

TDEs, QPEs and other eXotica



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25 June 2023
Hong Kong
Roger's Black Hole Bonanza

TDEs, QPEs and other eXotica



Kishalay De
MIT Einstein Fellow



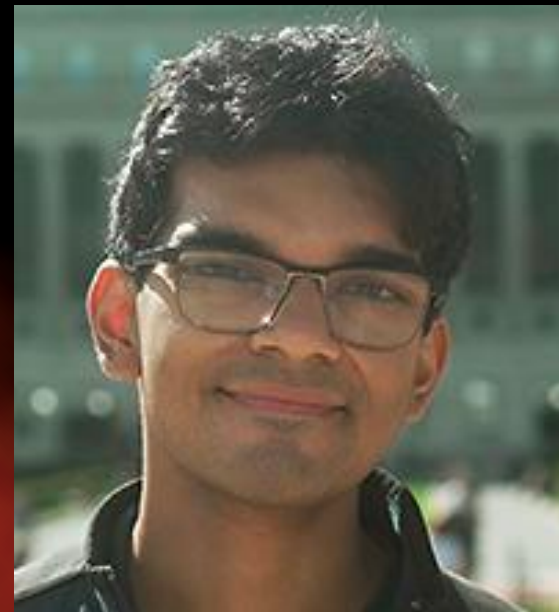
Christos Panagiotou
MIT Postdoc



Megan Masterson
3rd Yr PhD Student



Riccardo Arcodia
Einstein Fellow, MIT

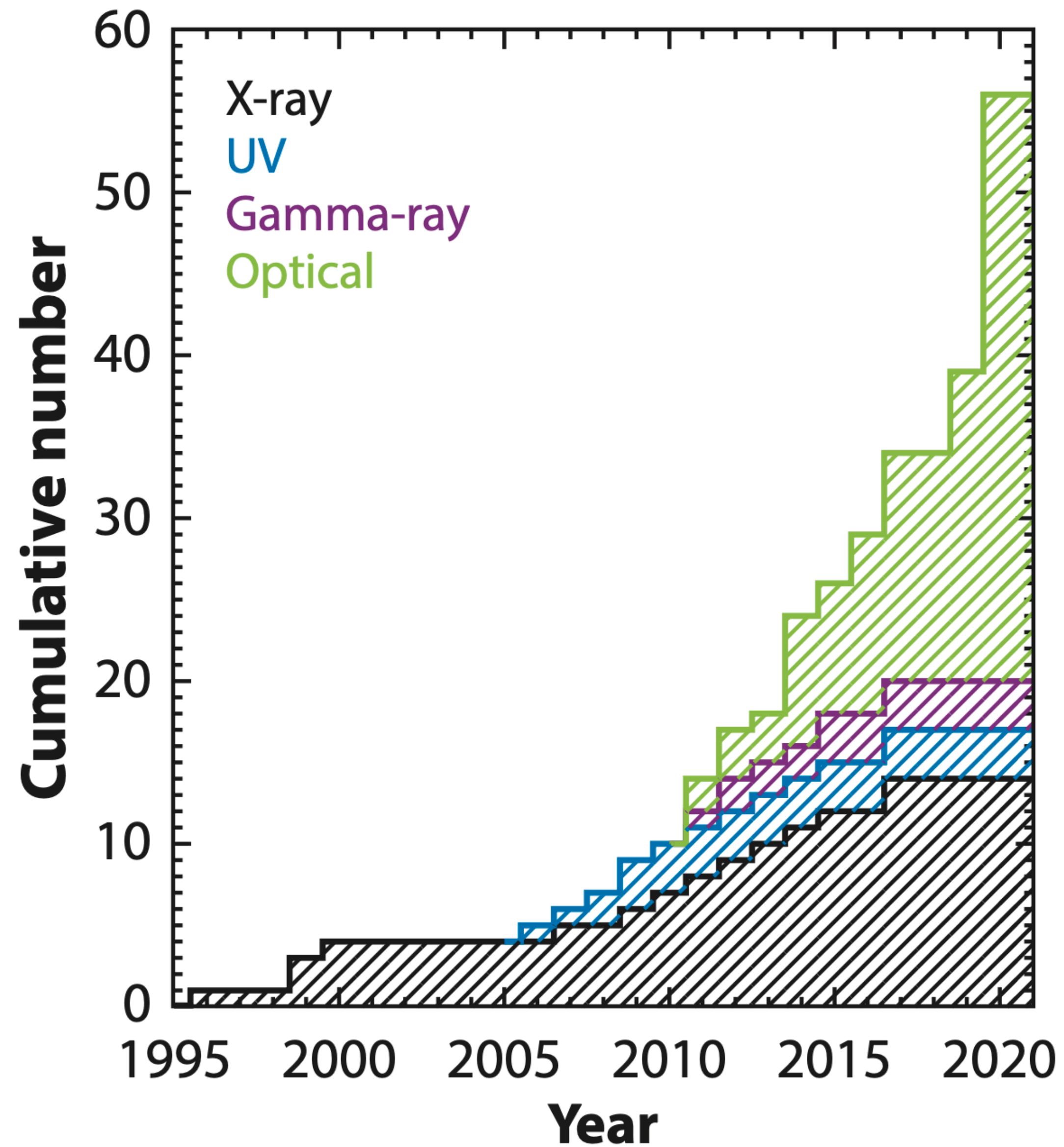


Joheen Chakraborty
1st Year Grad Student

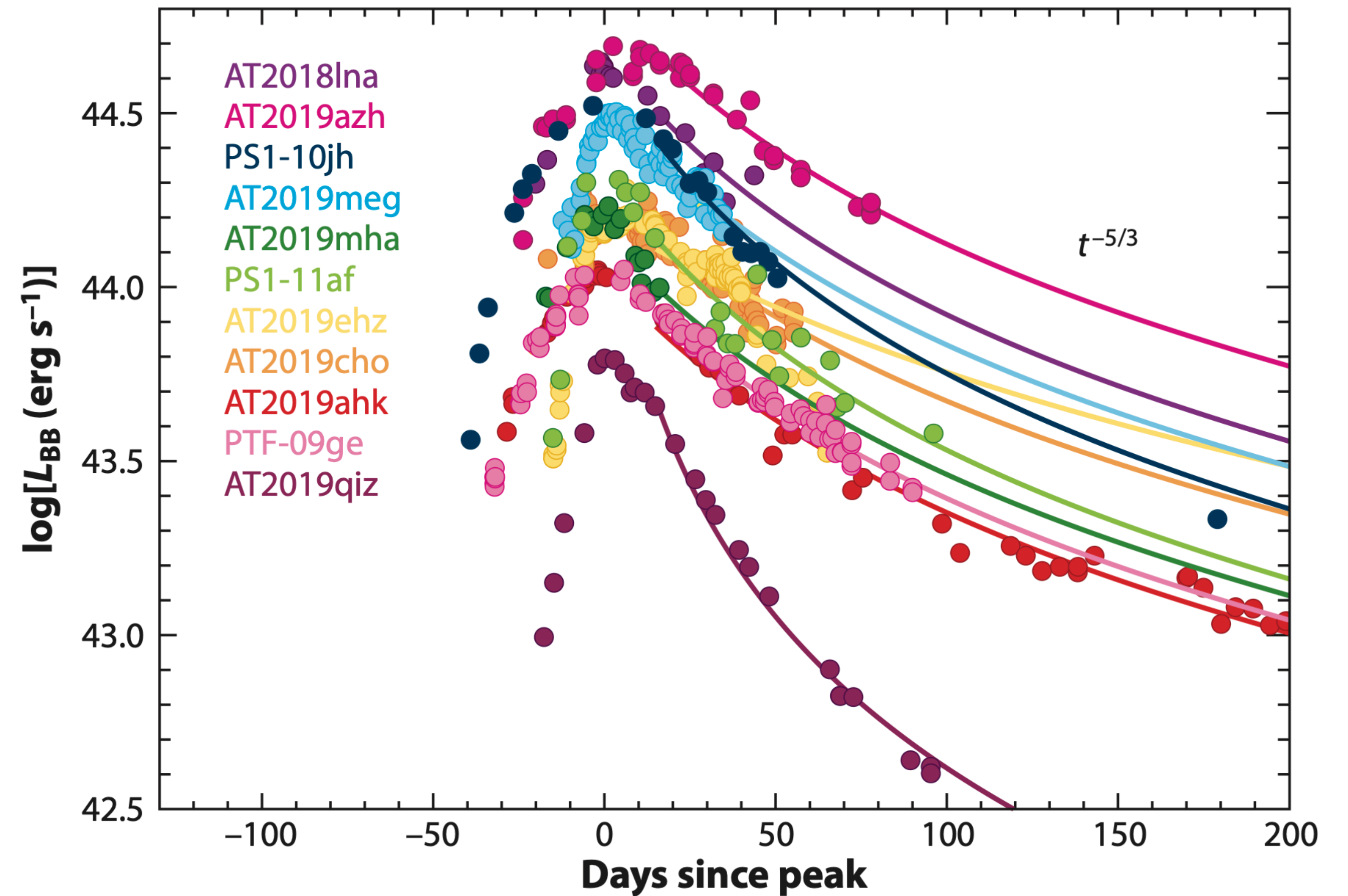


Jingyi Wang,
5th Year PhD

25 June 2023
Hong Kong
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Tidal Disruption Events

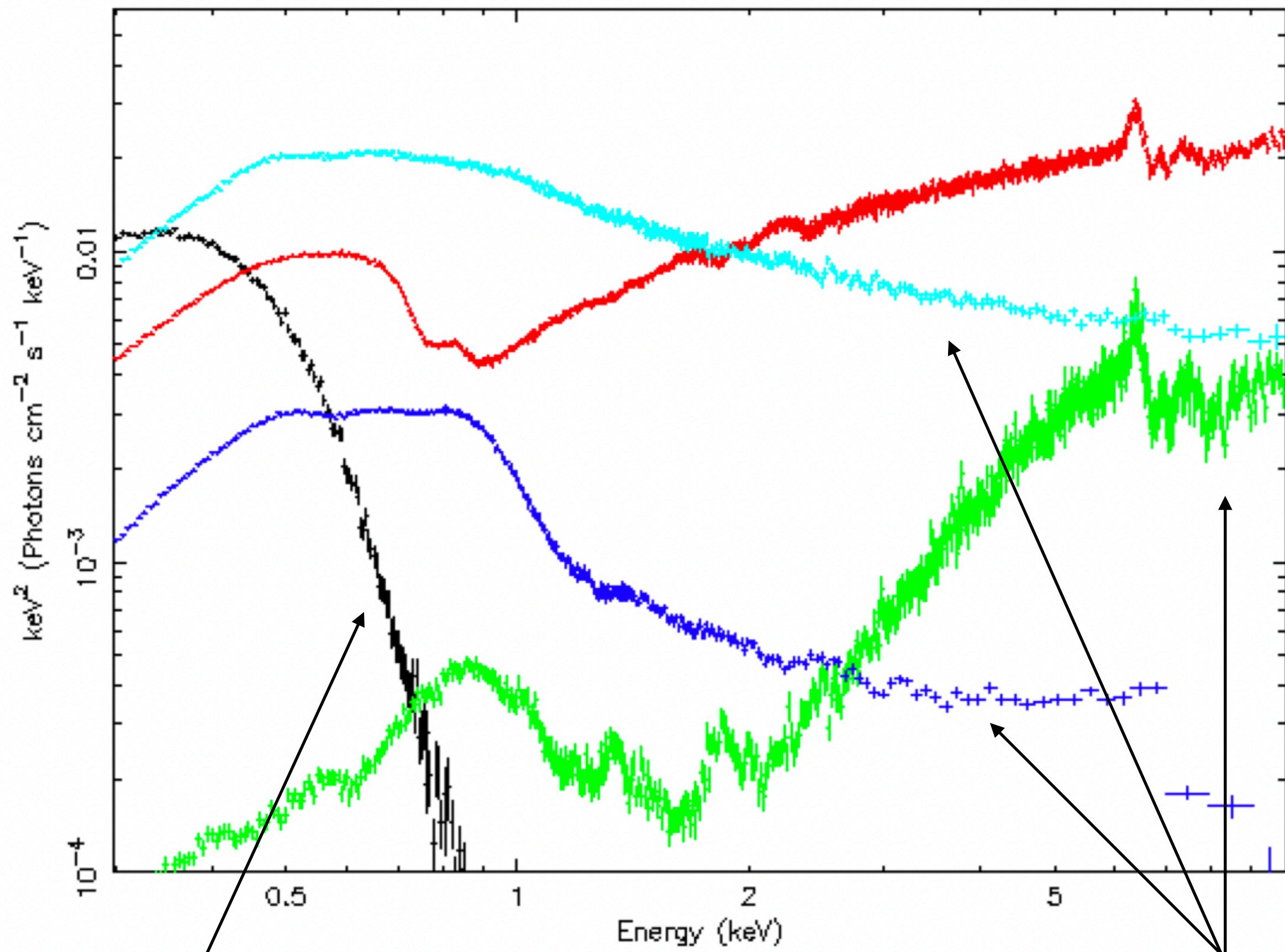


Gezari+21 review

X-ray Properties (spectra)

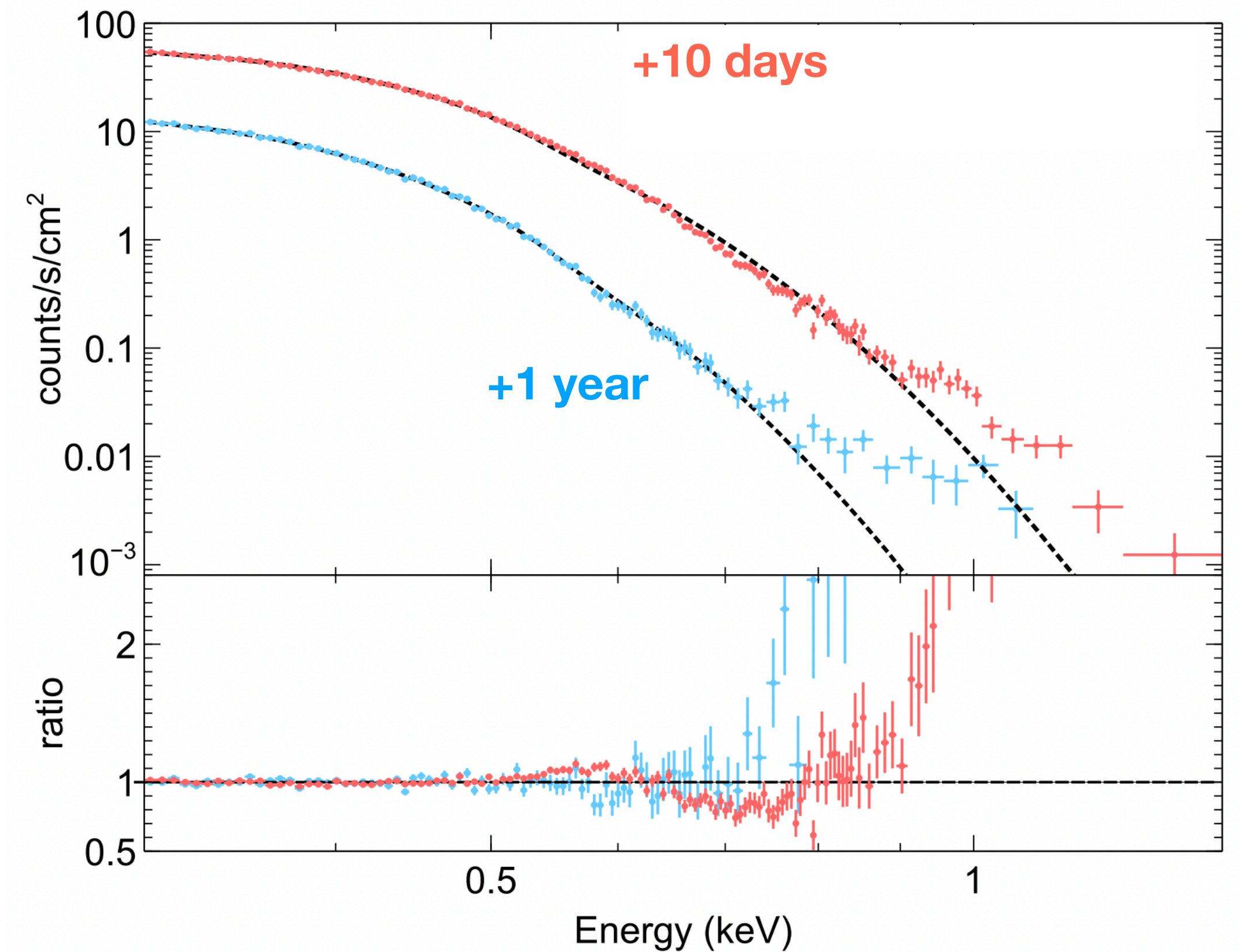
TDEs usually have no corona at early times

