

Changing-look Active Galactic Nuclei

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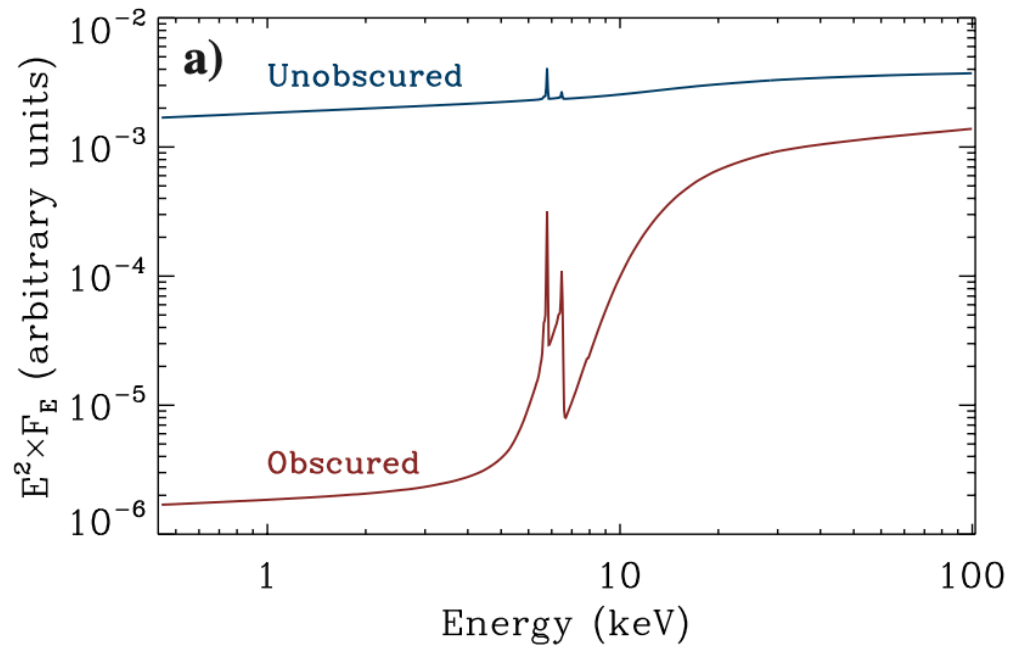
Changing-look AGN

Mon. Not. R. Astron. Soc. **342**, 422–426 (2003)

Changing look: from Compton-thick to Compton-thin, or the rebirth of fossil active galactic nuclei

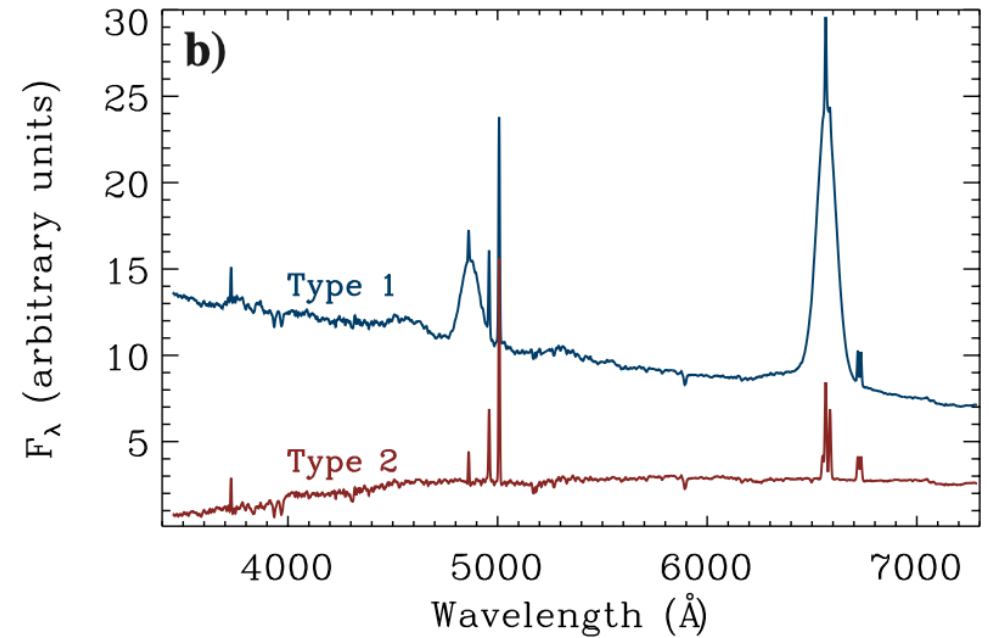
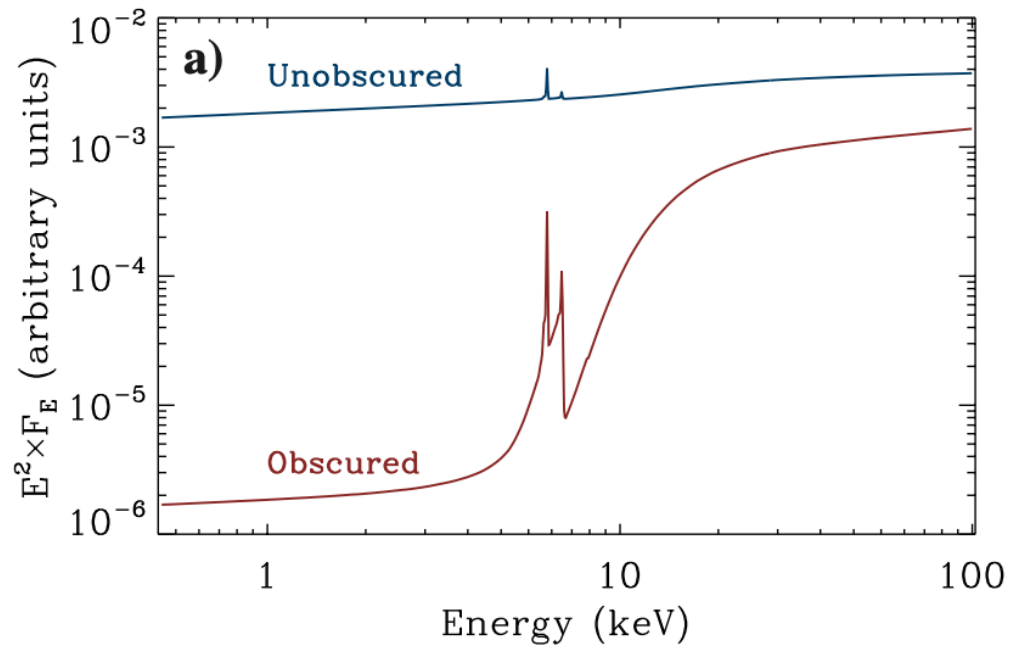
Giorgio Matt,^{1★} Matteo Guainazzi² and Roberto Maiolino^{1,3}

Changing-look AGN



Ricci & Trakhtenbrot 2023, Nature Astronomy review

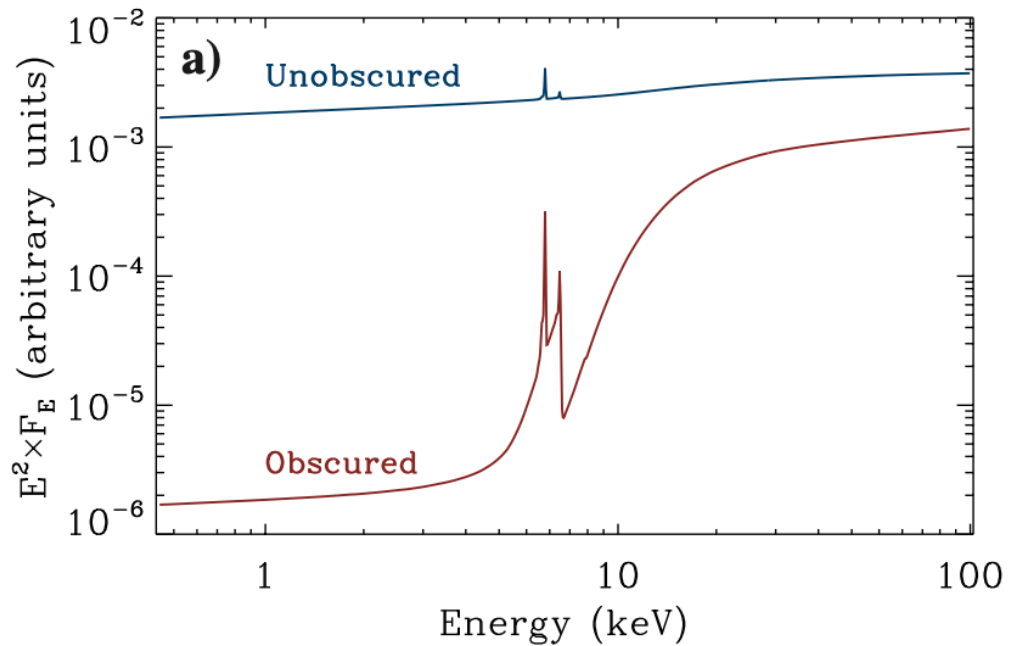
Changing-look AGN



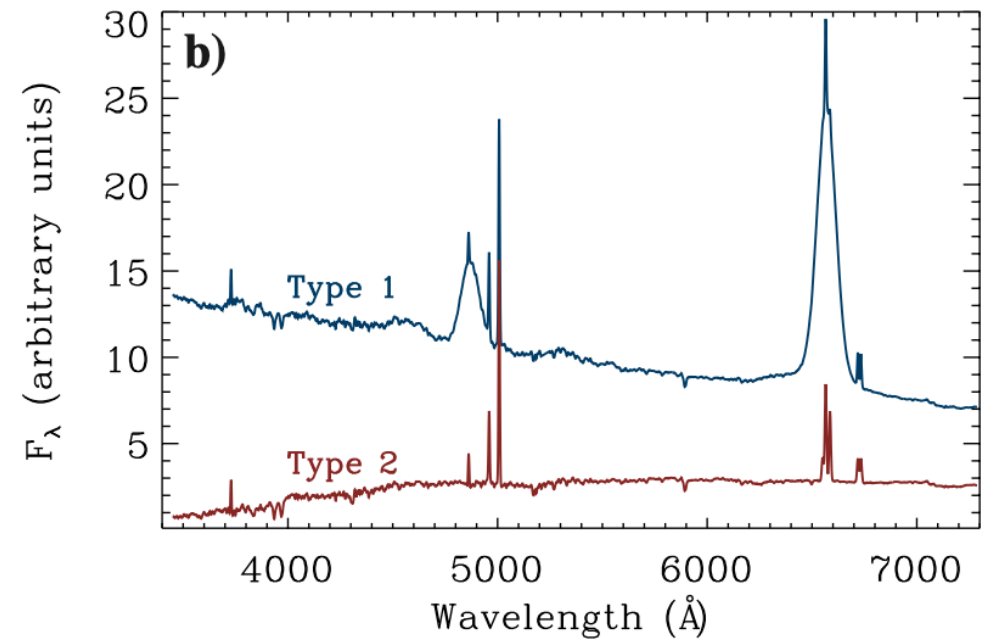
Ricci & Trakhtenbrot 2023, Nature Astronomy review

Changing-look AGN

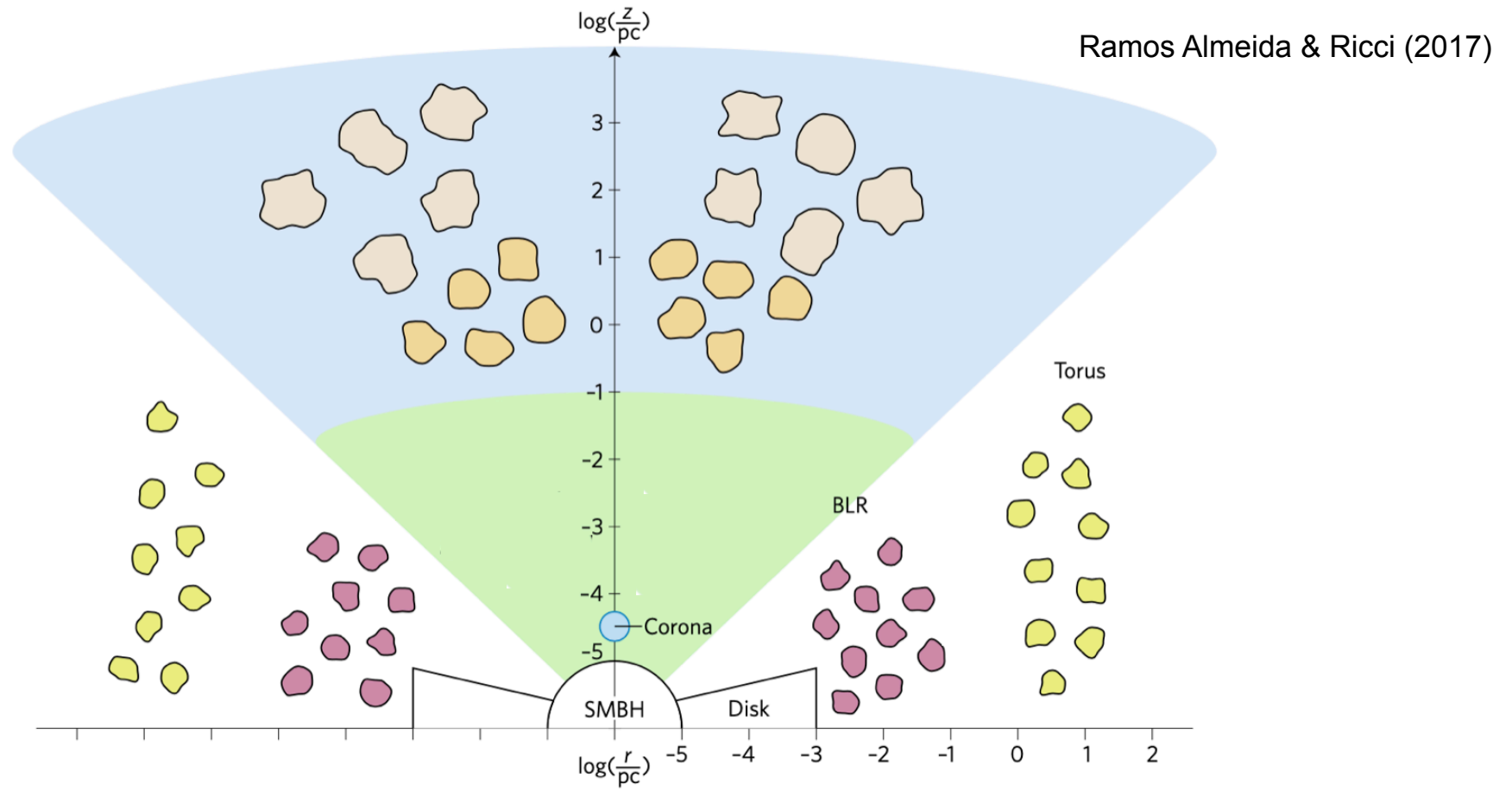
Changing-obscuration AGN



Changing-state AGN



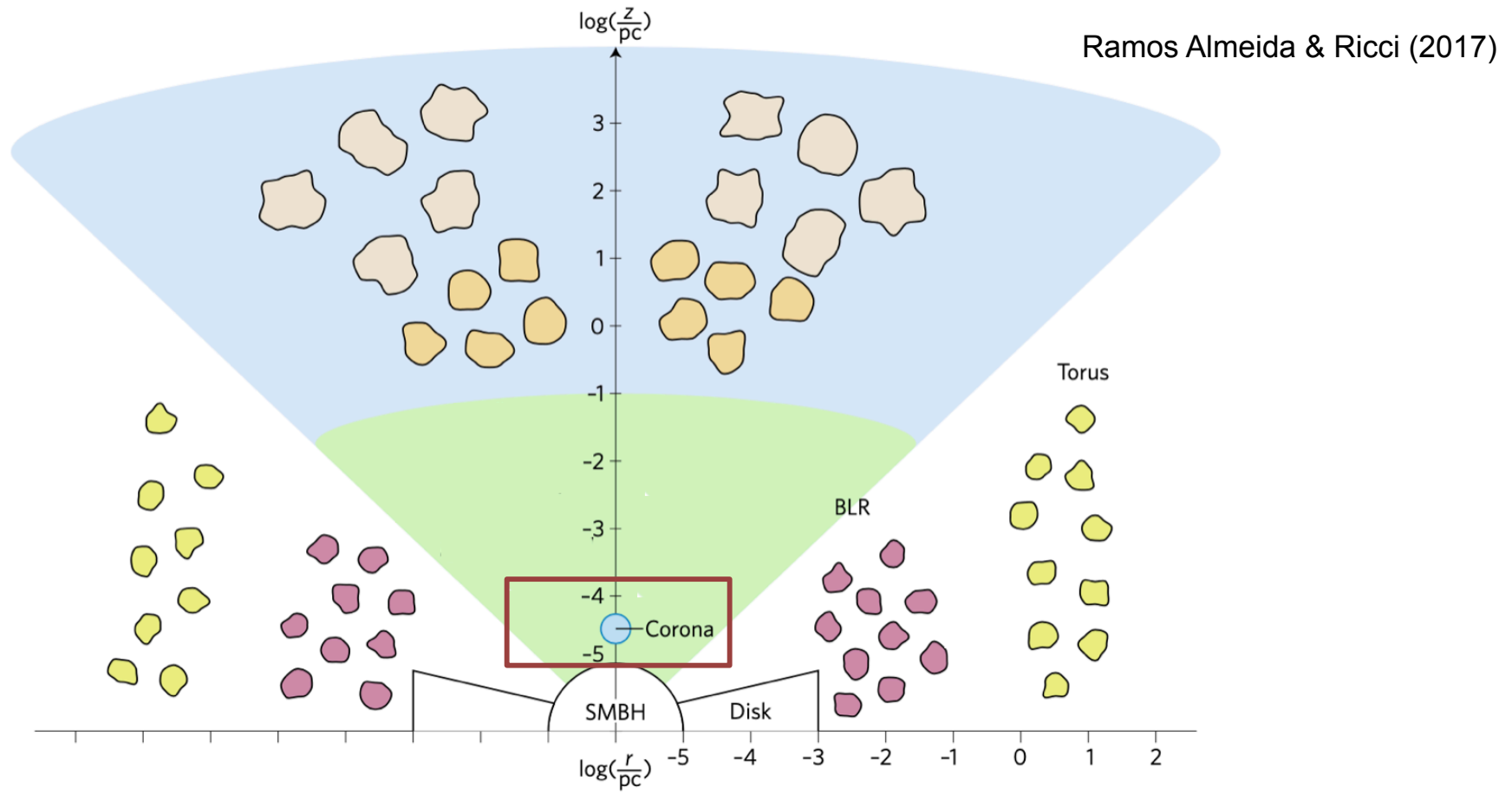
Why do we care about CL AGN?



Changing-obscuration AGN

Changing-state AGN

Why do we care about CL AGN?



Changing-obscuration AGN

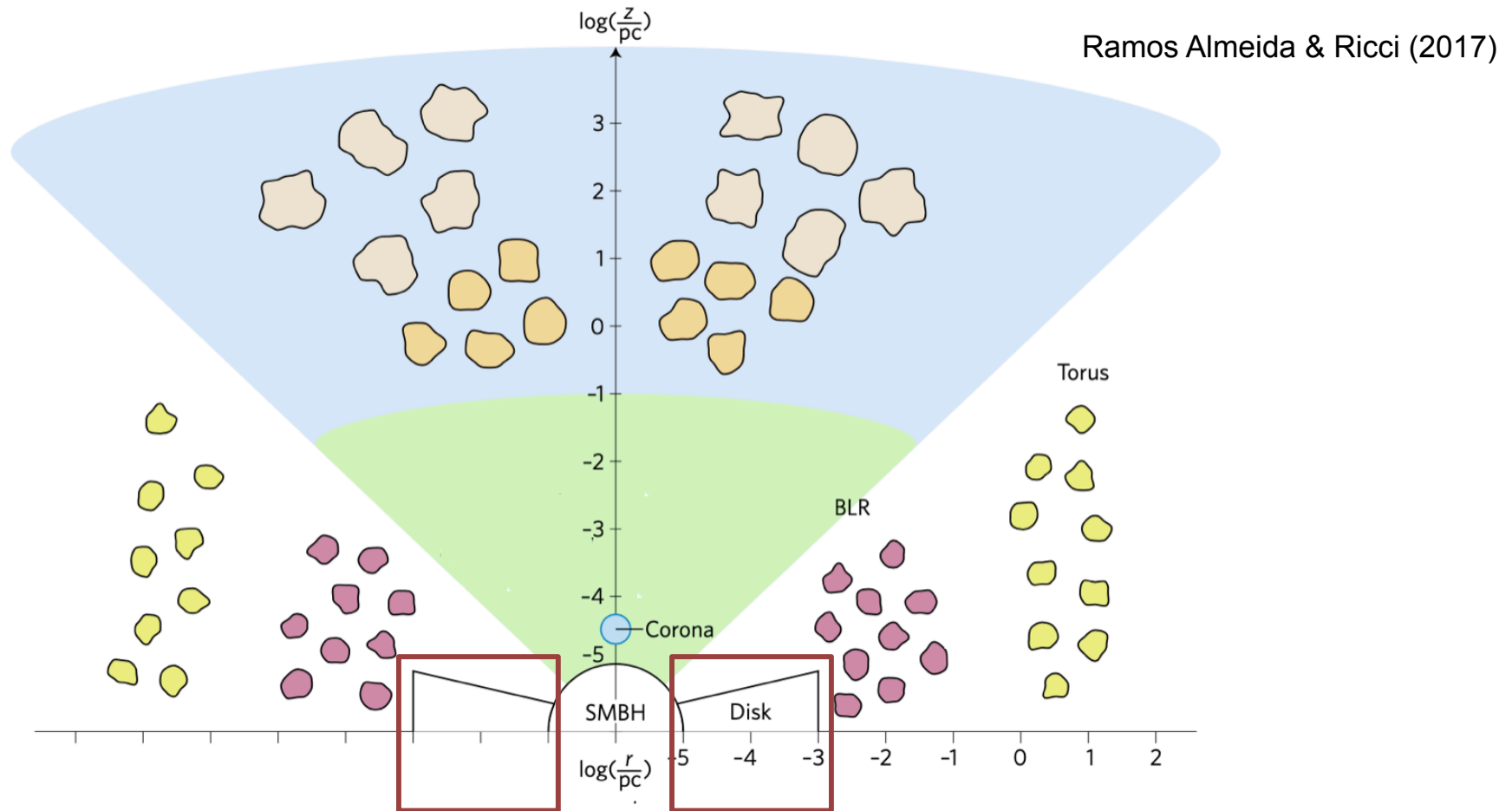
Changing-state AGN

X-ray corona

Size

**Creation, evolution with changes
in accretion**

Why do we care about CL AGN?



