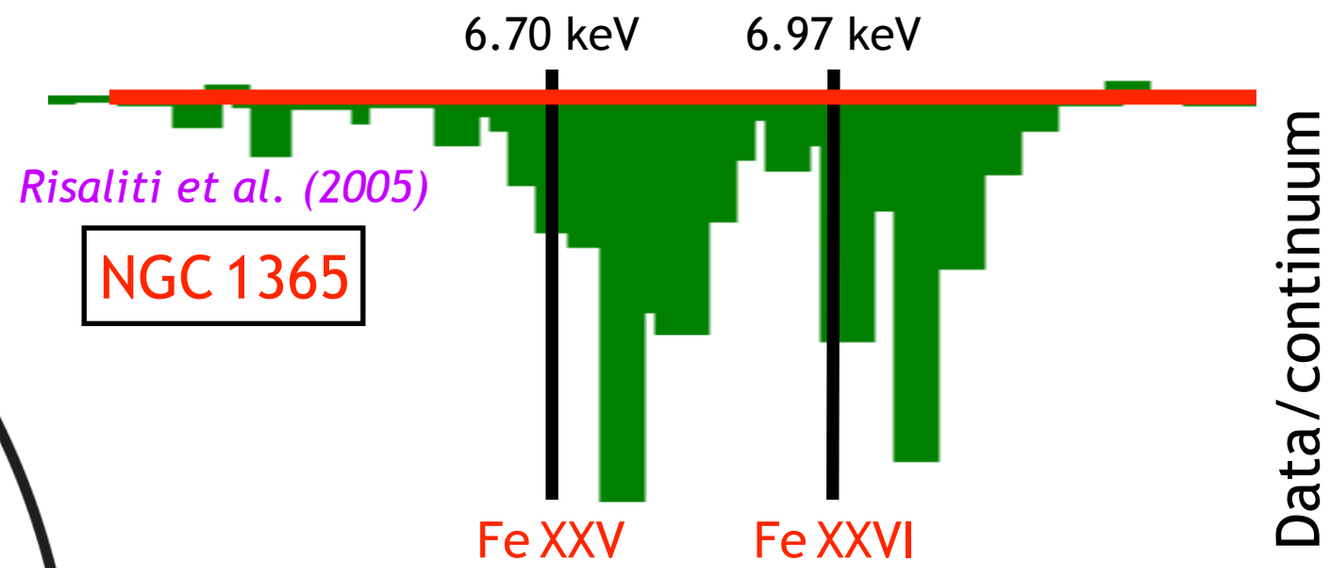


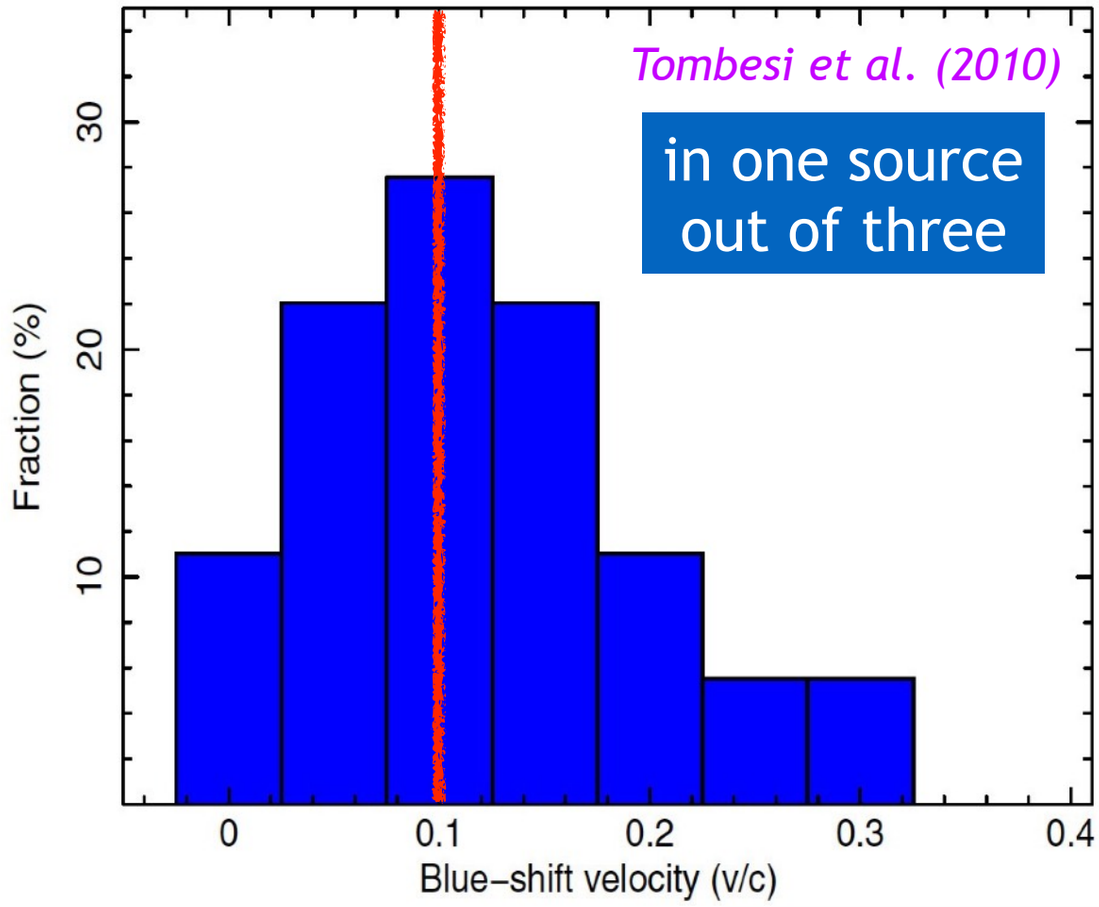
$$\dot{M}_{\rm out}v_{\rm out} \sim L_{\rm Edd}/c$$