Appears to form at late times



TDE

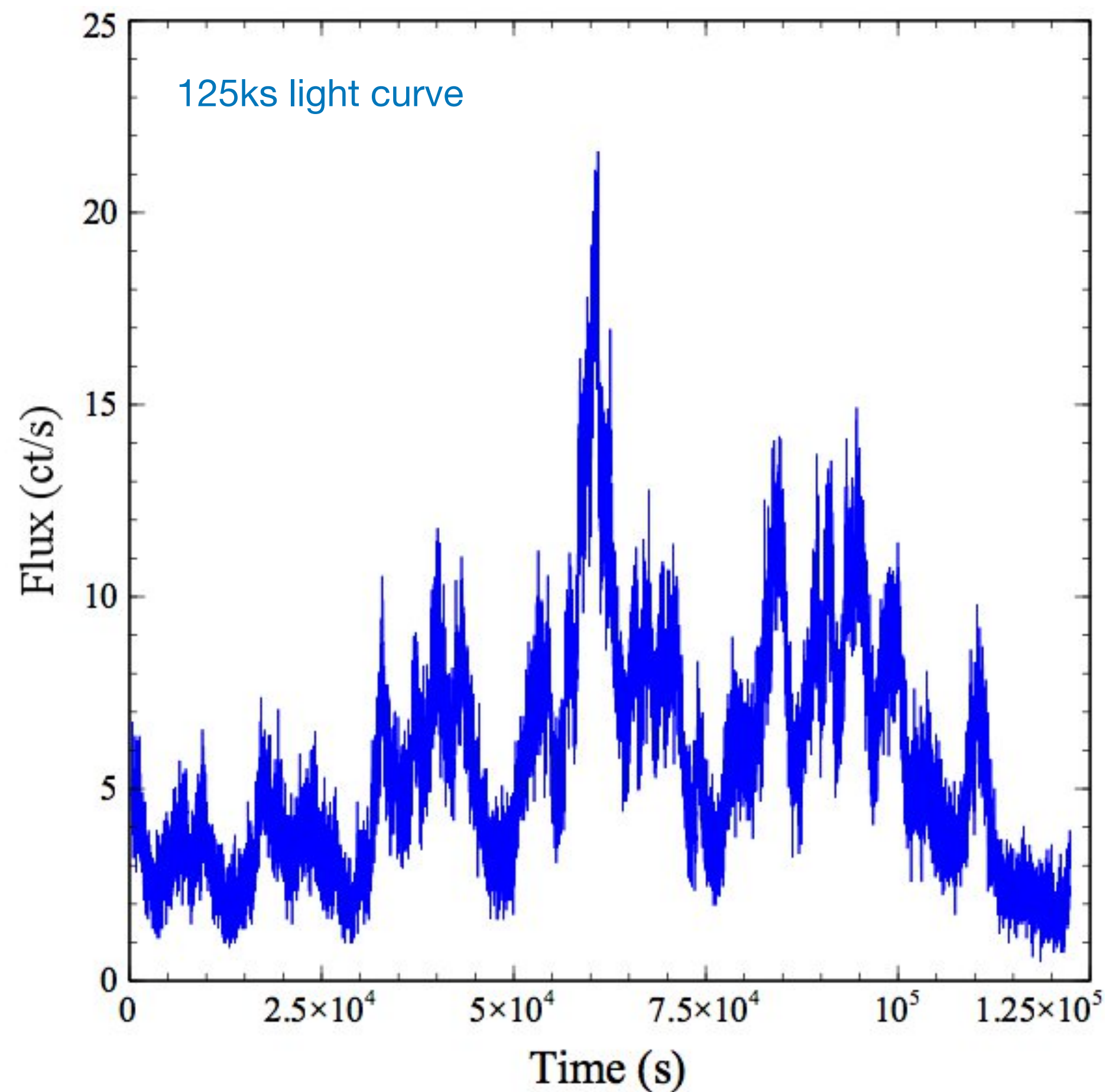
AGN



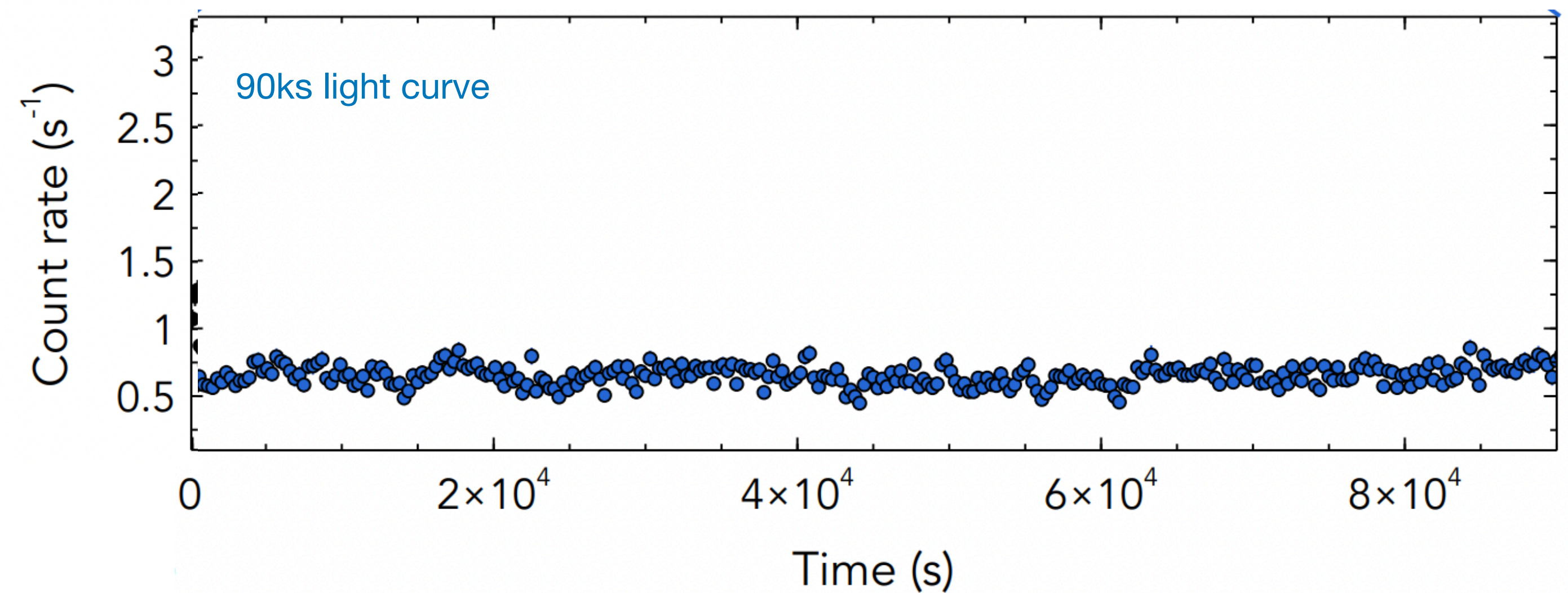
Kara et al., 2018
See also Jonker et al., 2021

X-ray Properties (variability)

Stochastic AGN Variability in 1e6 Msun BH



TDE of with same black hole



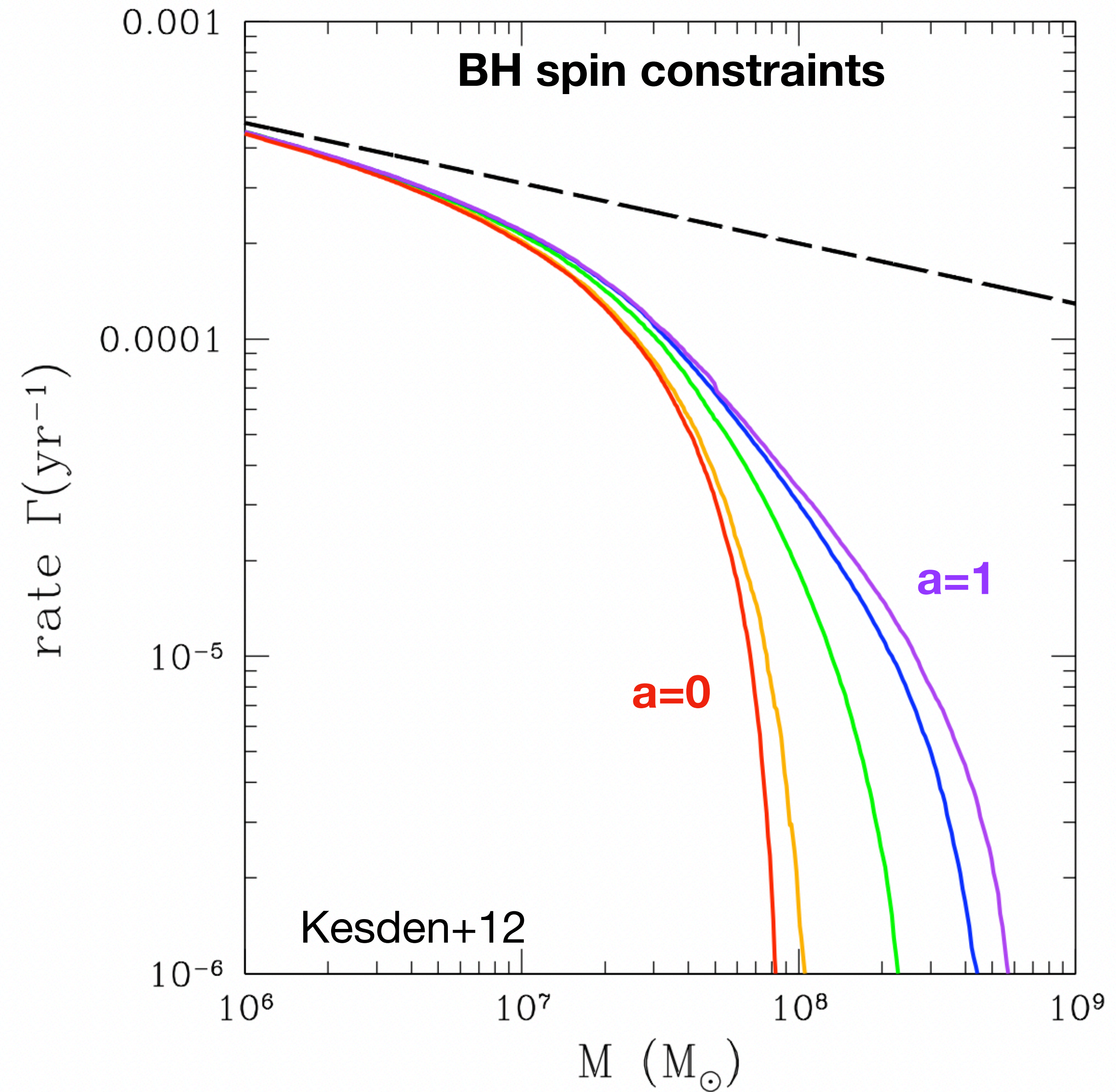
TDE rates & implications

observed rate $\sim 3 \times 10^{-5}$ / galaxy / yr
ZTF: Yao+23

theoretical rate \sim a few 10^{-4} / galaxy / year
Stone+20, Pfister+20

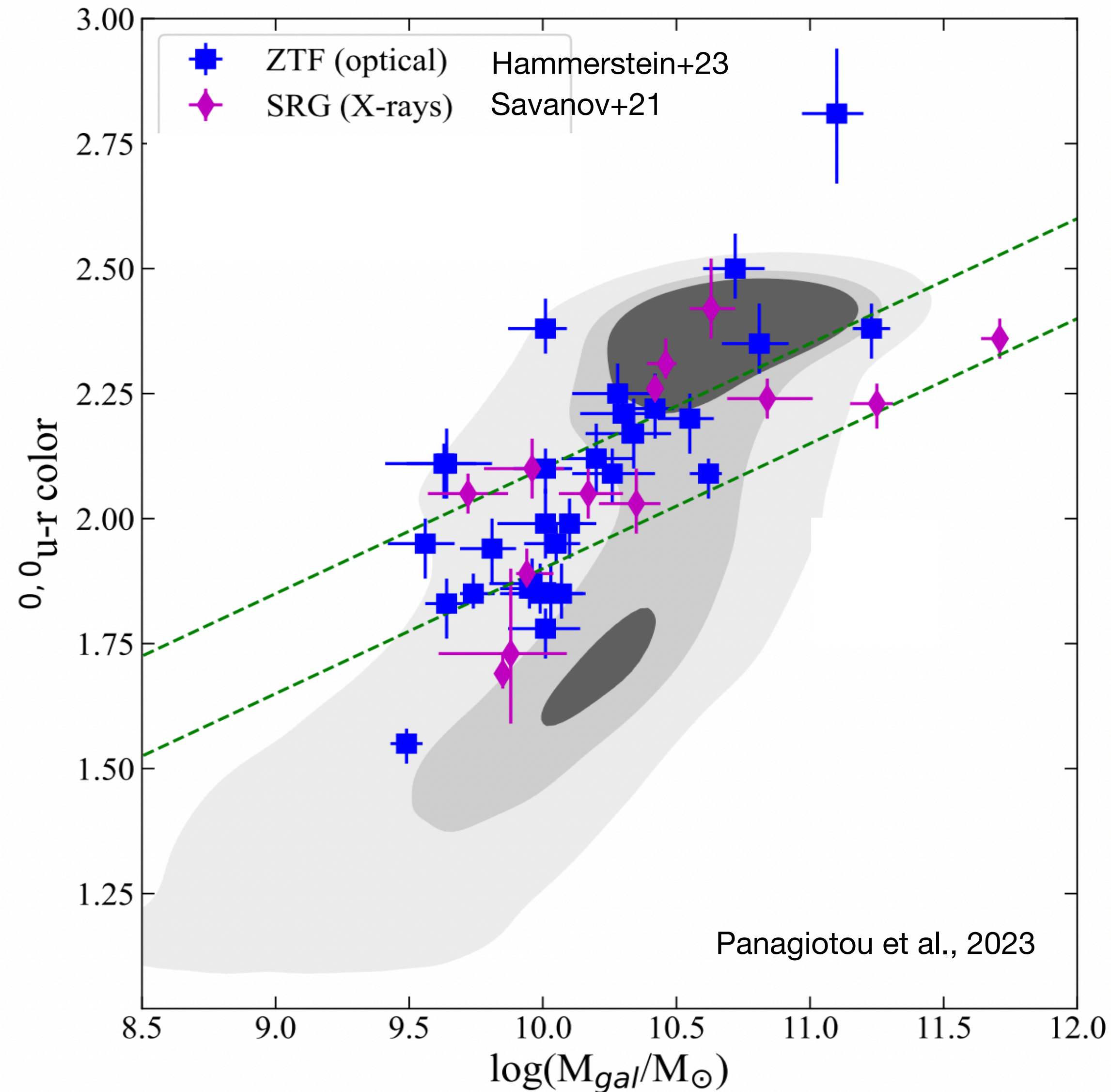
But **caveats** due to, e.g.:
Age of stellar population
(Huang & Lu 2022)

Delayed disk formation
(Wong, Pfister, Dai 2022)



TDE Host Galaxies: Preference for rare class of E+A galaxies

Arcavi+14, French+17

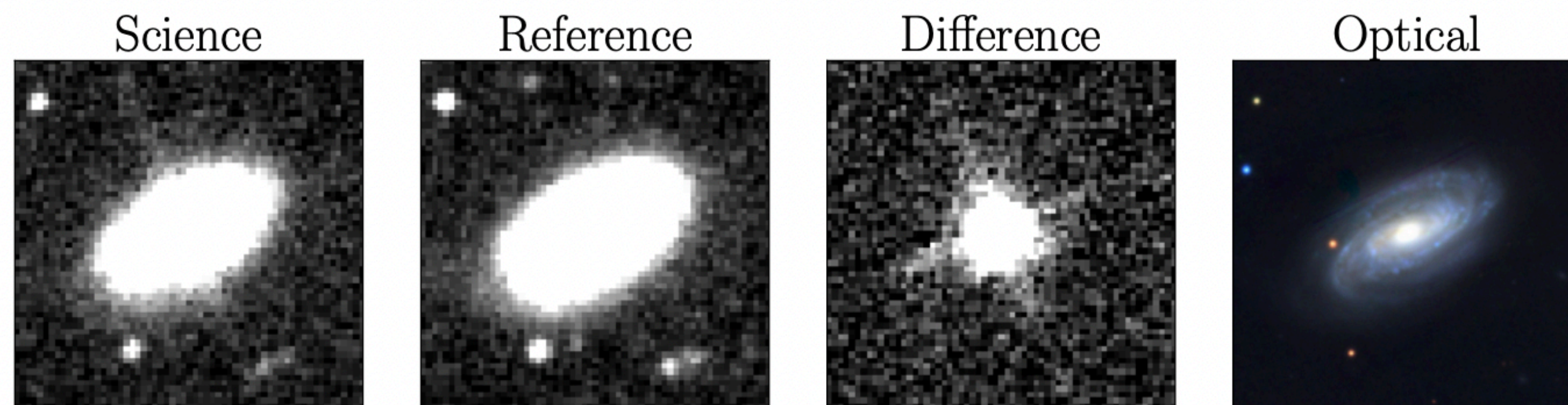


Physical?
(French+20; Hammerstein+21)
Selection effects?
(Roth+21)