Changing-obscuration AGN

Changing-state AGN

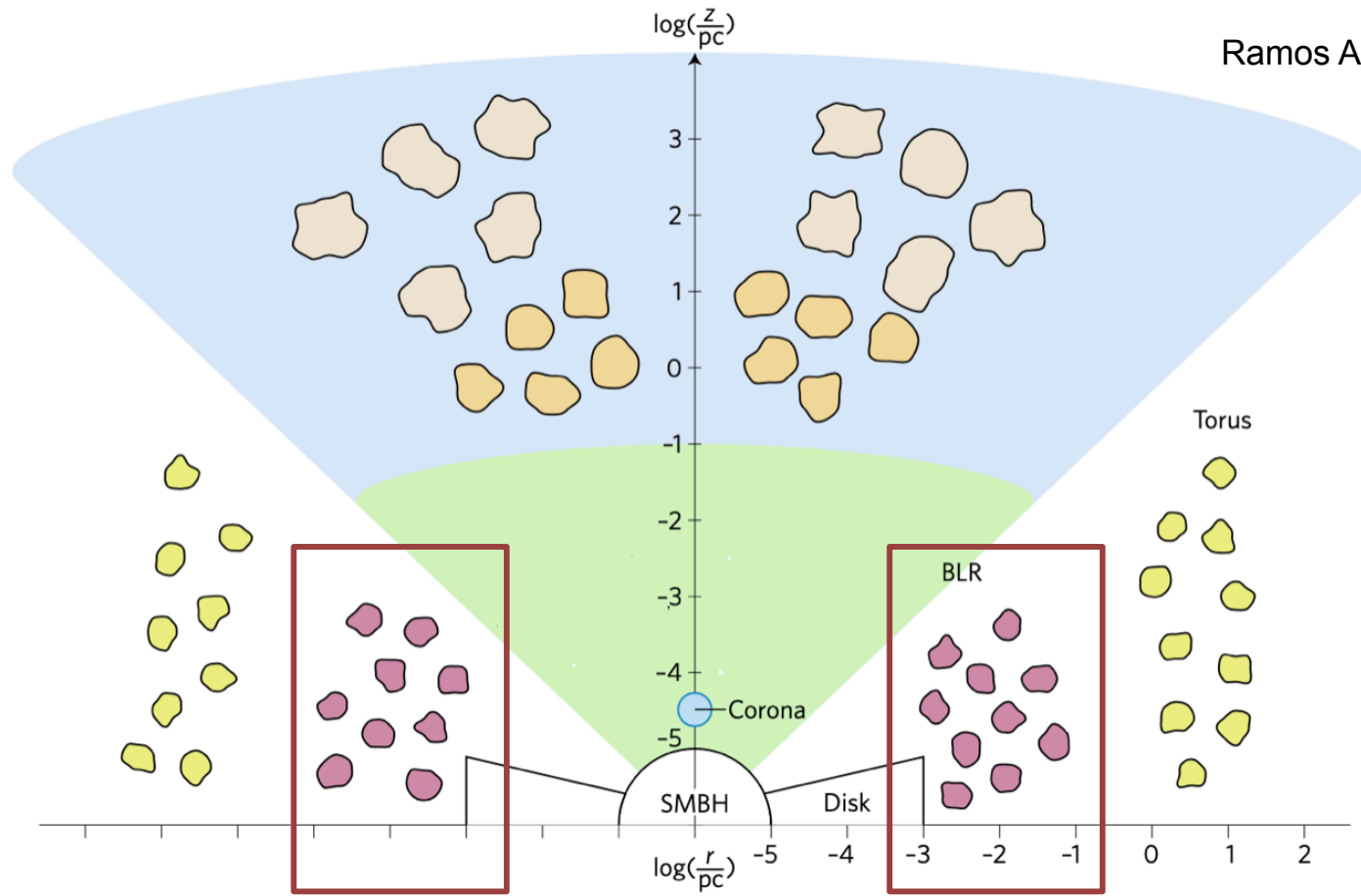
Accretion disk

Interplay disk/outflows

**Variability timescales, mechanisms
triggering instabilities and perturbations**

Why do we care about CL AGN?

Ramos Almeida & Ricci (2017)



Changing-obscuration AGN

Changing-state AGN

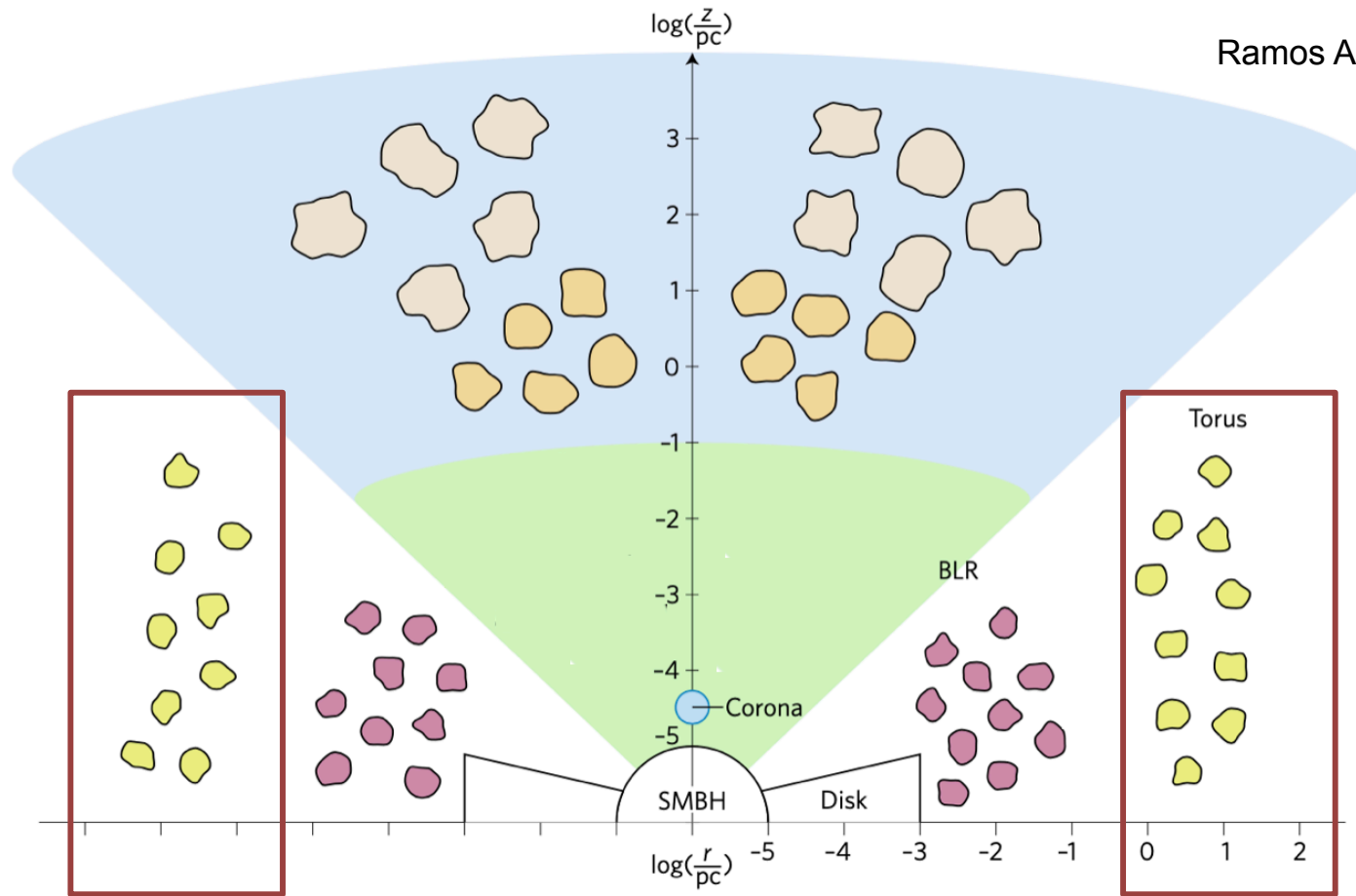
Broad-line region

Physical and kinematical properties
of the clouds

Creation and evolution

Why do we care about CL AGN?

Ramos Almeida & Ricci (2017)



Changing-obscuration AGN

Changing-state AGN

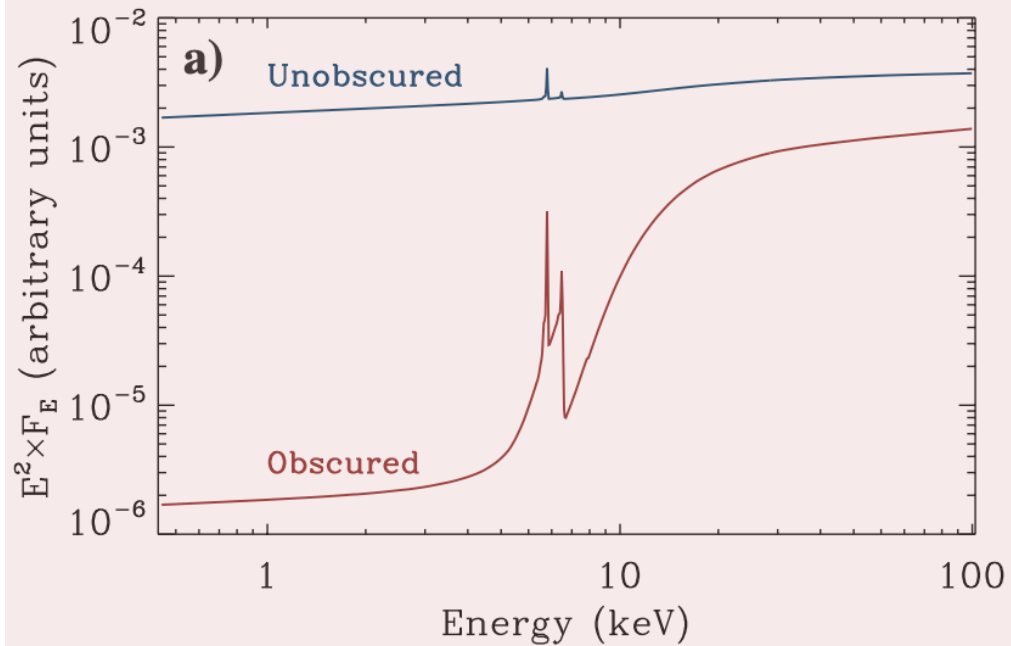
Torus

Physical and kinematical properties
of the clouds

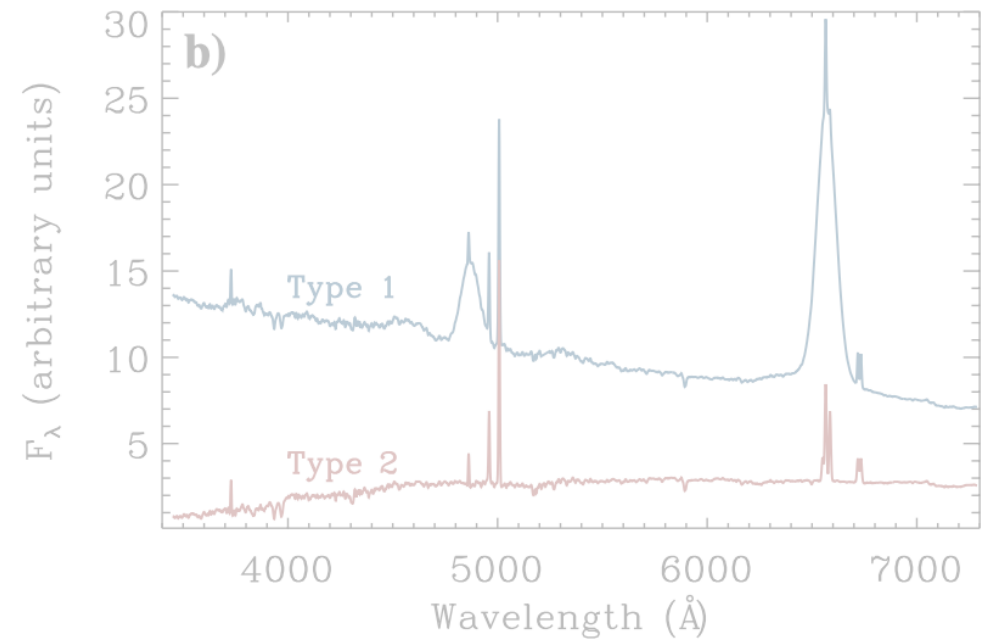
Size and dust replenishment

Changing-look AGN

Changing-obscuration AGN

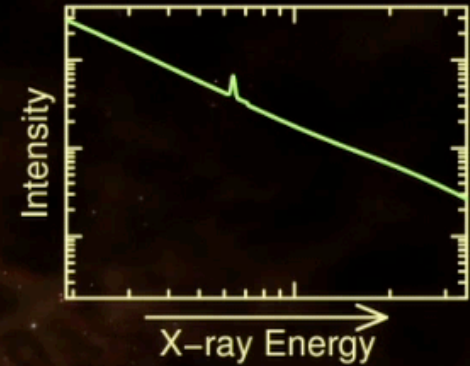


Changing-state AGN



Ricci & Trakhtenbrot 2023, Nature Astronomy review

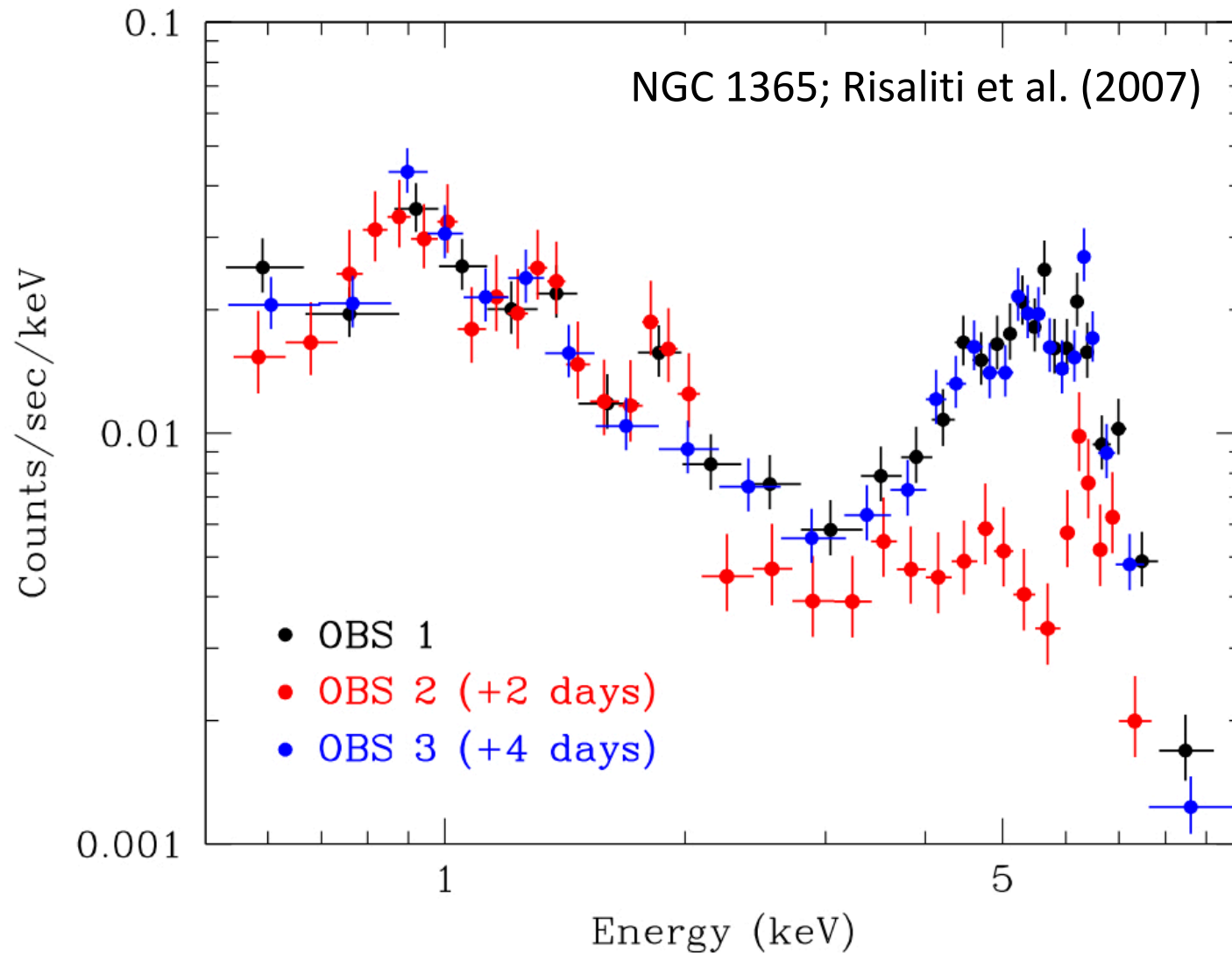
Changing-obscuration AGN: eclipses



Markowitz et al. (2014)

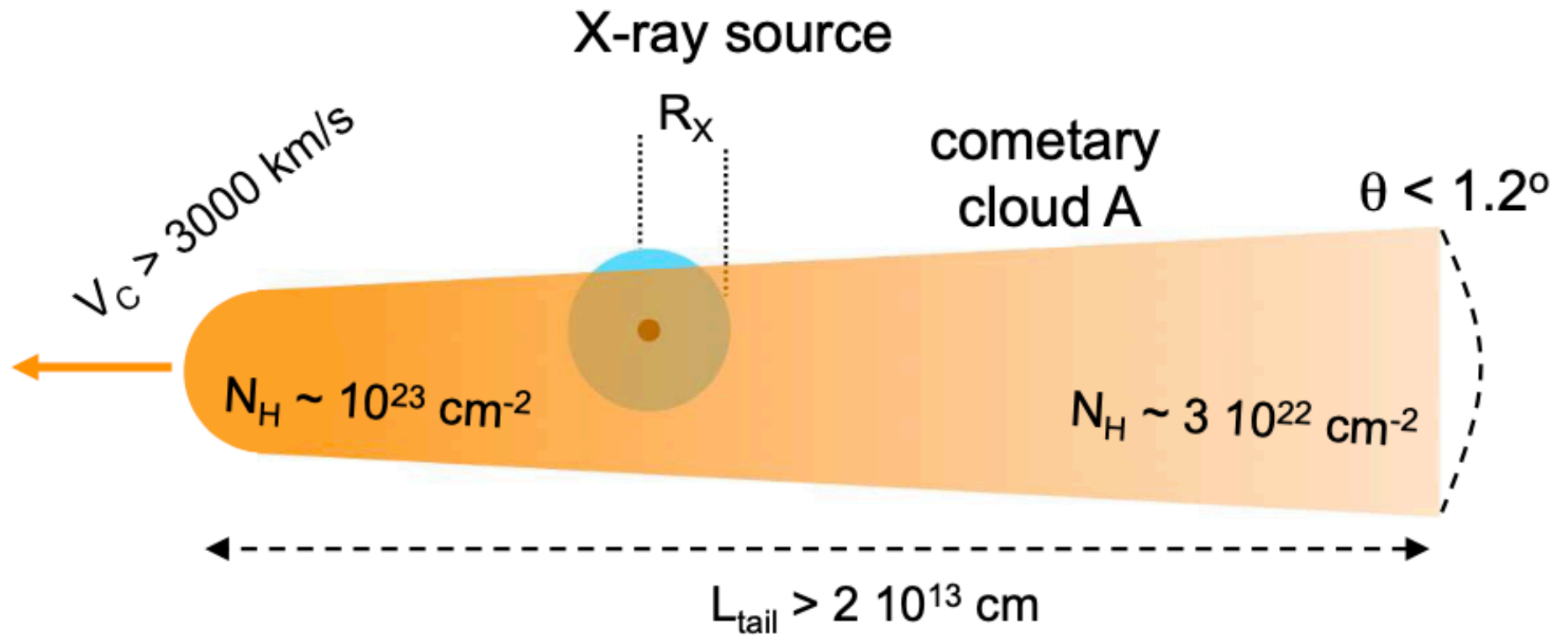
See talk by A. Markowitz, posters by A. Pizzetti, S. Marchesi, D. Sengupta