$$v_{\rm out}/c \sim 0.1$$

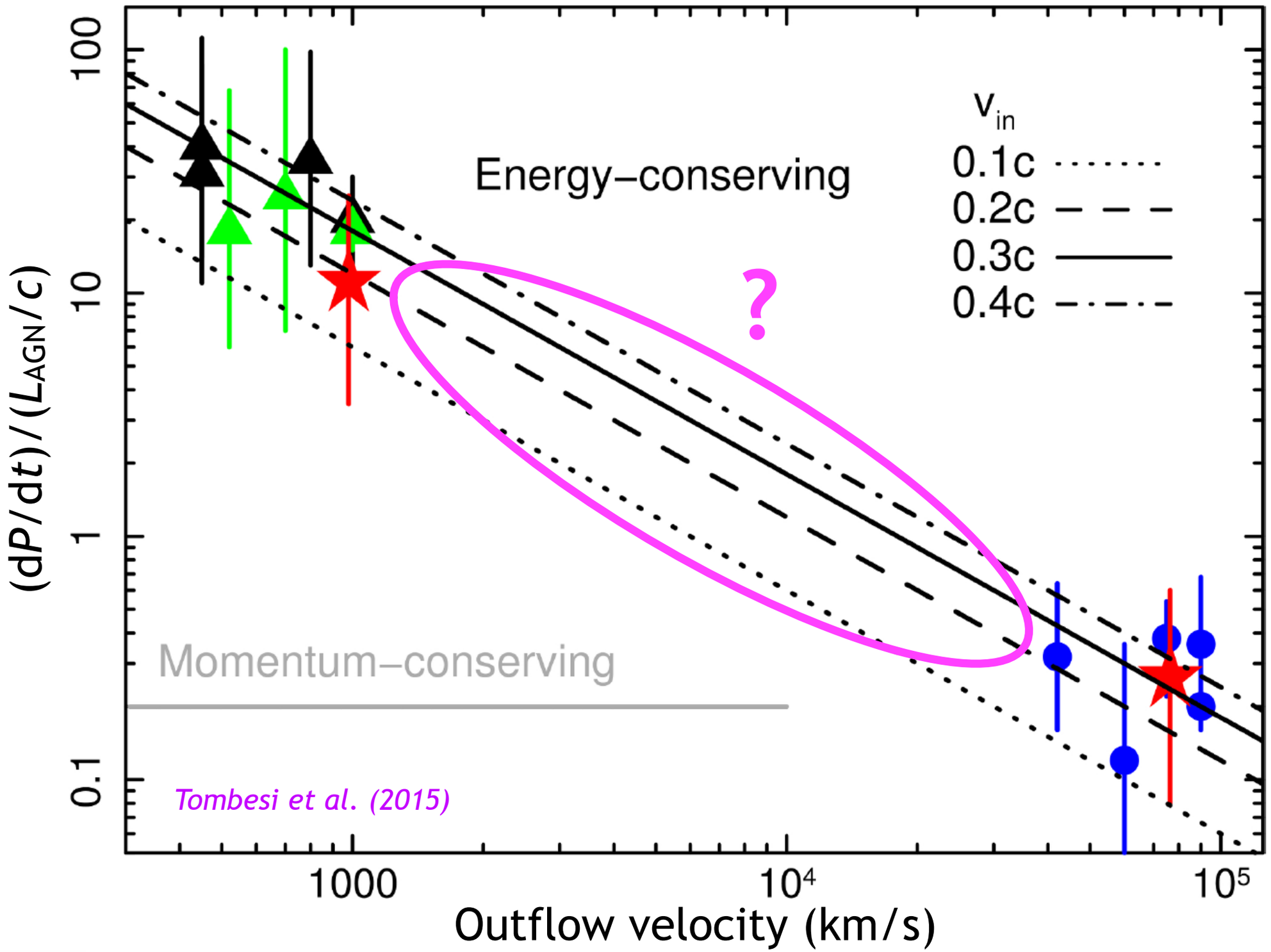
$$P_{\rm kin} \sim 0.05\,L_{\rm Edd}$$

Zubovas & King
Faucher-Giguère & Quataert
Ishibashi & Fabian