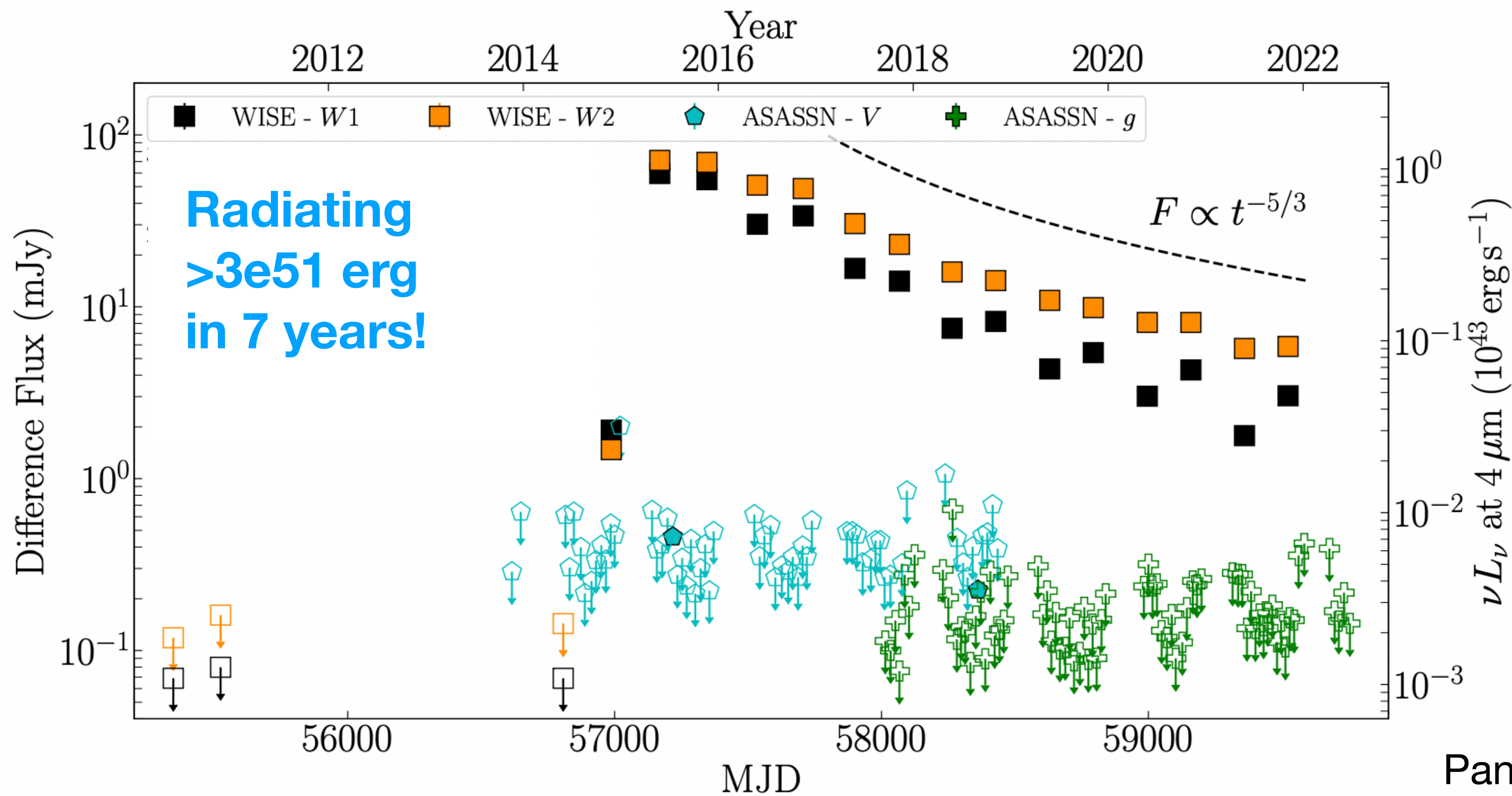


Kishalay De
MIT Einstein Fellow

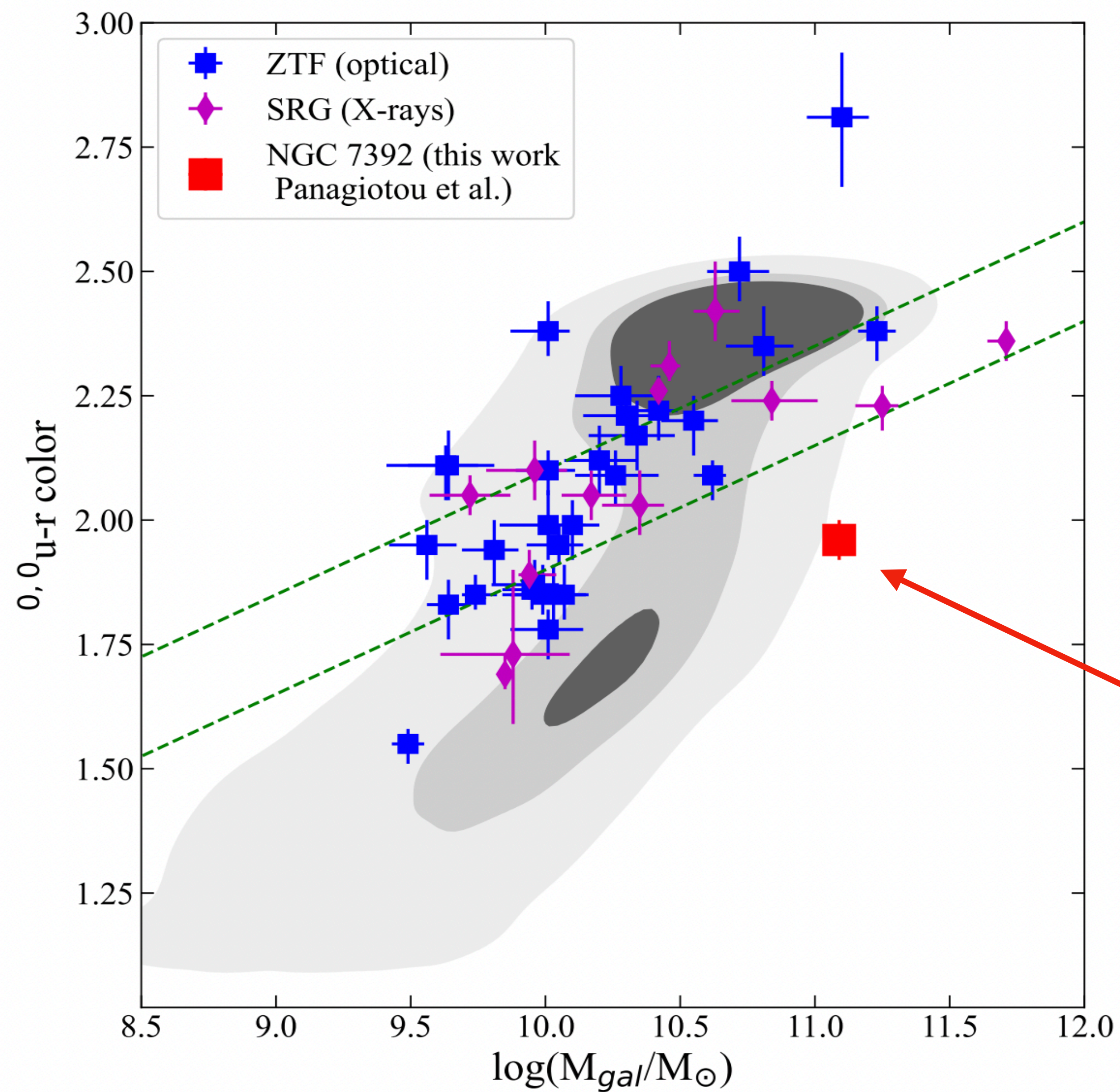
The nearest TDE to date at 42 Mpc



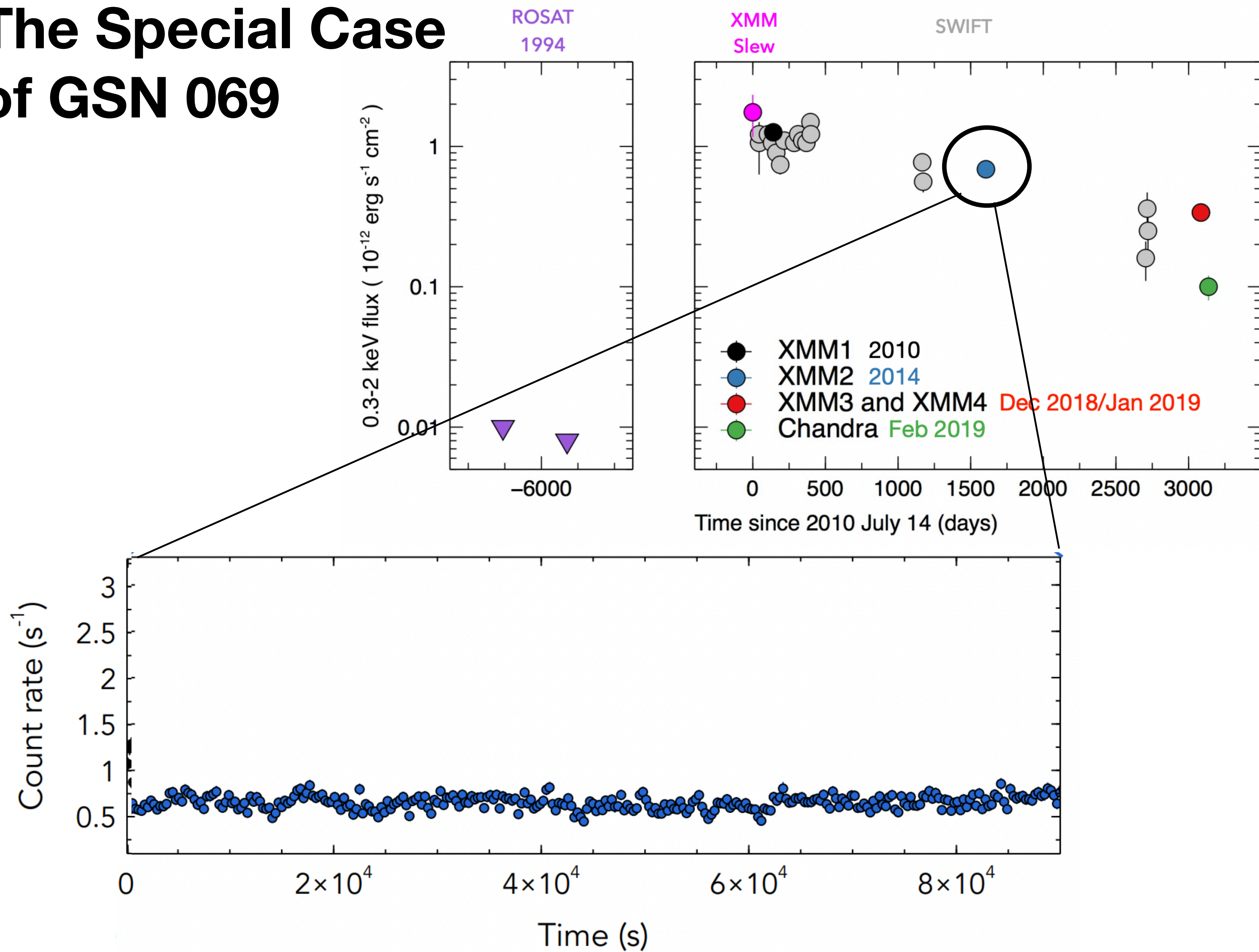
Christos Panagiotou
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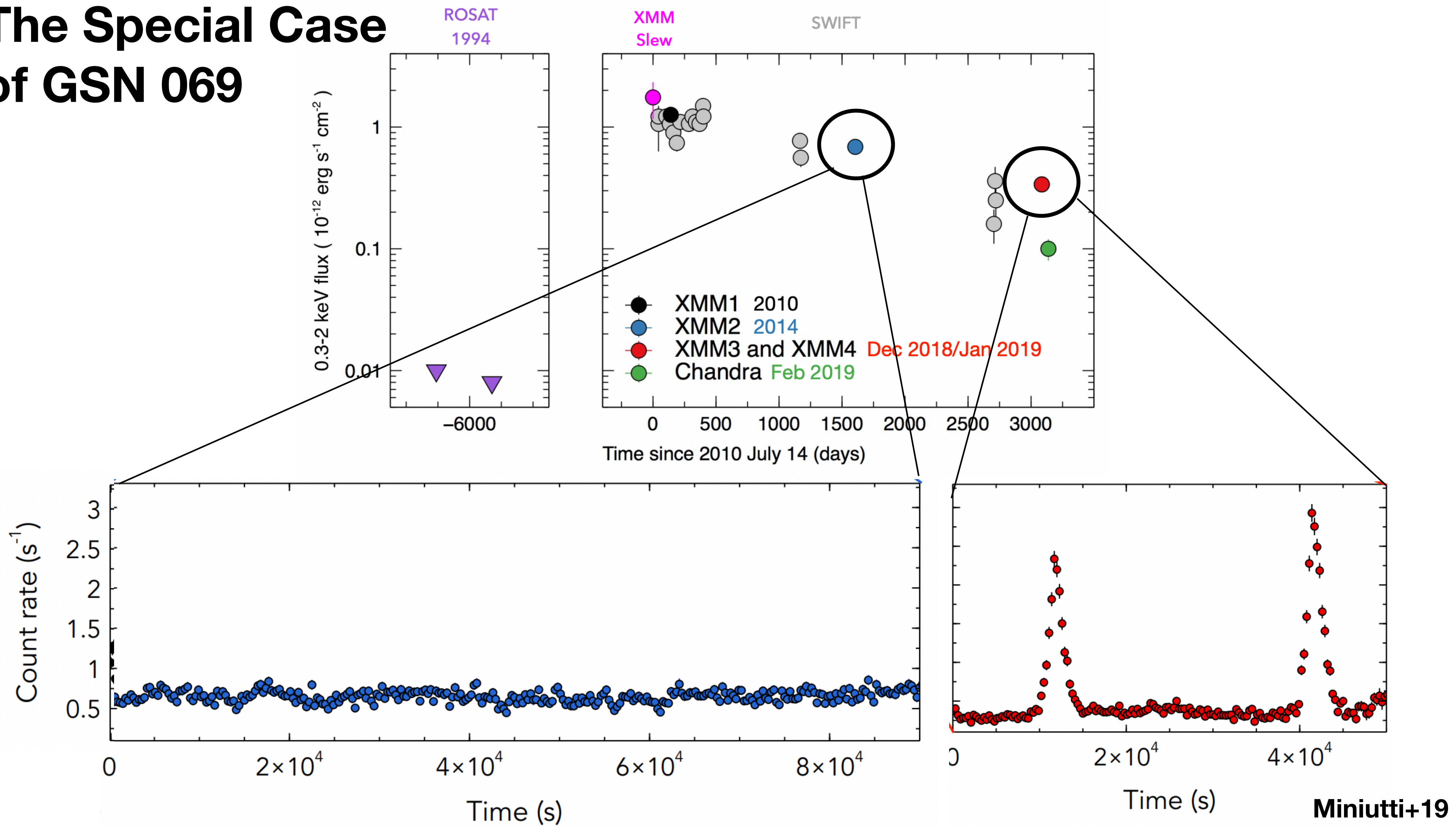
The nearest TDE to date at 42 Mpc