Changing-obscuration AGN: eclipses

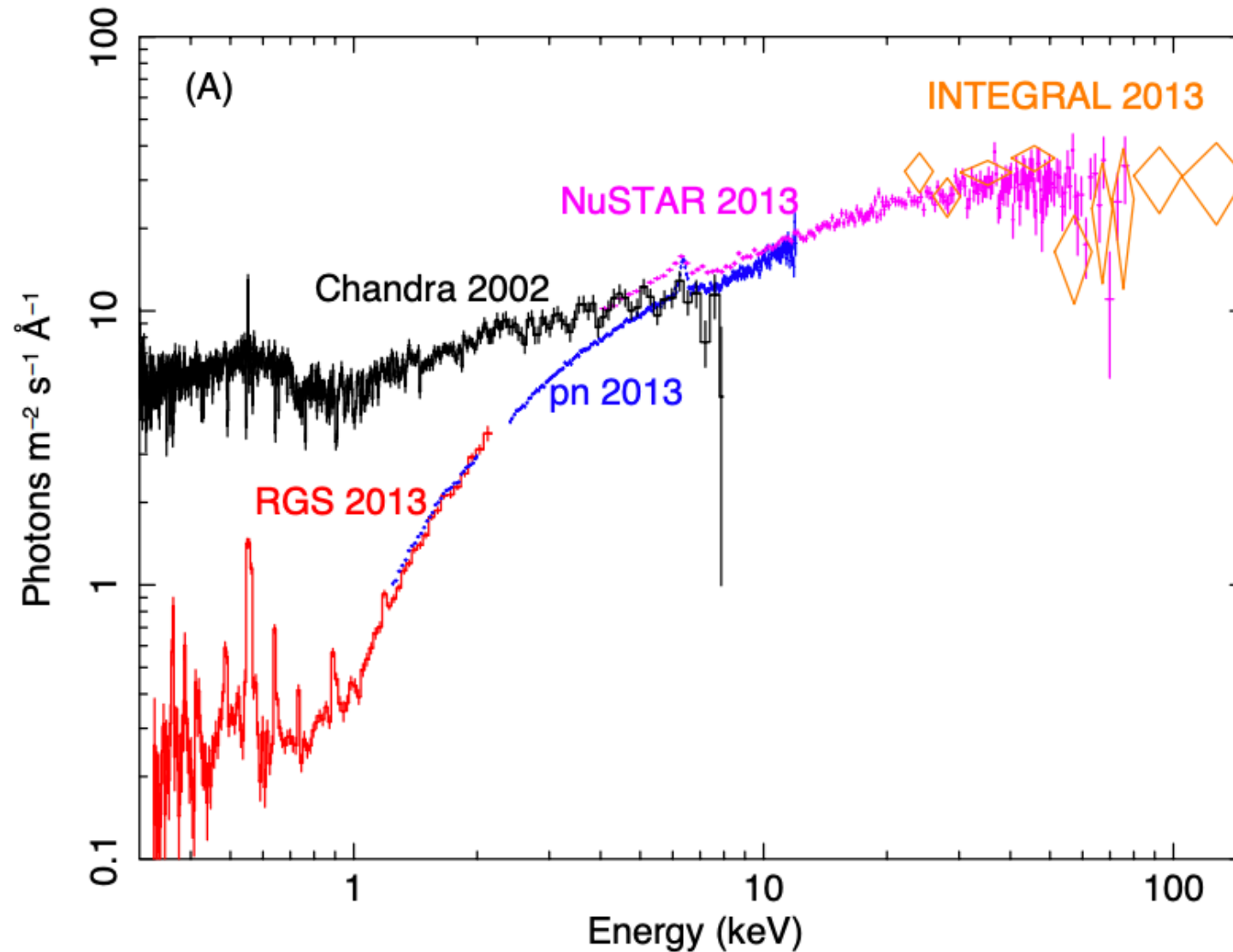


More than 50 AGN (e.g., Risaliti+05, Bianchi+09, Marinucci+13, Miniutti+14, Walton+14, Rivers+15, Burtscher+16, Ricci+16b, Laha+20); posters by A. Pizzetti, S. Marchesi, D. Sengupta

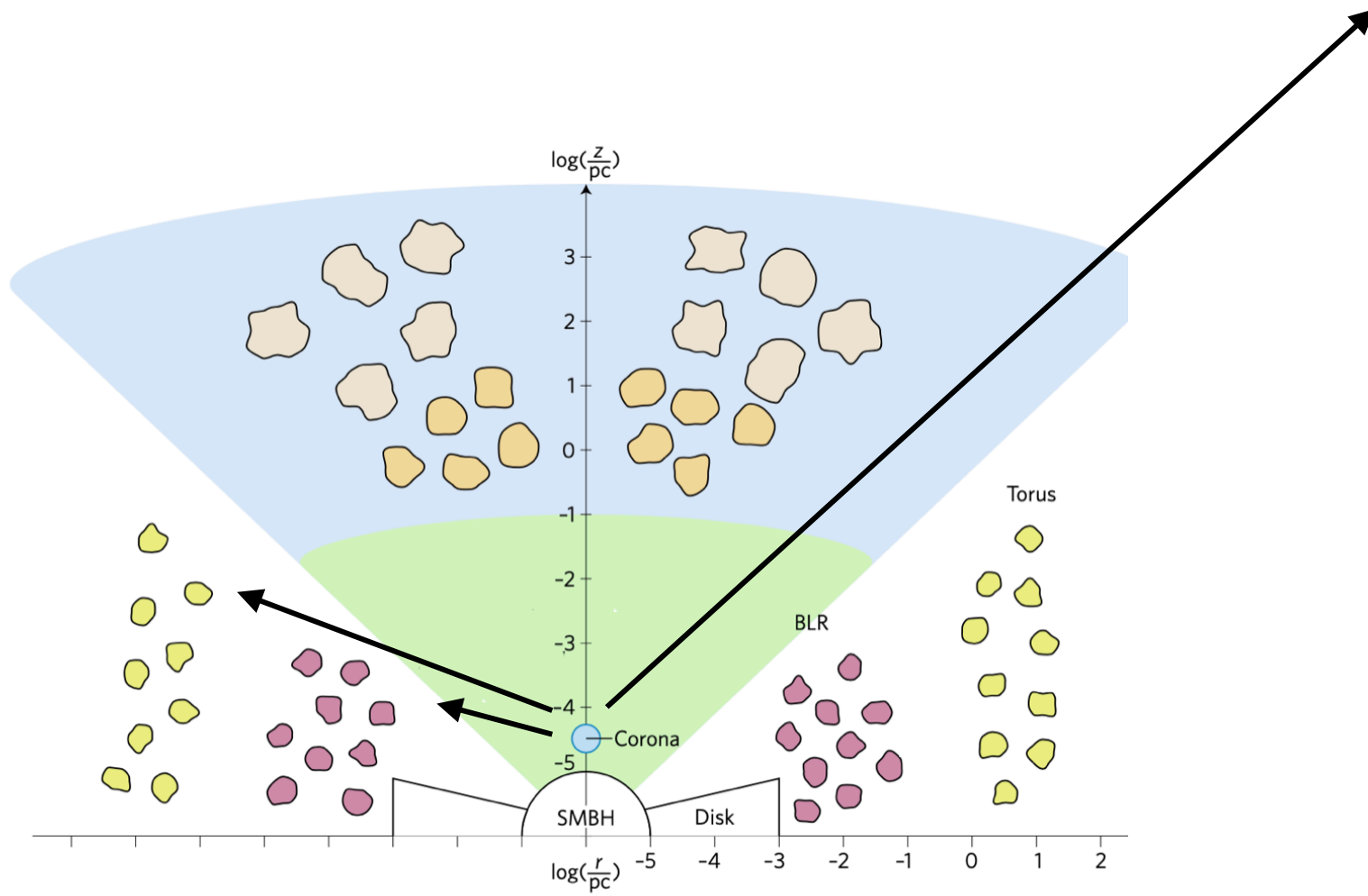
Changing-obscuration AGN: eclipses



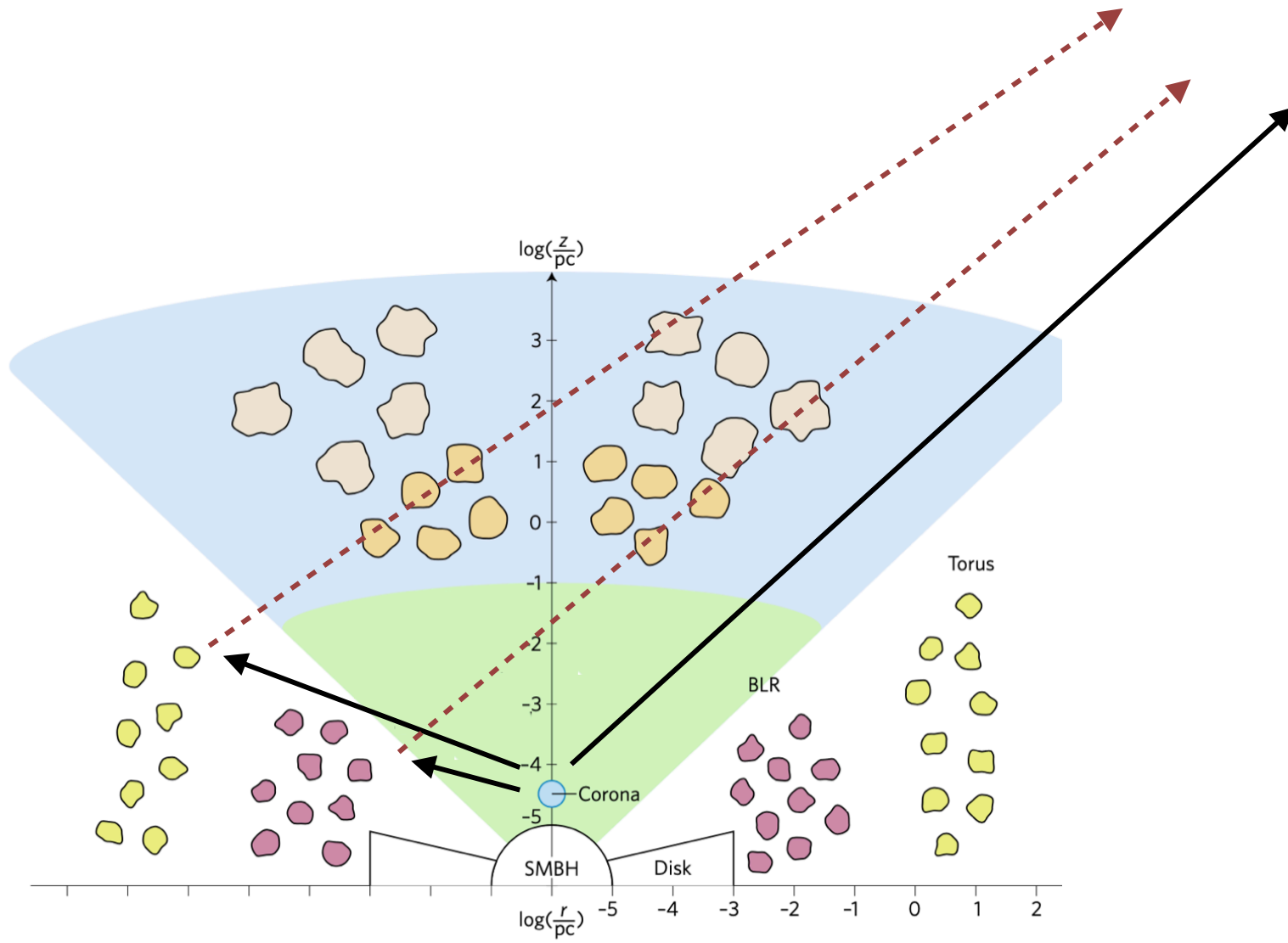
Changing-obscuration AGN: outflows



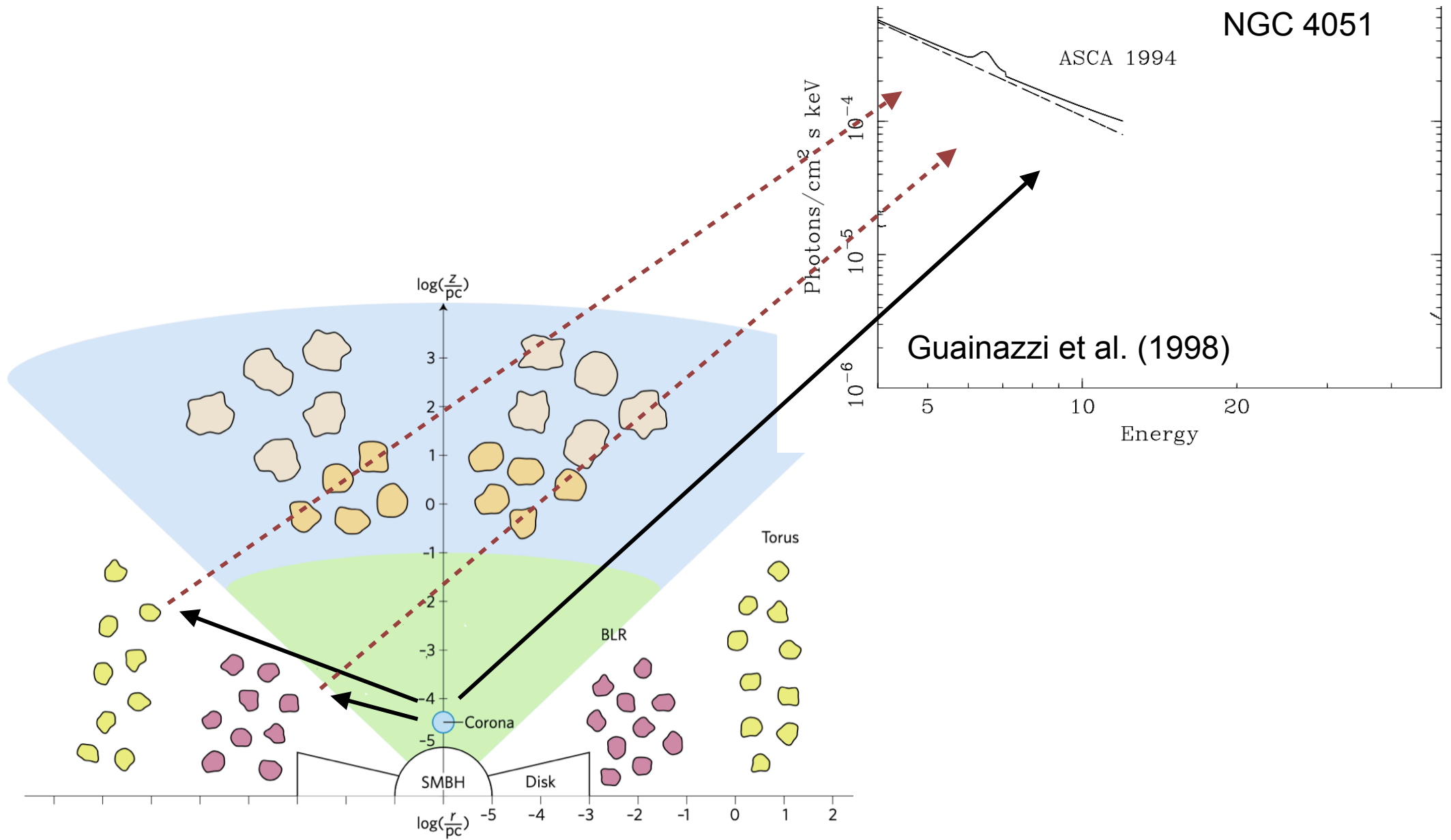
Changing-obscuration AGN: extreme flux variability



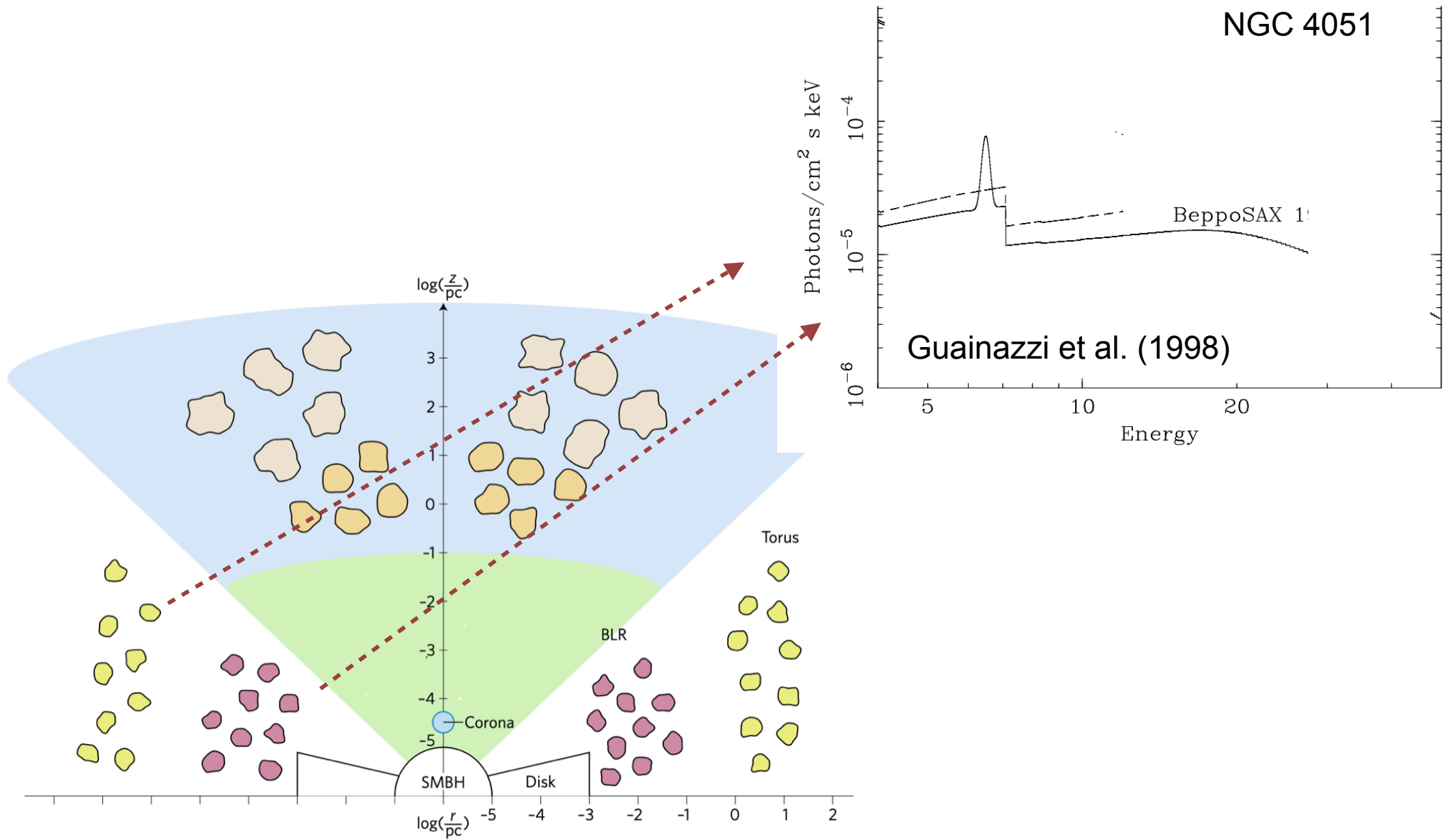
Changing-obscuration AGN: extreme flux variability