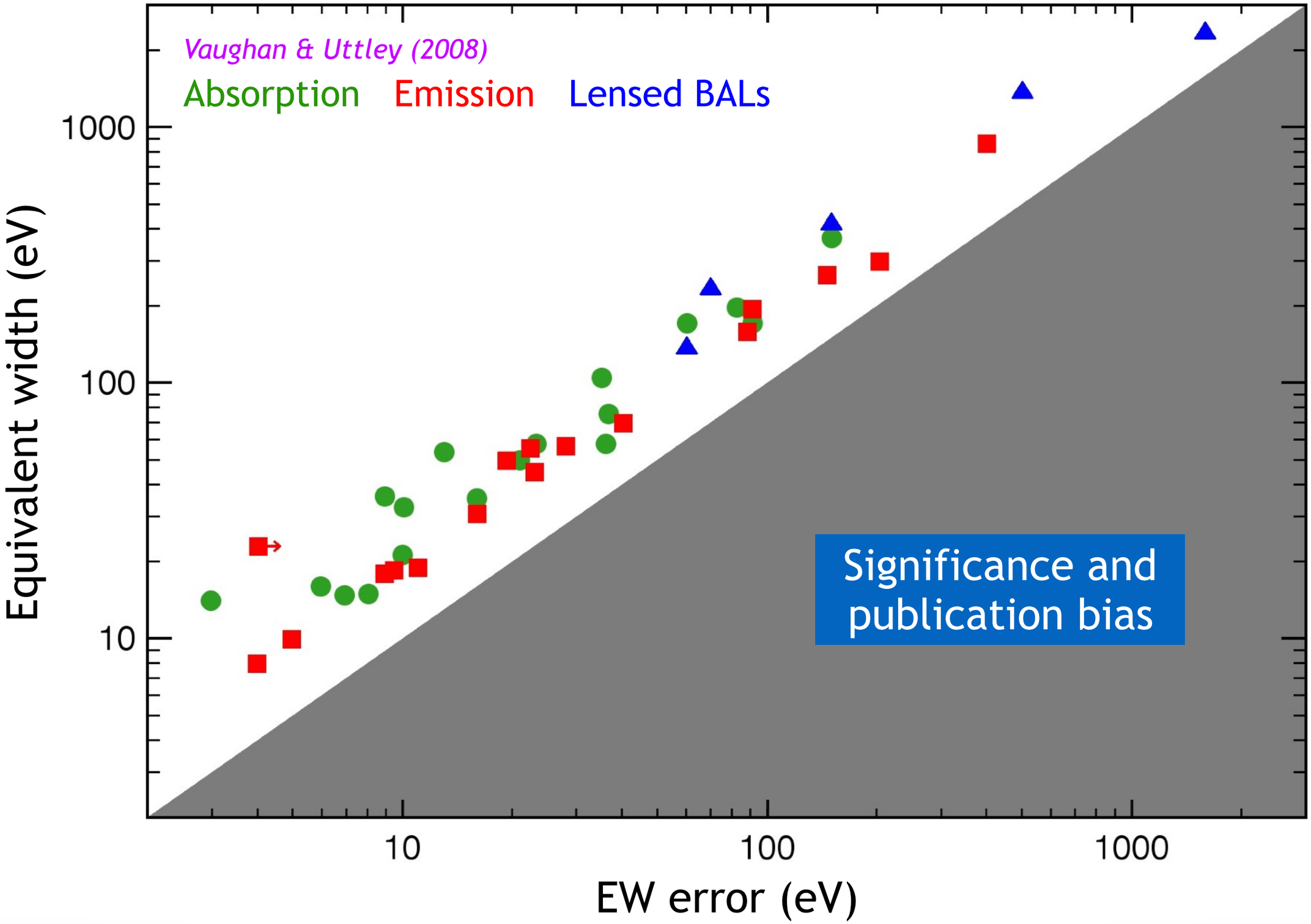




Unification of AGN winds



Critical issues with X-ray winds



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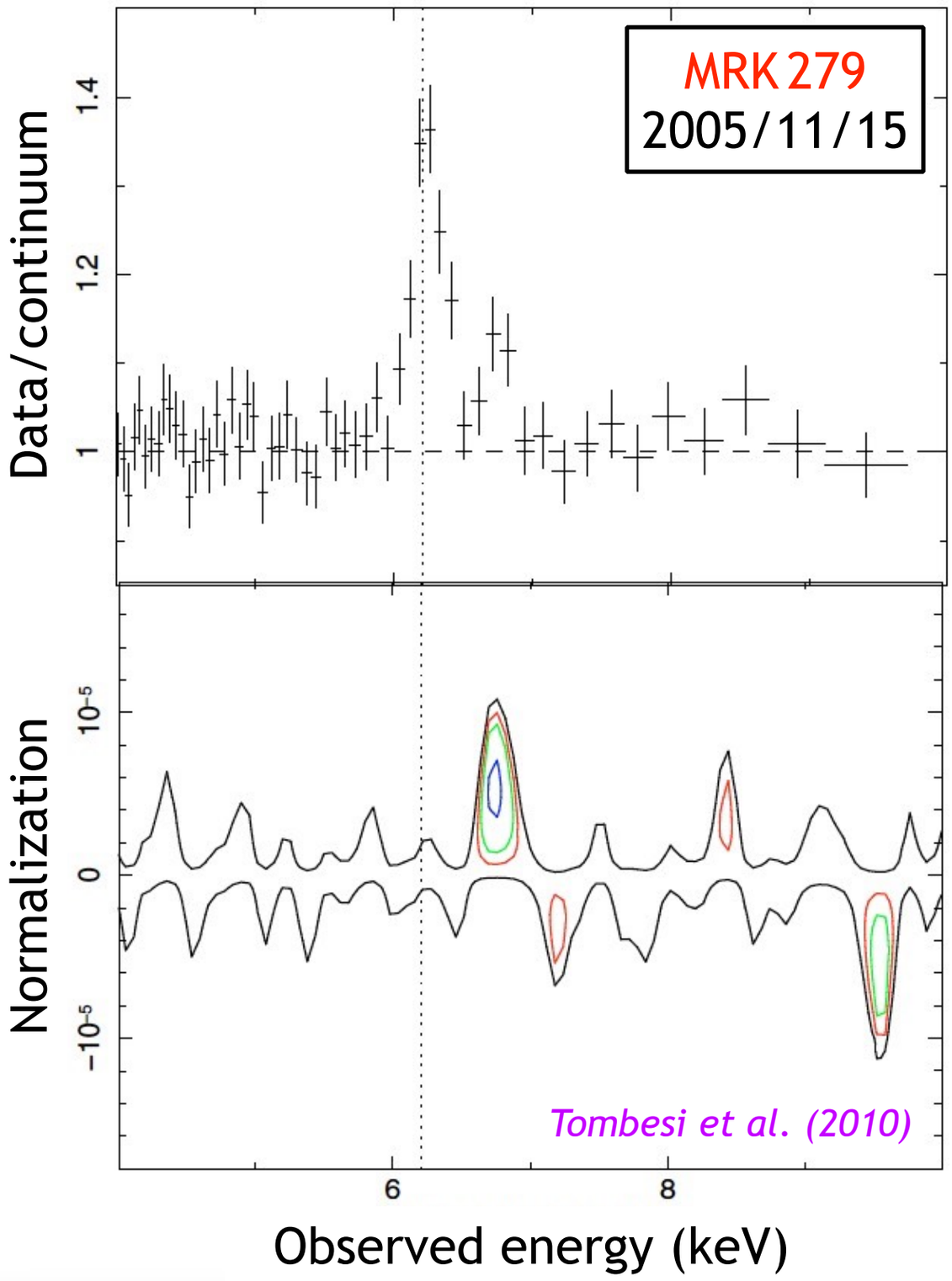

