



# **Decade-long monitoring of Active Galactic Nuclei with Swift**

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# COVERED TODAY

MAIN POINTS OF DISCUSSION

The Satellite: Swift

What is an AGN?

Variability in AGNs and its monitoring

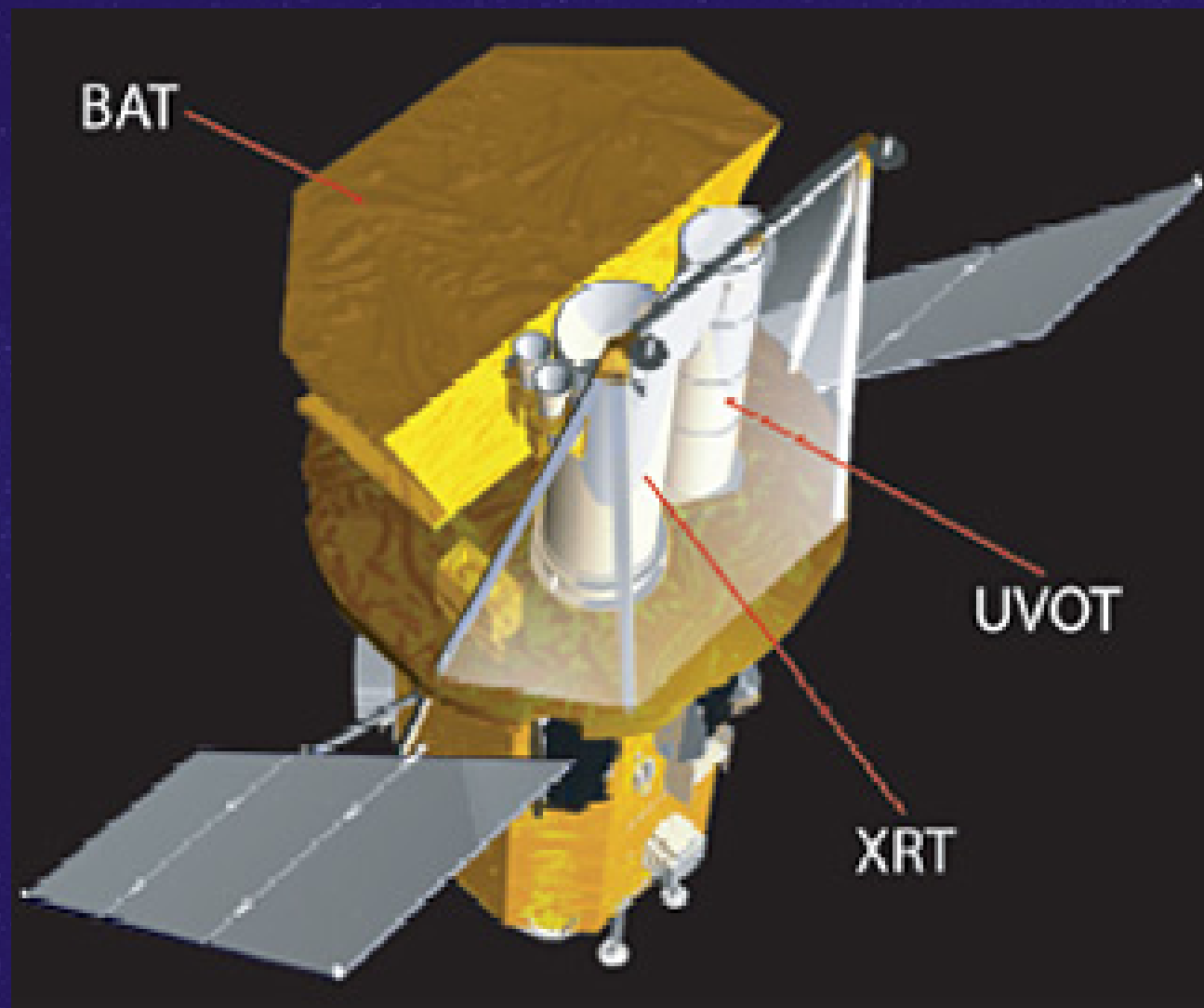
Illustrations

Conclusion



- Now known as The Neil Gehrels Swift Observatory
- Not an acronym
- Launched in 2004, aboard the Delta 2
- It was planned to operate for 2 years but it has been working for past 16 years.





- ➞ 3 Telescopes:
- Burst Alert Telescope (BAT)
  - X-ray Telescope (XRT)
  - UV-Optical Telescope (UVOT)
- ➞ Allows immediate follow-up of Gamma-Ray Bursts (GRBs)

