Black Hole Feedback: Towards the Unification of Outflows in Active Galactic Nuclei

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 664931.

Project rationale

Galaxy-wide outflows can only be sustained by the energy released in the accretion process onto the central supermassive black holes. The ultimate goal of this project was to understand the fate of the resulting disc winds and their role in galaxy evolution, connecting all my research interests into a comprehensive picture.

Black hole winds

Radiative efficiency and black hole spin

Galactic outflows

AGN environment

AGN feedback and galaxy evolution

ULIRGs and obscured AGN

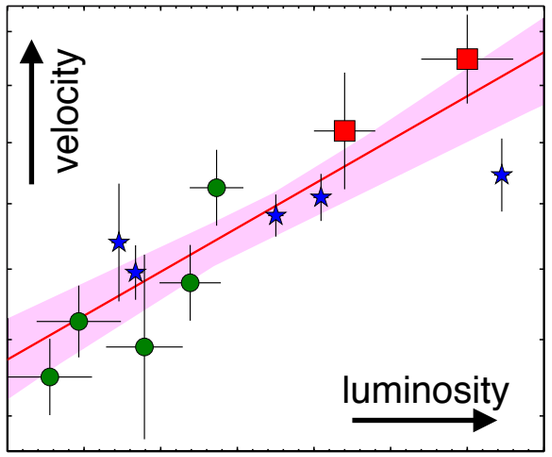
Score sheet

- **3** papers as first author (**+1** under review)
- **23** papers as co-author (**+2** under review)
- **9** successful proposals as PI (*XMM*, *NuSTAR*, *Swift*, *TNG*, *LBT)*
- **8** meetings and **1** workshop attended, **3** collaboration visits
- **5+3** contributed/invited talks and seminars
- **4+1** new long-term collaborations established
- **3** public lectures as part of INAF–OAA outreach activity

Main results and ongoing projects

- The prototypical SMBH disc wind in PDS 456
  - Discovery of velocity–luminosity correlation
  - Possible C IV counterpart of the Fe XXVI wind
  - Highest velocity component to date at 0.46*c*

  Matzeu+17, Hammann+18, Reeves+18

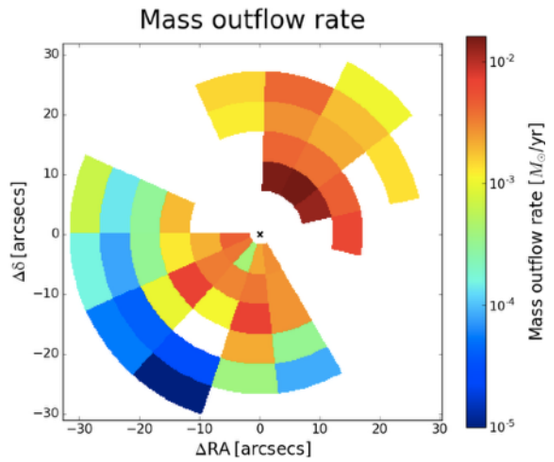


- X-ray activity in Brightest Cluster Galaxies

  Yang+18, collaboration with P. Tozzi at OAA

- Outflows as probes of past SMBH accretion

  ***EN** & Zubovas (2018),* new collaboration

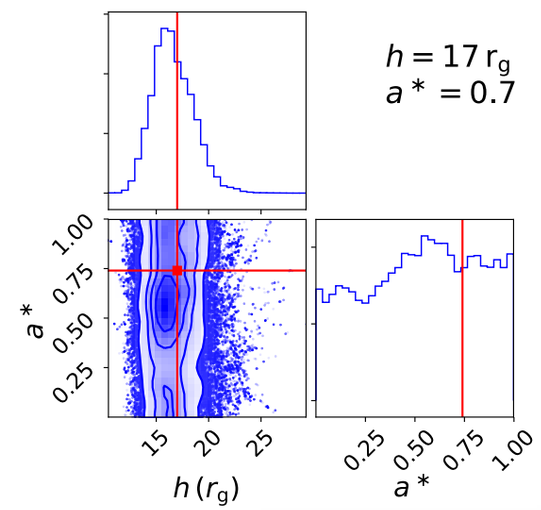


- Joint MUSE/*Chandra* view of nearby Seyferts

  *Venturi, **EN**+18, **EN**+ in prep.*, MAGNUM collaboration

- Simulation-based test of SMBH spin measures

  *Kammoun, **EN**, Risaliti (2018)*



- An informed quest for accretion-disc winds

  ***EN**+19*

- Disc winds at play in quasars at high redshift

  ***EN**+submitted*

Closing remarks

From my application:

The AstroFIt2 Fellowship is considered as the ideal final step to fully establish myself as an independent researcher and potential group leader

- Overall, the experience as an AstroFIt2 Fellow has been positive
- The length of the Fellowship (3 years) ensures the minimum stability to pursue ambitious plans and/or *unsafe* lines of investigation
- The travel allowance is adequate to attend all the major conferences on the research topics of the project and give broad visibility to the results, create new collaboration links and maintain the existing ones
- The opportunity to carry out an independent research agenda is fundamental to prove one's capability of taking any position of responsibility in the long term, although immediate prospects after the Fellowship are somewhat subject to contingent circumstances

The future I.

An informed quest for X-ray winds

Why informed

The fraction of AGN with at least one blueshifted Fe-K feature is about 40%

… at least one, and at least ***once*** → wind incidence is possibly lower

Evidence is now growing that the ratio $E_{\rm outflow}$ / (d$E_{\rm wind}$ / dt) is in many cases much smaller than the lifetime of the large-scale outflow

e.g. ***EN*** *& Zubovas (2018)*

→ disc wind duty cycle can be very short (< 10^5 yr)