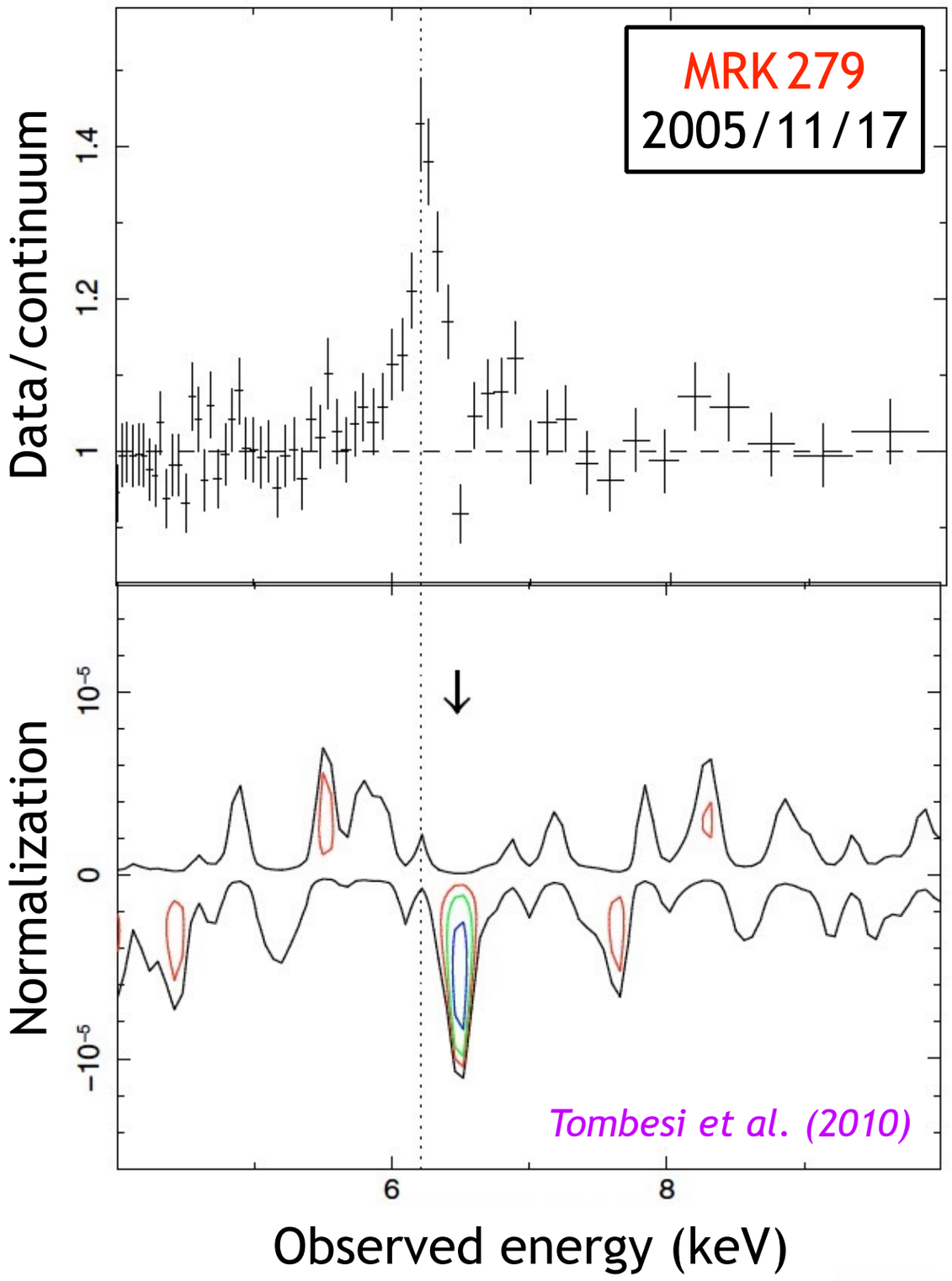

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