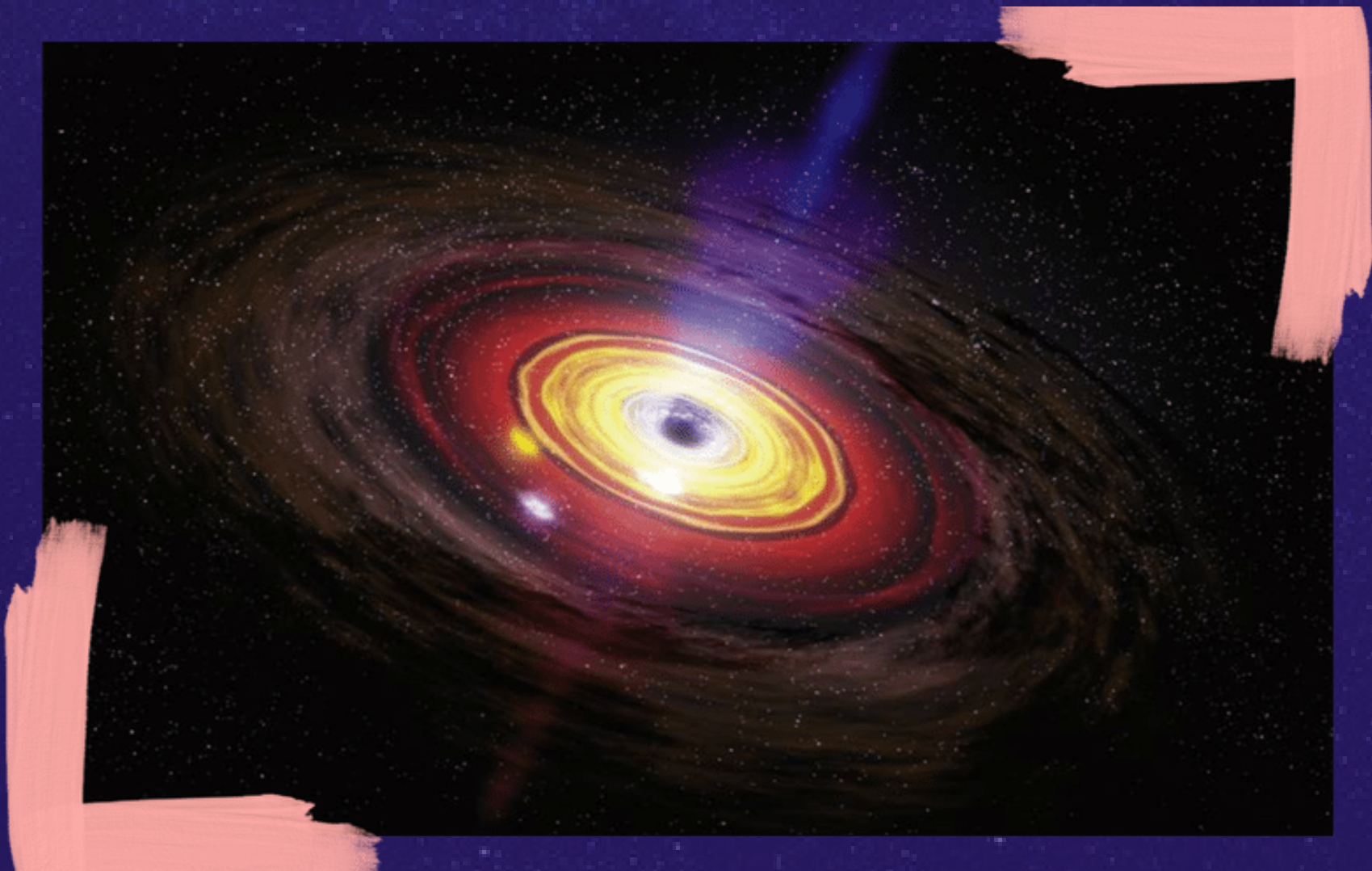


# What is an AGN?

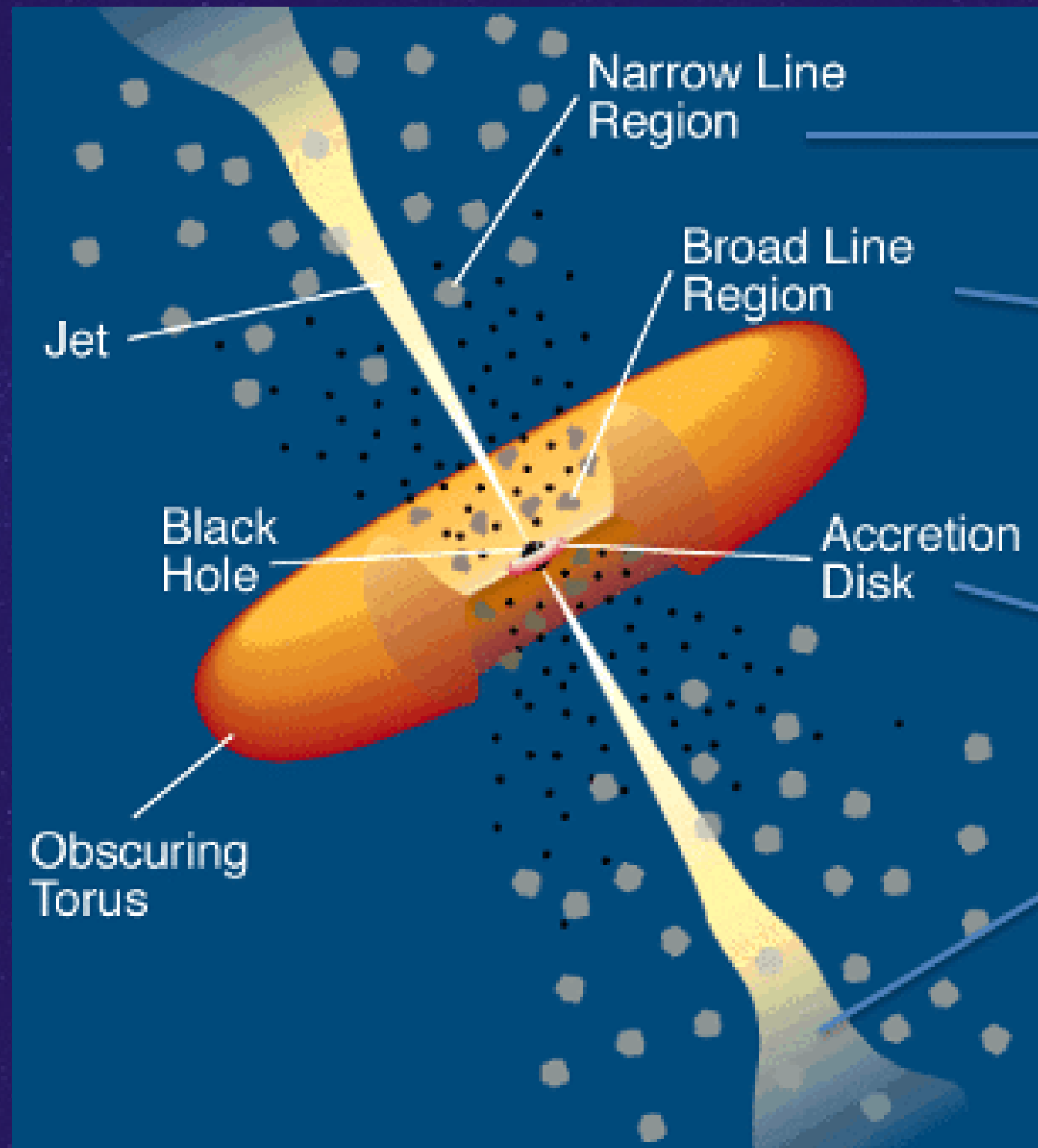
Active Galactic Nucleus



- ★ Compact region at the center of a galaxy
- ★ High in luminosity on certain parts of the electromagnetic spectrum
- ★ Constantly accreting/ingesting matter, hence the name active