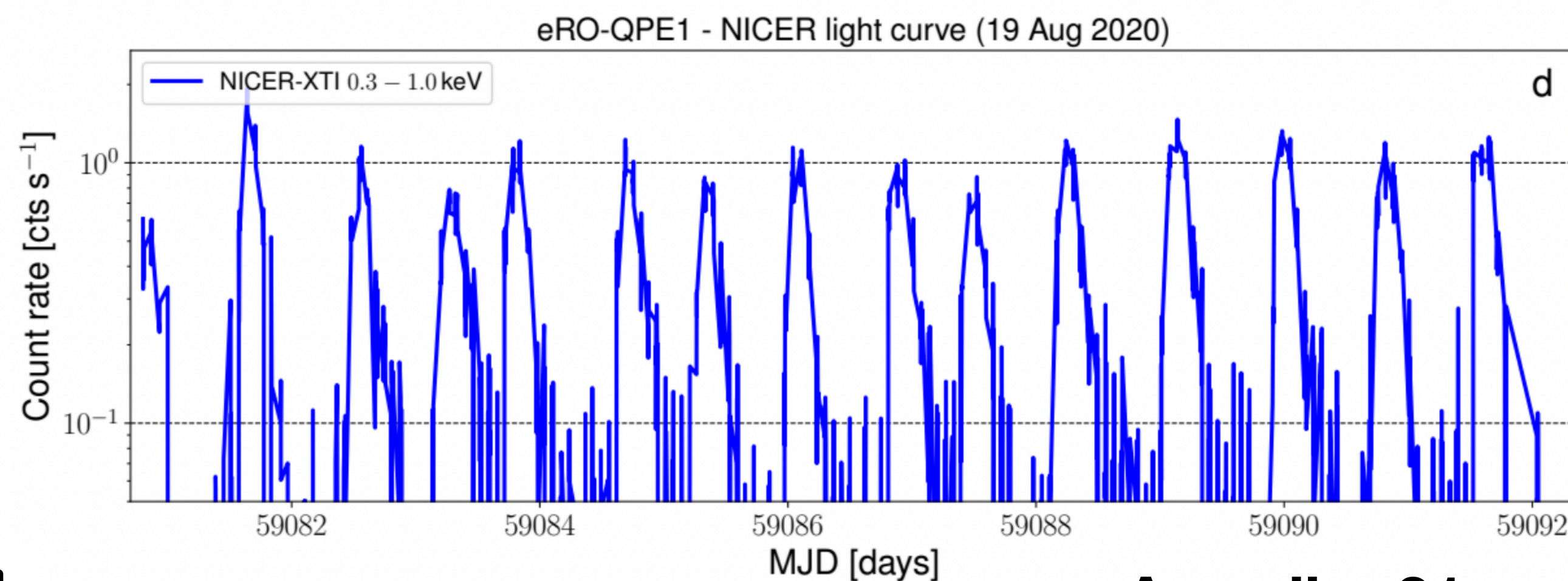
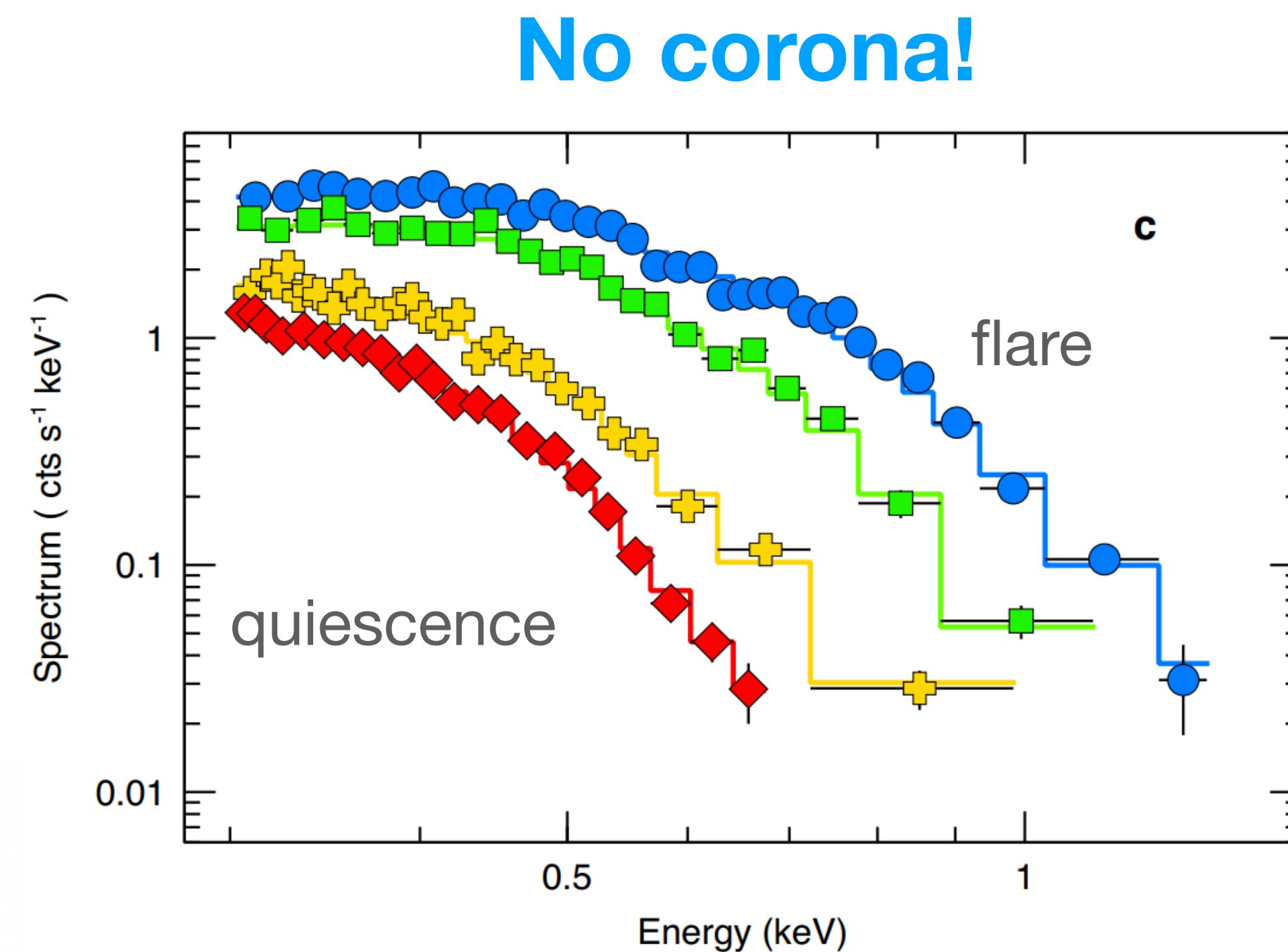
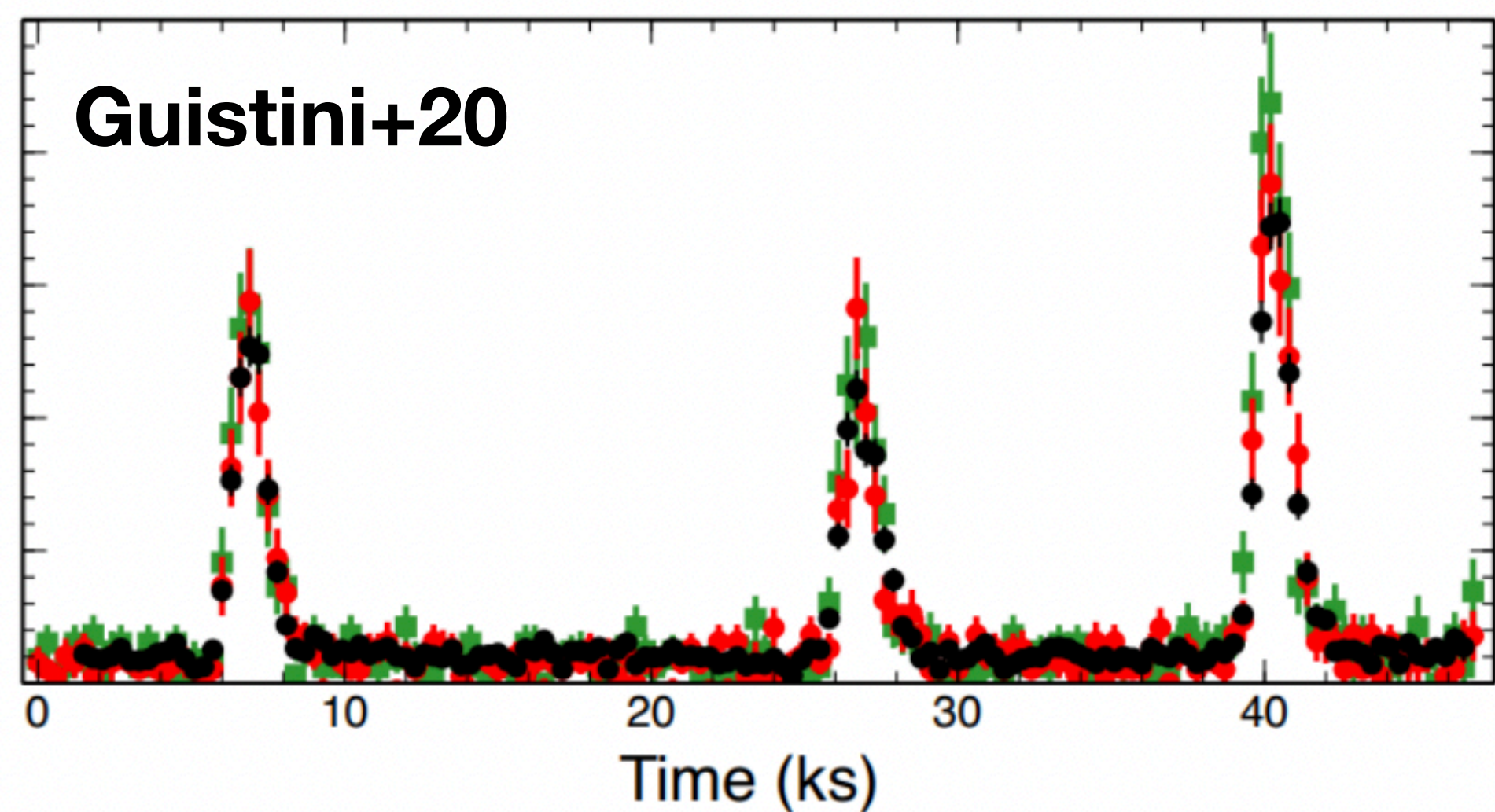
The Special Case of GSN 069



The Special Case of GSN 069



More QPEs in AGN!



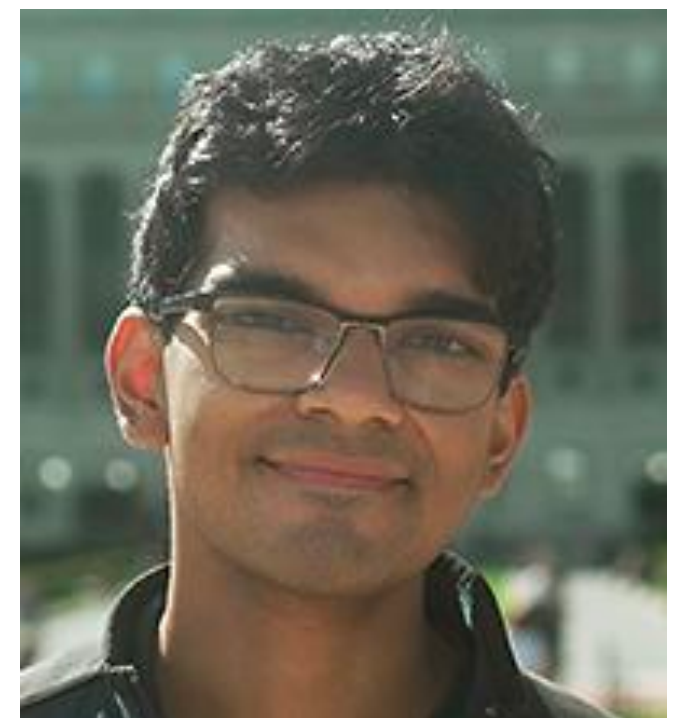
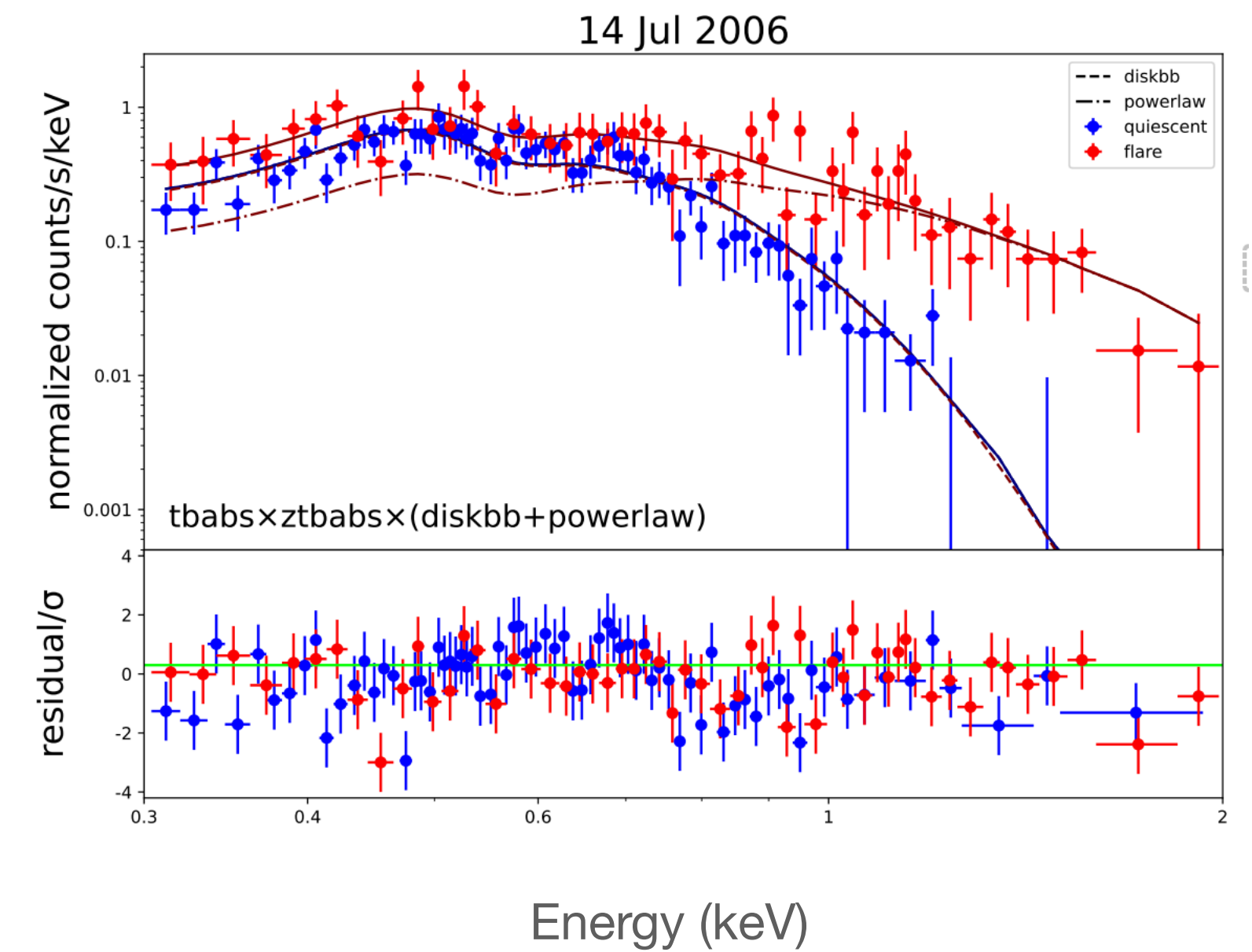
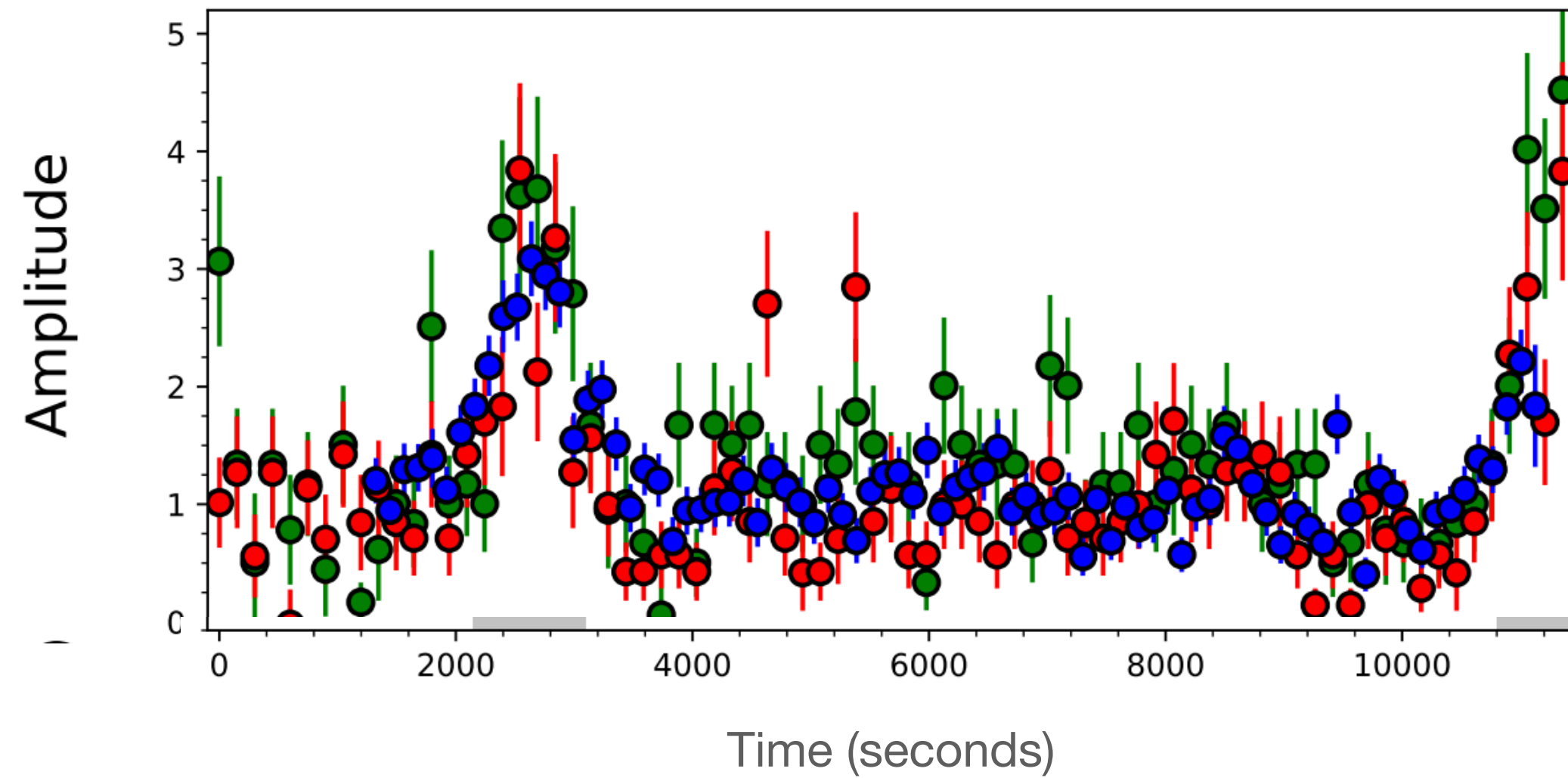
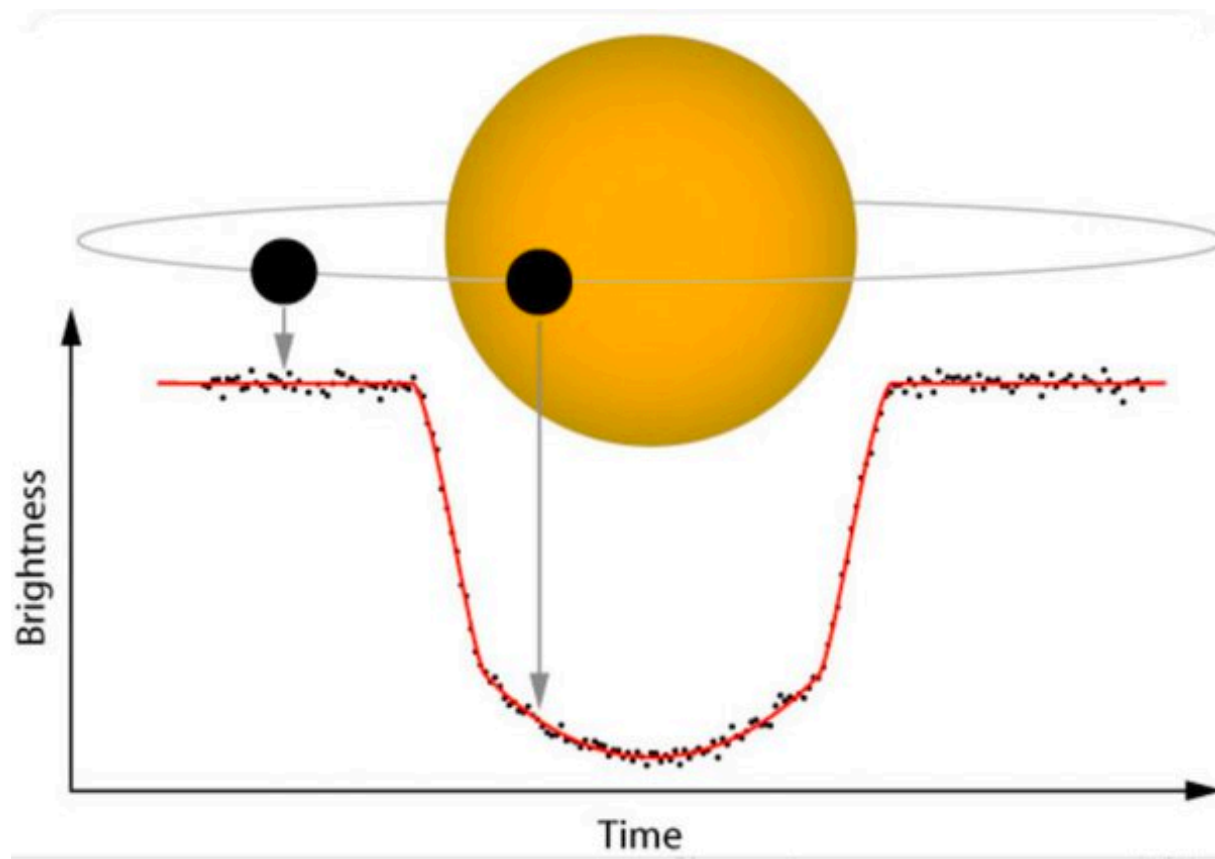
Miniutti+19