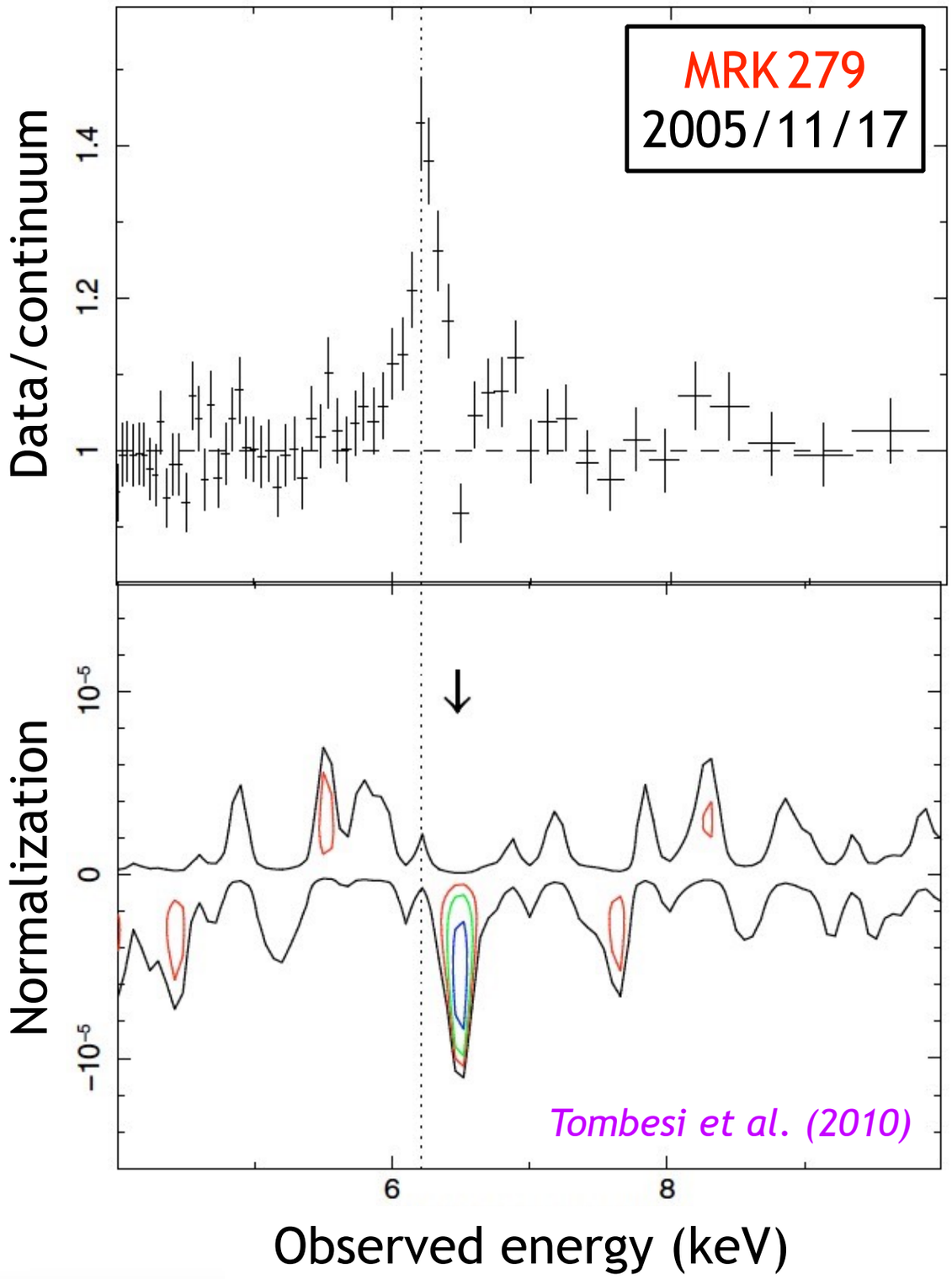
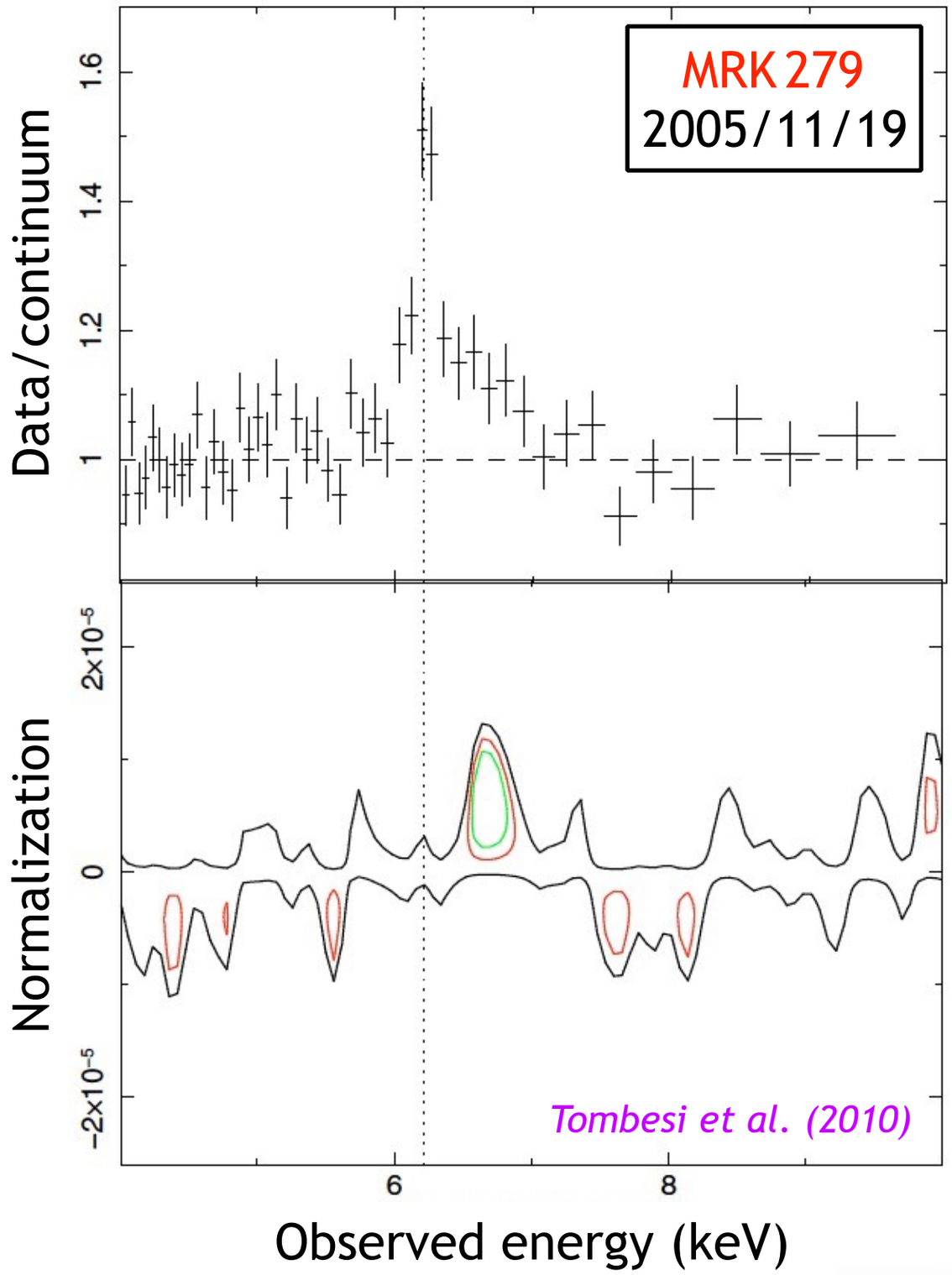
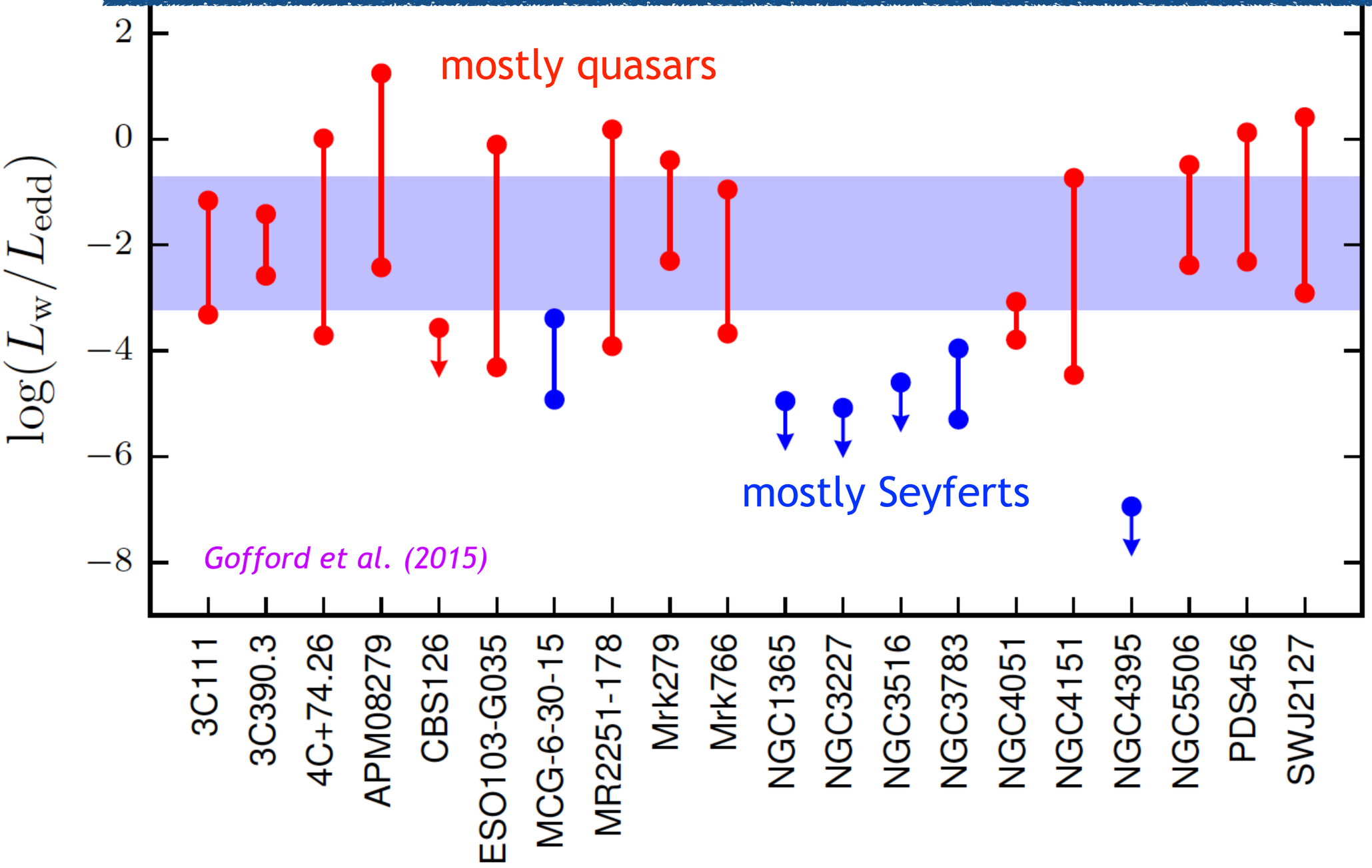