Changing-obscuration AGN: extreme flux variability

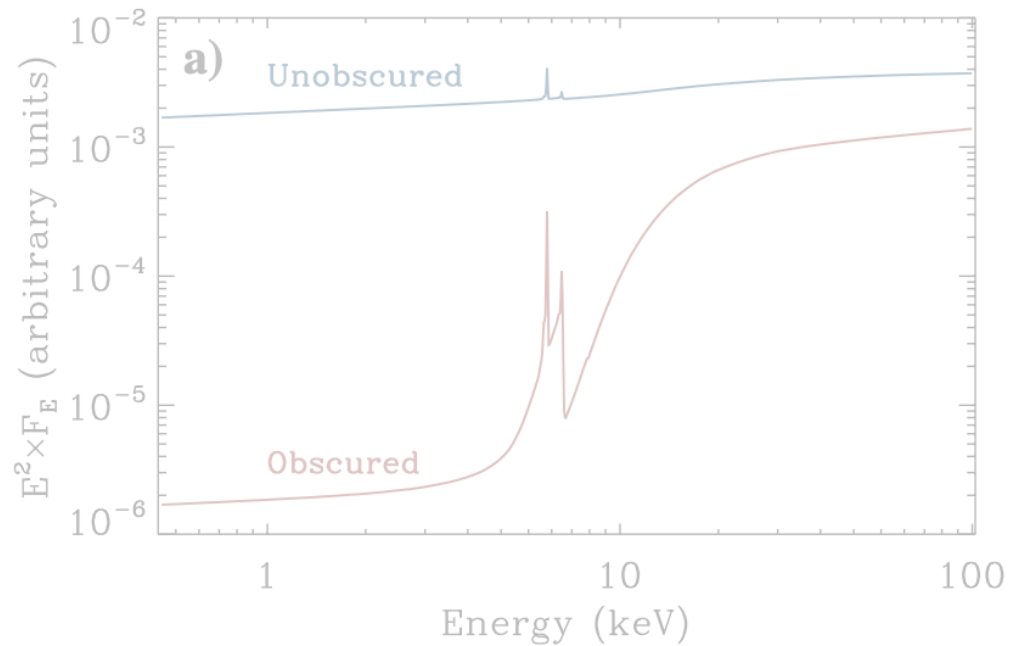


Changing-obscuration AGN: extreme flux variability

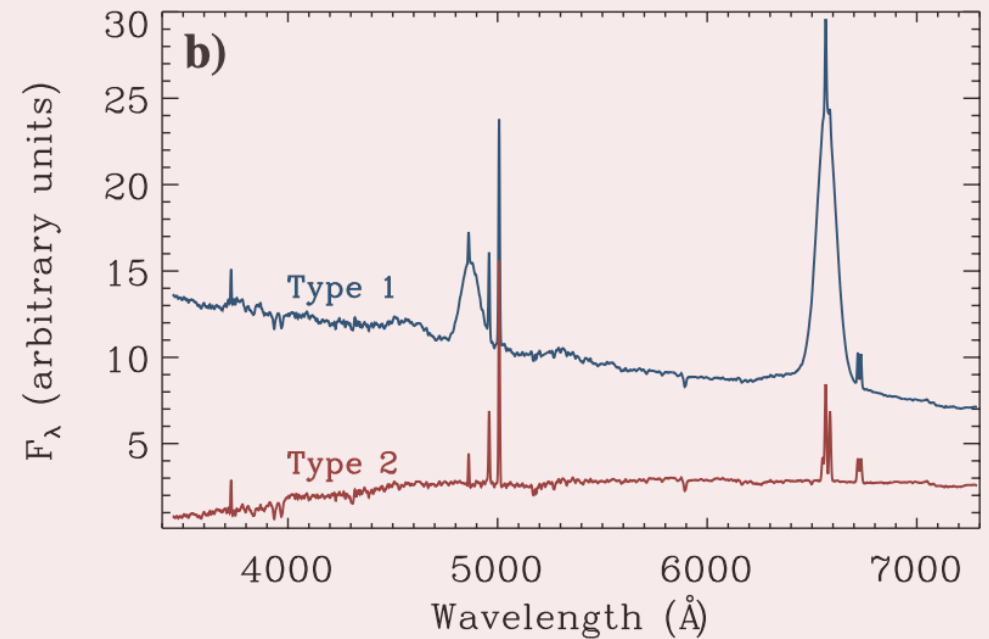


Changing-look AGN

Changing-obscuration AGN

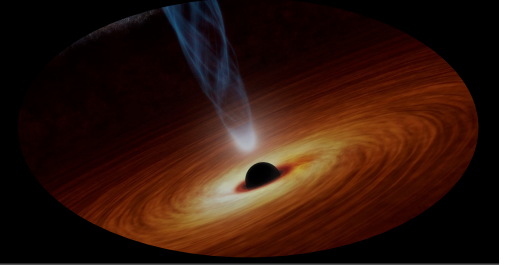


Changing-state AGN

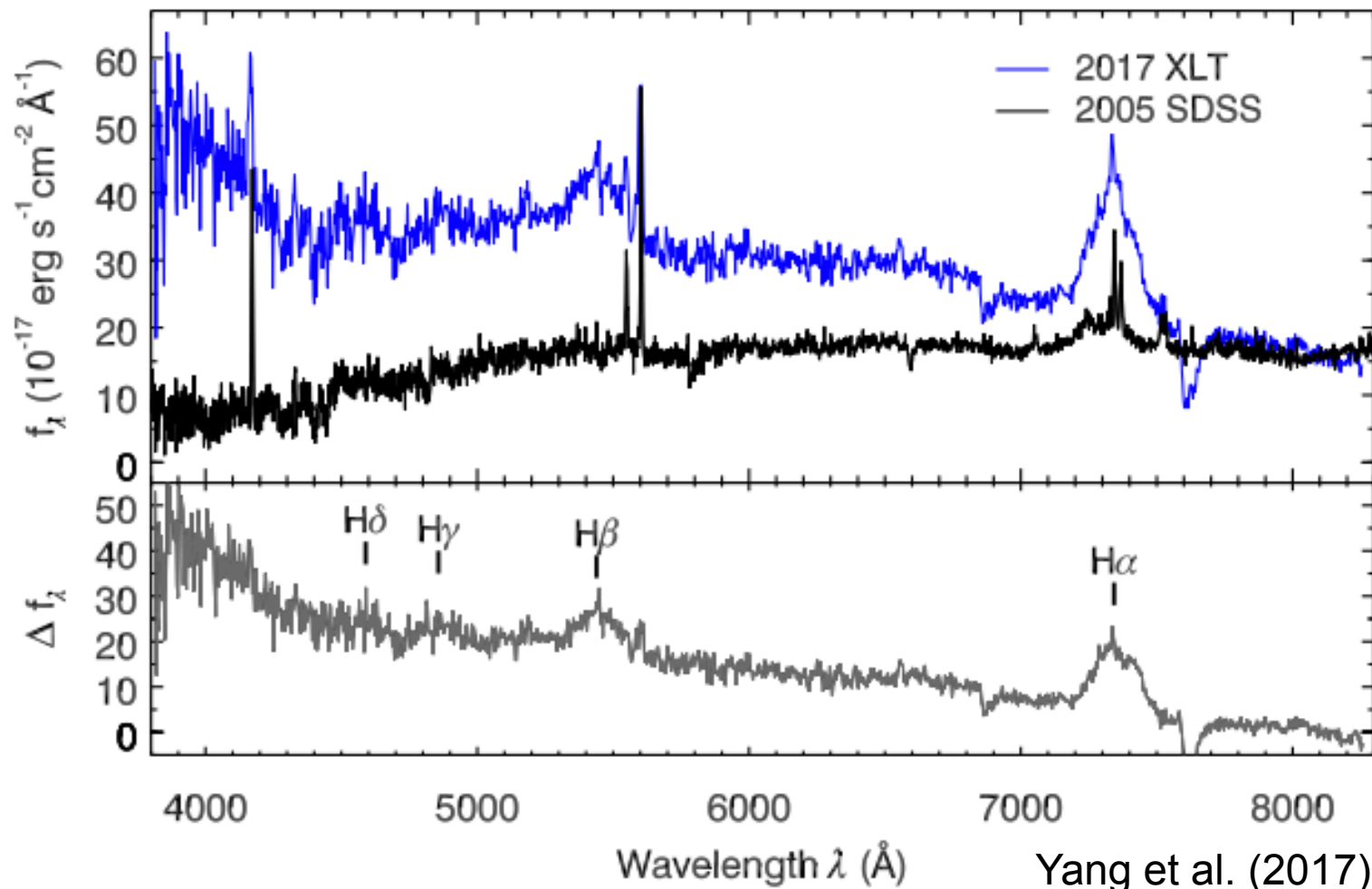


Ricci & Trakhtenbrot 2023, Nature Astronomy review

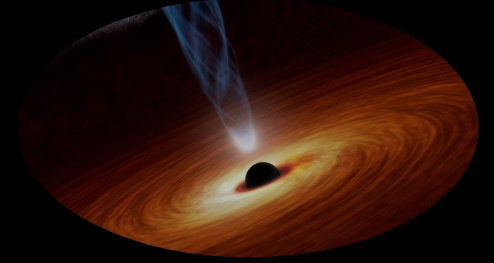
Changing-state AGN



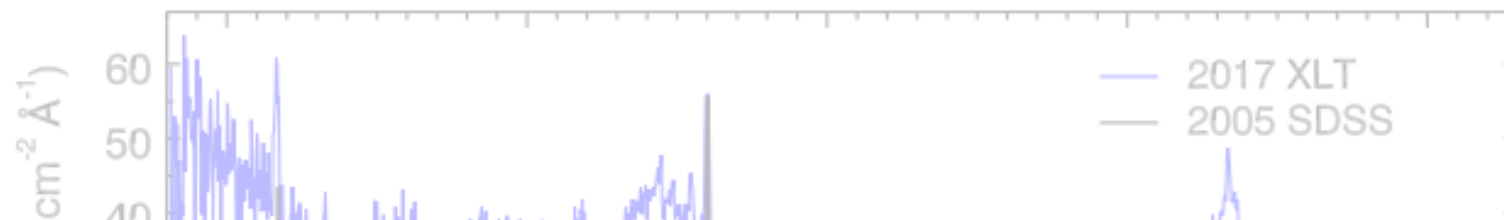
Type 1 \longleftrightarrow Type 2



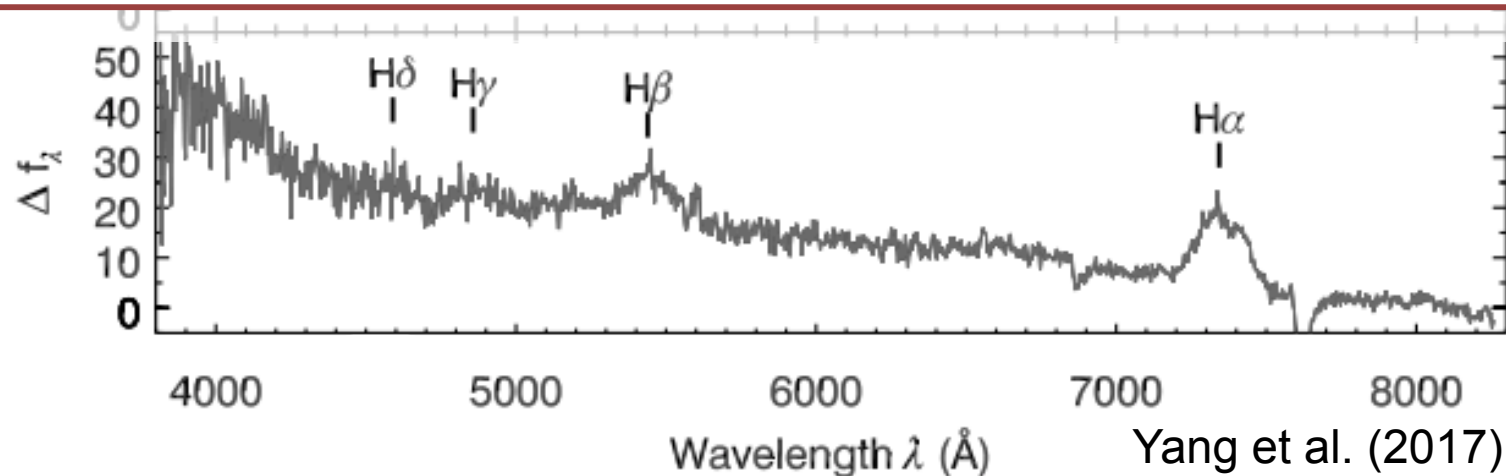
Changing-state AGN



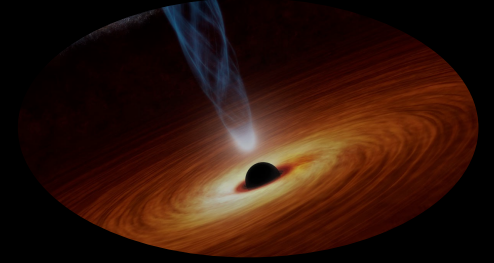
Type 1 \longleftrightarrow Type 2



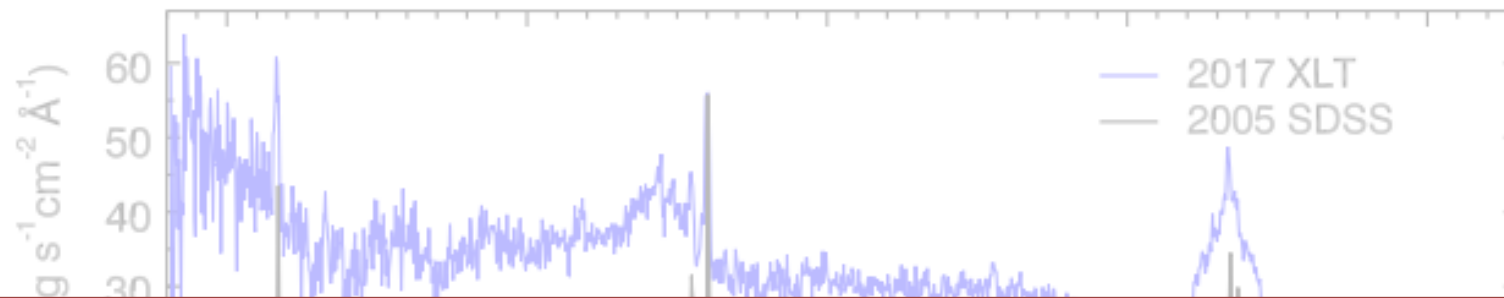
Appearance of broad lines corresponds to increase optical continuum ; X-ray/IR/Radio proportional to optical/UV



Changing-state AGN

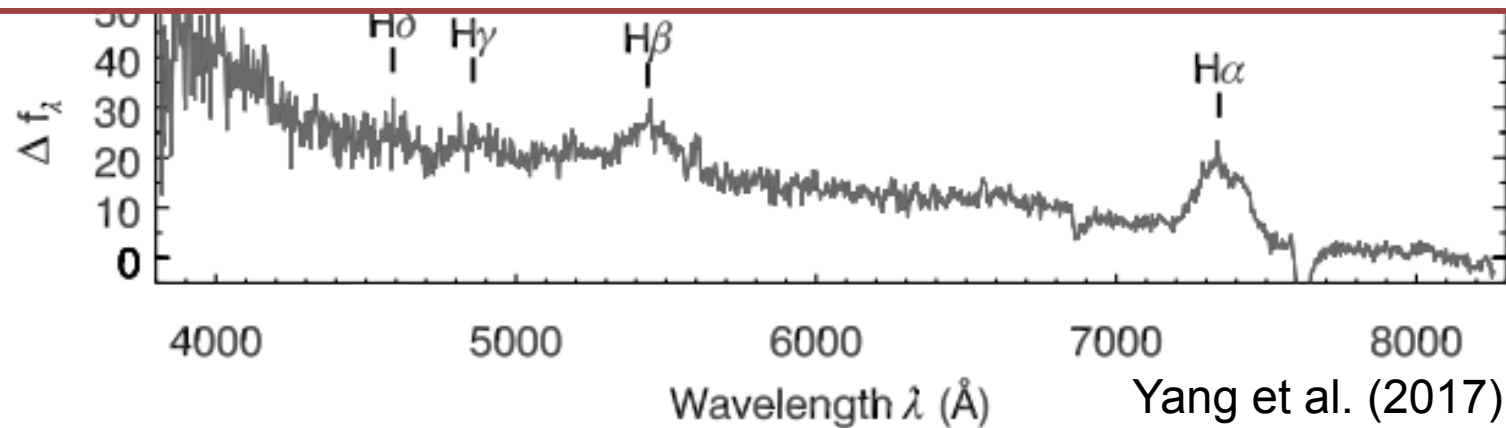


Type 1 \longleftrightarrow Type 2



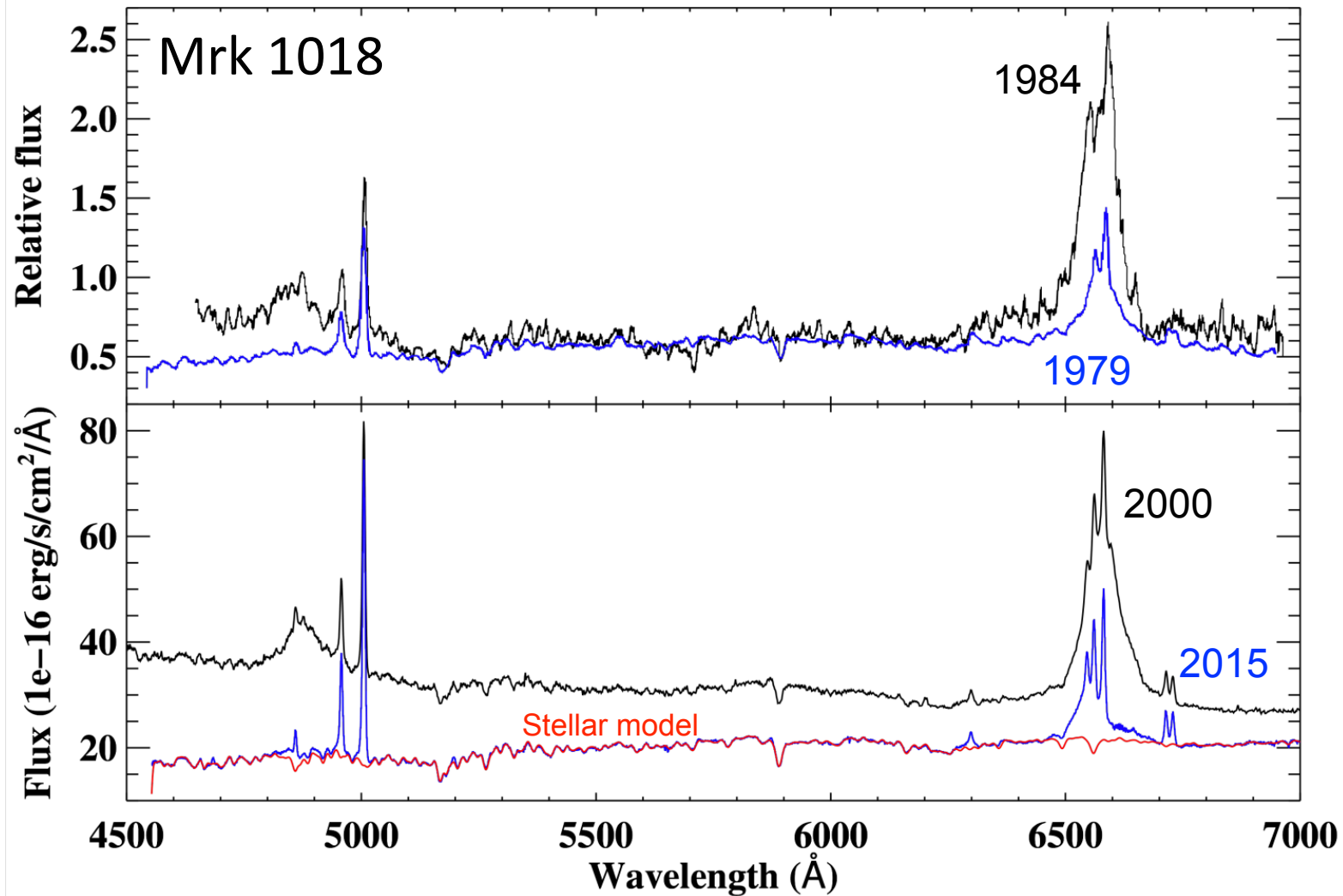
No reddening or X-ray absorption

(but see talk by Grisha Zeltyn)



Yang et al. (2017)

CS AGN can transition more than once

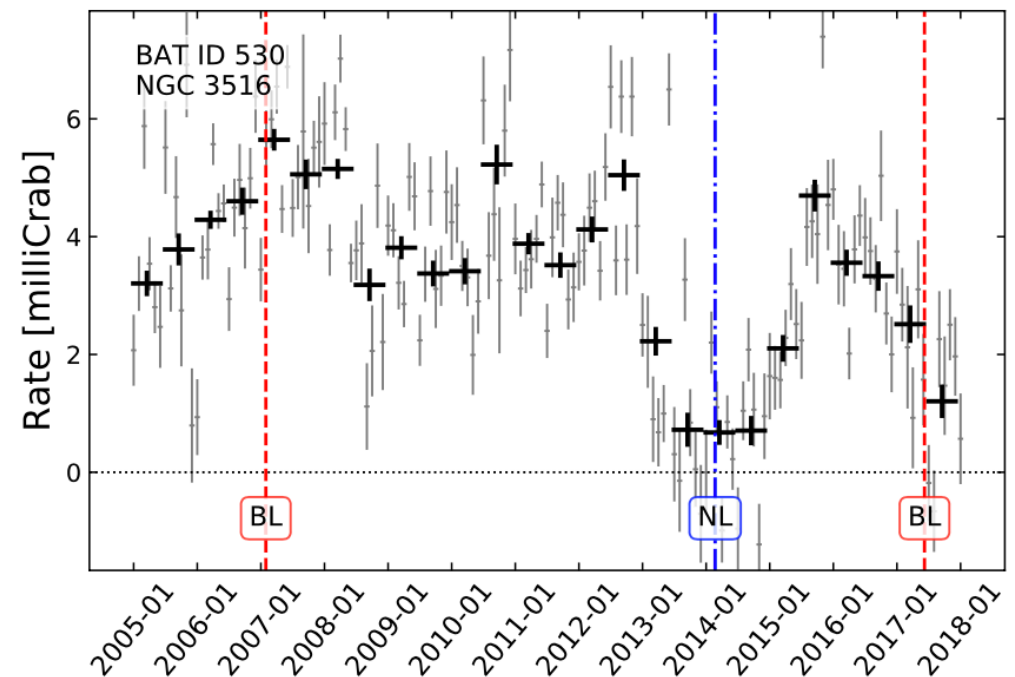
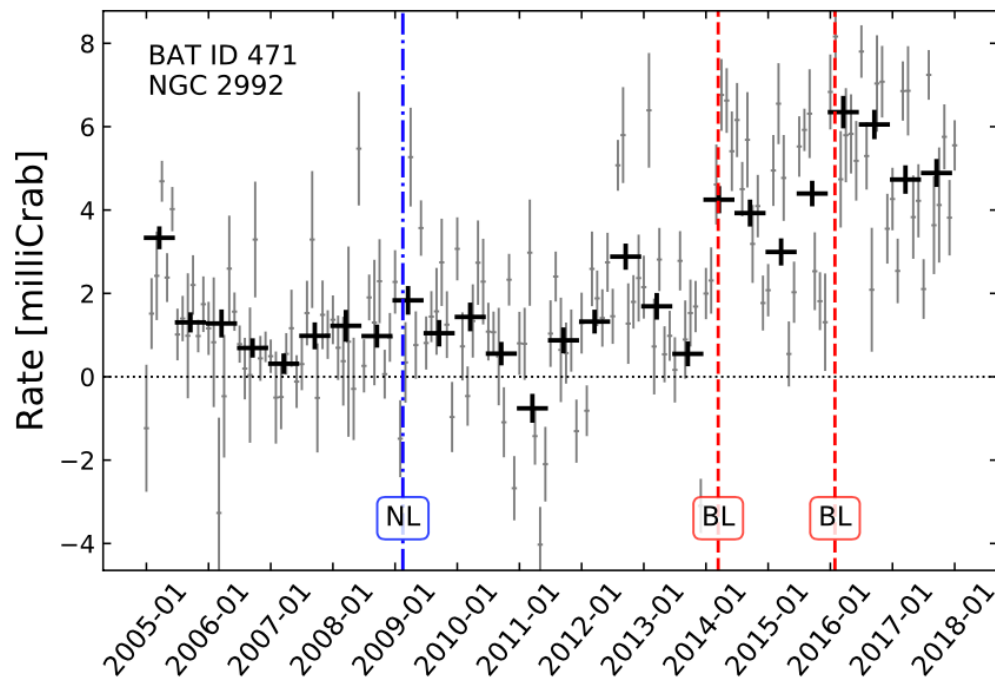