Arcodia+21



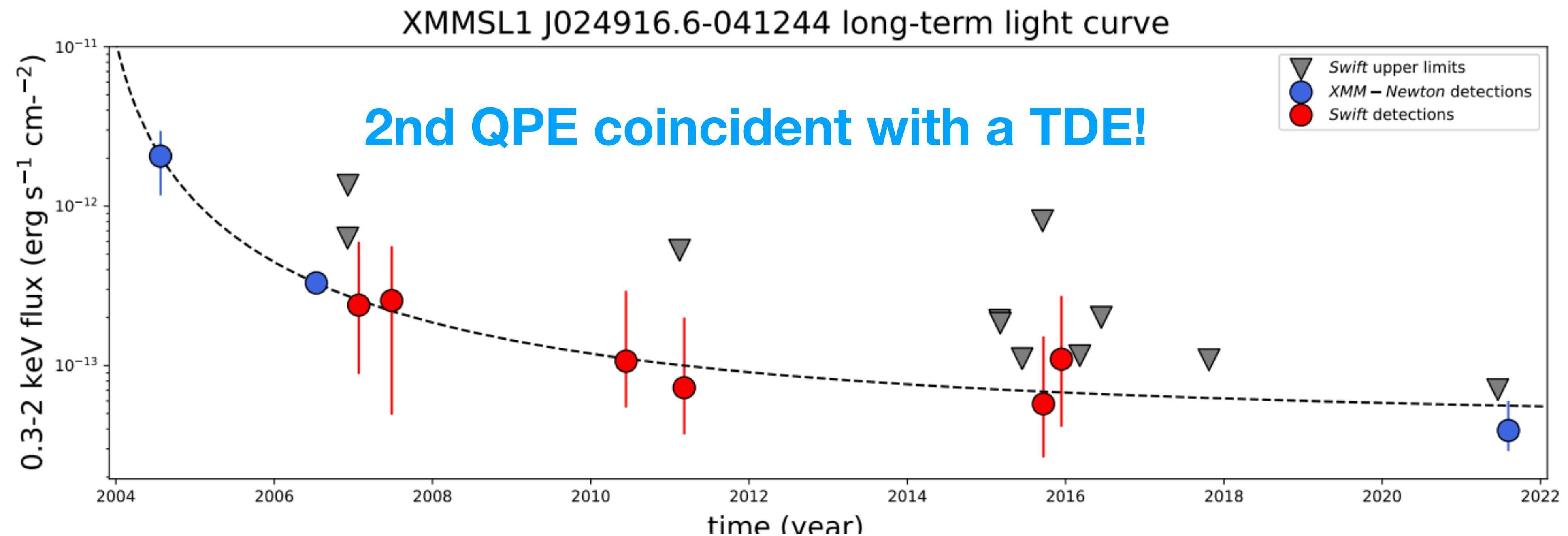
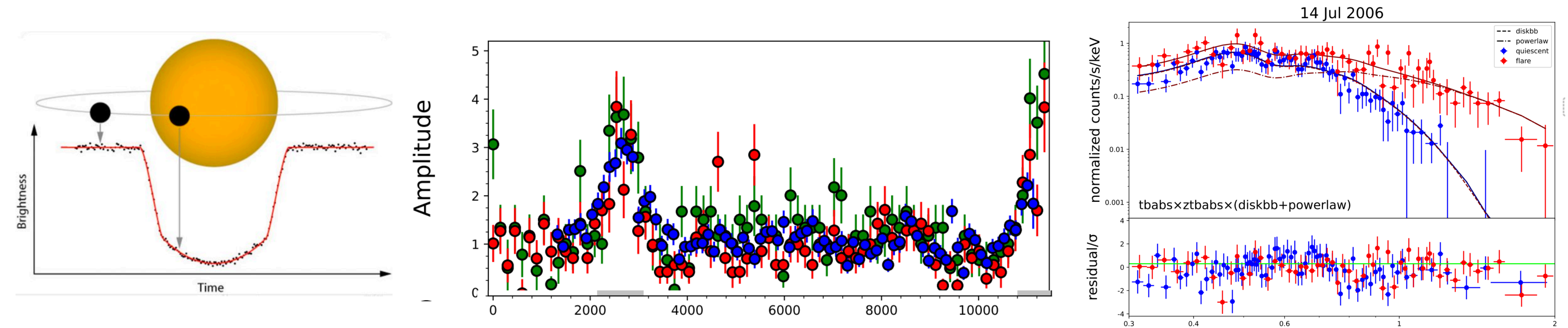
Riccardo Arcodia
Einstein Fellow, MIT

A blind search for QPEs in the archive

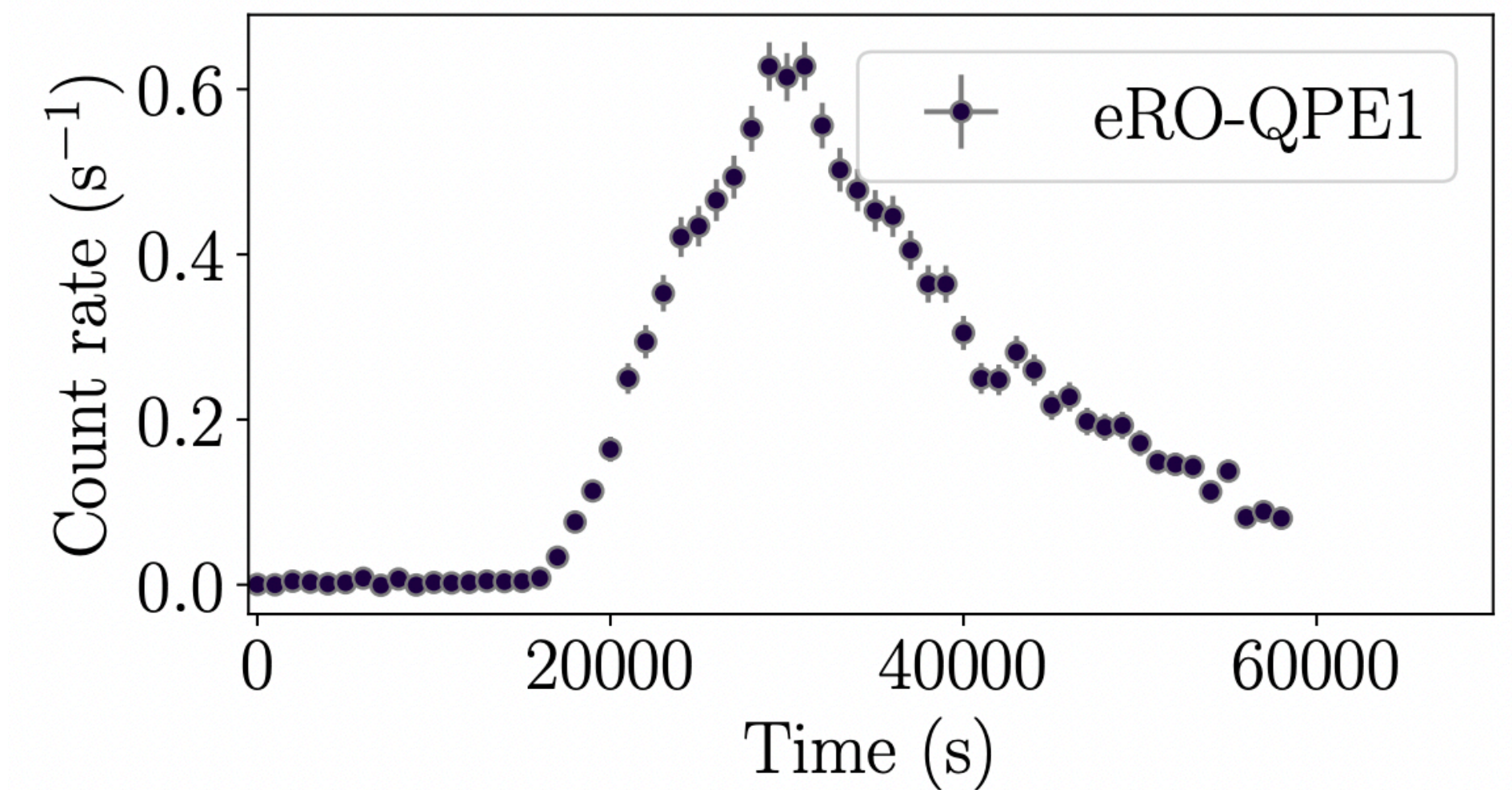
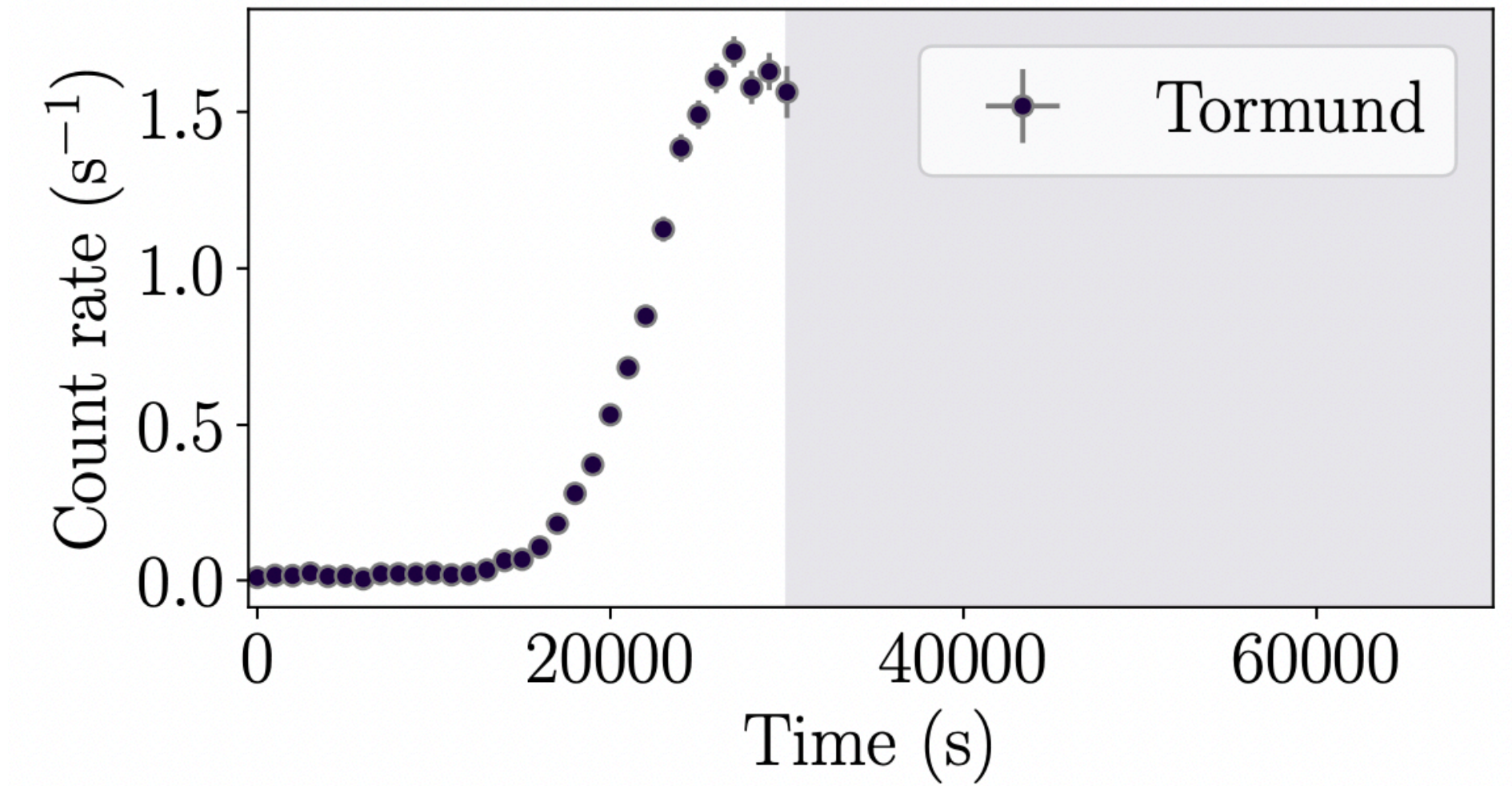
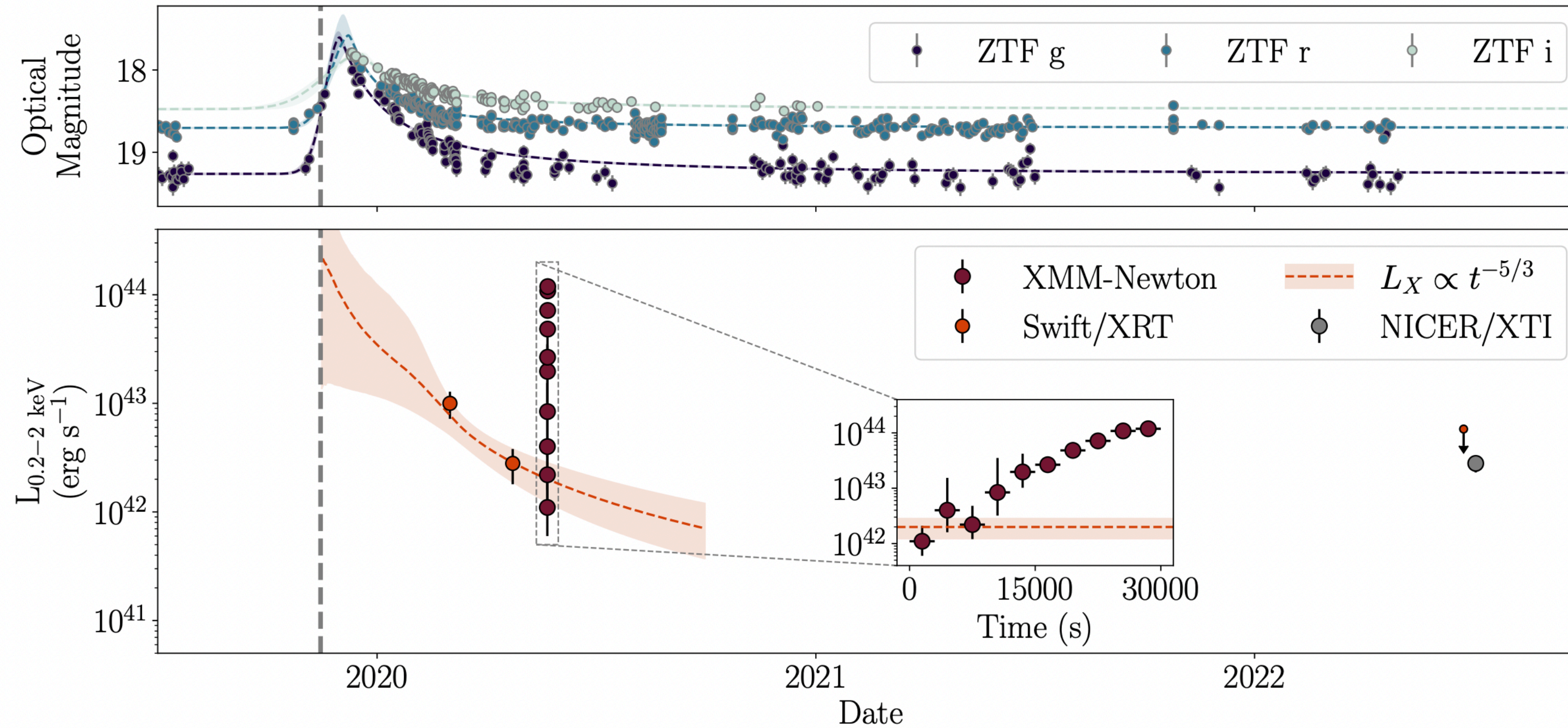