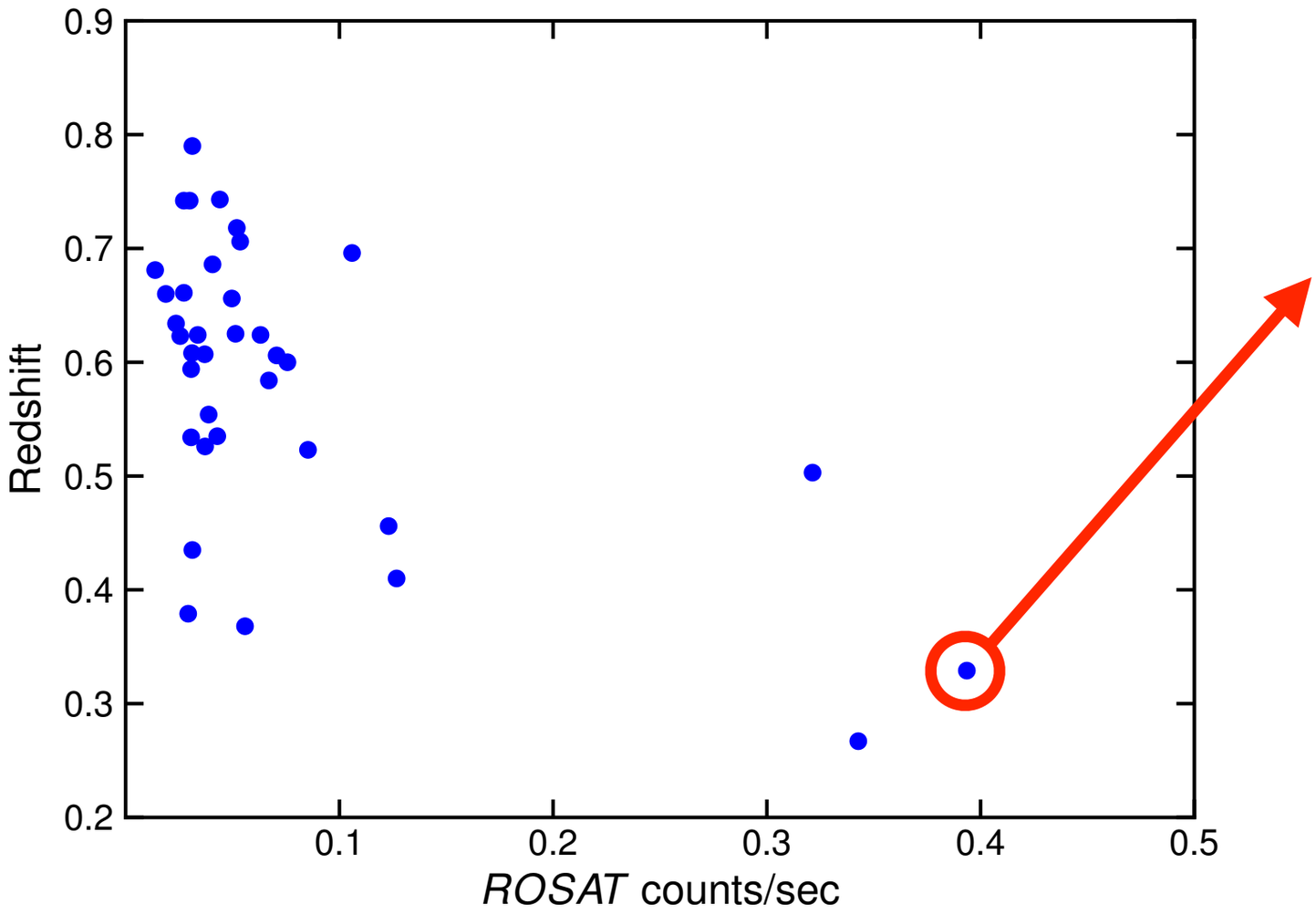
The discovery of ultra-fast X-ray winds still relies on blind searches over highly inhomogeneous samples (many Seyferts, some PG quasars, a few lensed high-*z* objects) or follow-ups of otherwise peculiar sources

→ element of *fortuity* and impediment to coherent picture

★ Identify any distinctive multi-wavelength signature of the *X-ray blow-out phase* for an indirect characterization of X-ray winds

A tailored selection method

- 1,091 objects with EW [O III] < 6 Å (most likely to be face-on)
- High luminosity: $L_{bol} > 10^{46}$ erg/s (proxy of high accretion rate)
- Radio-quiet and detected by *ROSAT* (36 objects)