Critical issues with X-ray winds

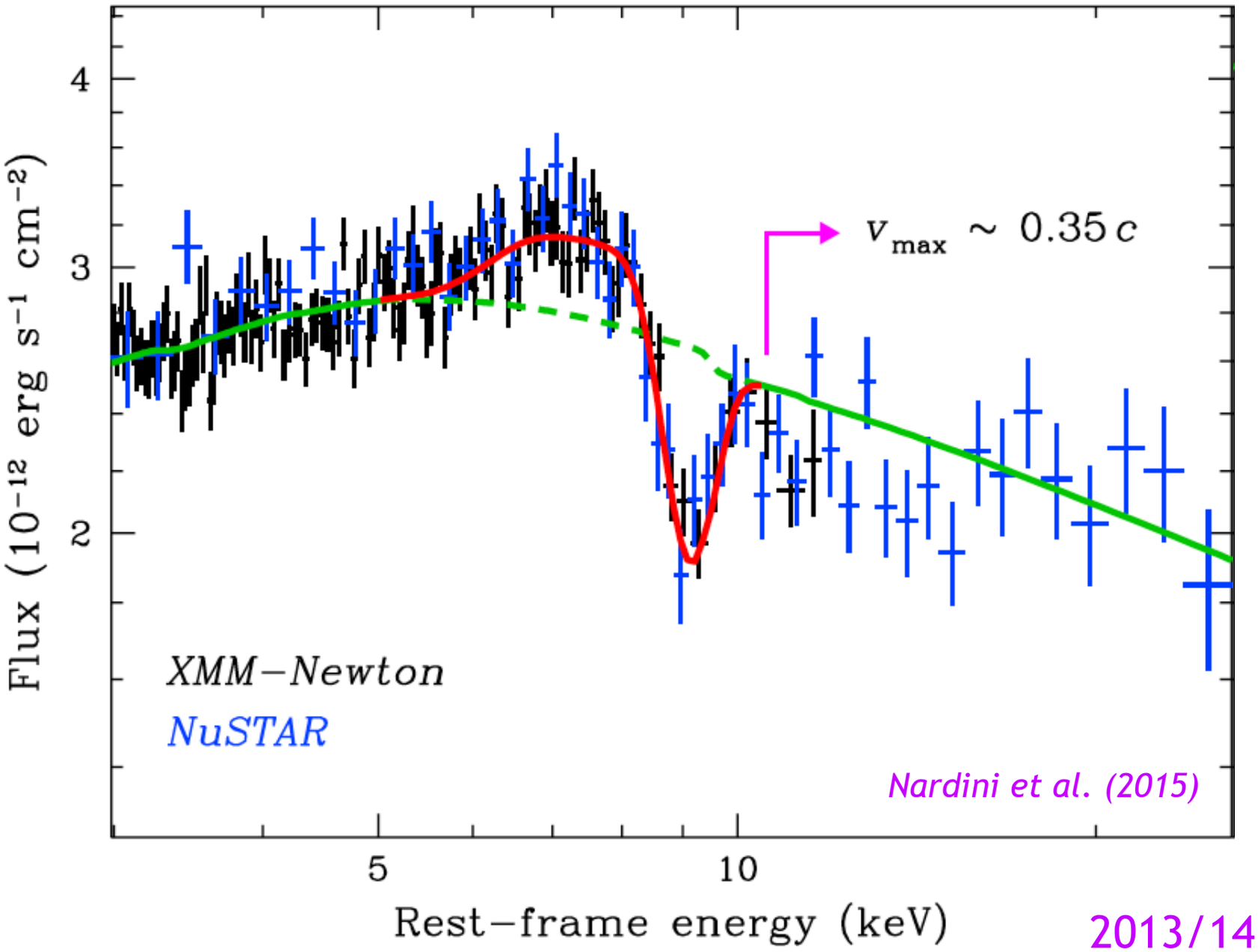
Significance/reliability, transient nature, dependence on continuum modelling, …

Cosmic downsizing also applies to wind energetics



The Rosetta stone of SMBH winds

PDS 456 is the most luminous radio-quiet AGN in the local Universe ($z < 0.3$), and it is a unique target to study X-ray winds in the Eddington-limited regime



2013/14 *XMM+NuSTAR*

Iron Blowing in Quasar Winds

Nardini et al., Science 347, 860 (2015)

$$\dot{M}_{\rm out} \sim 10\, M_\odot\, {\rm yr}^{-1} \Rightarrow P_{\rm kin} \sim 2 \times 10^{46}\, {\rm erg\, s}^{-1} \sim 0.2\, L_{\rm bol}$$