Joheen Chakraborty
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A blind search for QPEs in the archive



QPE candidate in an optically-selected TDE

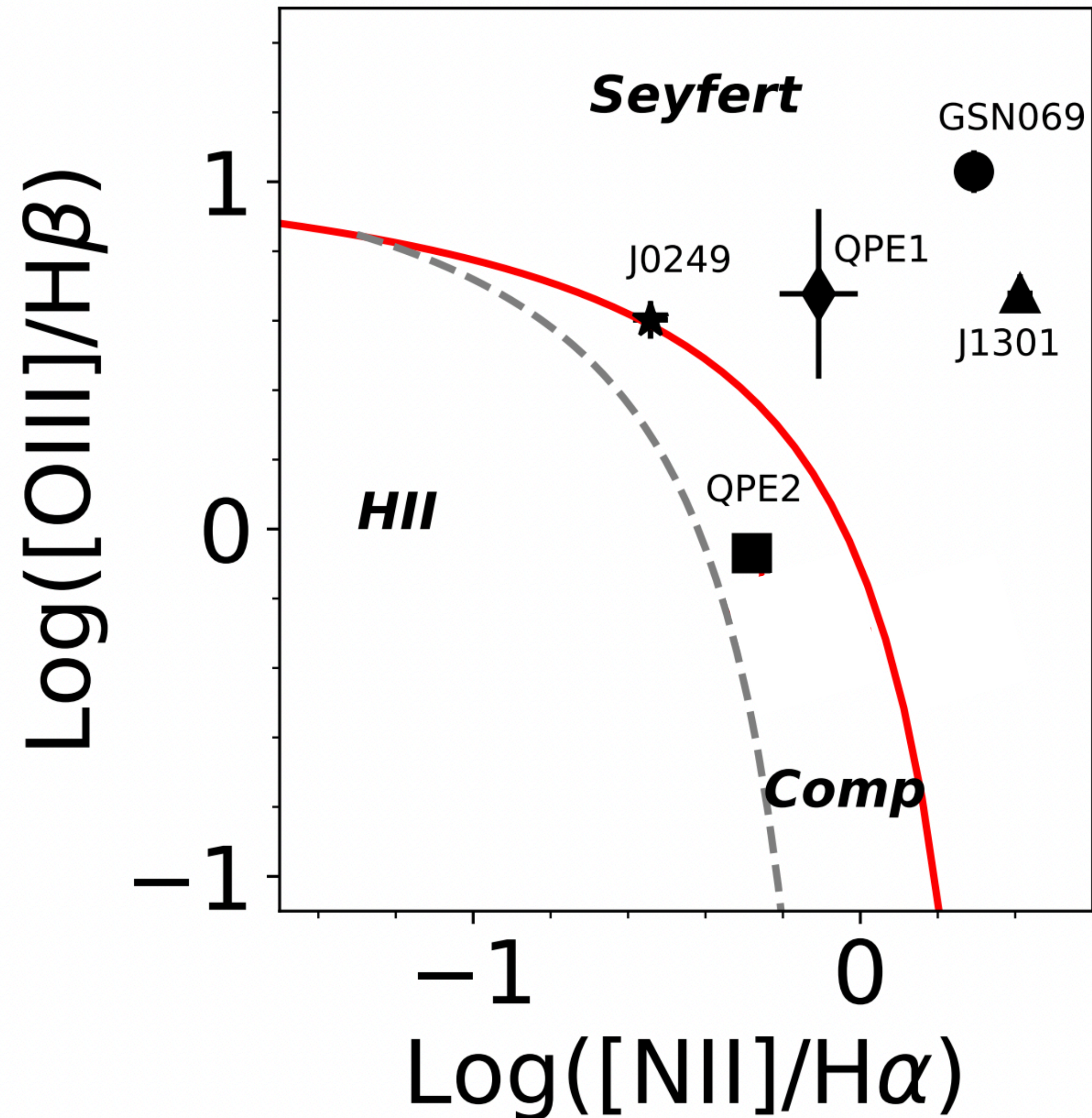


QPE Host Galaxies: similar to TDEs

Wevers et al., 2022

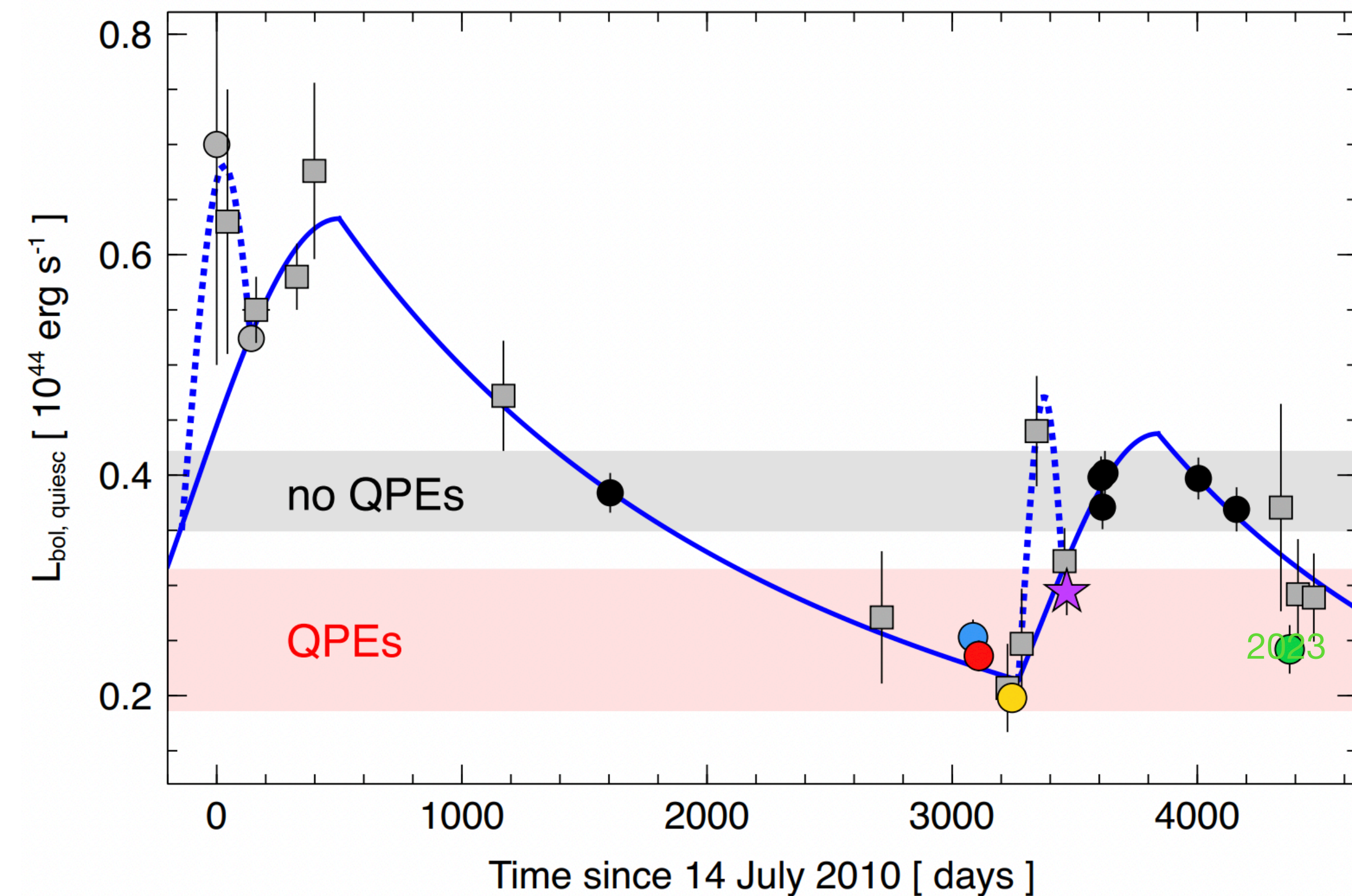
2/5 QPEs in E+A galaxies, too!
(But small number stats)