# Structure of an AGN



Narrow forbidden and  
permitted emission lines

Broad permitted emission lines

Continuum emission

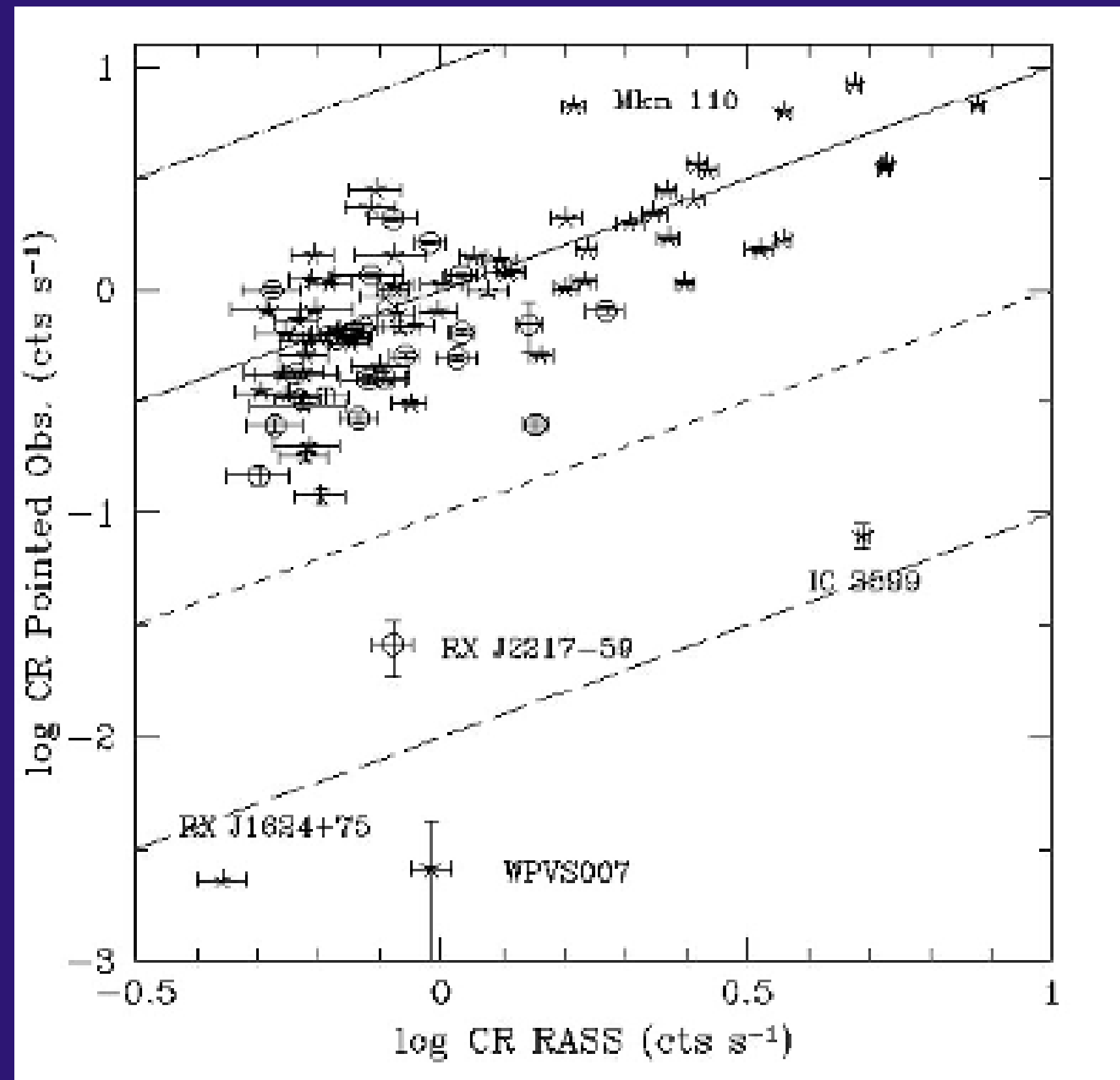


# Variability in AGN

Variability usually occurs due to change in accretion rate.