Ton 28

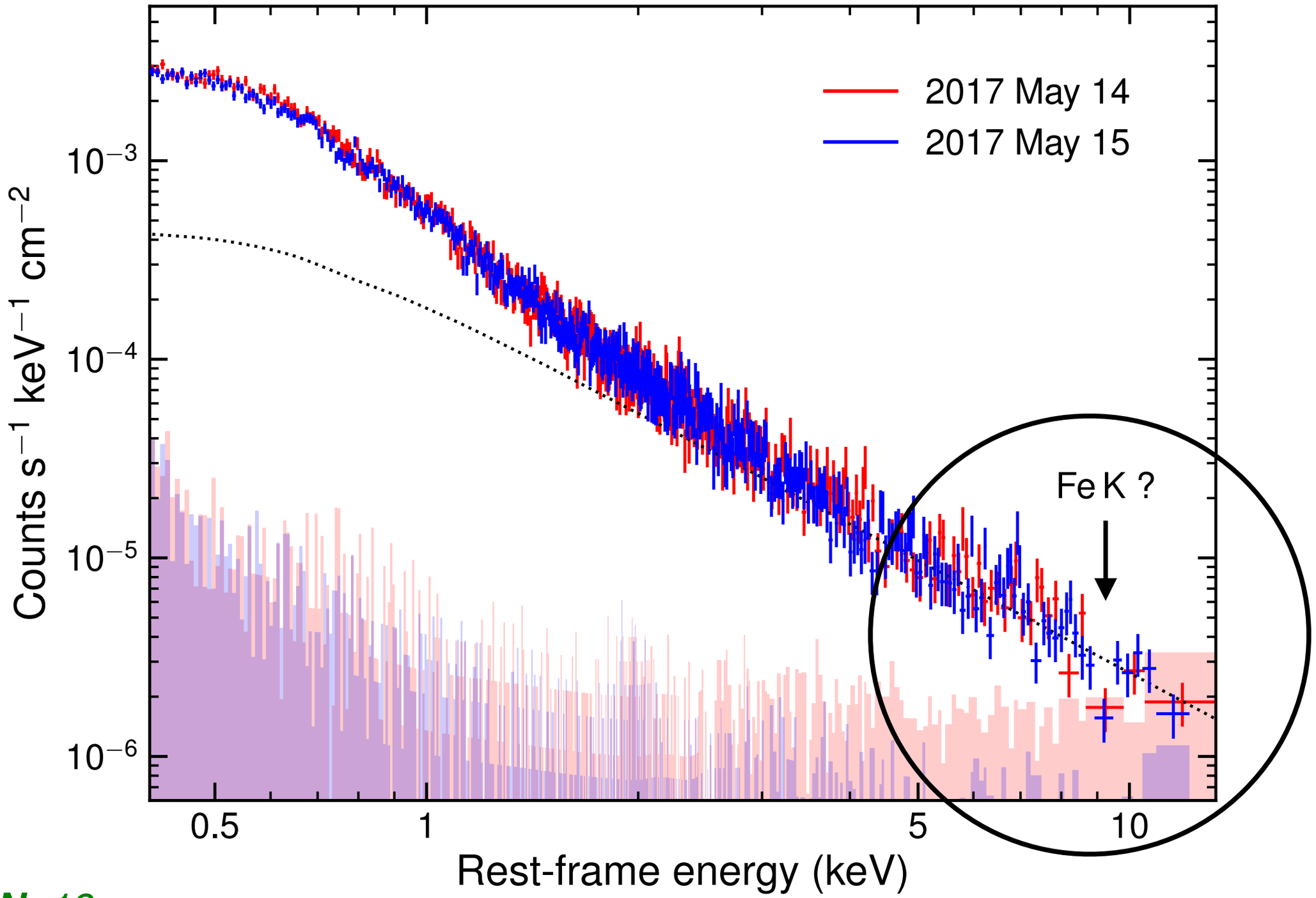
$z = 0.329$

$\log L_{bol} = 46.4$

Optimal target to reveal an ultra-fast X-ray wind

EN+19

XMM-Newton observation(s) of Ton 28



EN+19

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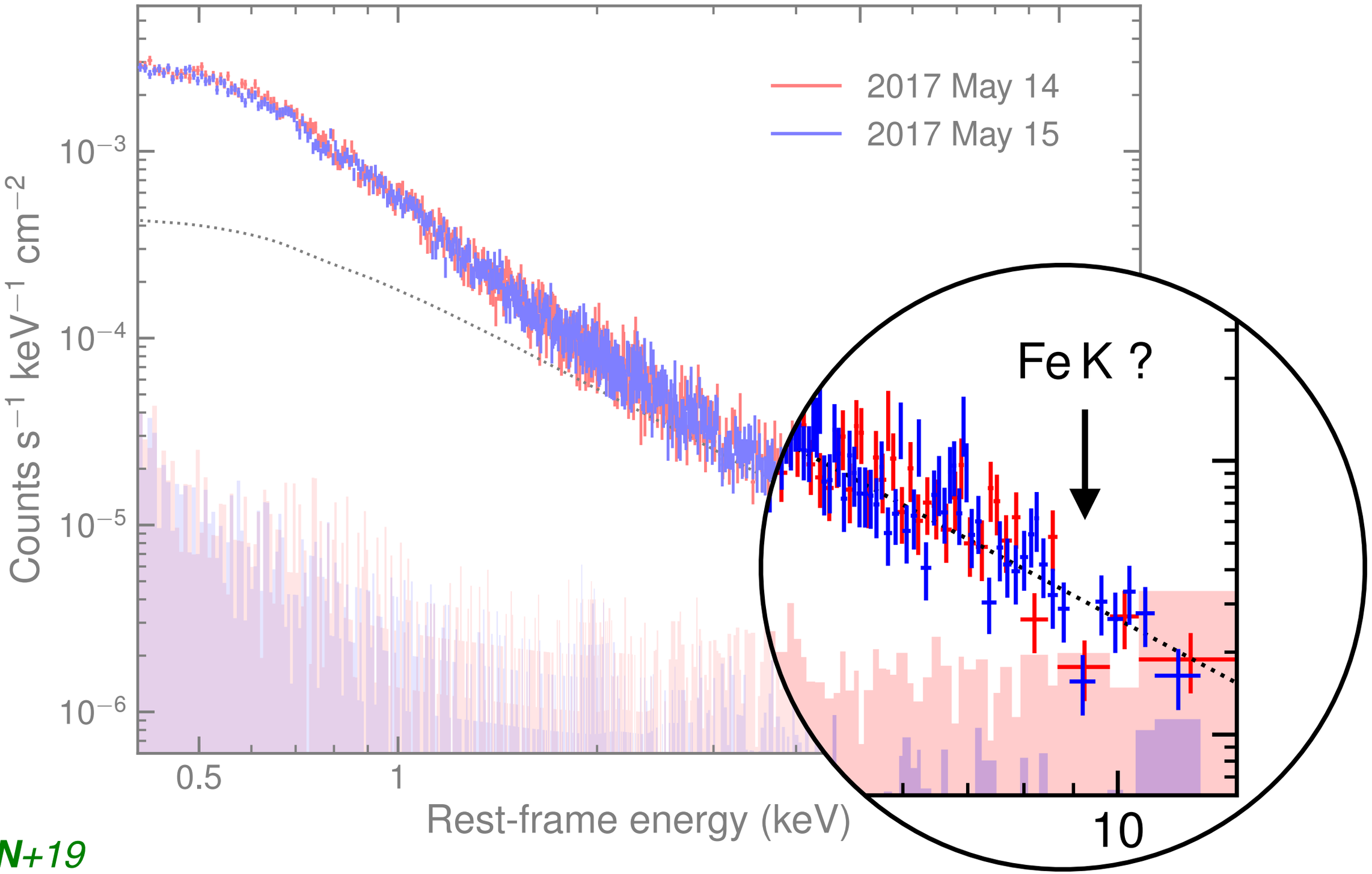
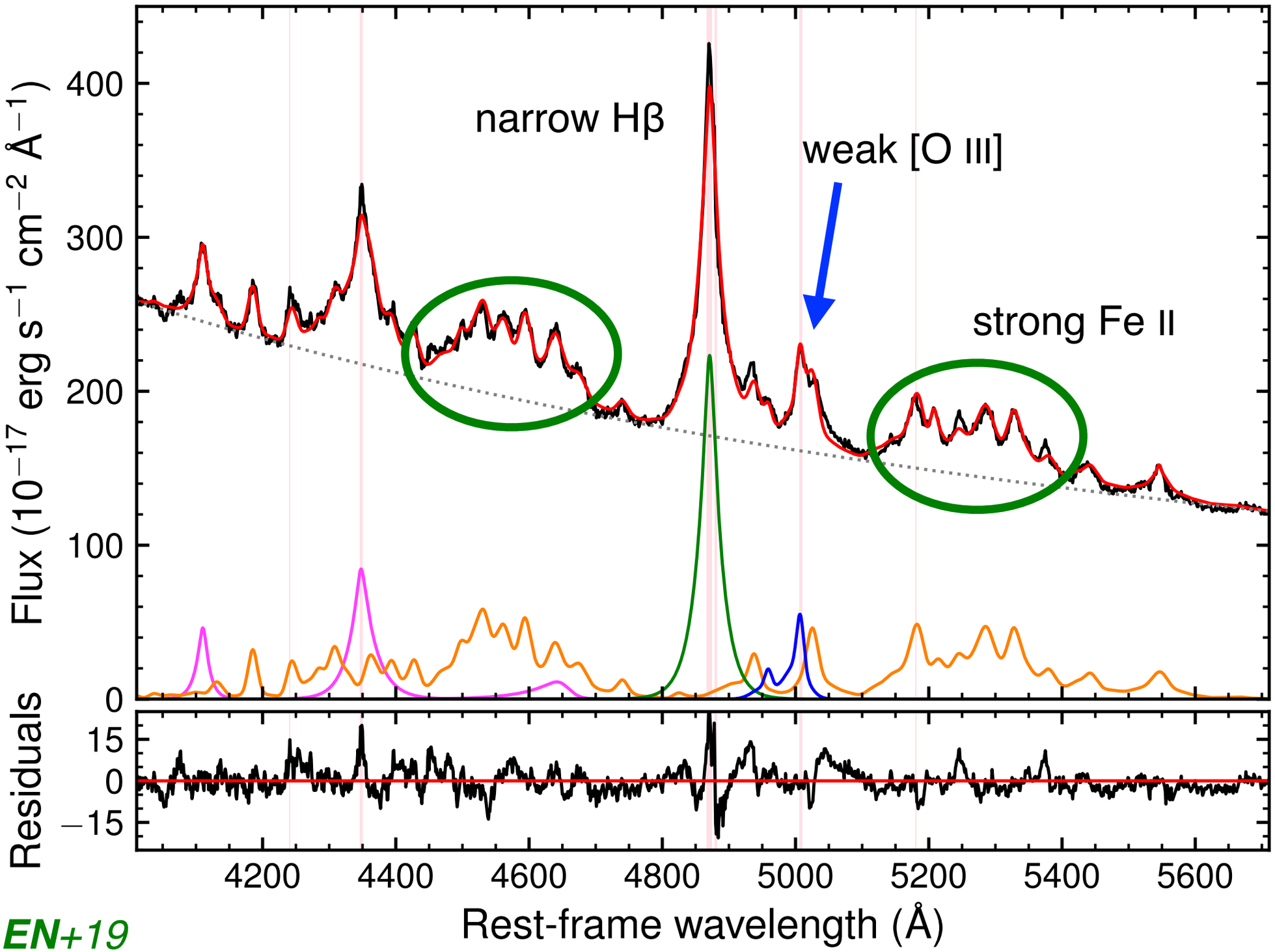