Unlike many TDEs:
AGN Narrow Emission Lines

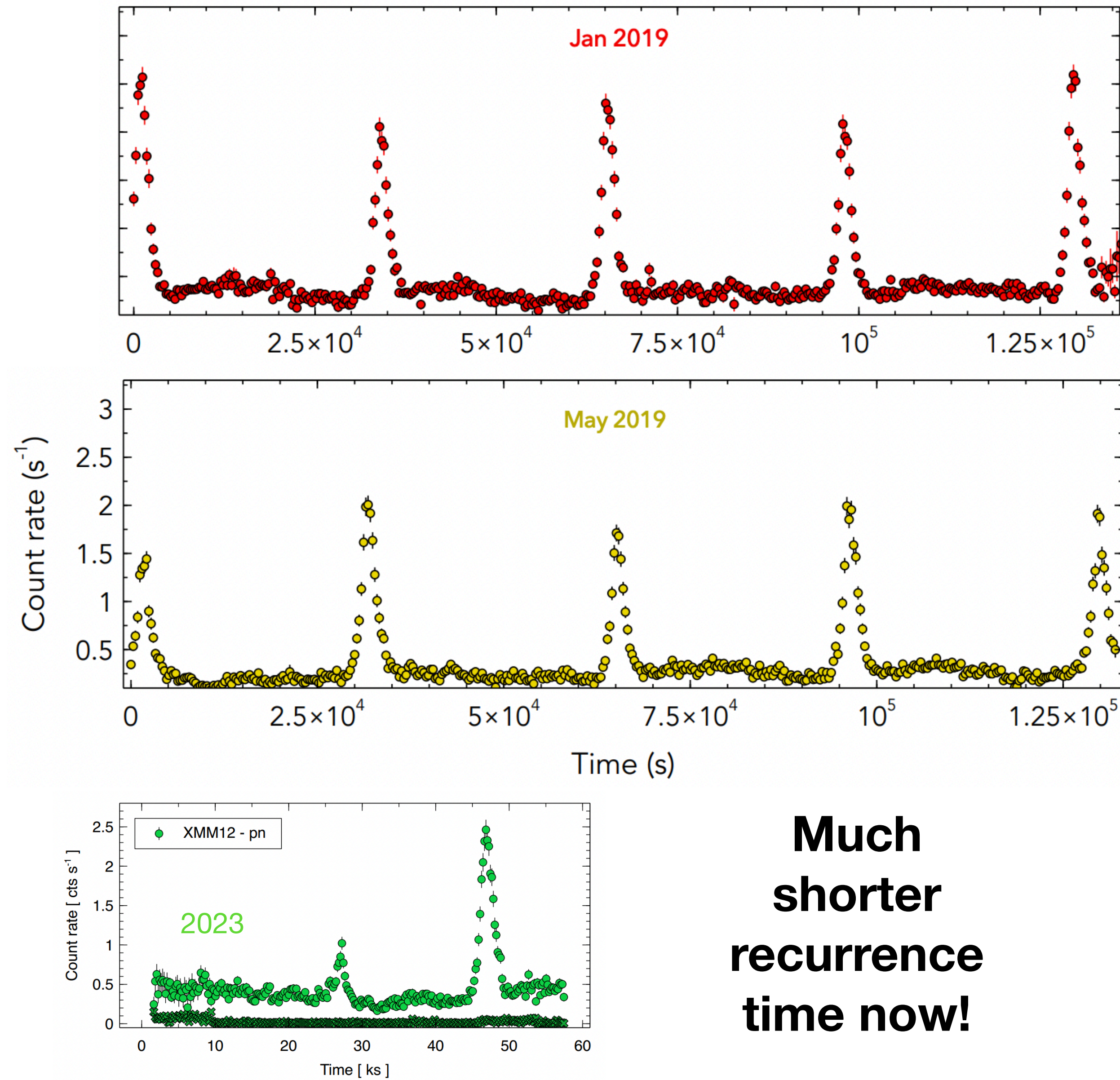


Complexities

A Partial TDE and QPE luminosity dependence



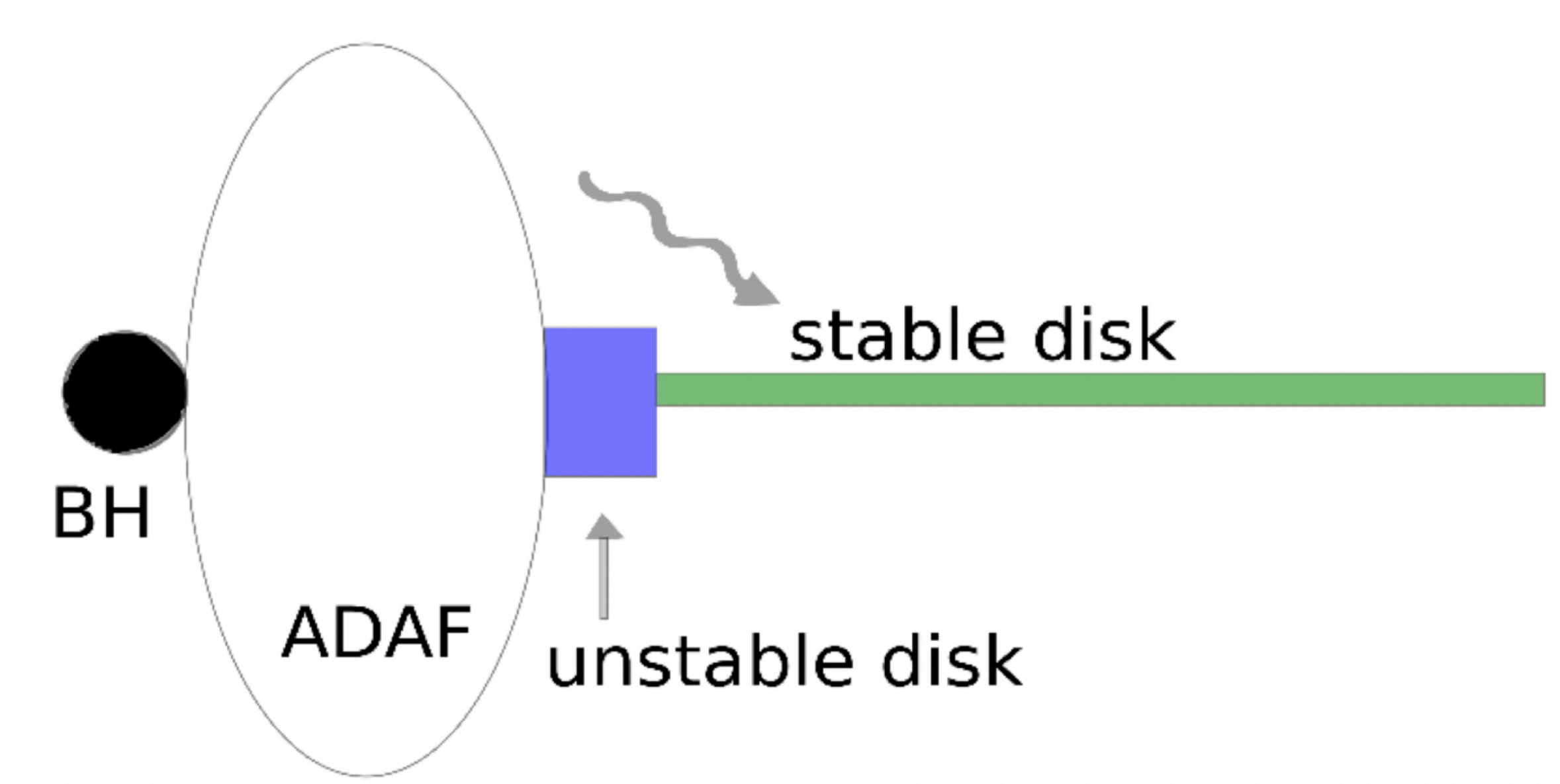
Miniutti+23



**Much
shorter
recurrence
time now!**

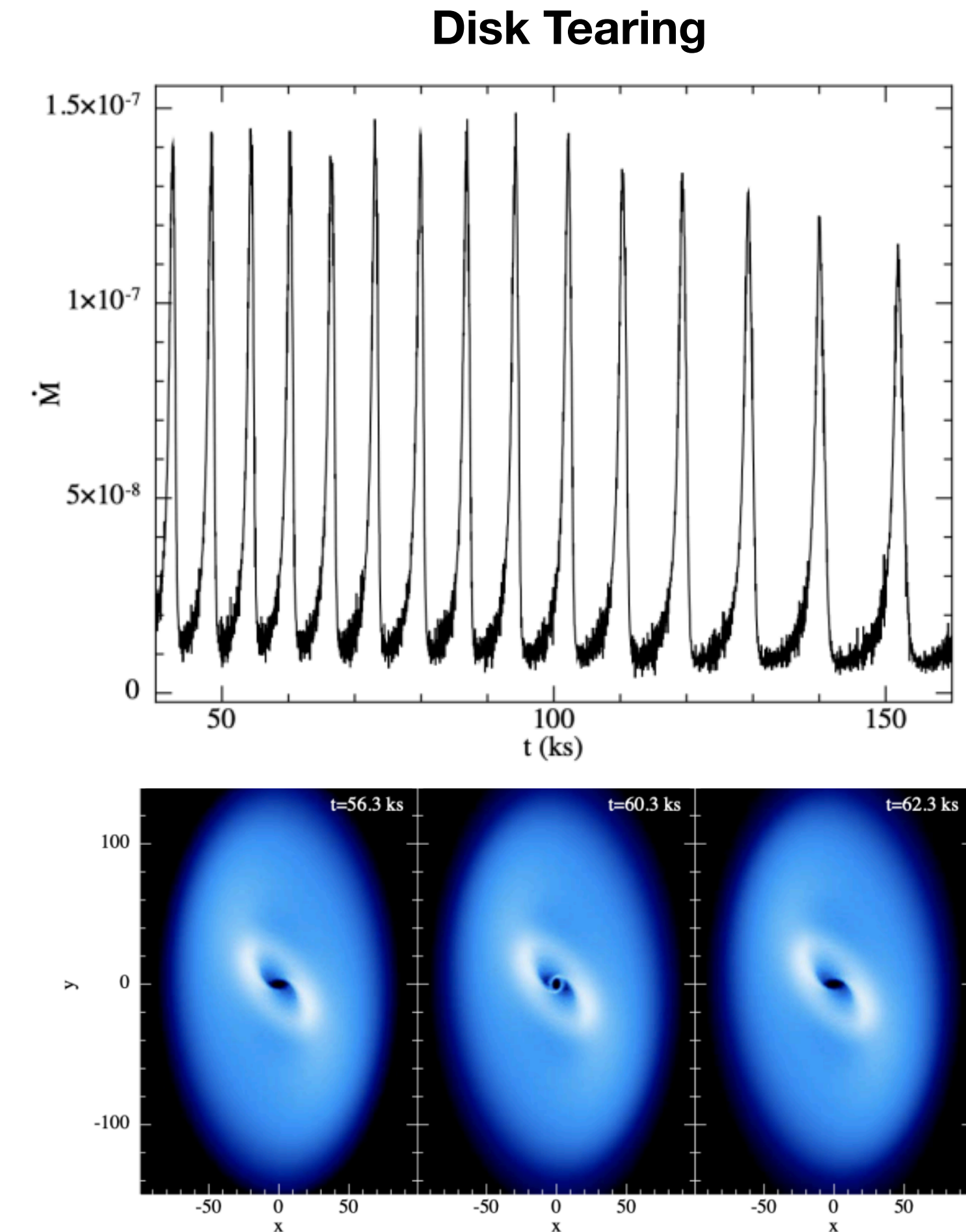
So what is it?

disk instability models



radiation-pressure dominated disk
thermal-viscous instability

Sniegowska et al. 2020



Raj & Nixon 21

So what is it?

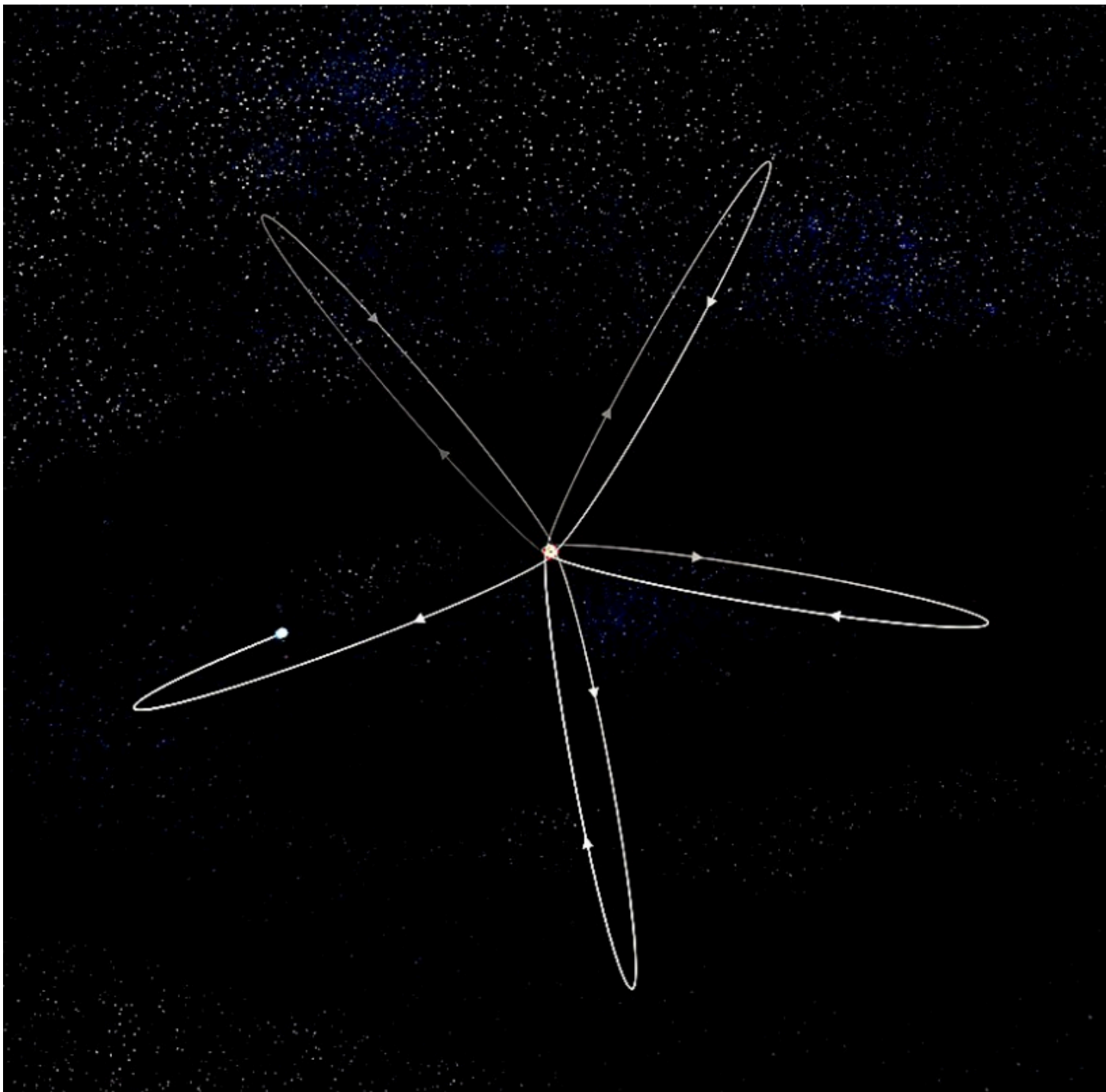
Orbital models

Quasi-periodic flares from star–accretion-disc collisions

Lixin (Jane) Dai,[★] Steven V. Fuerst[★] and Roger Blandford[★]

Kavli Institute for Particle Astrophysics and Cosmology, Stanford University, Menlo Park, CA 94025, USA