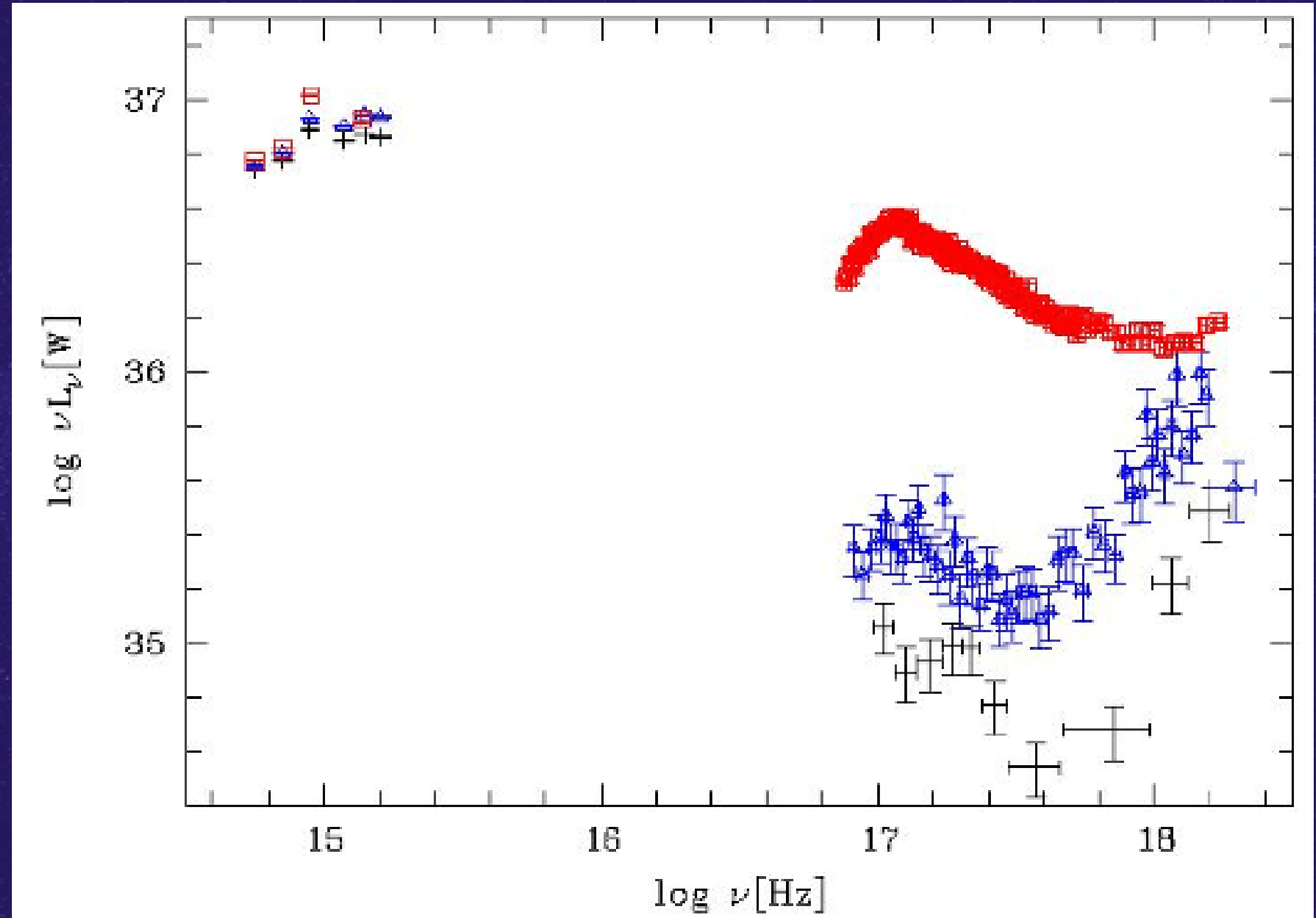
Long-term study of change in emission helps us learn detailed structure of it and possibly other phenomenon.

Variability in factors of 3-5 is normal but sometimes it can be drastic with factors of 10 or more.