EN+19

Relation with multi-wavelength features



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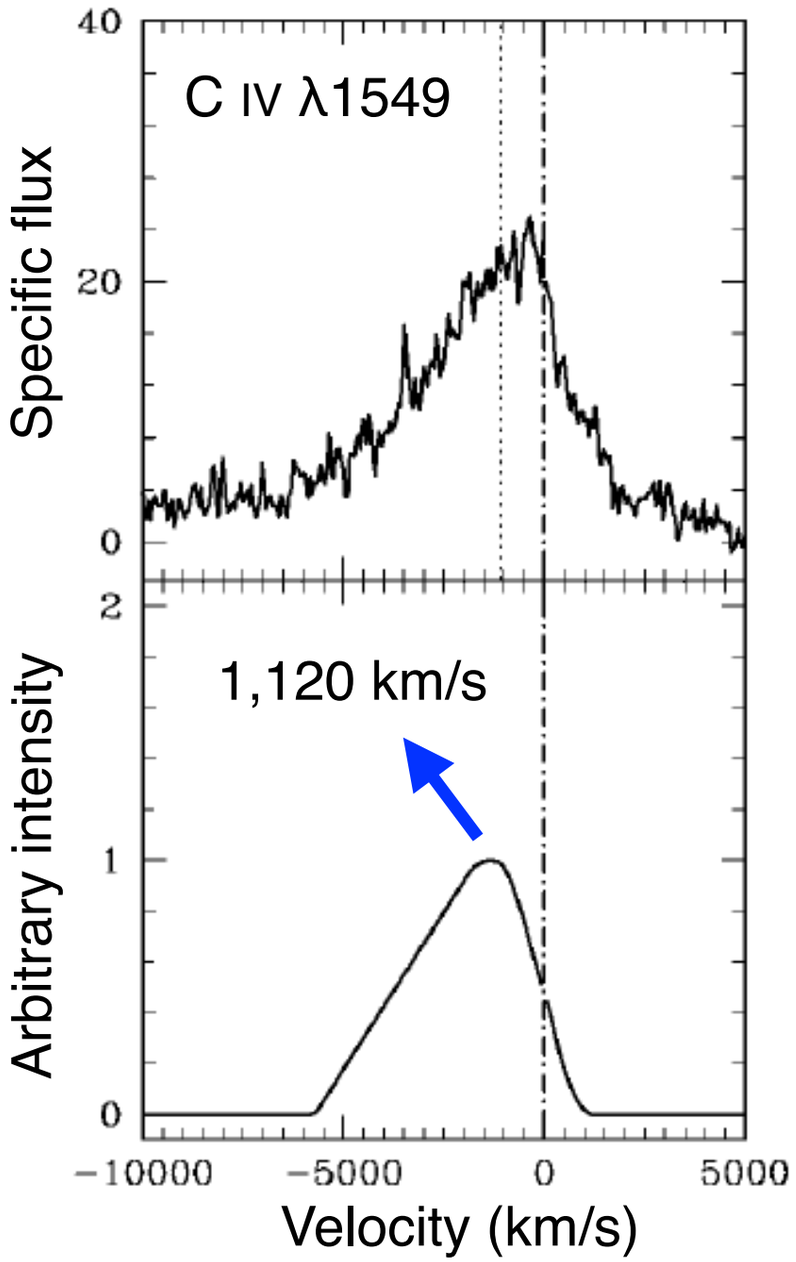
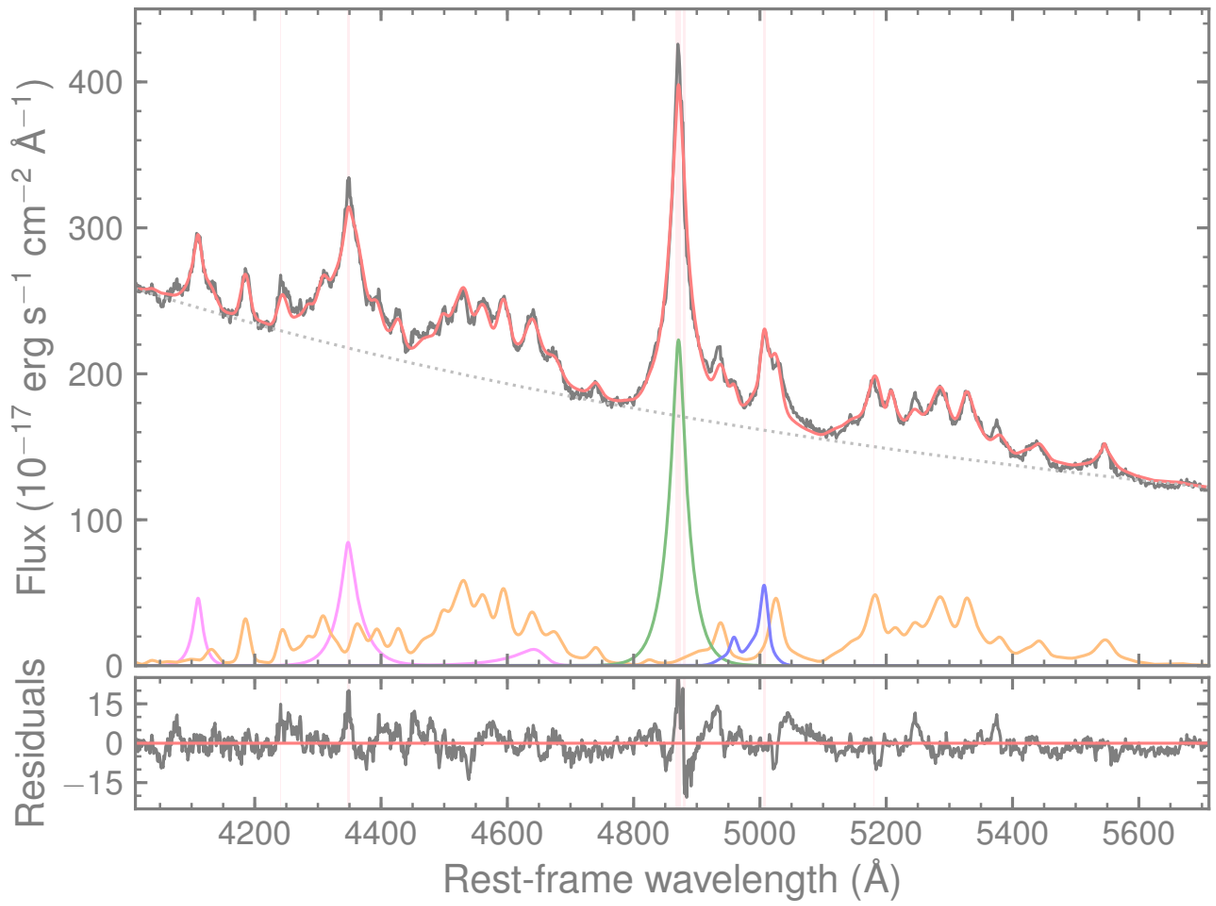