McElroy (2016), see talk by R. Brogan

Occurrence rate and timescales



Systematic studies of 412 Swift/BAT AGN
w/ repeated optical spectroscopy

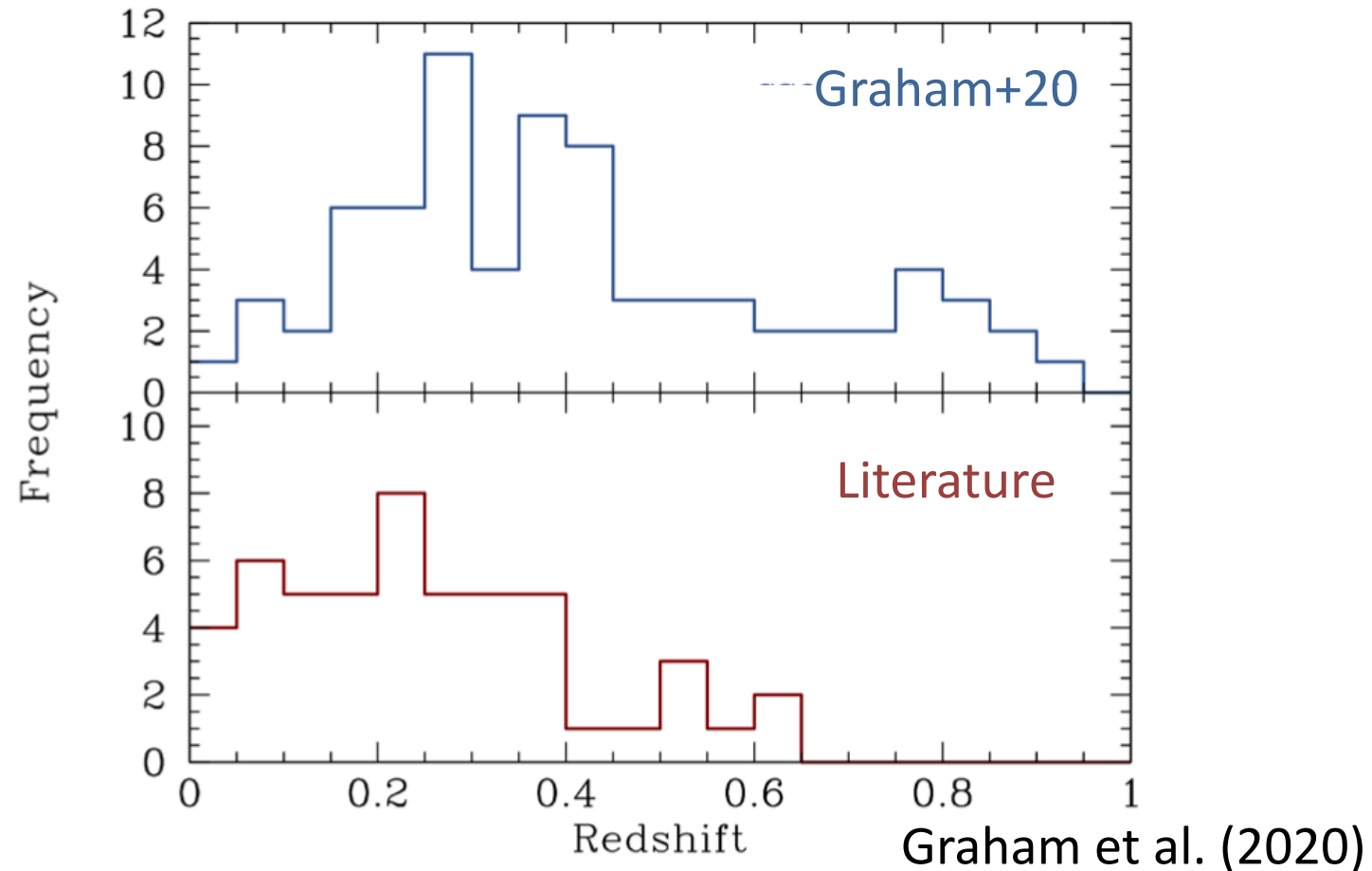


Temple, CR et al. (2022)

0.7-6.2% on 10-25 year time-scales; typical timescales 3-10 years
(see Matthew Temple's talk)

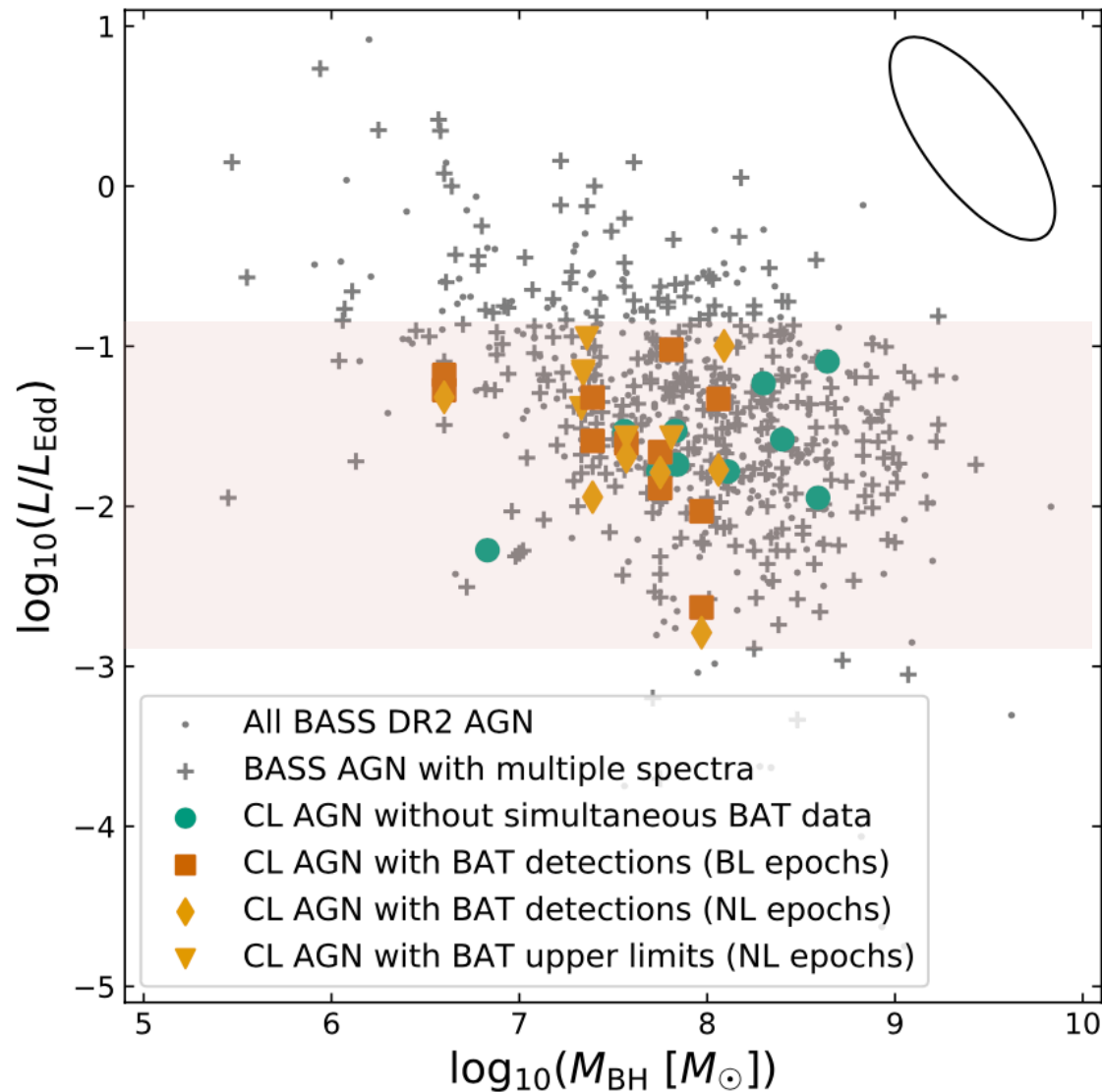
What are their typical properties?

Currently ~ 100 -200 CS AGN known (Graham+20, Green+22, Yang+23)



See talks by G. Zeltyn, M. Sniegowska, D. Homan, K. Suberlak, W. Kollatschny, G. Tozzi, L. Popovic;
posters by A. Vietri, J. Yang, T. Saha, S. Wang

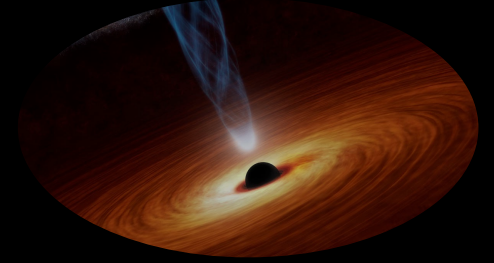
What are their typical properties?



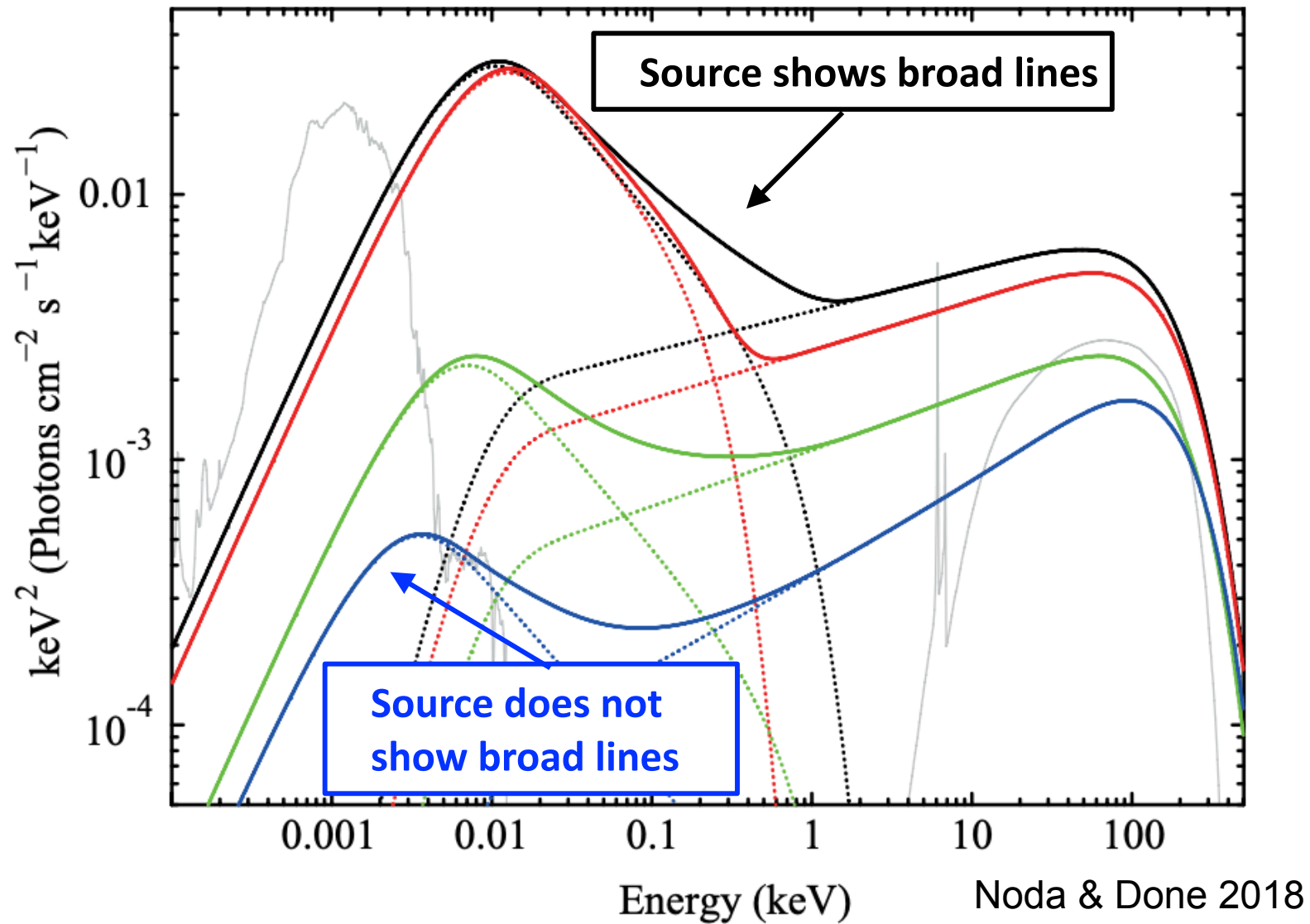
Temple, CR et al. (2022); see also MacLeod+19, Graham+20
(see M. Temple's, G. Zeltyn's talks)

What triggers changing-state events?

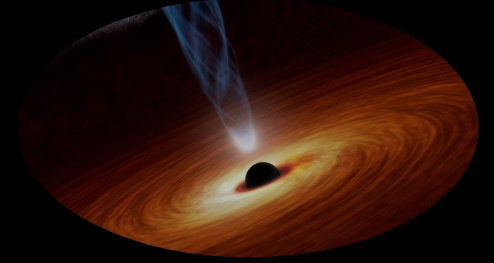
1) Disk instabilities



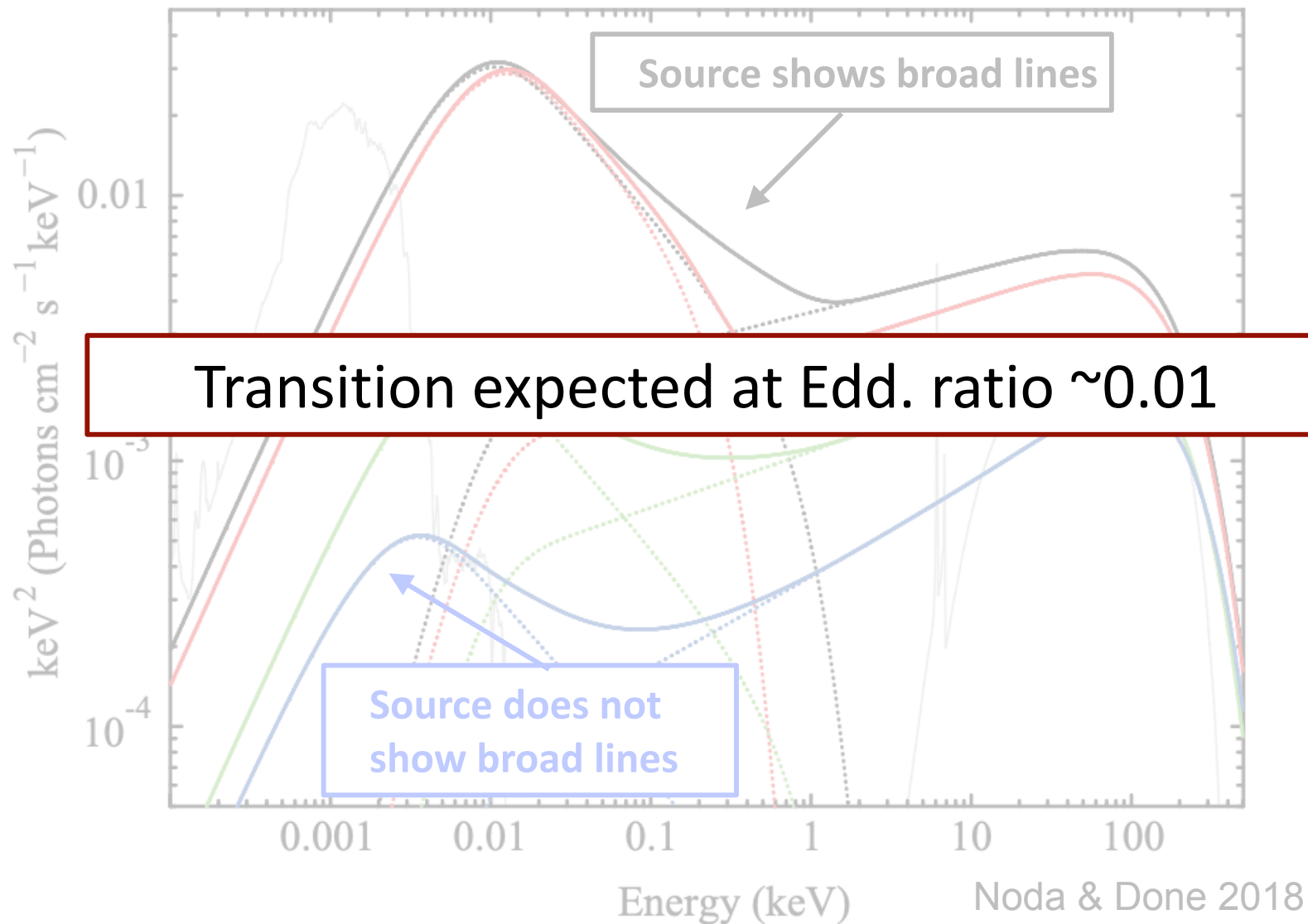
State transitions (as in BH binaries; e.g. Noda & Done 18)



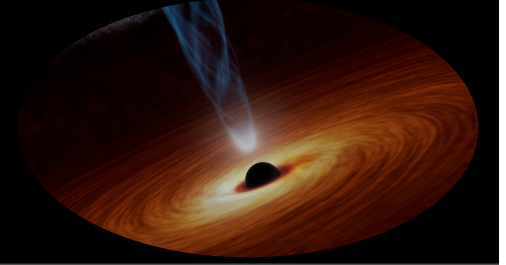
1) Disk instabilities



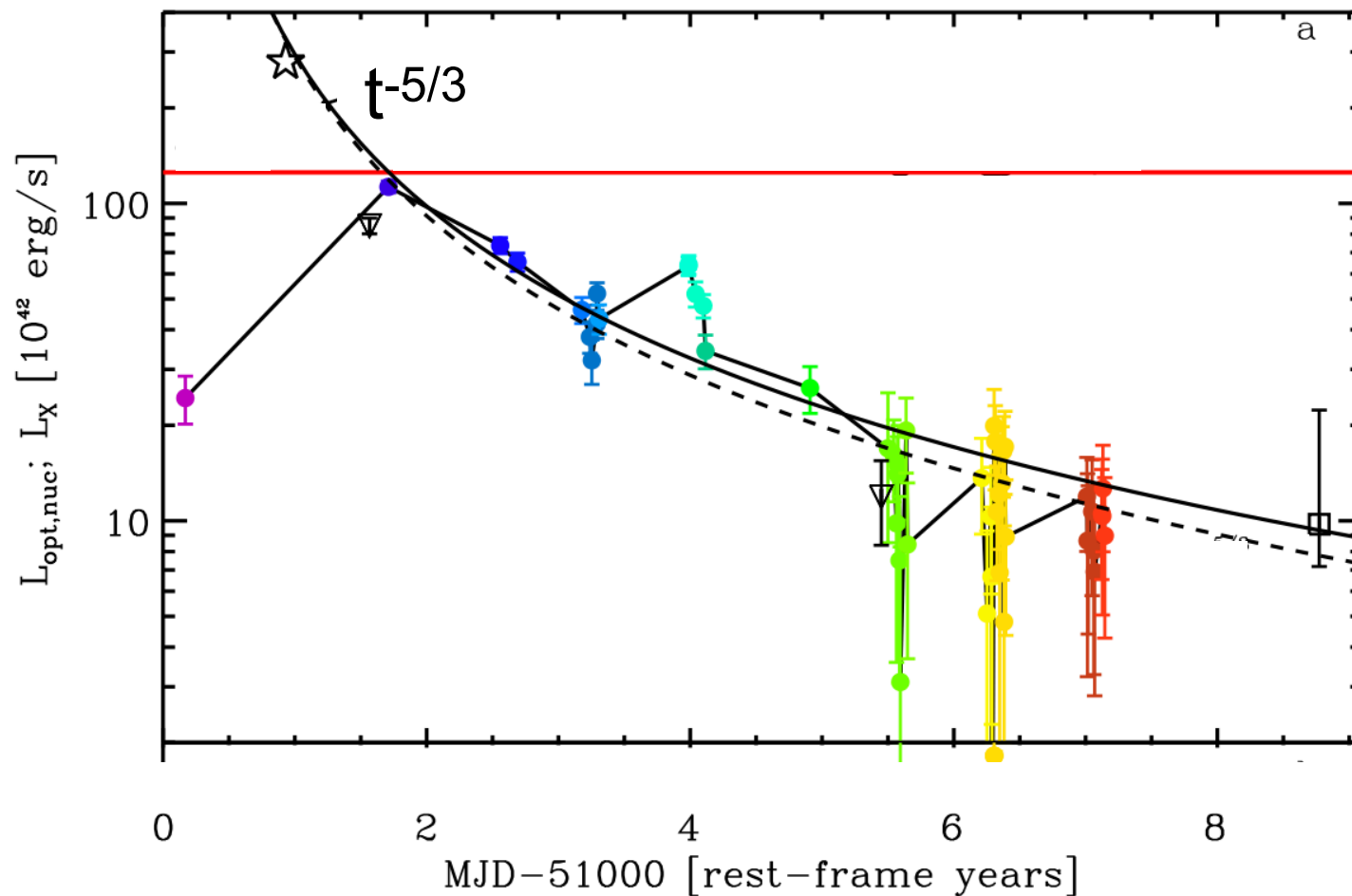
State transitions (as in BH binaries; e.g. Noda & Done 18)



2) Disk perturbations



SDSS J0159+0033: a TDE-triggered event?