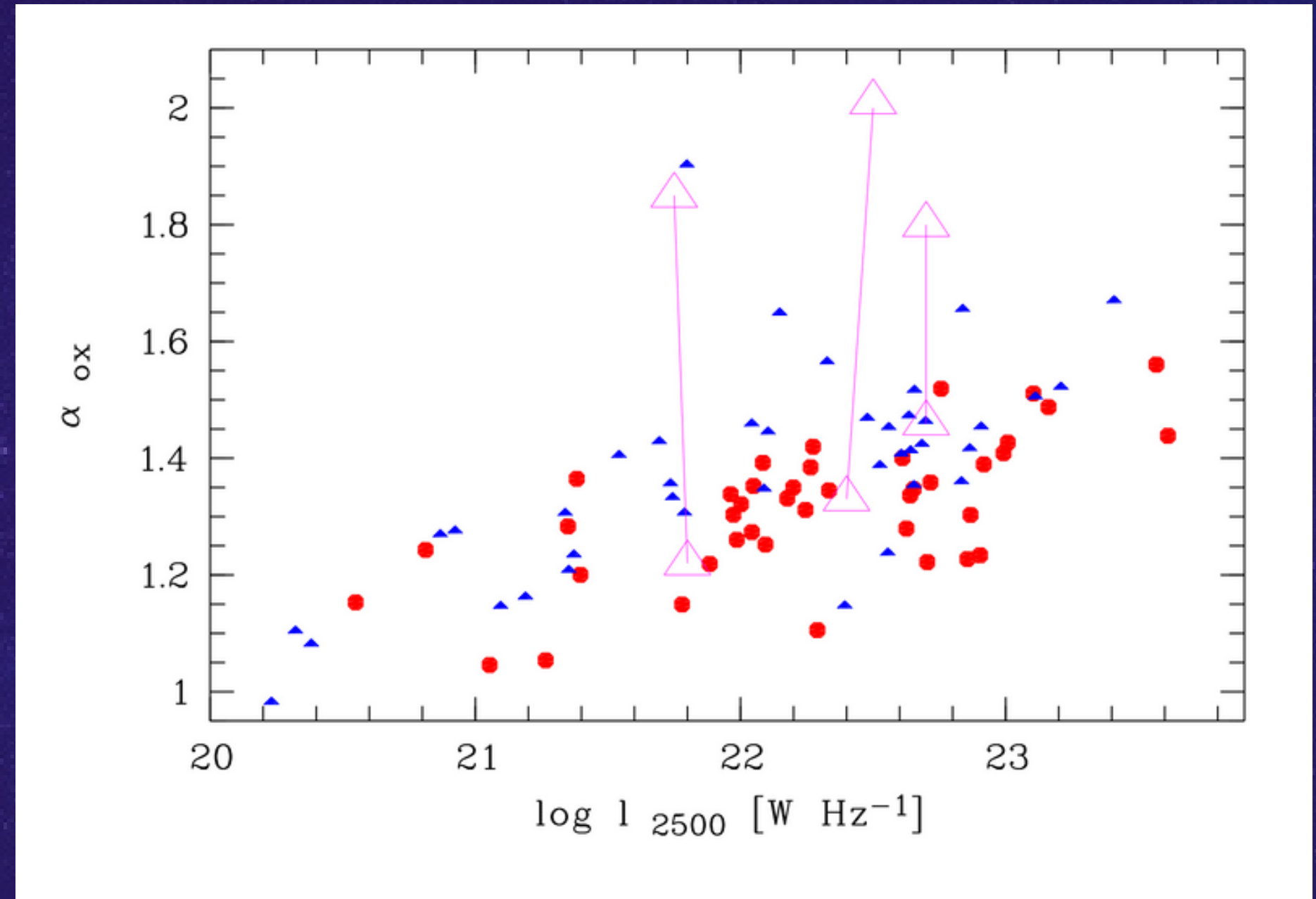
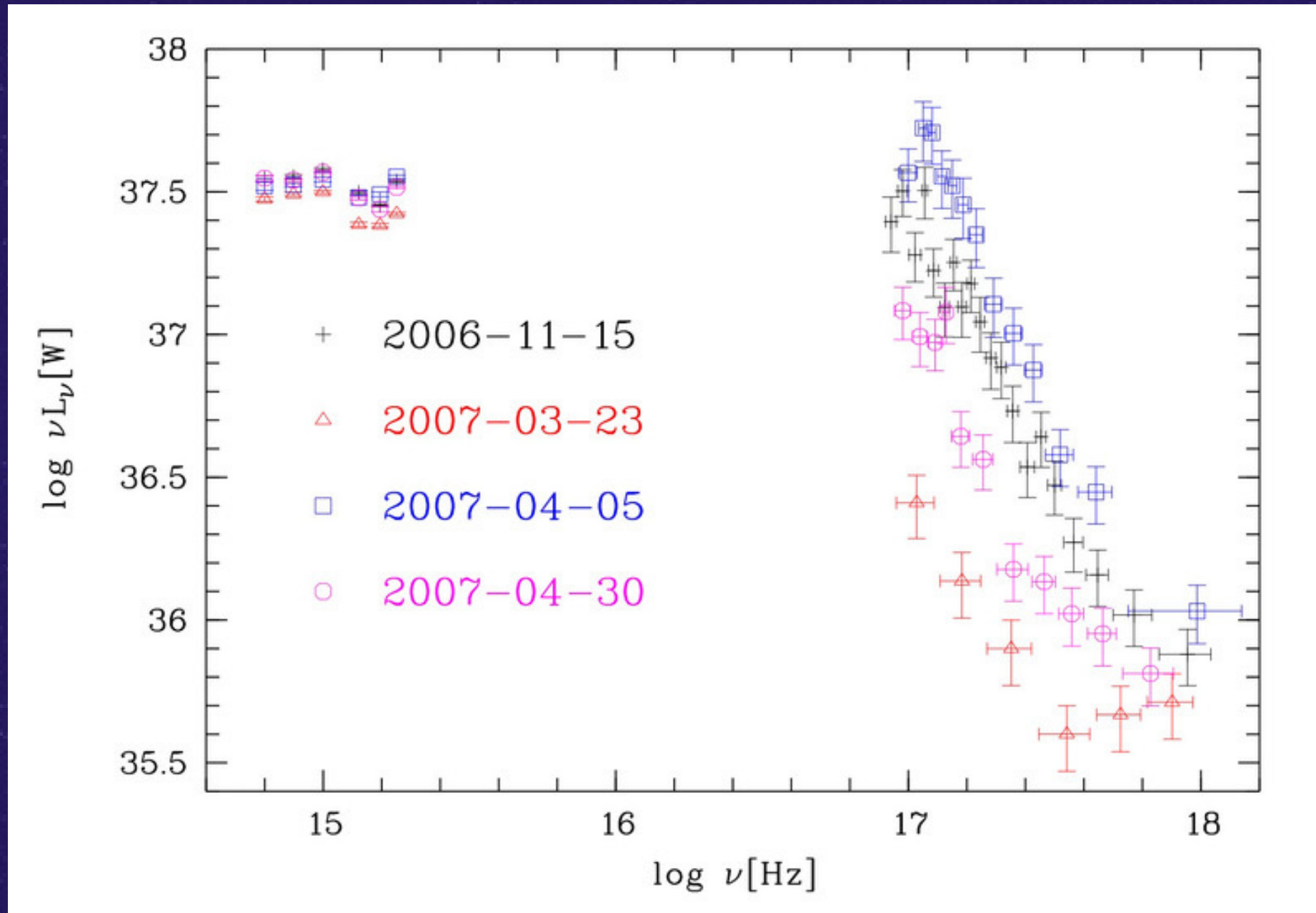