Zamanov et al. (2002)



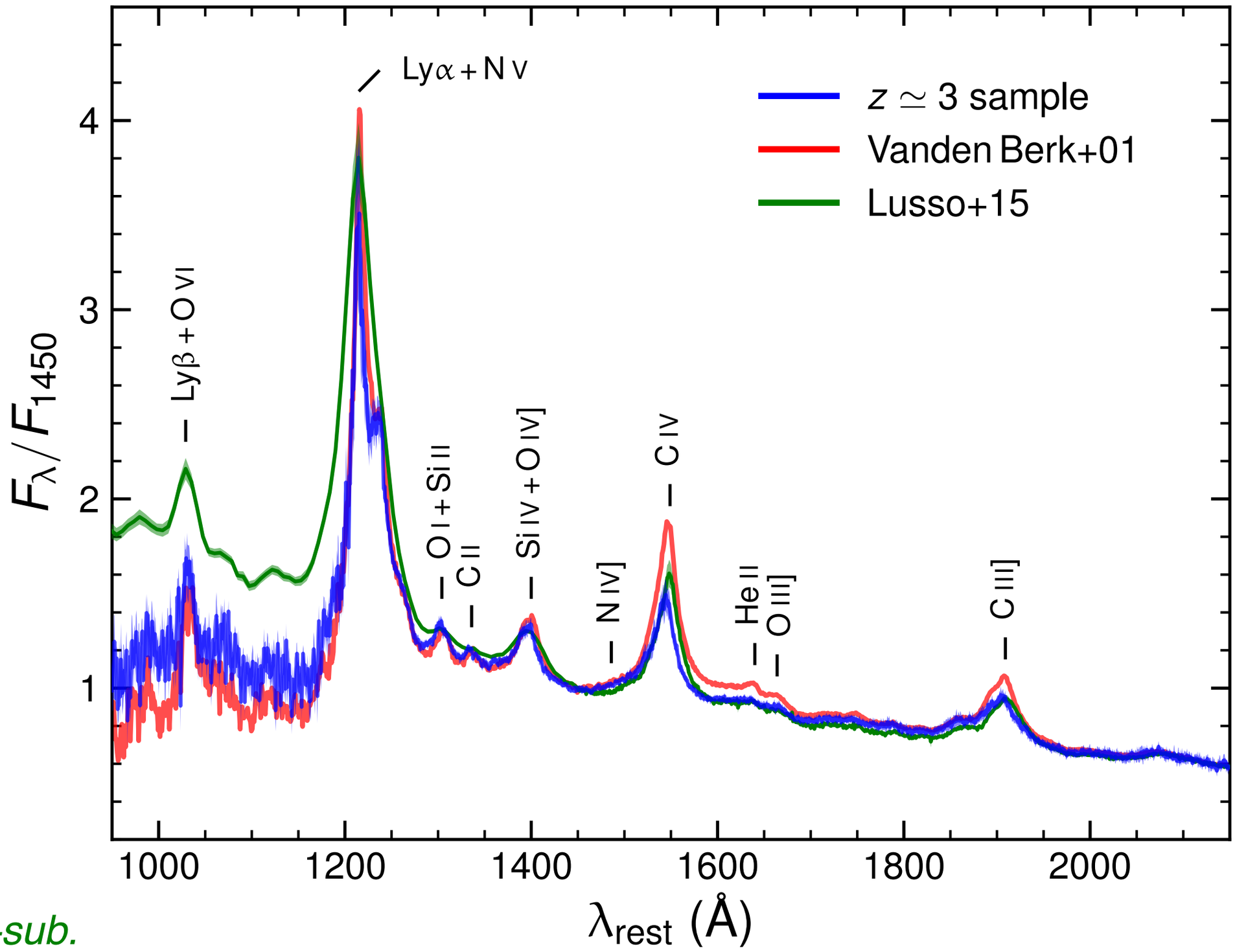
In terms of the Eigenvector 1 formalism, Ton 28 is a *blue outlier* of the extreme population A

If the connection is confirmed, we can estimate the duty cycle of X-ray winds from the fraction of *xA* sources within the AGN population

The future II.