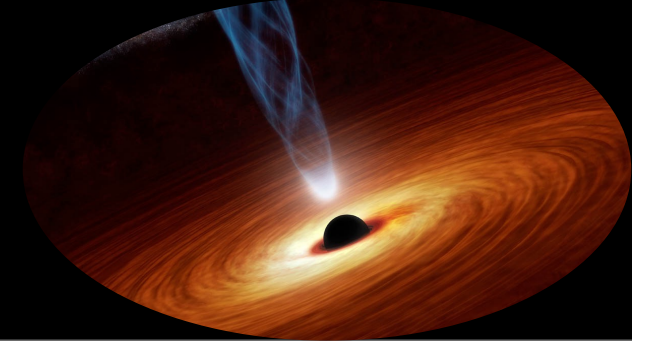
Merloni et al. (2015), see also Runnoe et al. (2015)

An XMM-Newton/NICER/NuSTAR/Swift original series

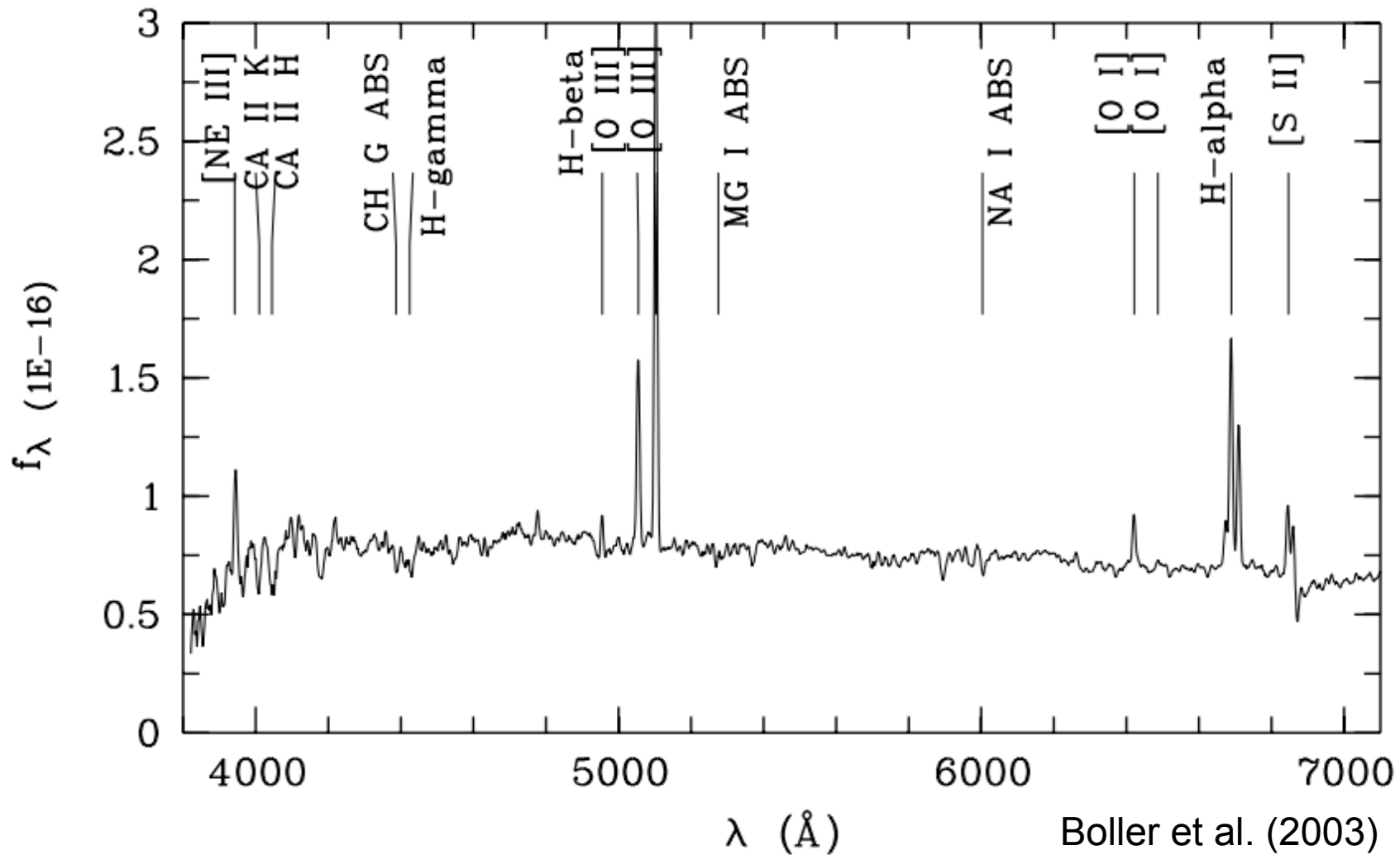
THE STRANGE CASE OF 1ES1927 + 654



1ES 1927+654



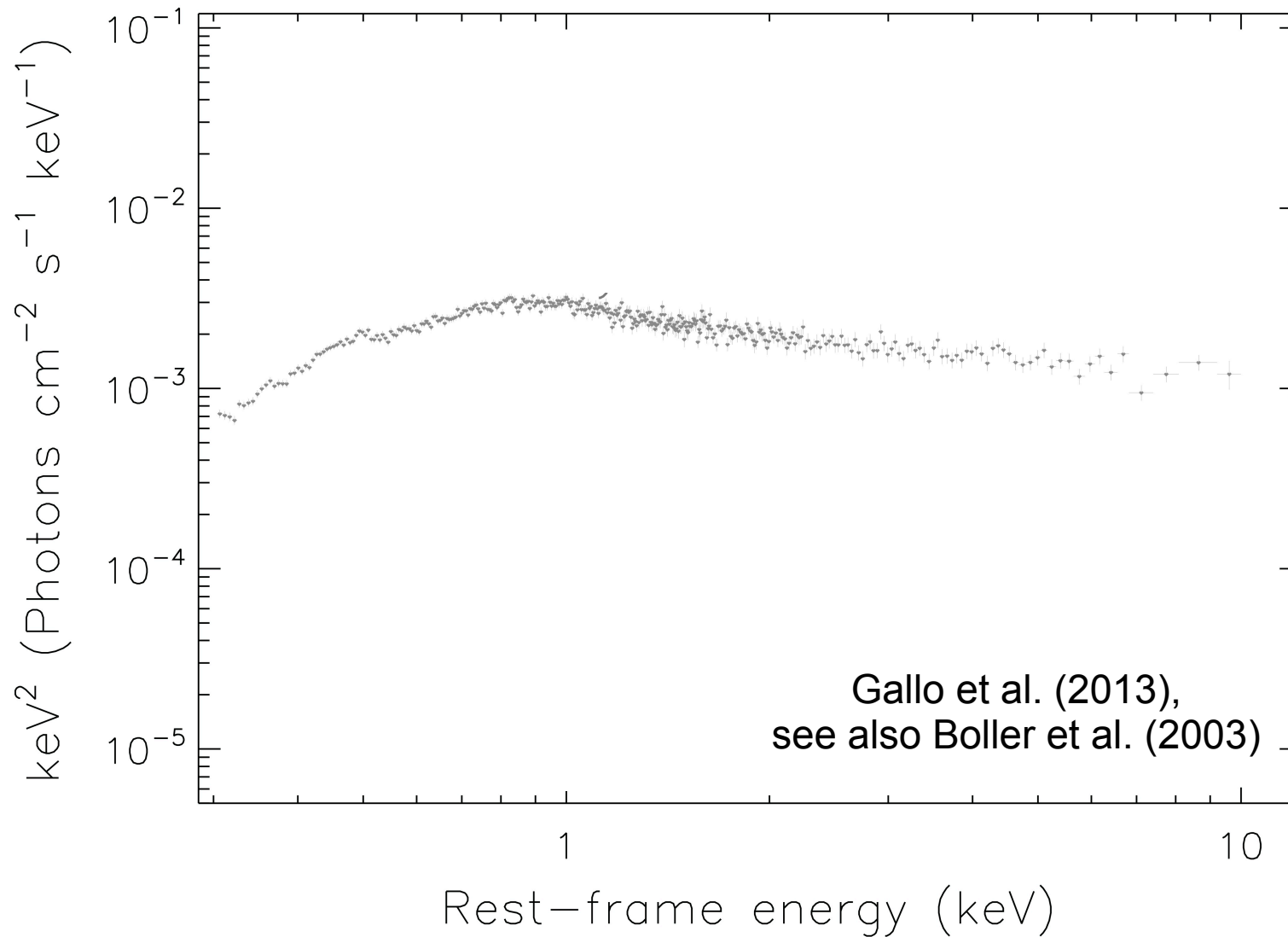
Source previously classified as an AGN in the optical..



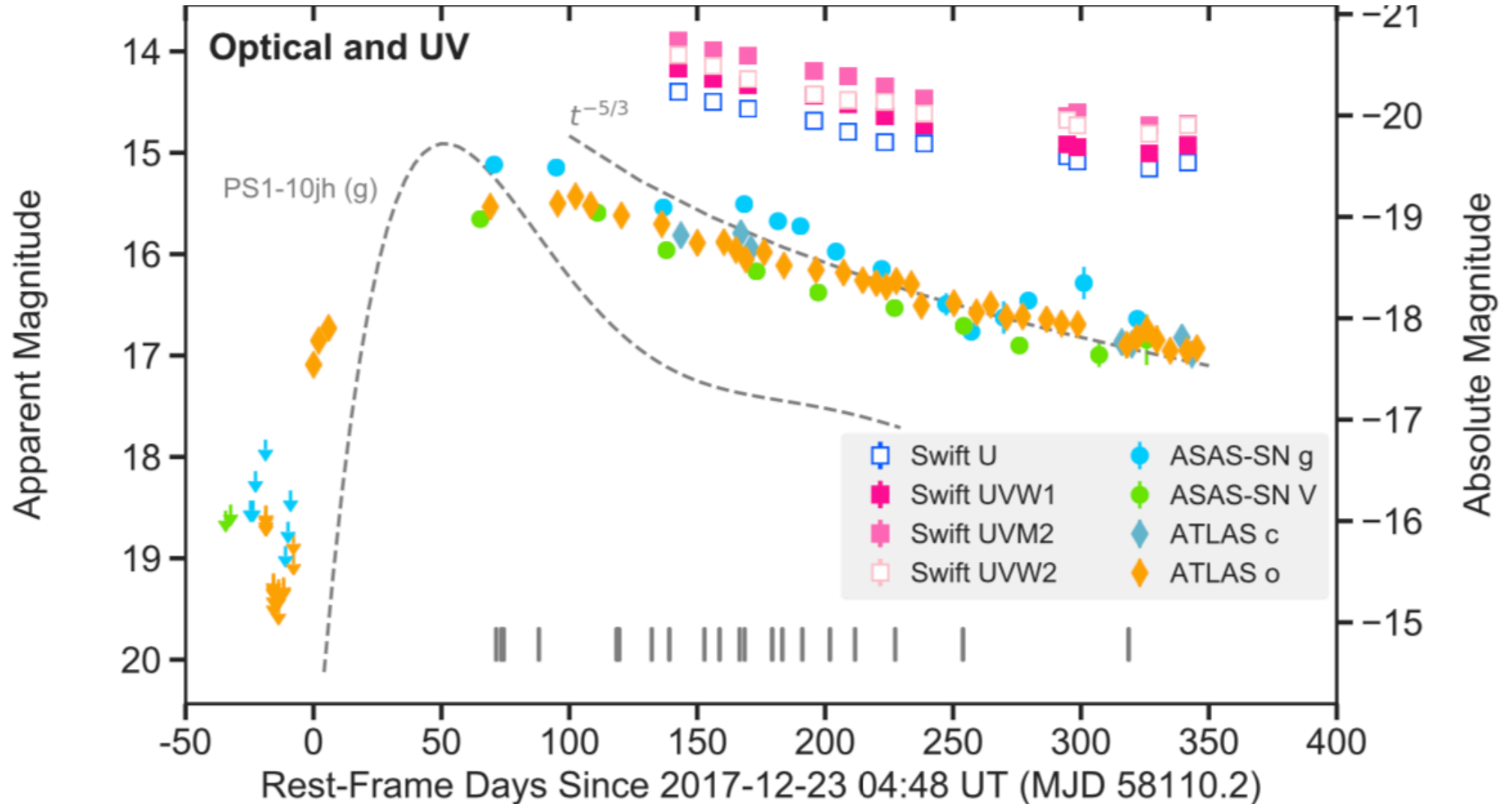
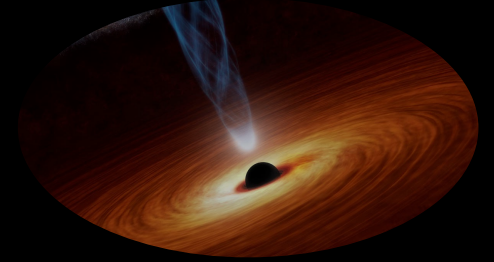
1ES 1927+654



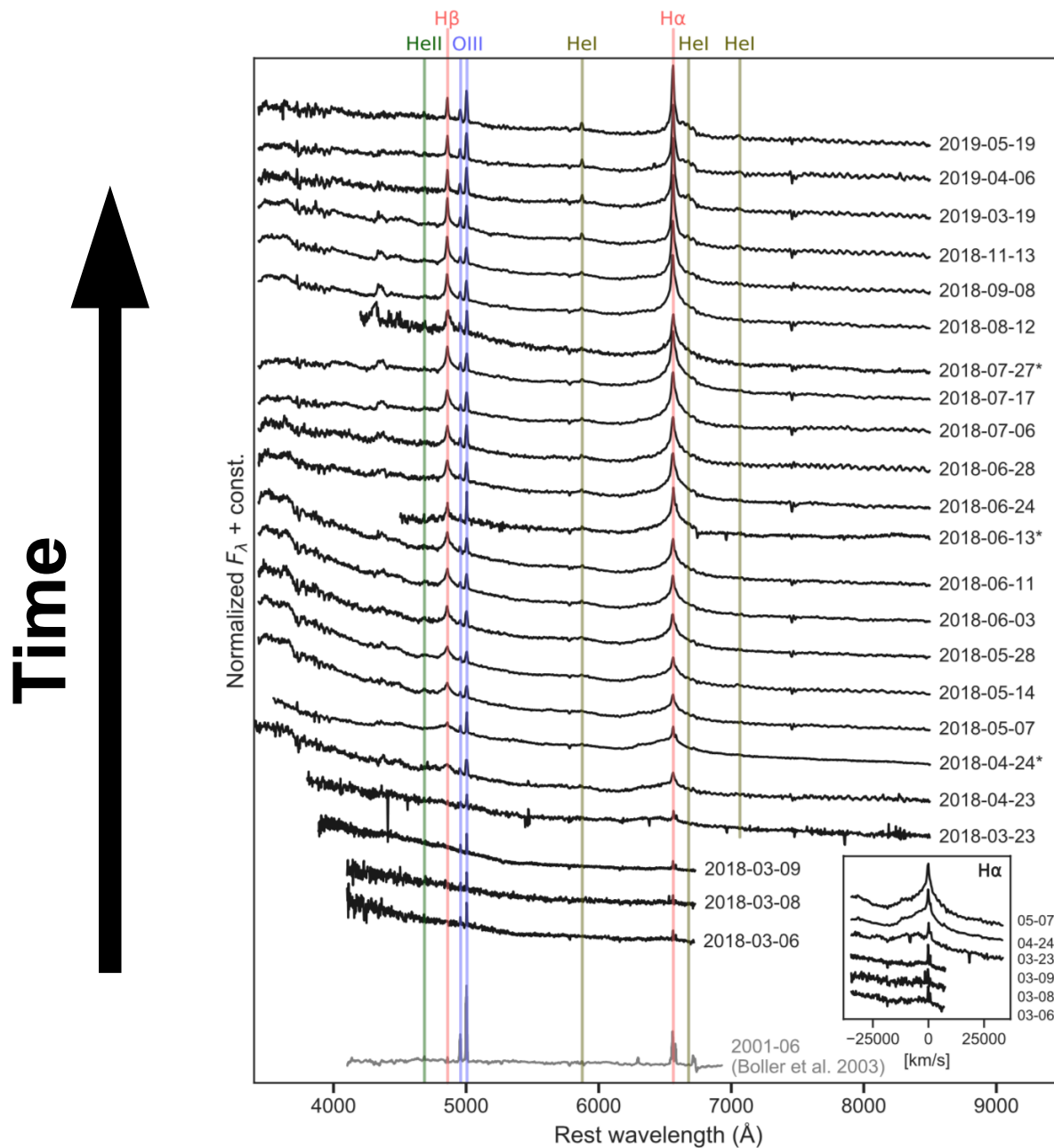
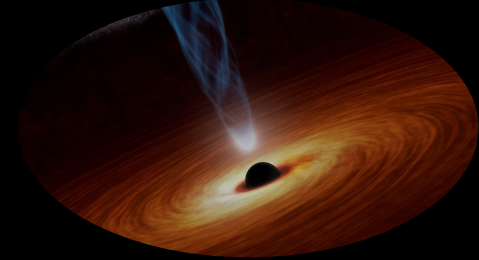
.. and in the X-rays ($L_x \sim 1e43$ erg/s)



The optical/UV outburst of 1ES 1927+654

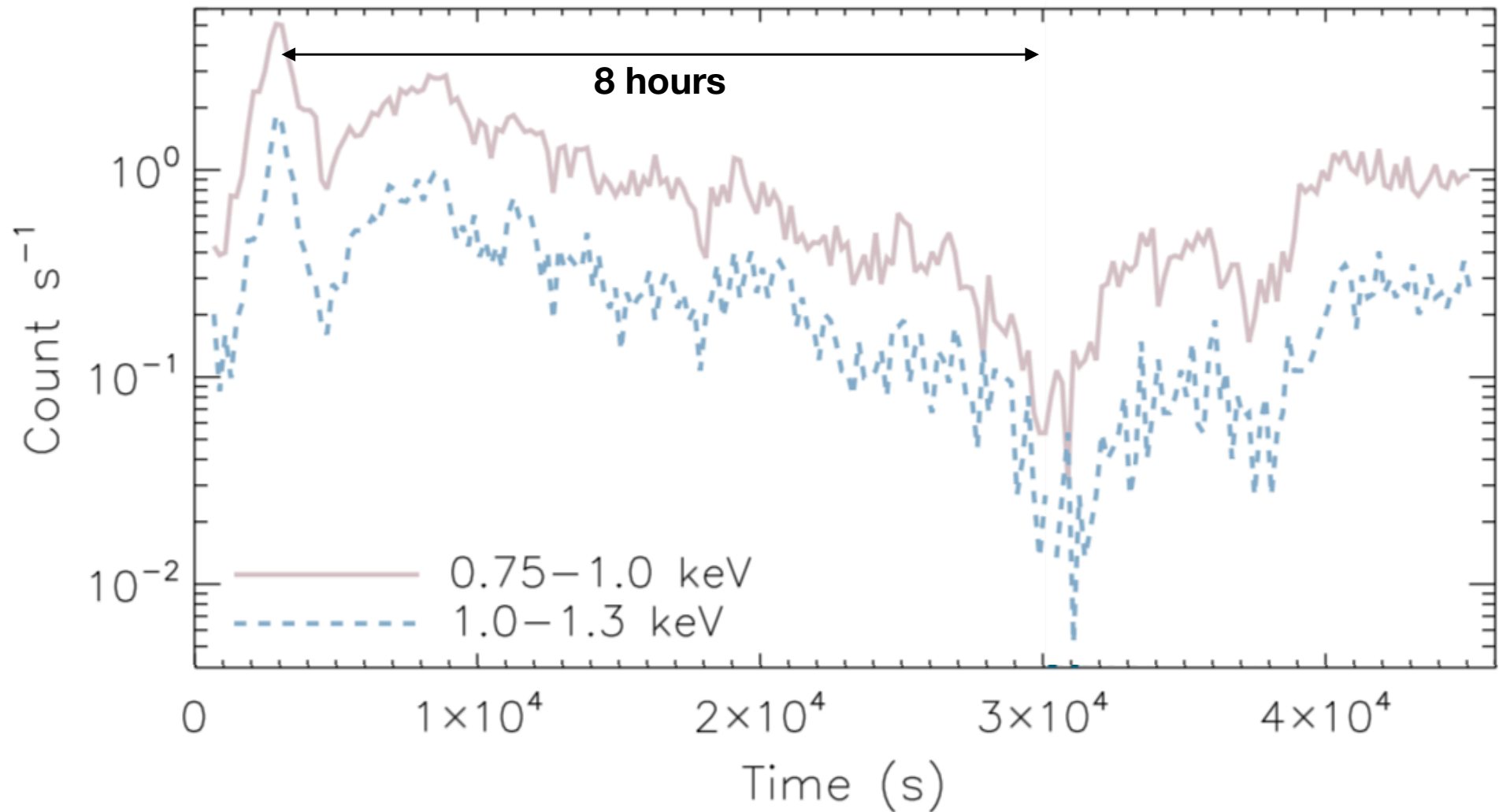


The changing-state AGN 1ES 1927+654

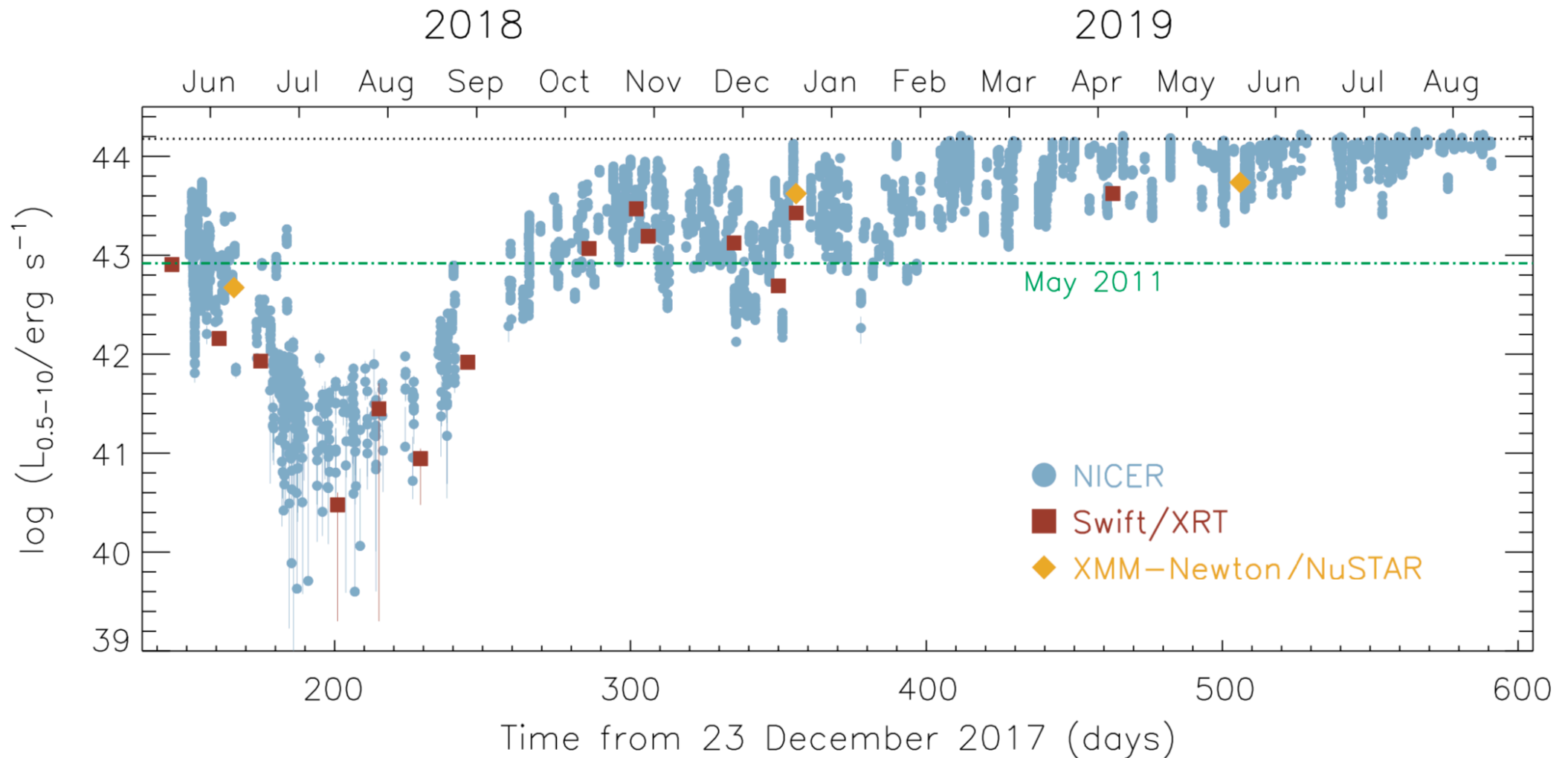


Trakhtenbrot et al. (2019)