- Some AGN can drop in the X-ray flux rapidly by factors of 30 or more. Here's an example of Mkn 335:





★ Variability in  $L_{2500\text{\AA}}$  and Alpha-ox



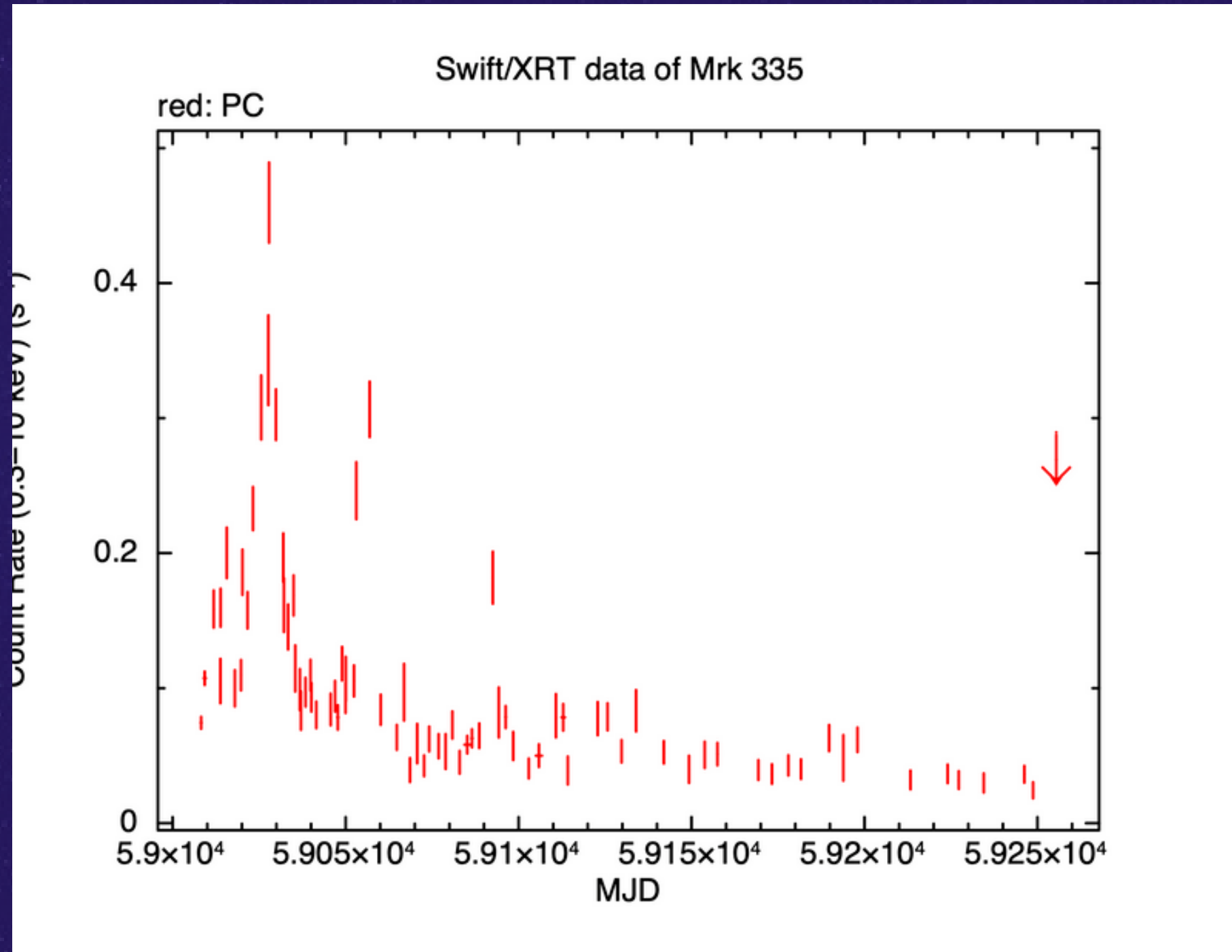
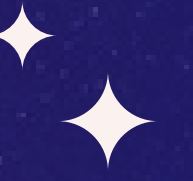
Approximately,