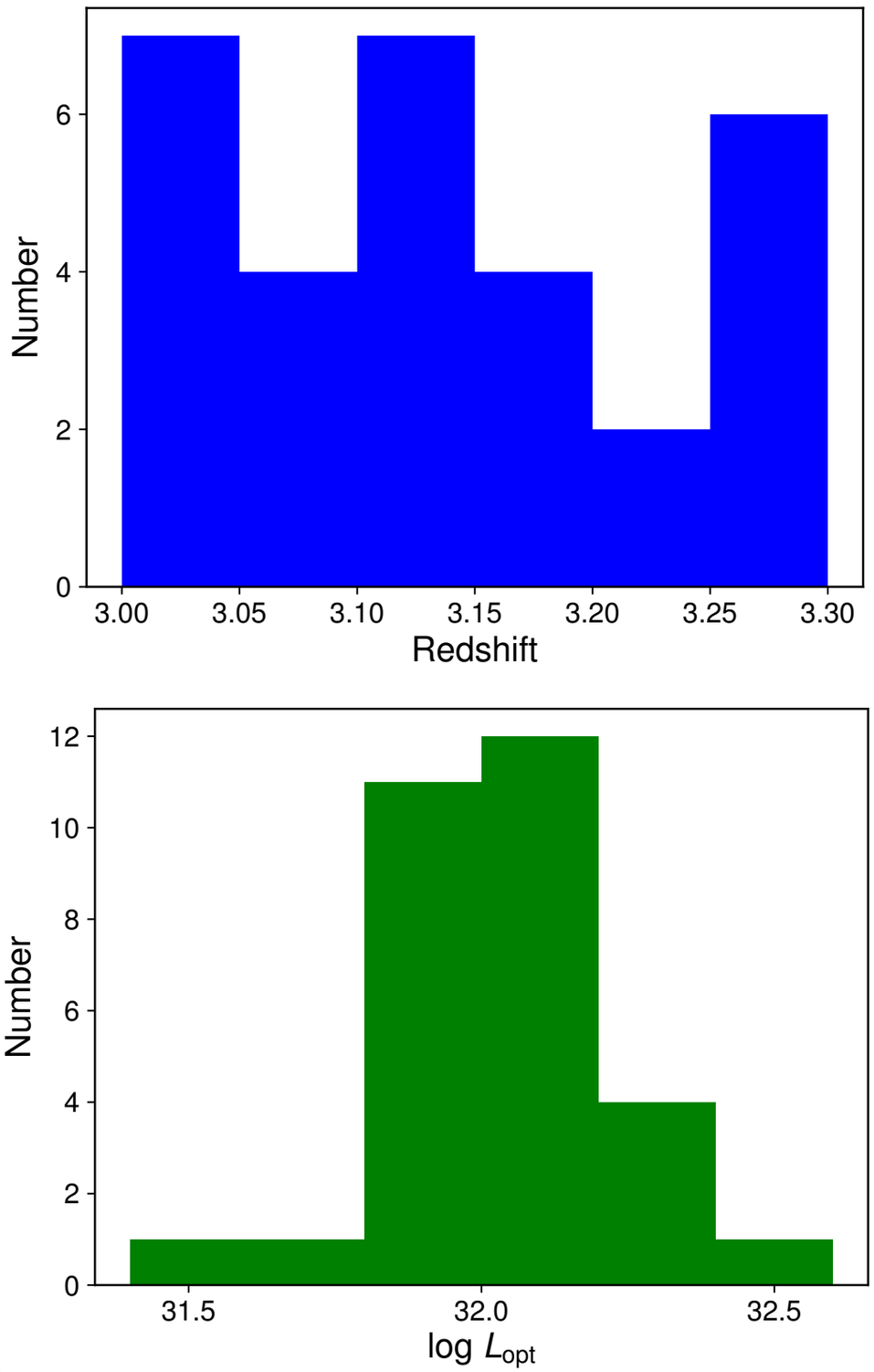
X-ray weak, UV luminous quasars

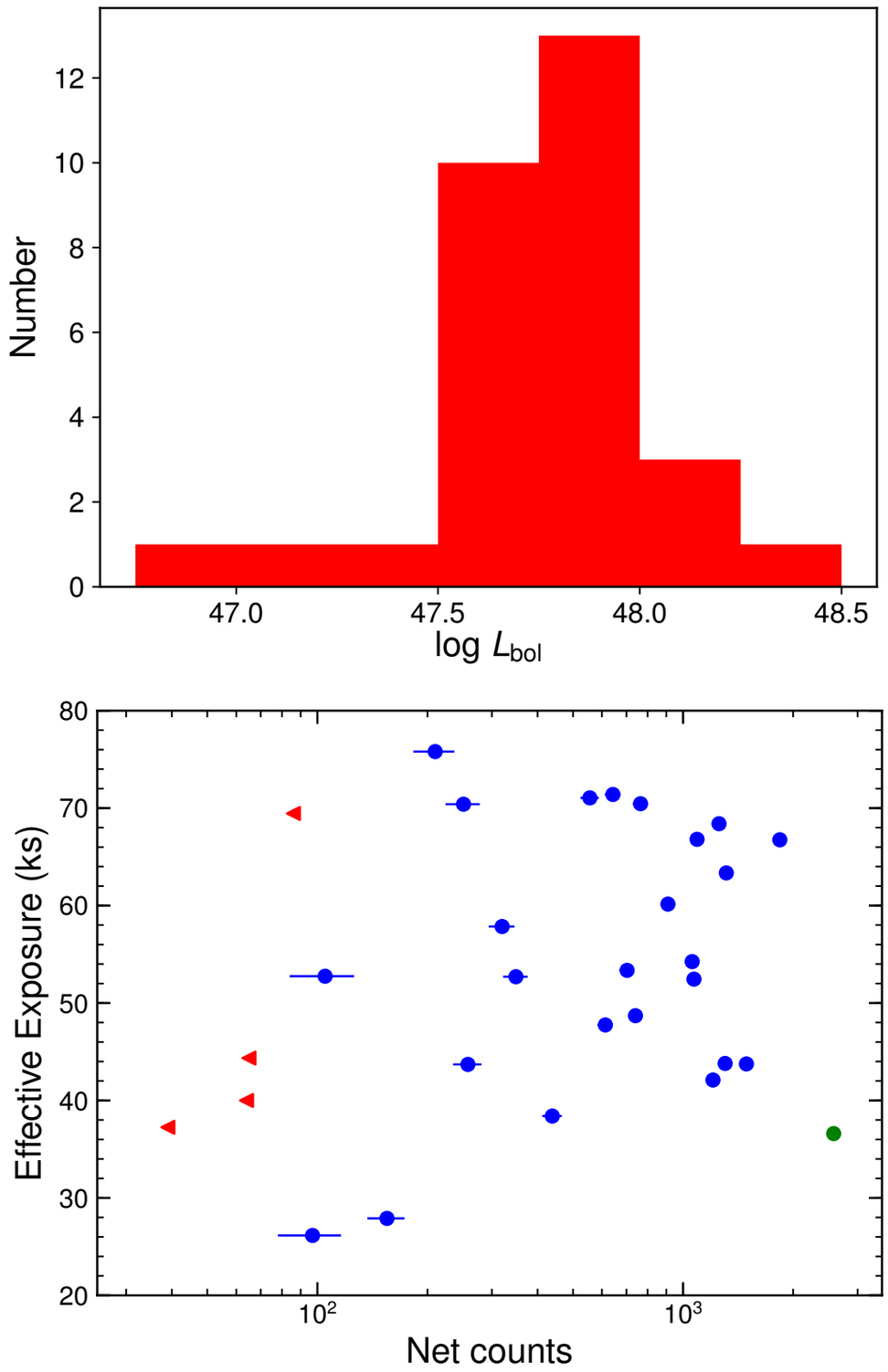
The z~3 XMM-Newton sample



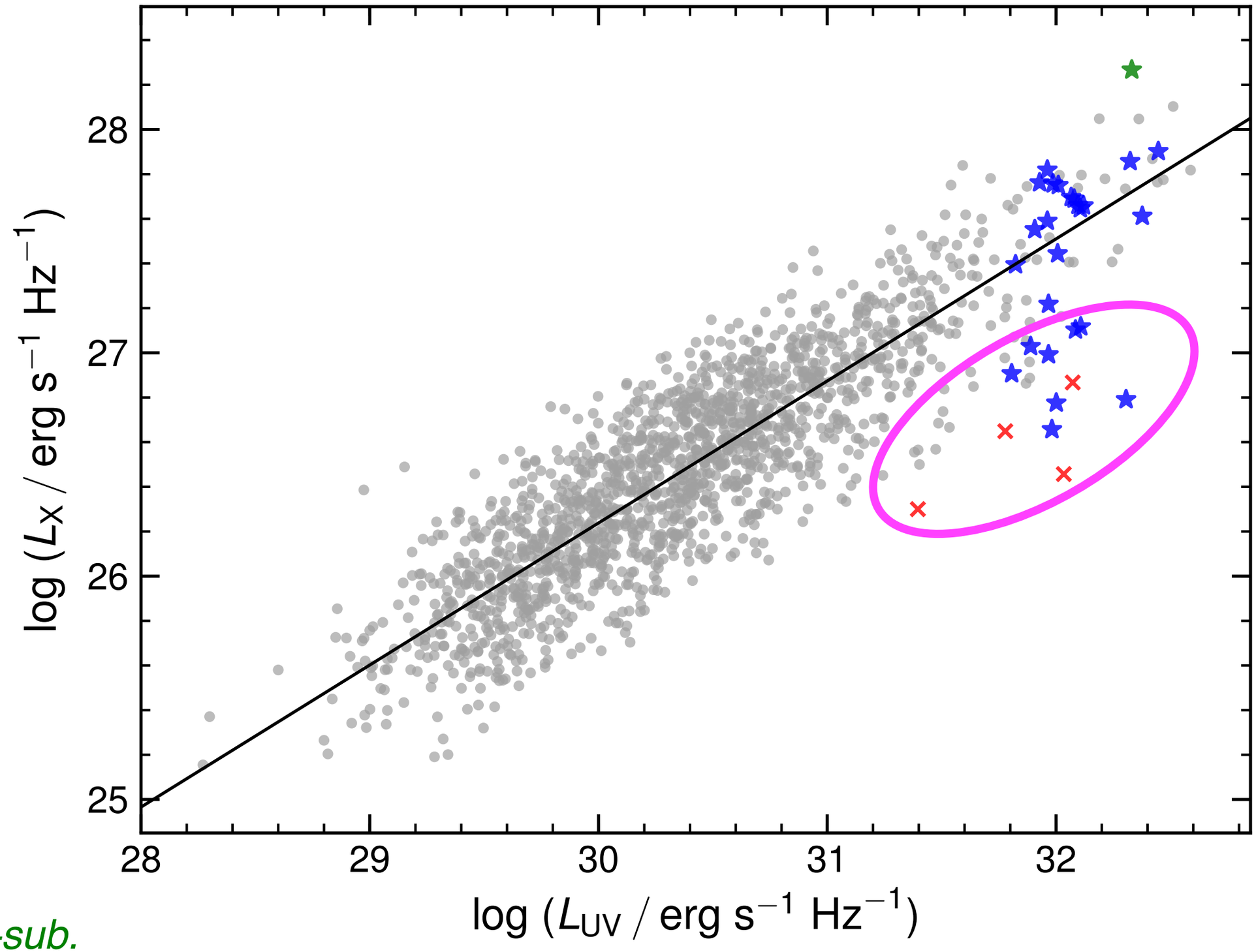