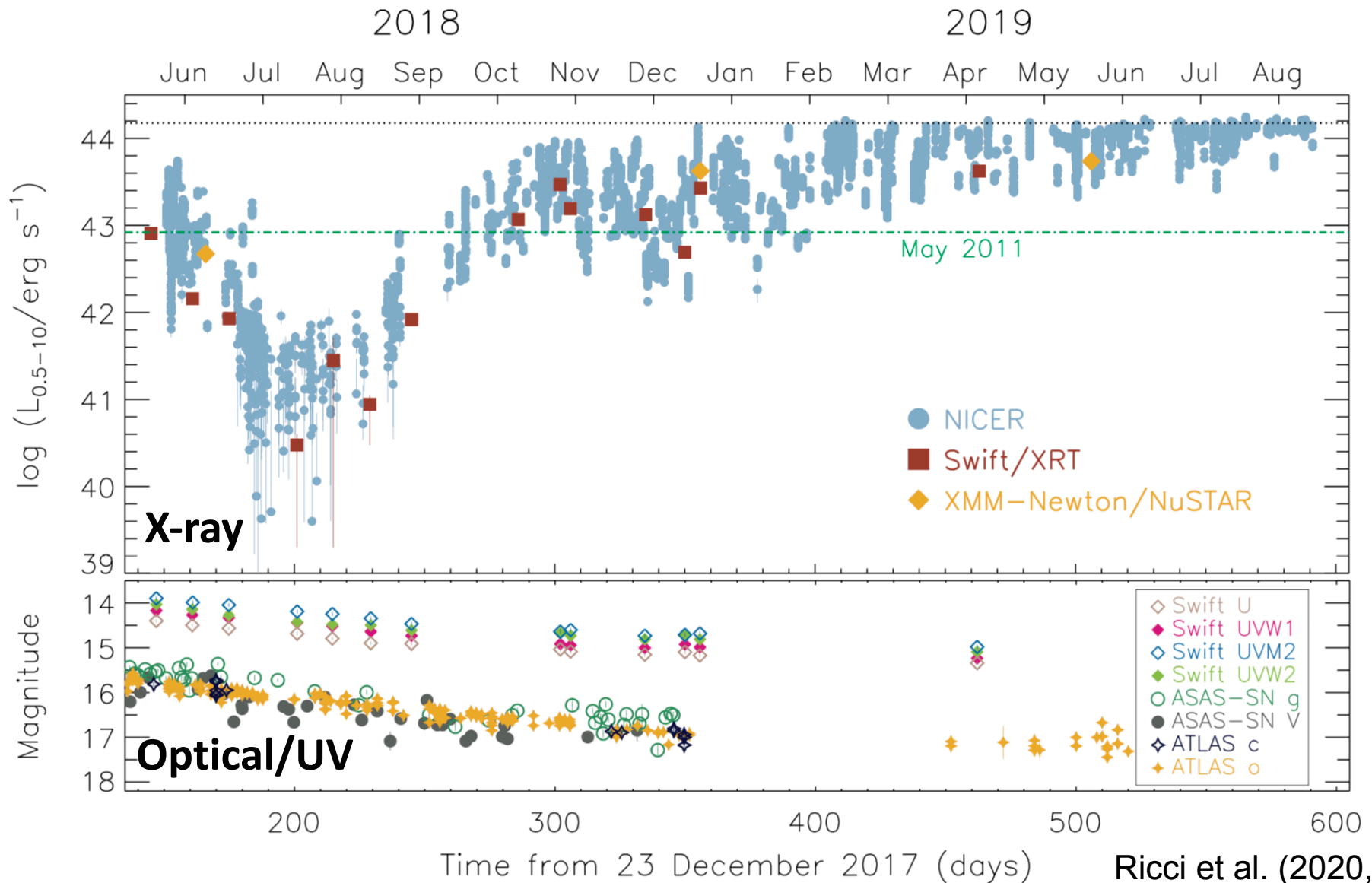
Extreme variability on short timescales..



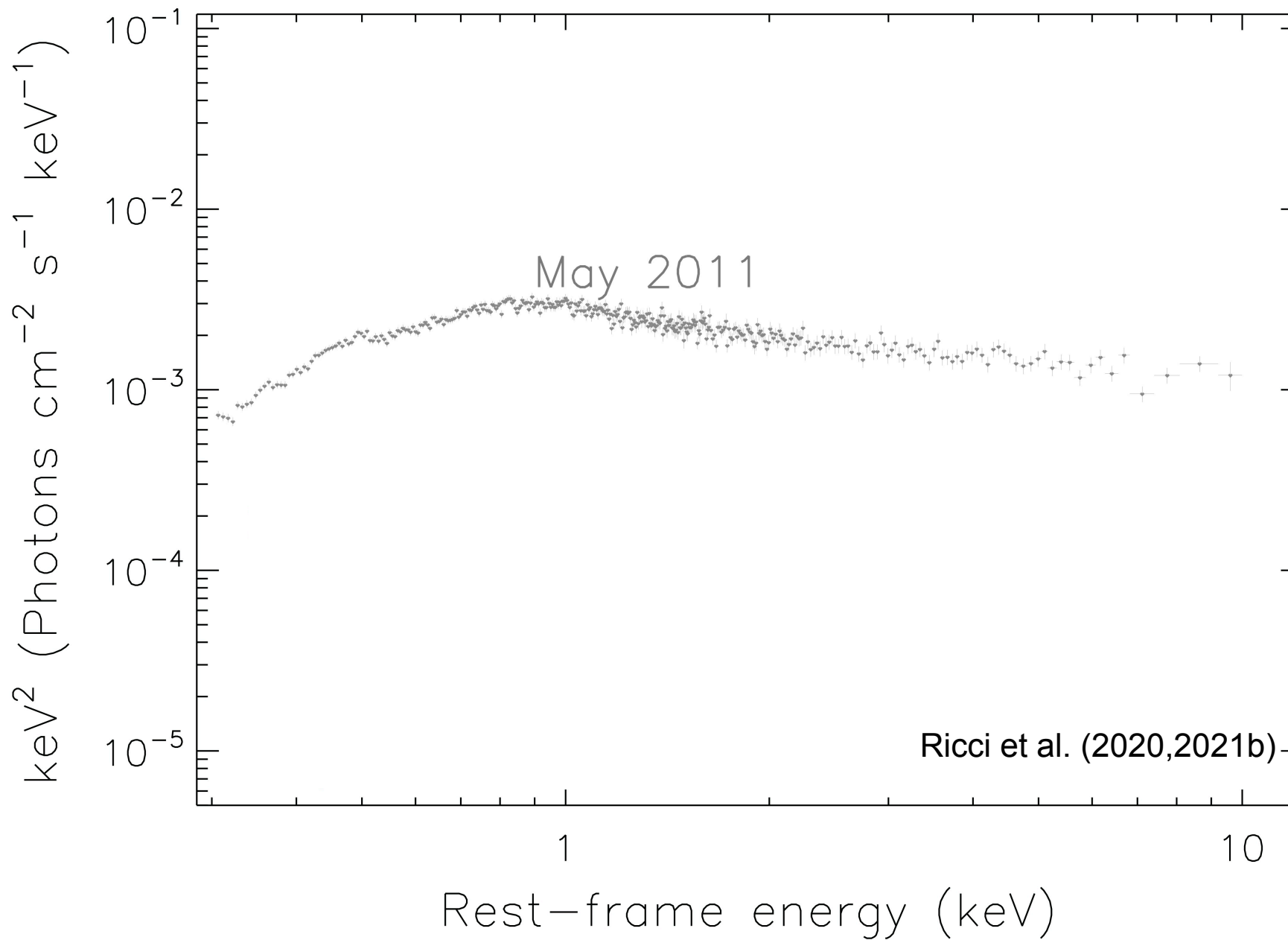
..and on long timescales



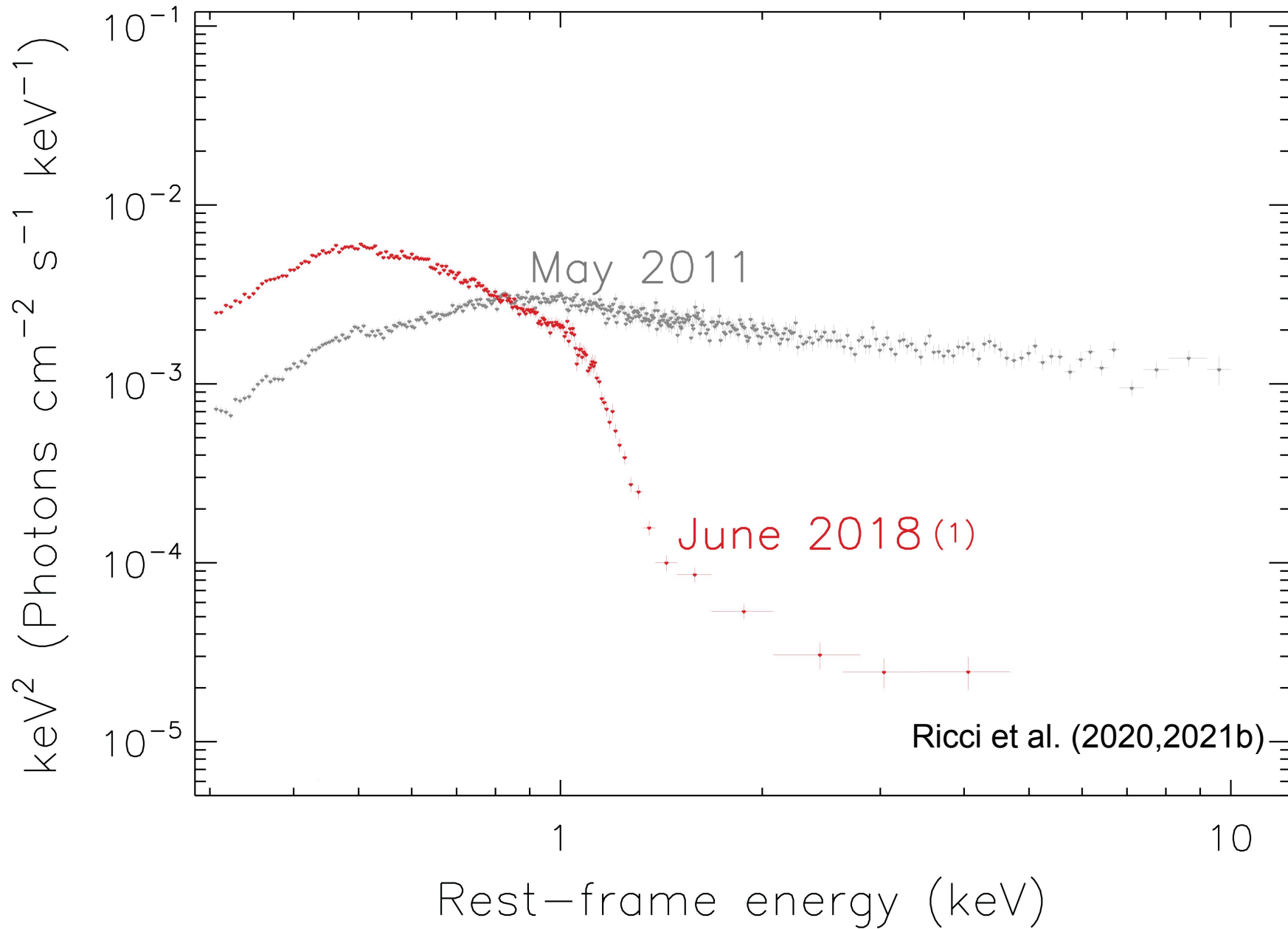
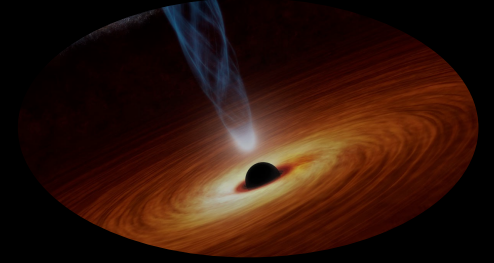
X-ray and UV variability are disconnected



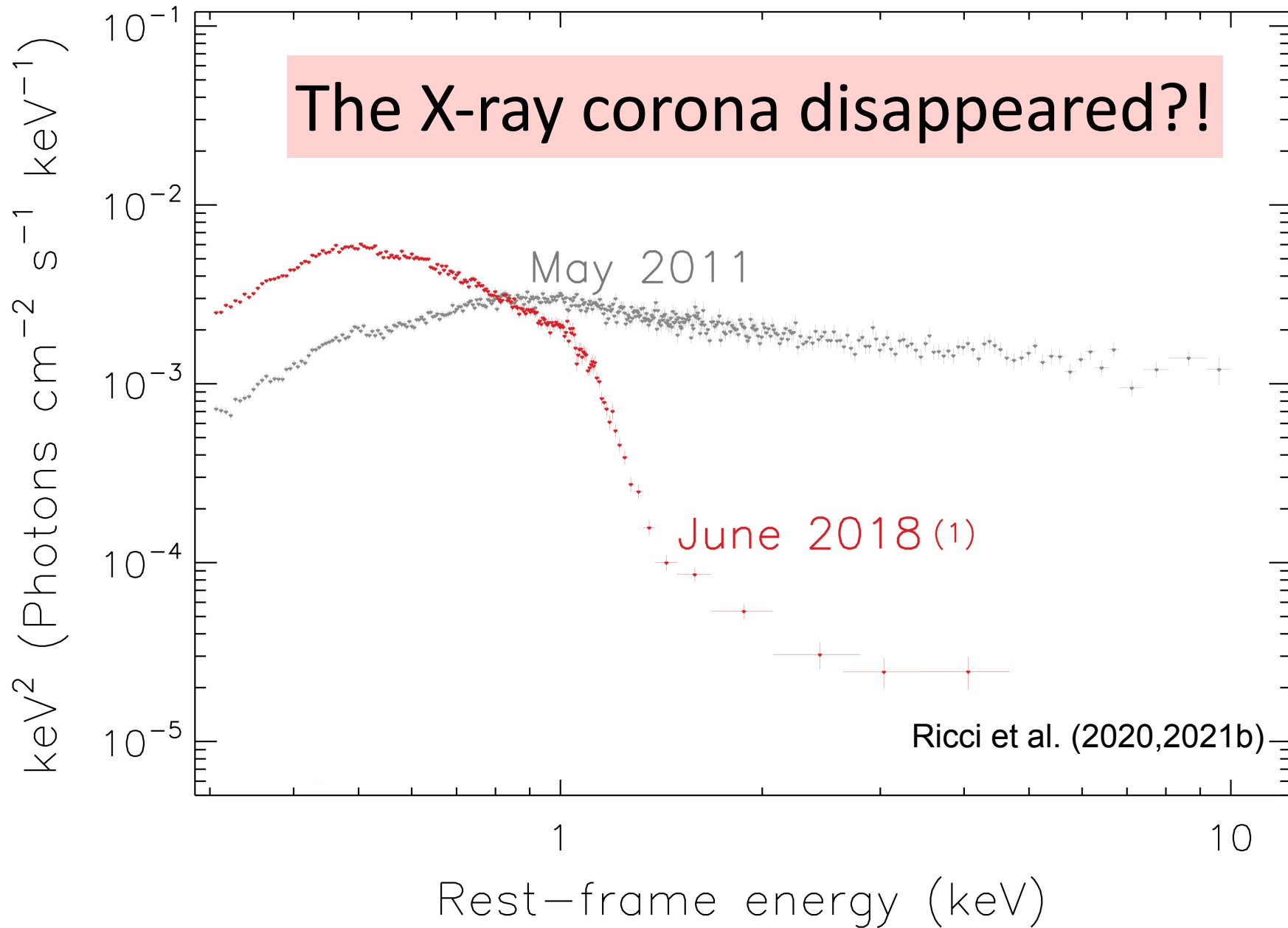
The X-ray campaign



The X-ray campaign



The X-ray campaign



The X-ray campaign



Astronomers Observe The Never-Before-Seen Disappearance Of A Black Hole Corona

The X-ray campaign

Astronomers Observe The Never-Before-Seen Disappearance Of A Black Hole Corona



Christian Leatham

It didn't disappear. It relocated here. ...

Like Reply 2y



Joel McCollough

So...you're saying this is a novel corona?...