**100**

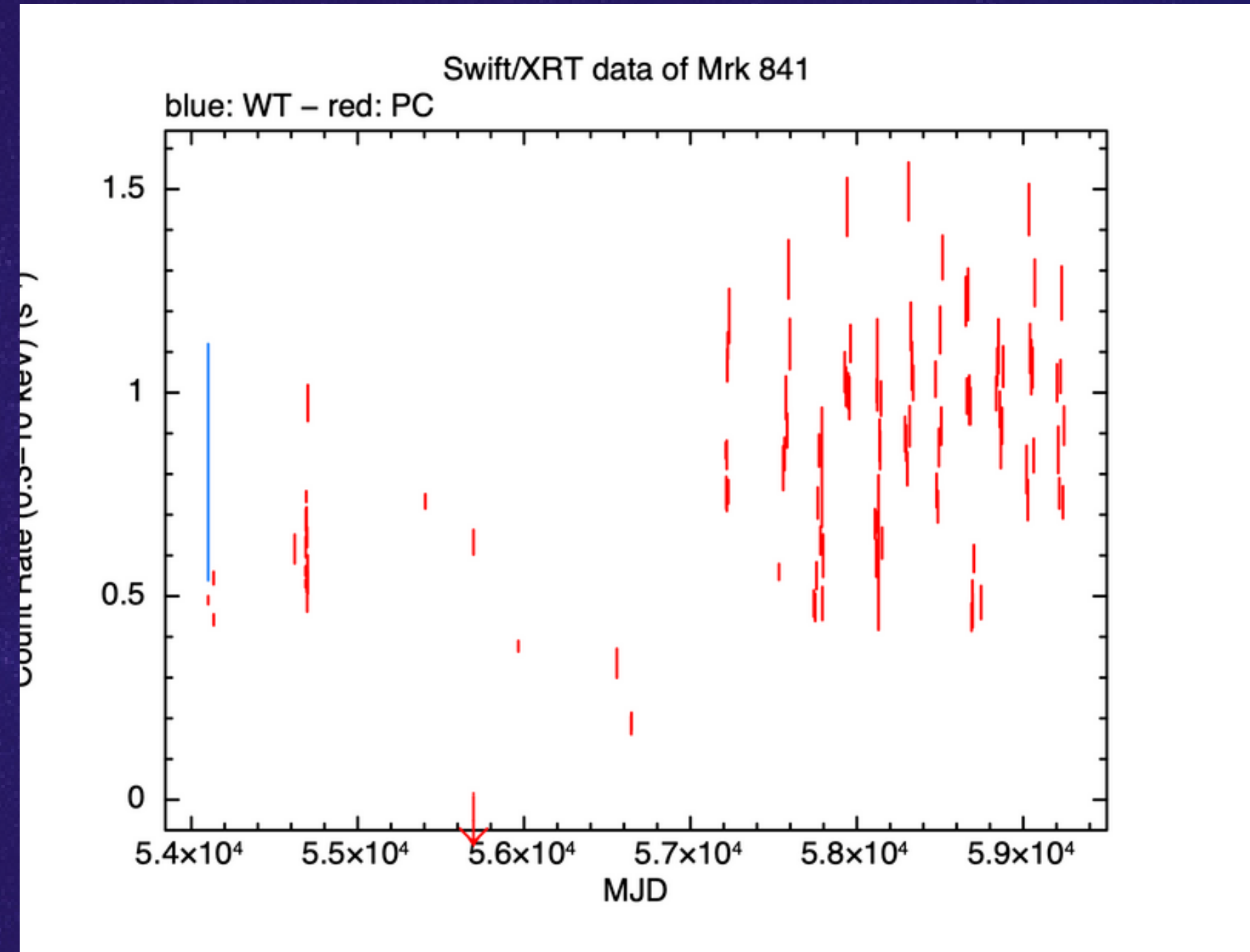
sources were monitored. Light curves  
were generated to analyze the  
lumonisty output.



# LIGHT CURVES



Mrk 335



Mrk 841



# ✧ ✧ AGN with Dramatic X-ray flux variations ✧

● Three causes for these variations:

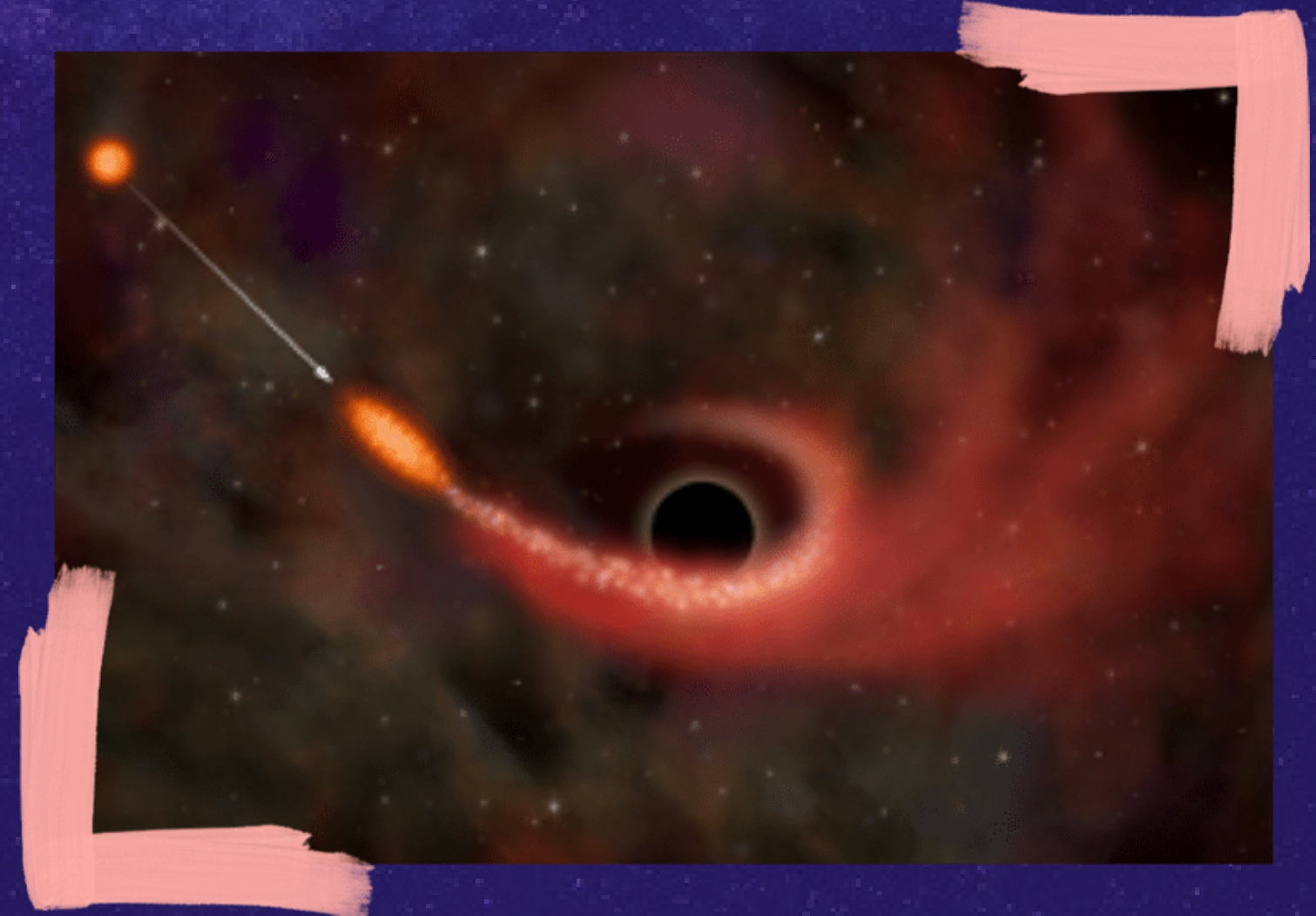
- Absorption
- Reflection
- Change in the Accretion Rate