***EN**+sub.*

The z~3 XMM-Newton sample





The ‘cleaned’ L_X-L_{UV} relation



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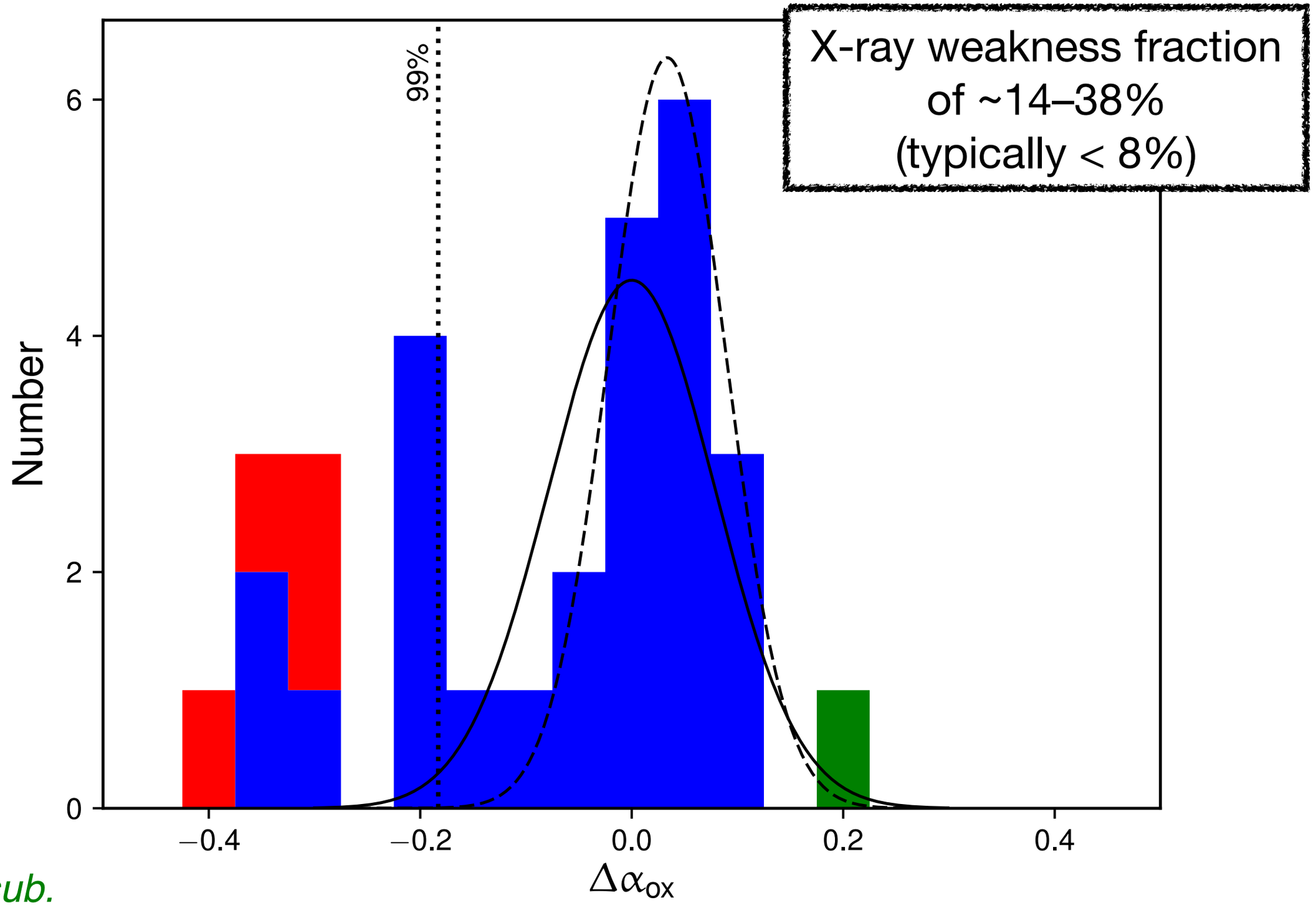
A new population of X-ray weak quasars?