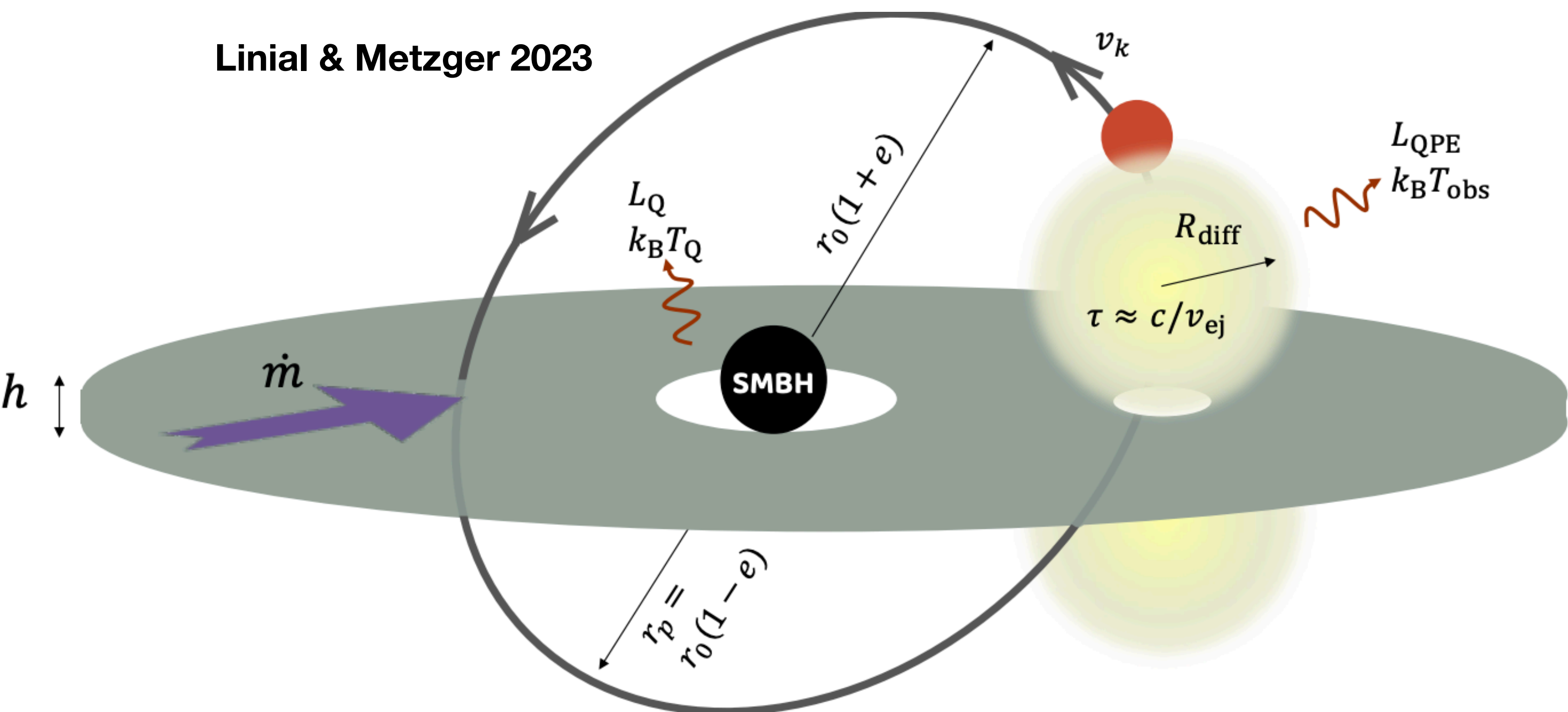
White Dwarf in highly eccentric orbit



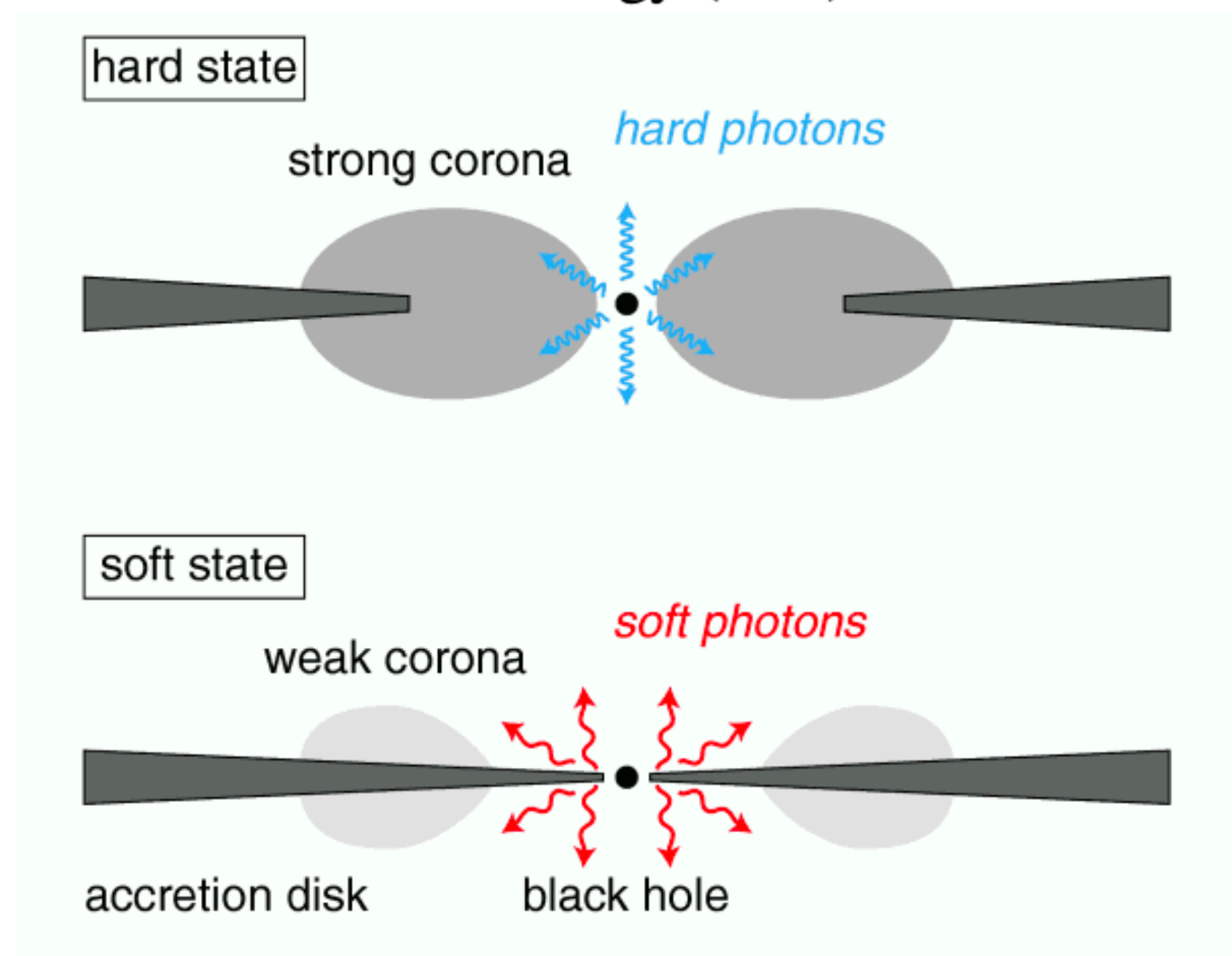
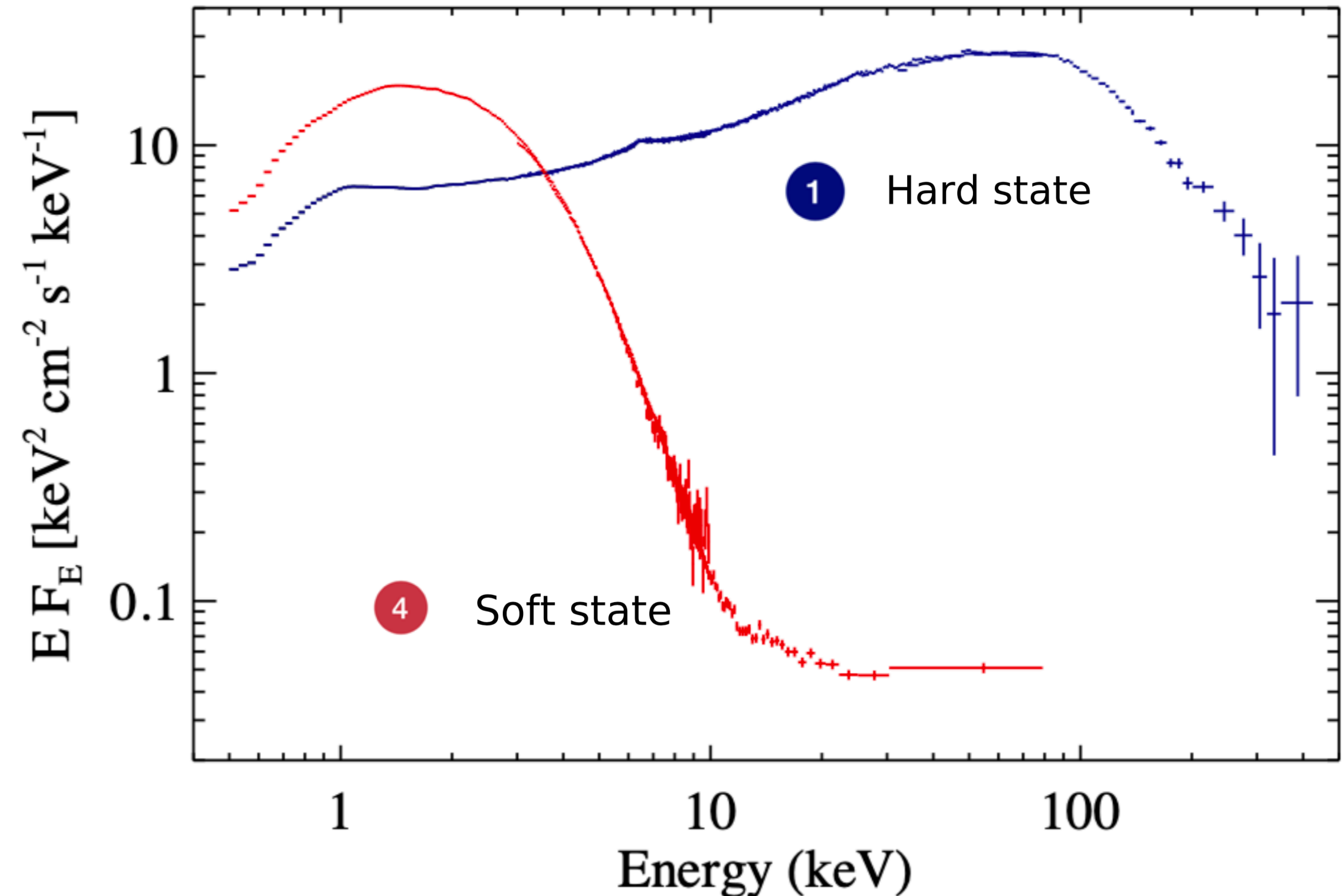
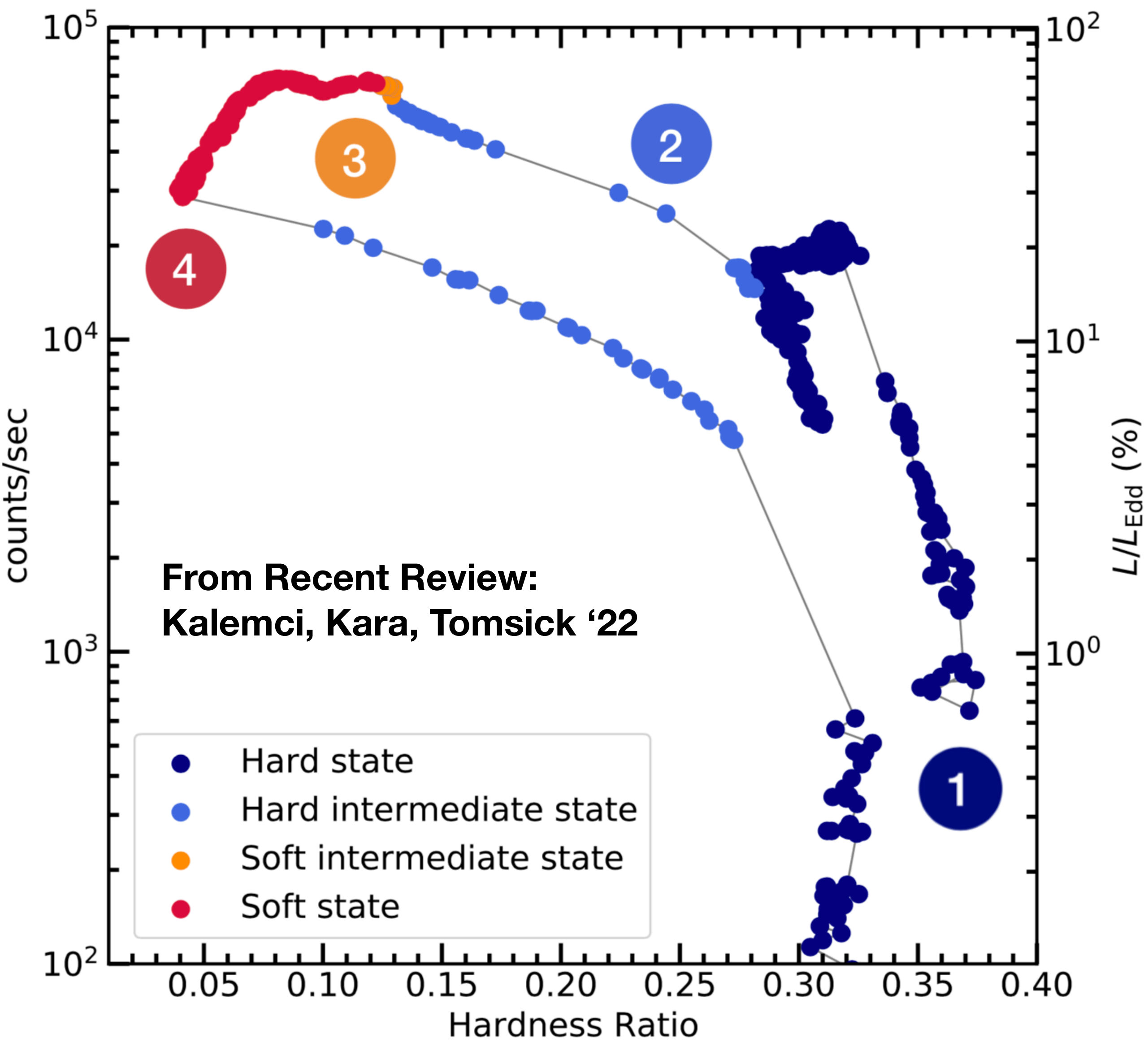
King 2020, 2023

"EMRI + TDE = QPE"

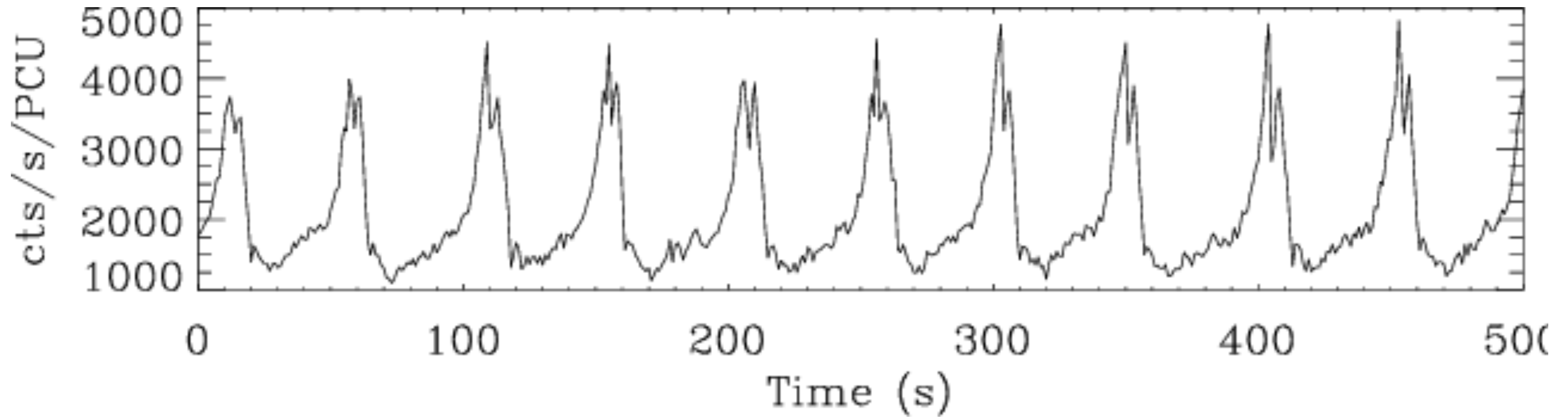
Linial & Metzger 2023



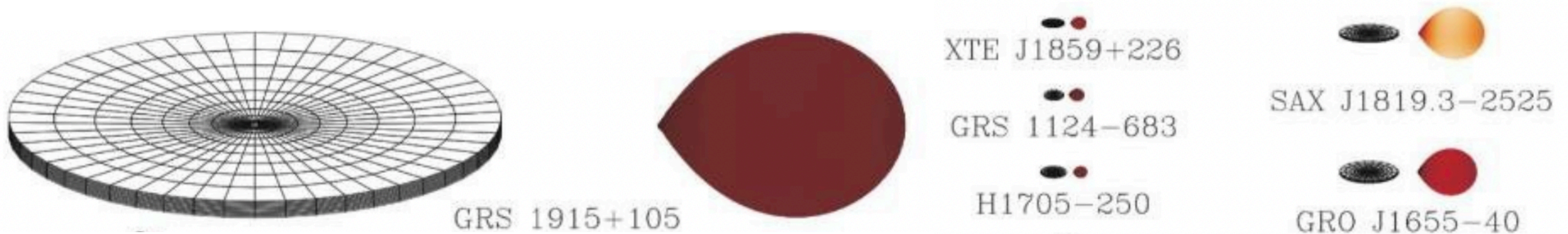
Black hole X-ray Binaries



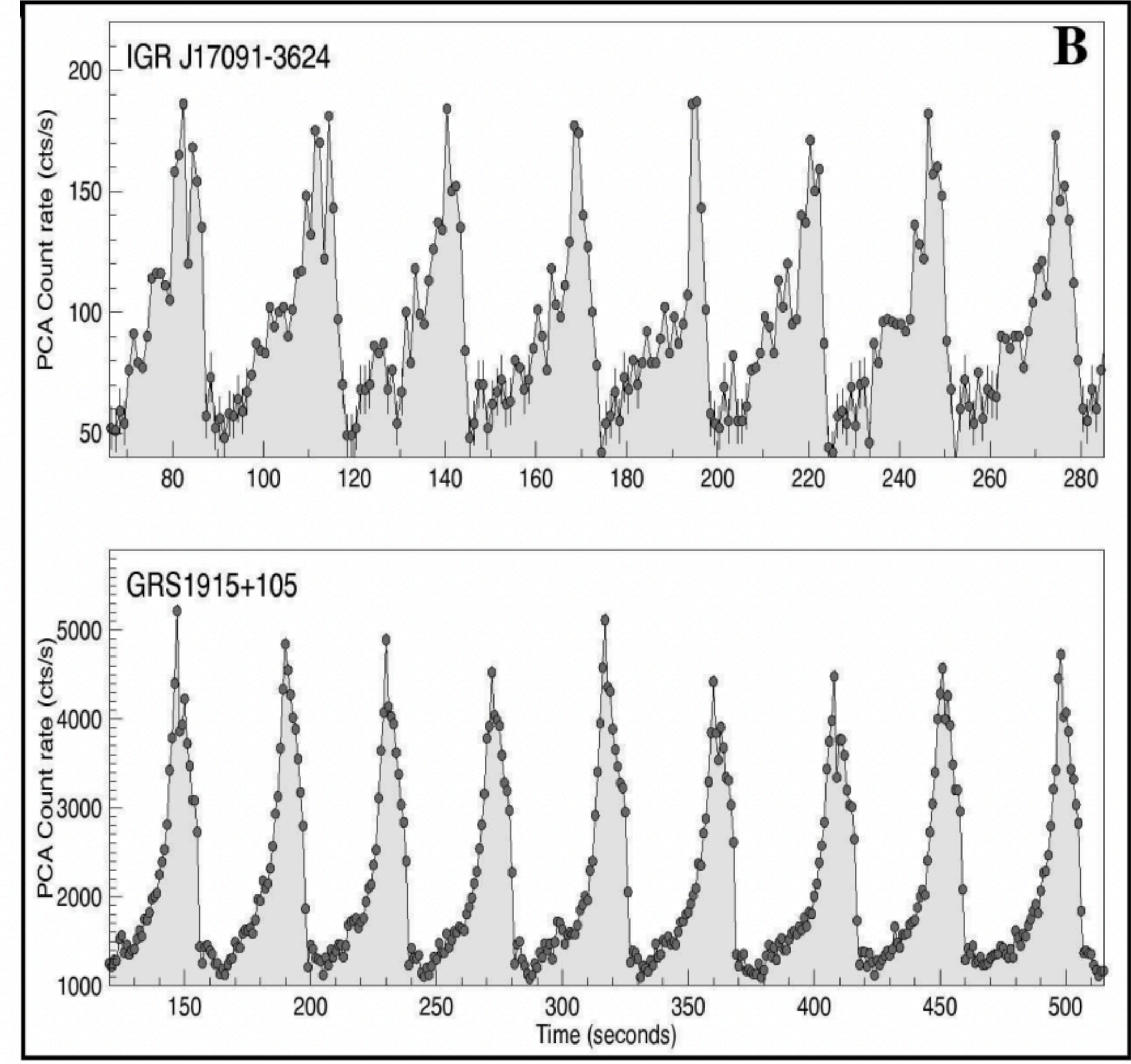
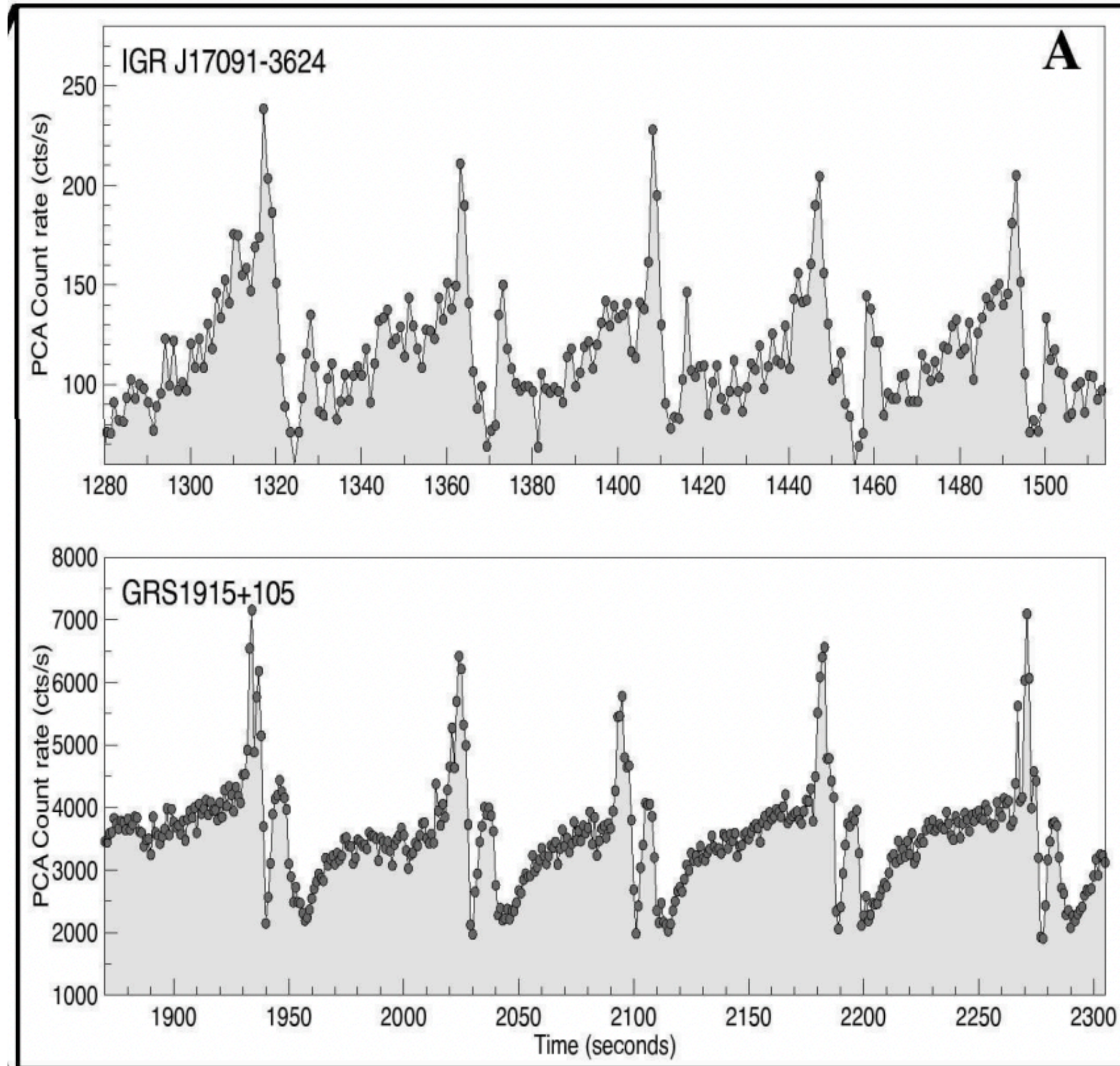
The Heartbeat Black Hole GRS 1915



Super-Eddington BH in outburst for 20+ years



IGR J17091: The “little sister” of GRS 1915



Conclusion

As Roger says: Nature is more clever than we are.

TDE population is growing, and discoveries need to be multi-wavelength to unleash full potential

But still plenty of surprises, especially with QPEs.

Perhaps related to EMRIs, but don't yet forget about disk instabilities.

Much to learn from Galactic X-ray binaries.