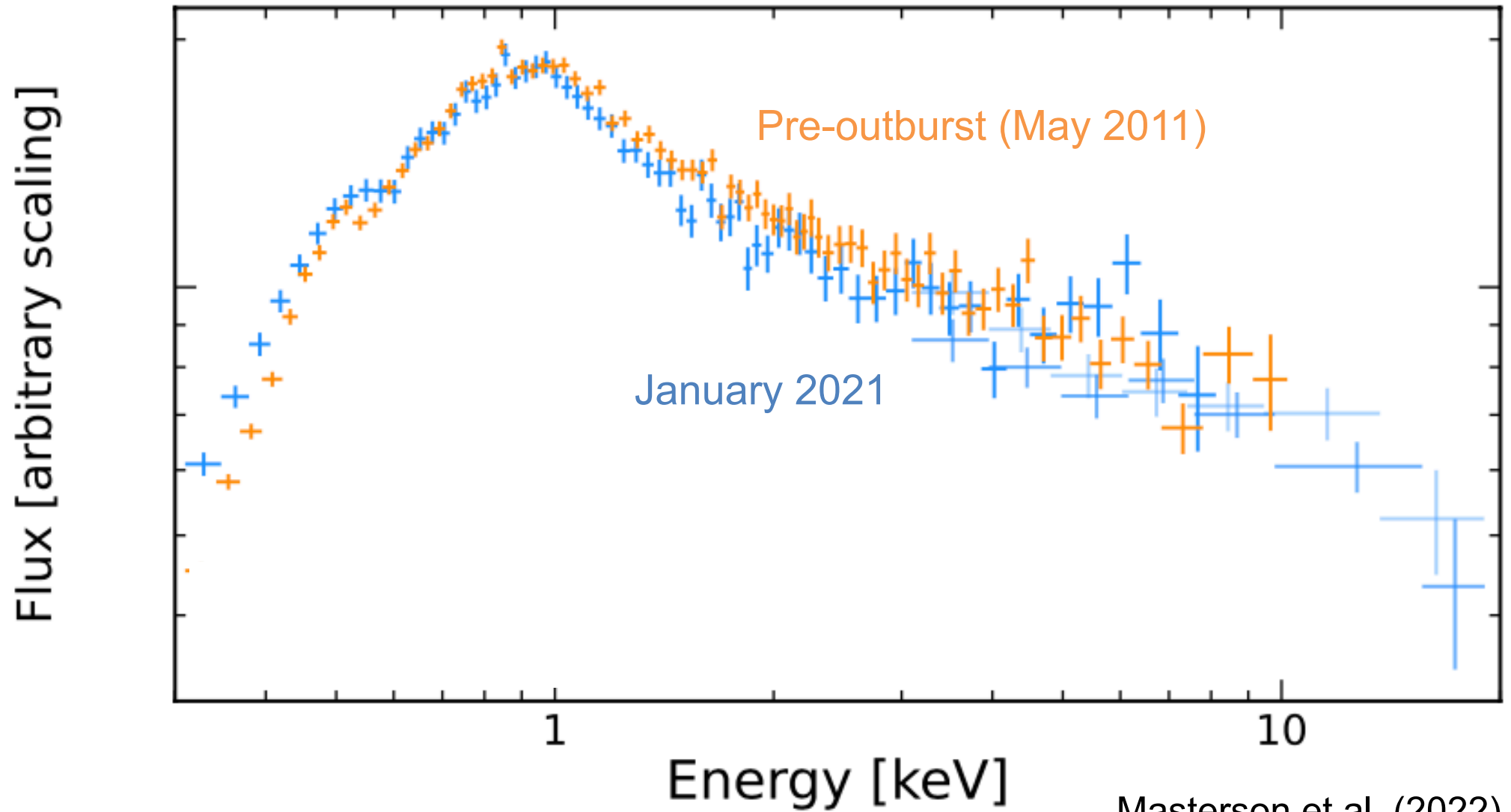
Like Reply 2y



Jacob Garcia

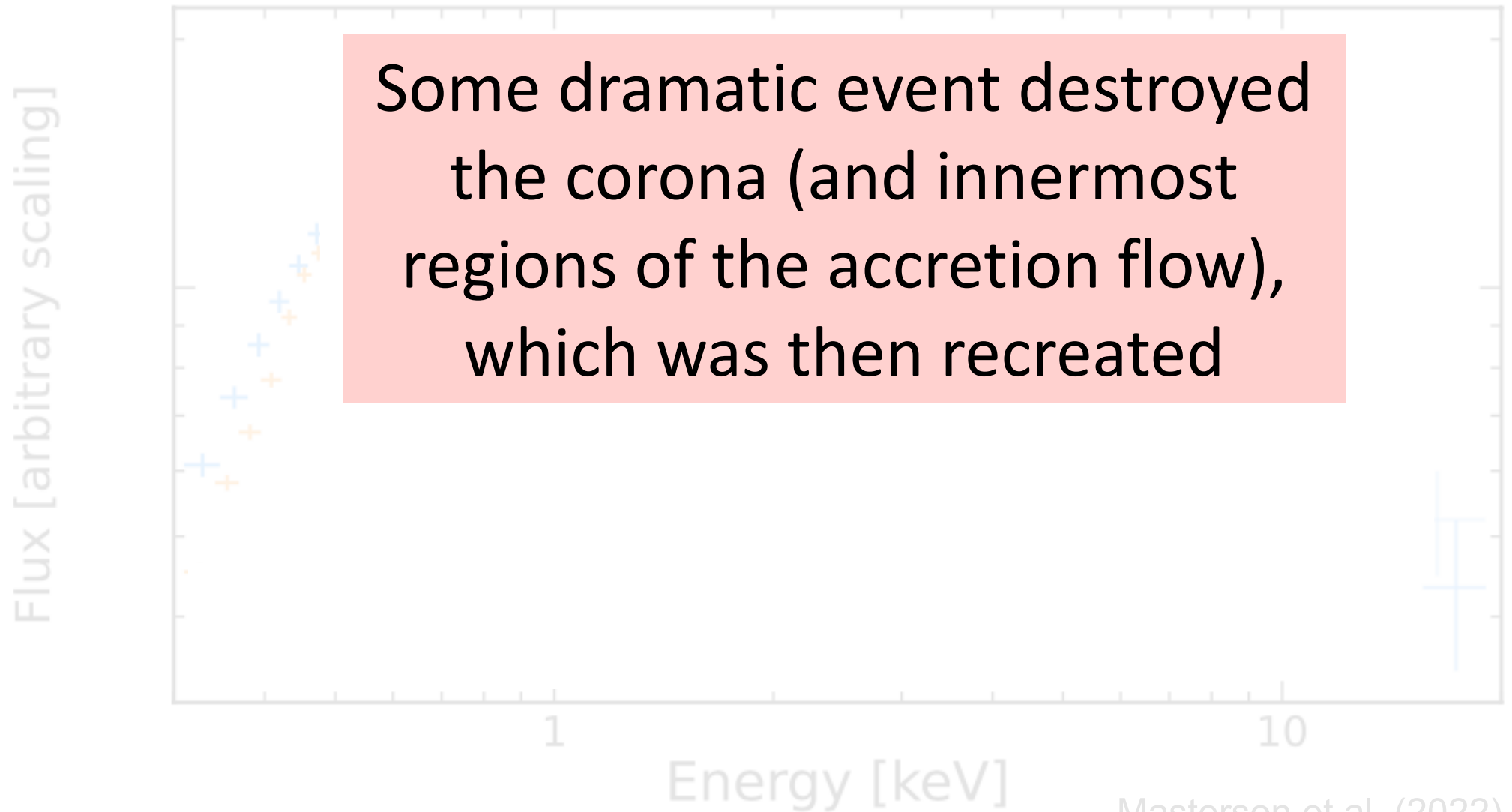
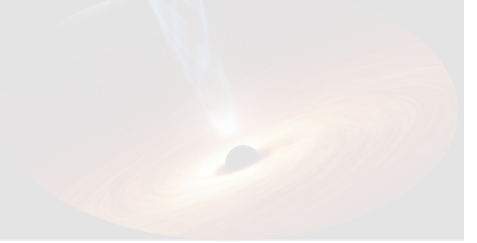
Lola Zamora Garcia That's cause the corona made it here ...

The X-ray campaign



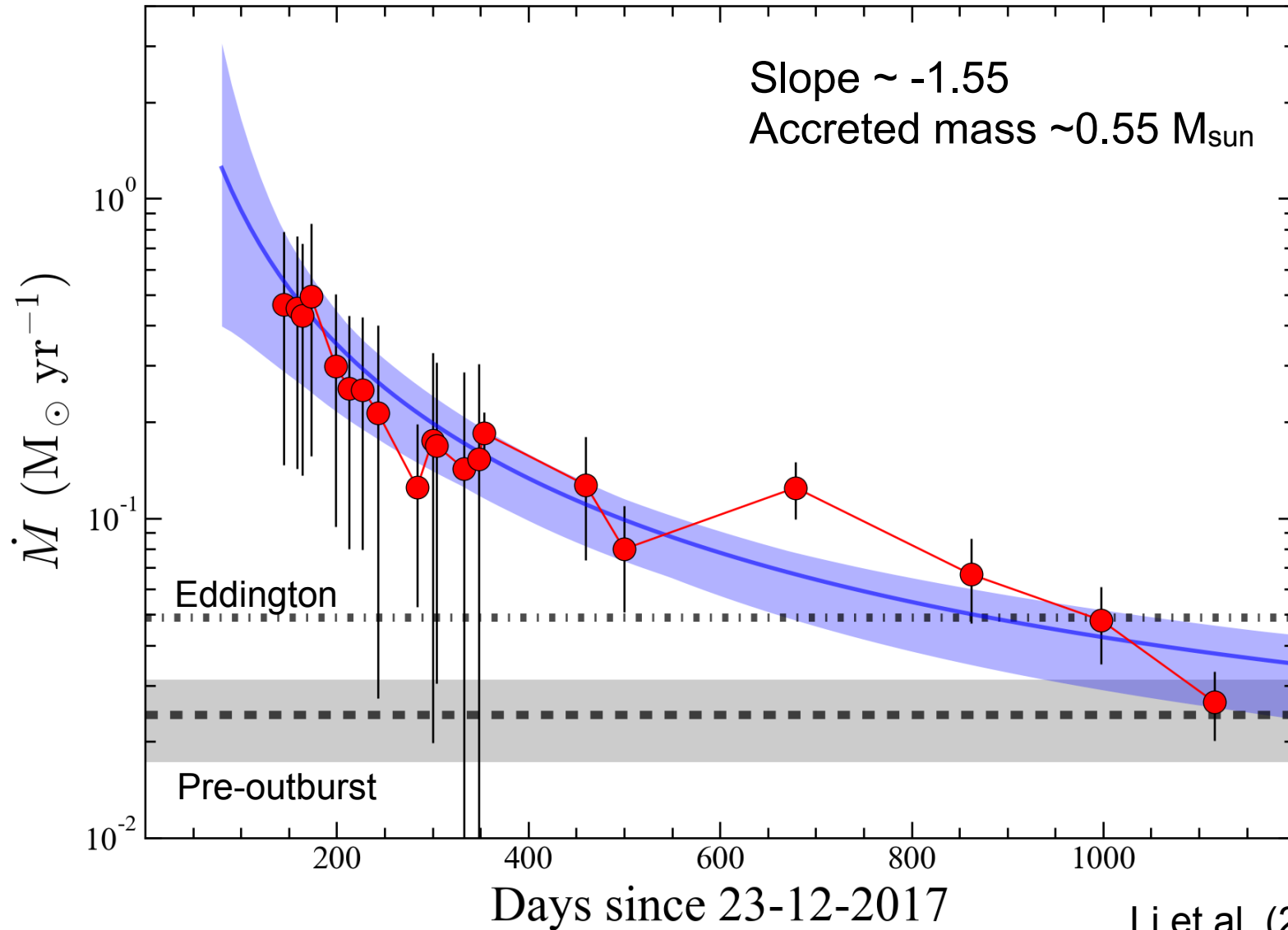
Masterson et al. (2022)

The X-ray campaign

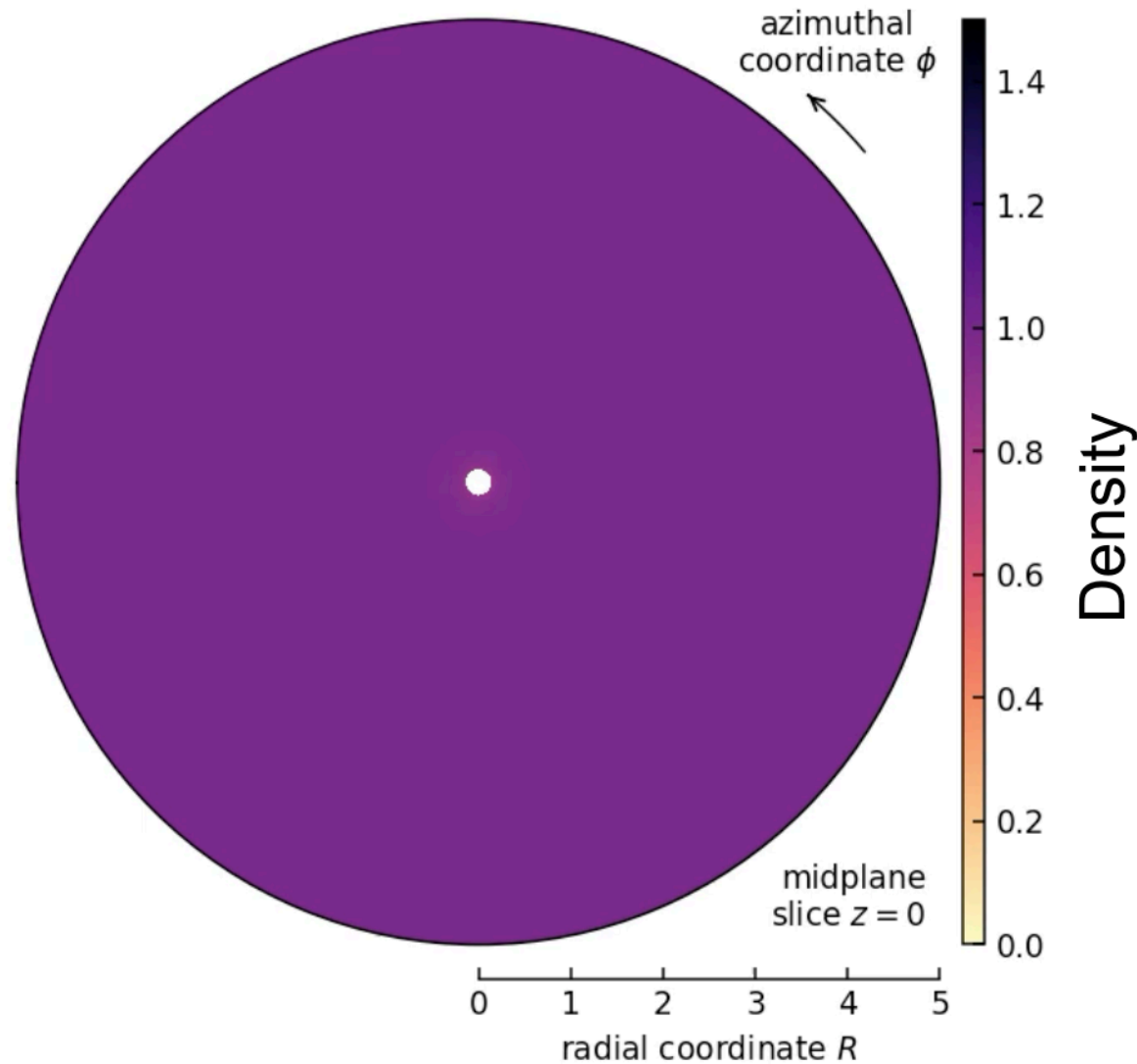


Masterson et al. (2022)

The decline of the accretion rate

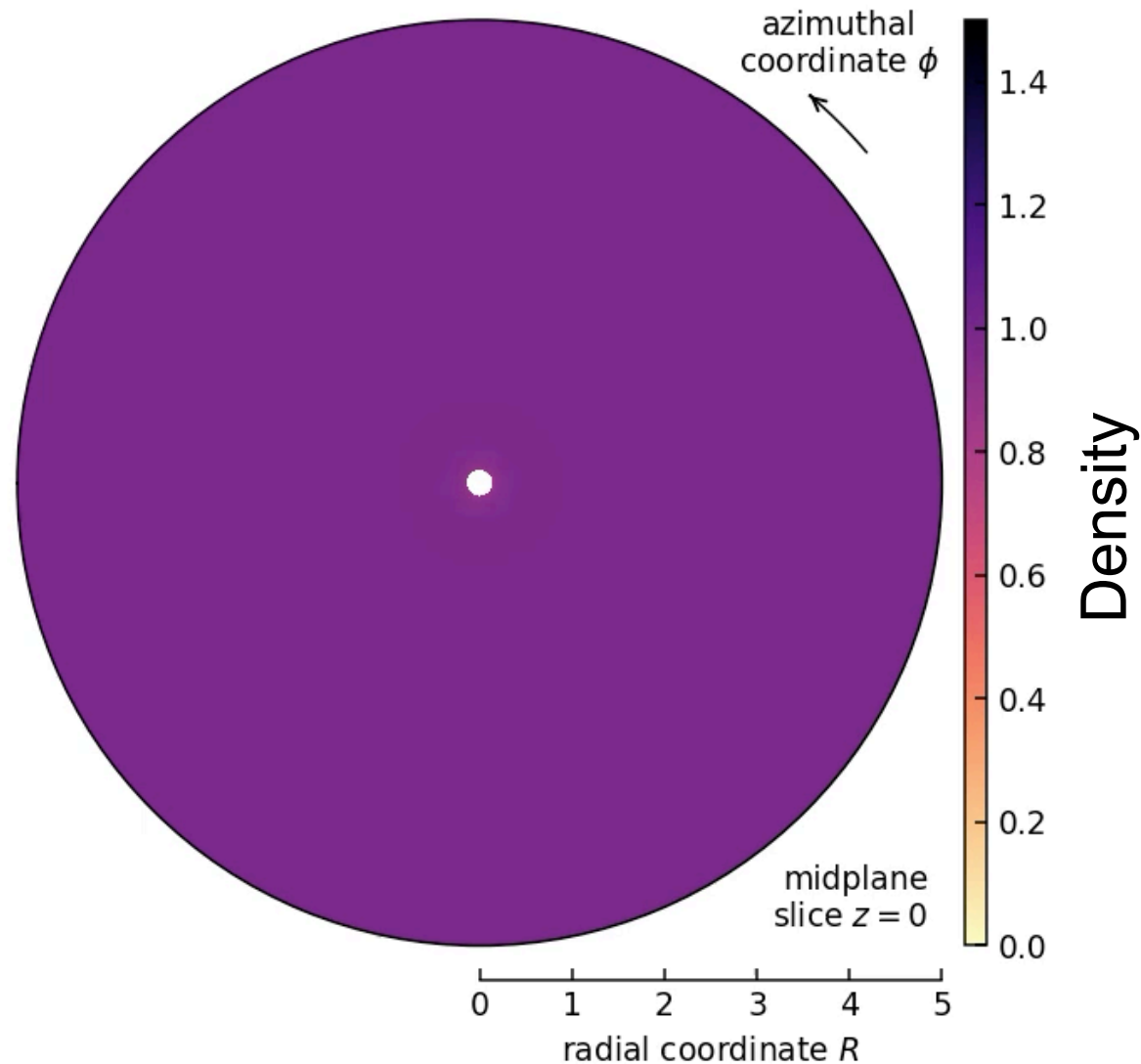


A Tidal disruption event in an AGN?



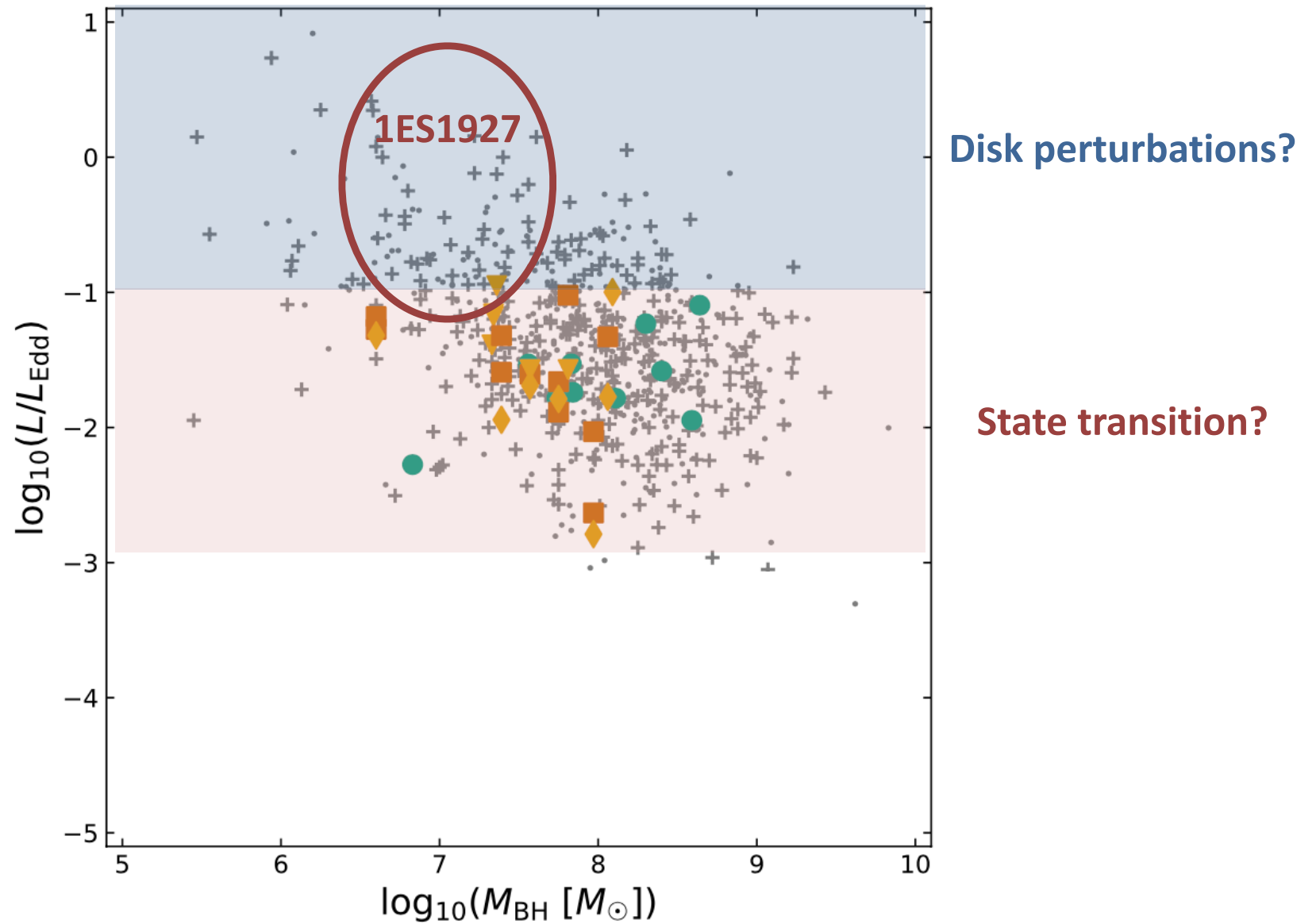
Chan+19

A Tidal disruption event in an AGN?



Chan+19

The origin of CS AGN



Temple, CR et al. (2022)

Summary

- Changing look AGN can allow us to shed light on the inner regions of AGN
- CO AGN are typically due to eclipses, outflows, or extreme flux variations
- CS AGN might be commonly triggered by changes in the SED
- Changing-state events in AGN can be associated with dramatic and quick transformations of the innermost regions of accreting SMBHs (and TDEs?)
- Future studies with SDSS-V, LSST/4MOST (e.g., ChANGES) + brokers (e.g. Alerce), *eROSITA* and the *Einstein probe* will find lots of CS AGN, and also more extreme objects such as 1ES 1927+654

See our review for more: Ricci & Trakhtenbrot 2023 Nat. Astro