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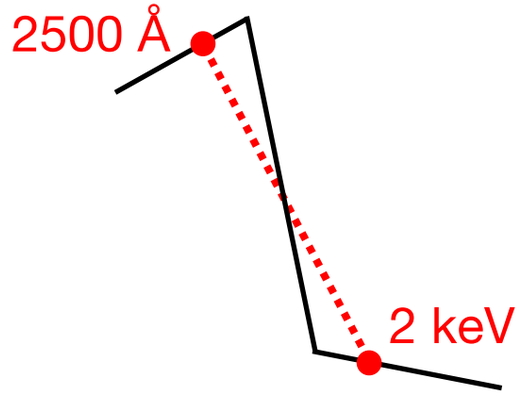
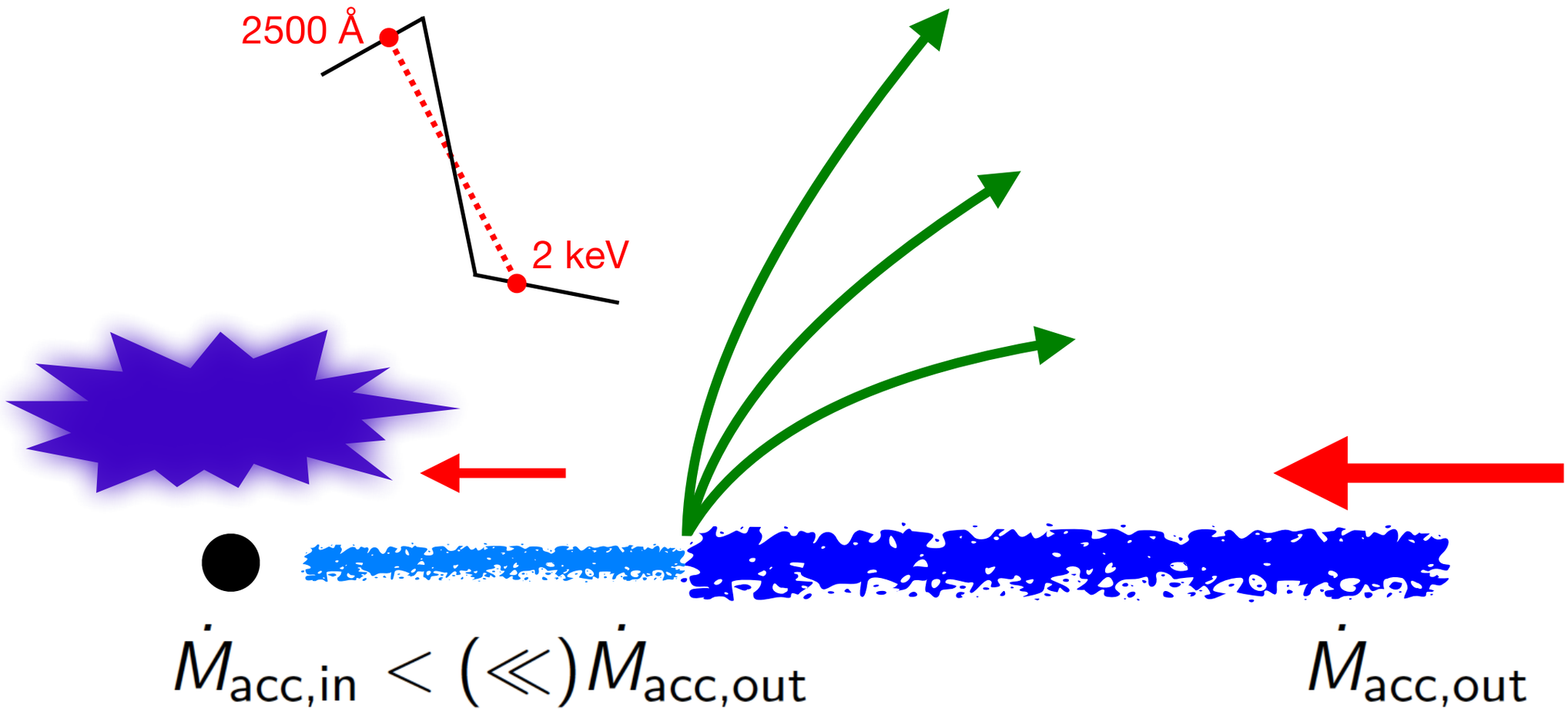
X-ray weakness and disc winds

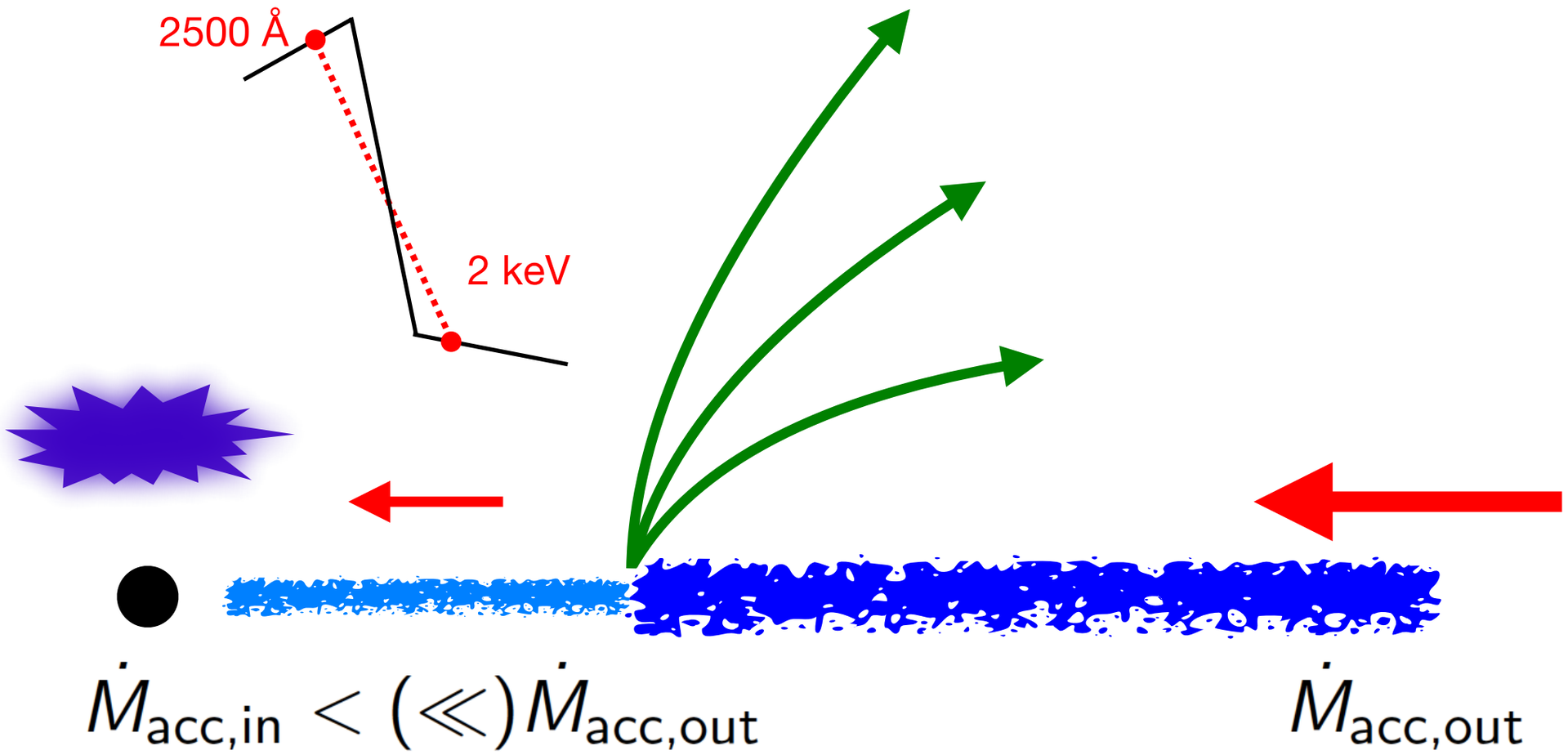


$\dot{M}_{\rm acc,out}$

X-ray weakness and disc winds



X-ray weakness and disc winds



- X-ray weakness: *requirement* for winds or *consequence* thereof?
- Departure from L_X-L_{UV} relation as a diagnostic of the wind power
- Further clues from two approved LBT observational campaigns

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