Brightness

NuSTAR

XMM-Newton

Iron Absorption

NASA/JPL-Caltech/Keele

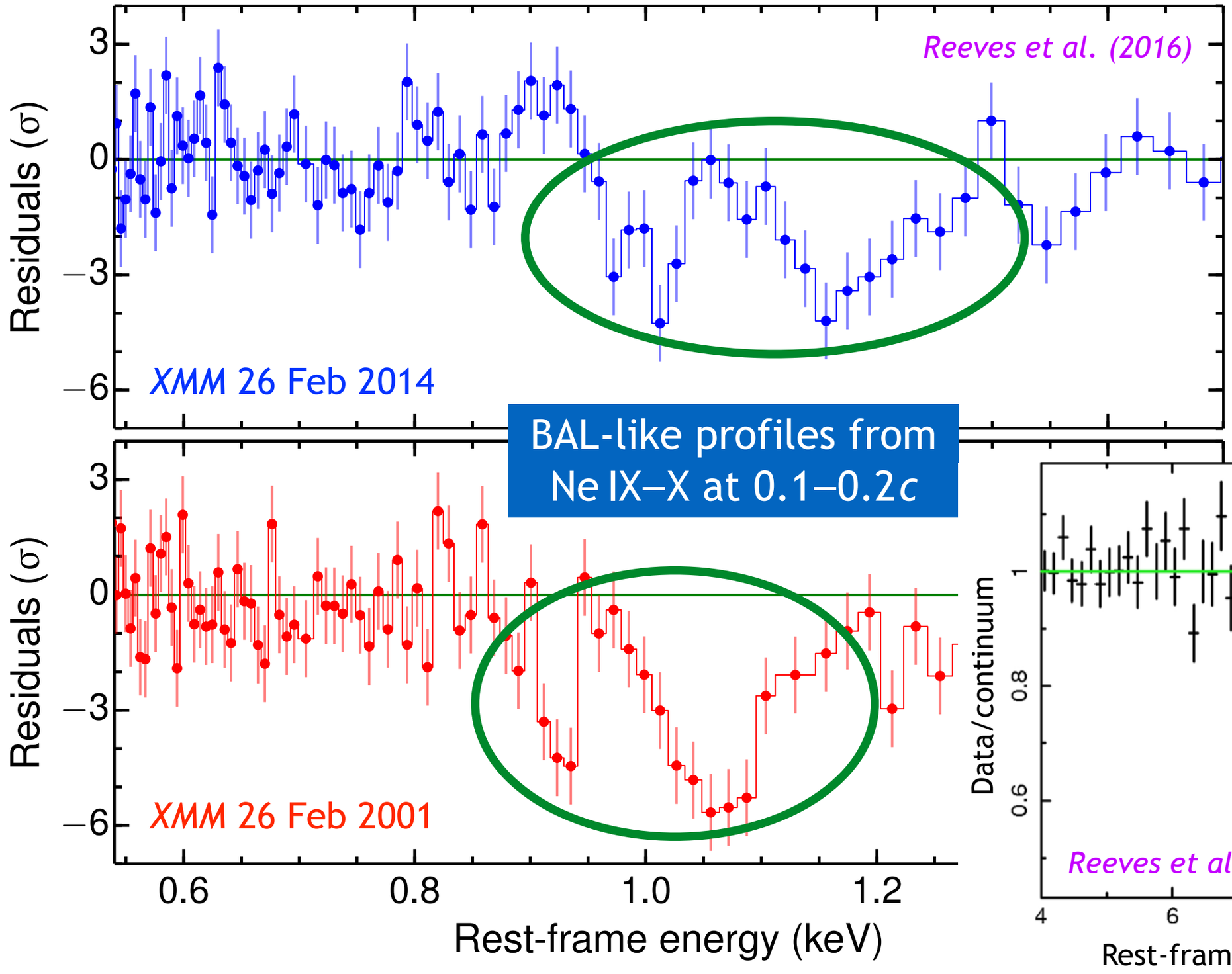
5

10

20

Energy (kiloelectron volts)

Following the wind's propagation



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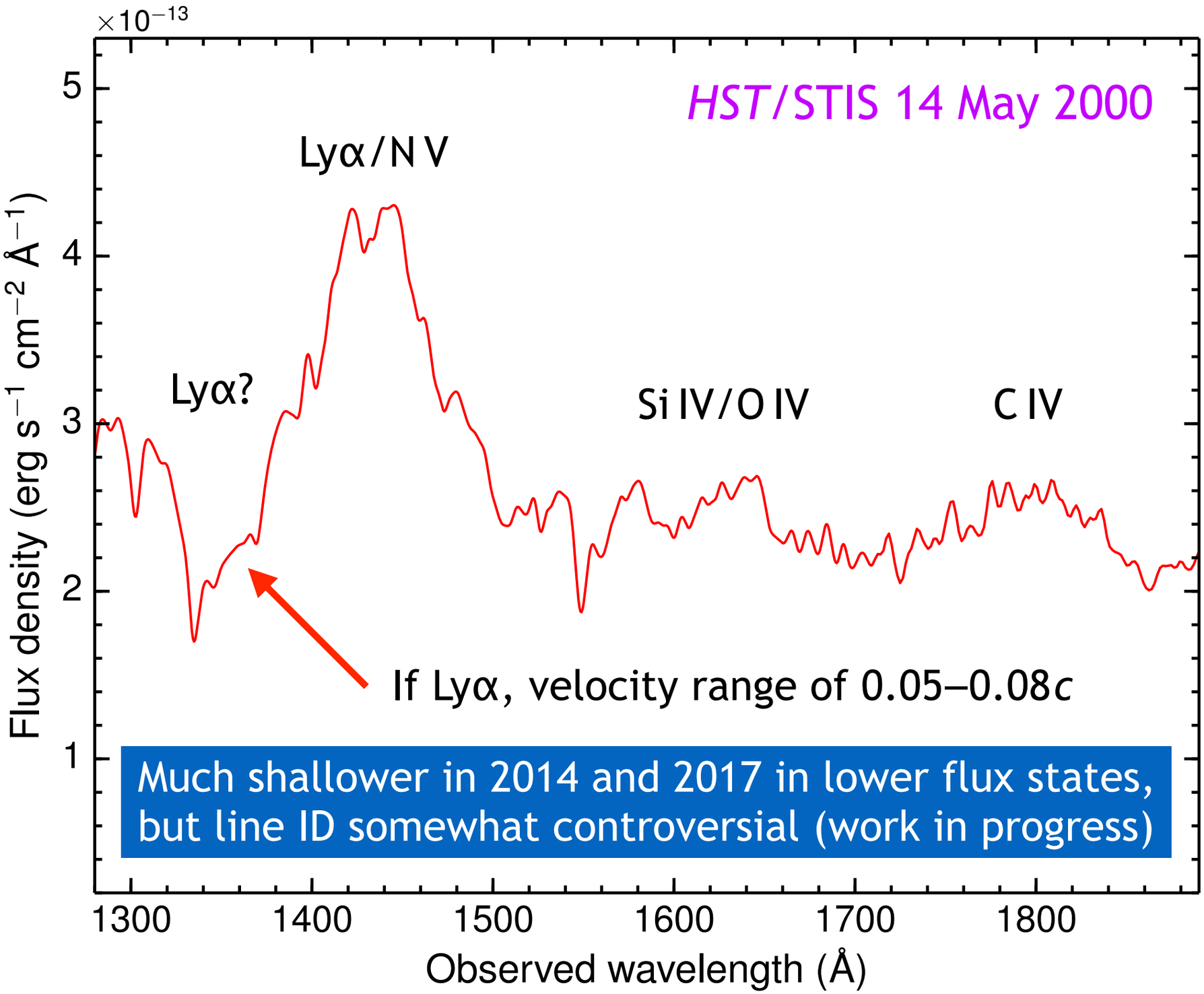
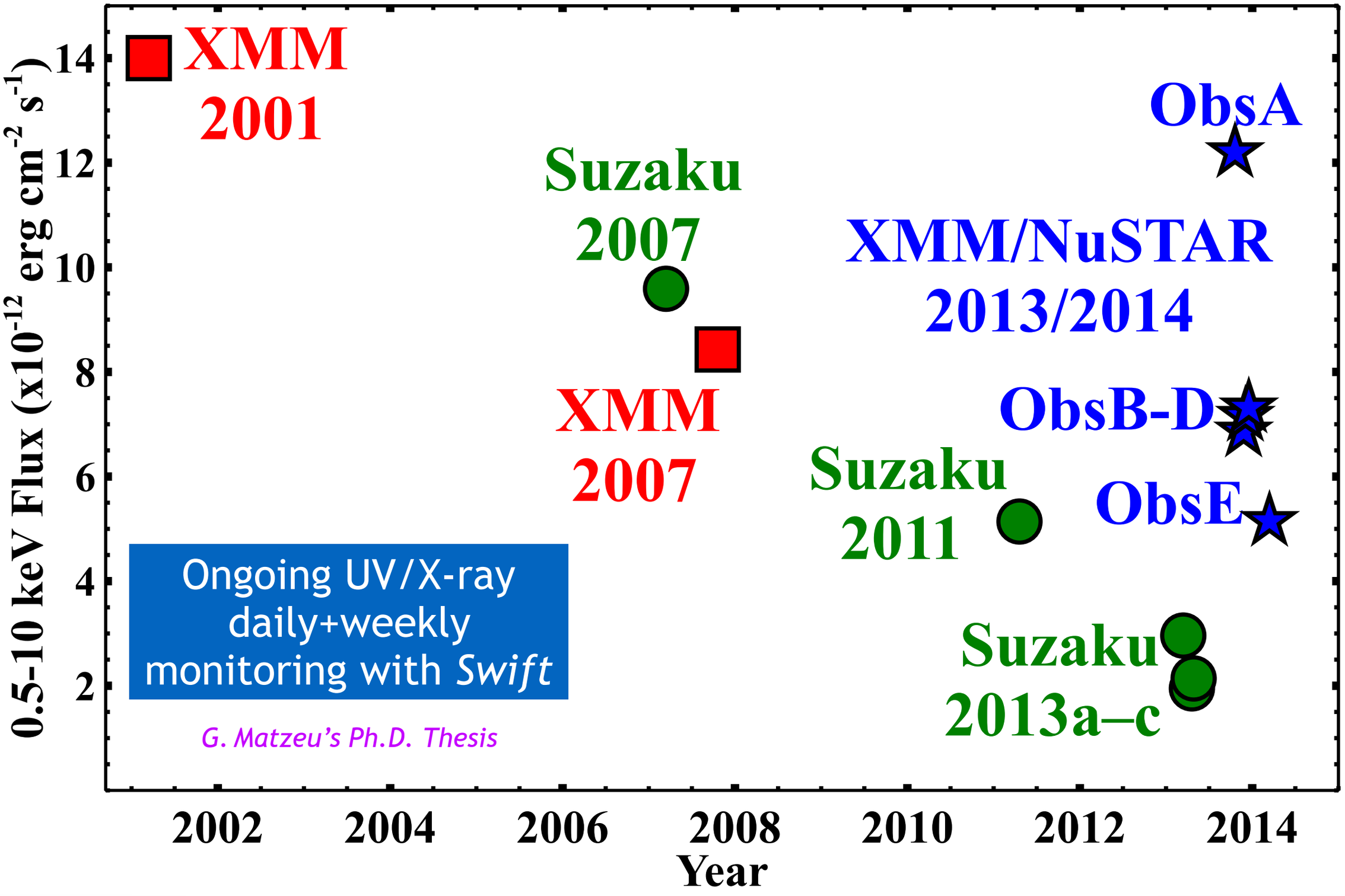


Evidence for radiative driving?



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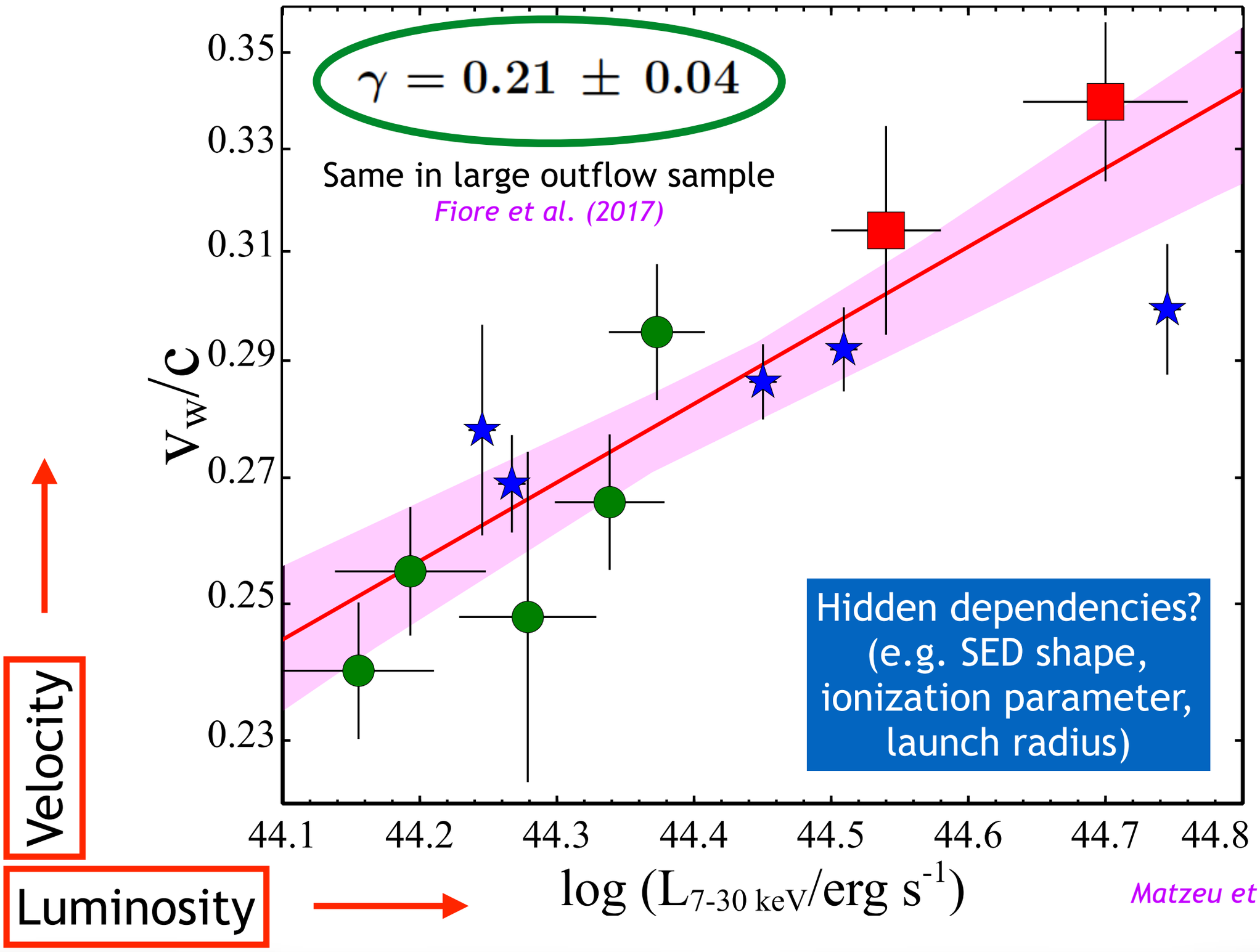

Matzeu et al. (in press)

Summary and future prospects

★ Galaxy-wide outflows observed in a large number of AGN at high redshift must be powered by the energy released during the central SMBH accretion process

★ The initial stage of SMBH winds is hard to probe in X-ray faint sources, so the trigger of AGN feedback at the peak of the quasar epoch remains rather obscure

★ PDS 456 is a genuine counterpart of the quasar population where feedback effects should be so dramatic to regulate SMBH growth and star formation in the host-galaxy bulge

★ ***What comes next?***

- Unification of different flavours of AGN-driven outflows
- Investigating the wind response to continuum changes
- Legacy programmes for X-ray winds at high redshift
- The long-awaited revolution of X-ray micro-calorimeters