● Three major methods to find these events:

- Comparison with ROSAT All-Sky Survey
- XMM Slew Survey
- Swift AGN long-term Monitoring through filling programs

# Dramatic Changes in the Accretion Rate: TDEs and Accretion Disk Instabilities

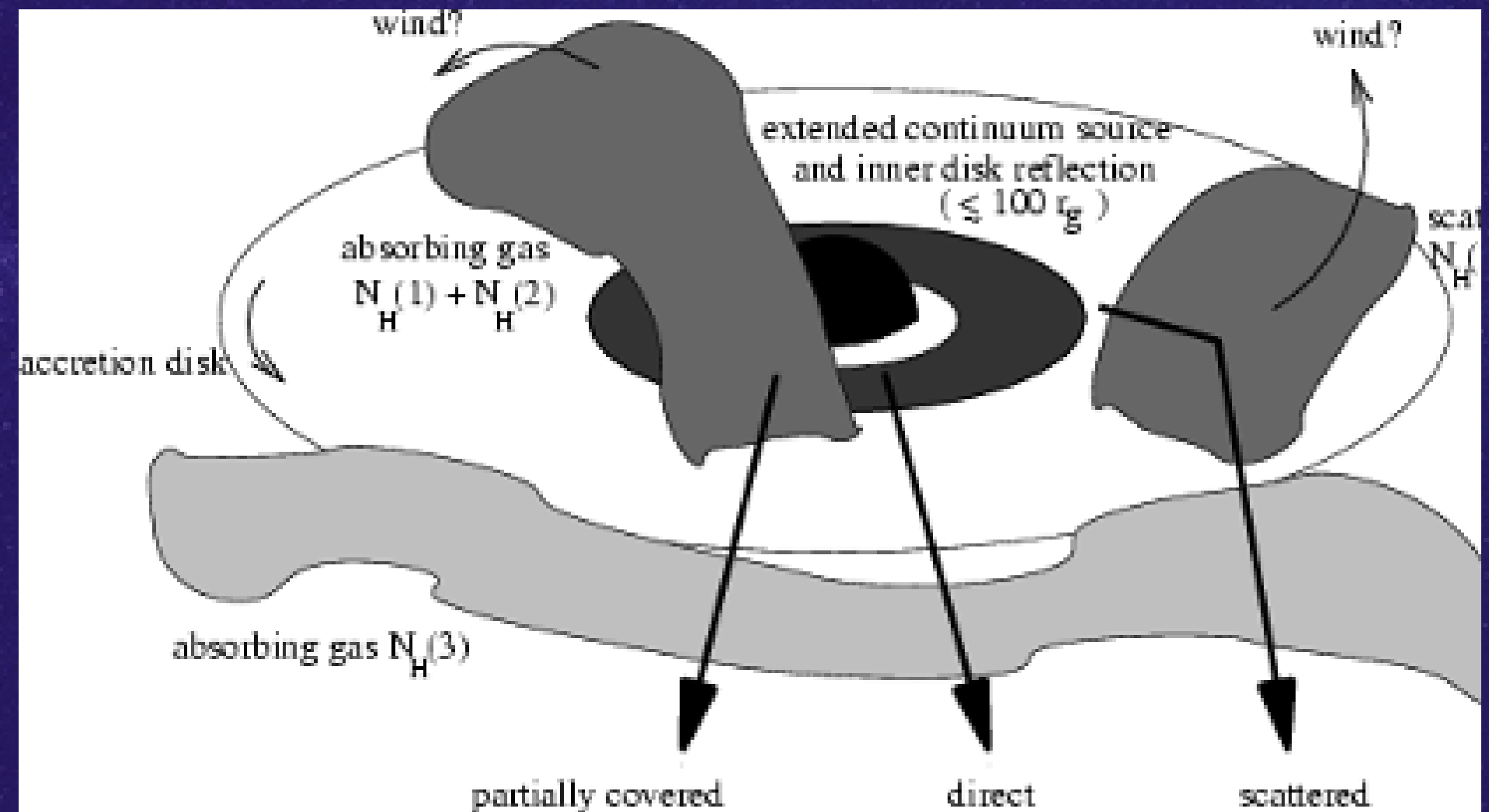
- IC 3599 is a low-luminosity Seyfert 1.9 galaxy in its normal state
- One possible explanation why it appeared so bright in X-rays was that a star got too close to its central black hole, and it was disrupted by the central black hole (Increase in accretion rate)
- However, we know today, it was an accretion disk instability





# Partial Covering Absorber

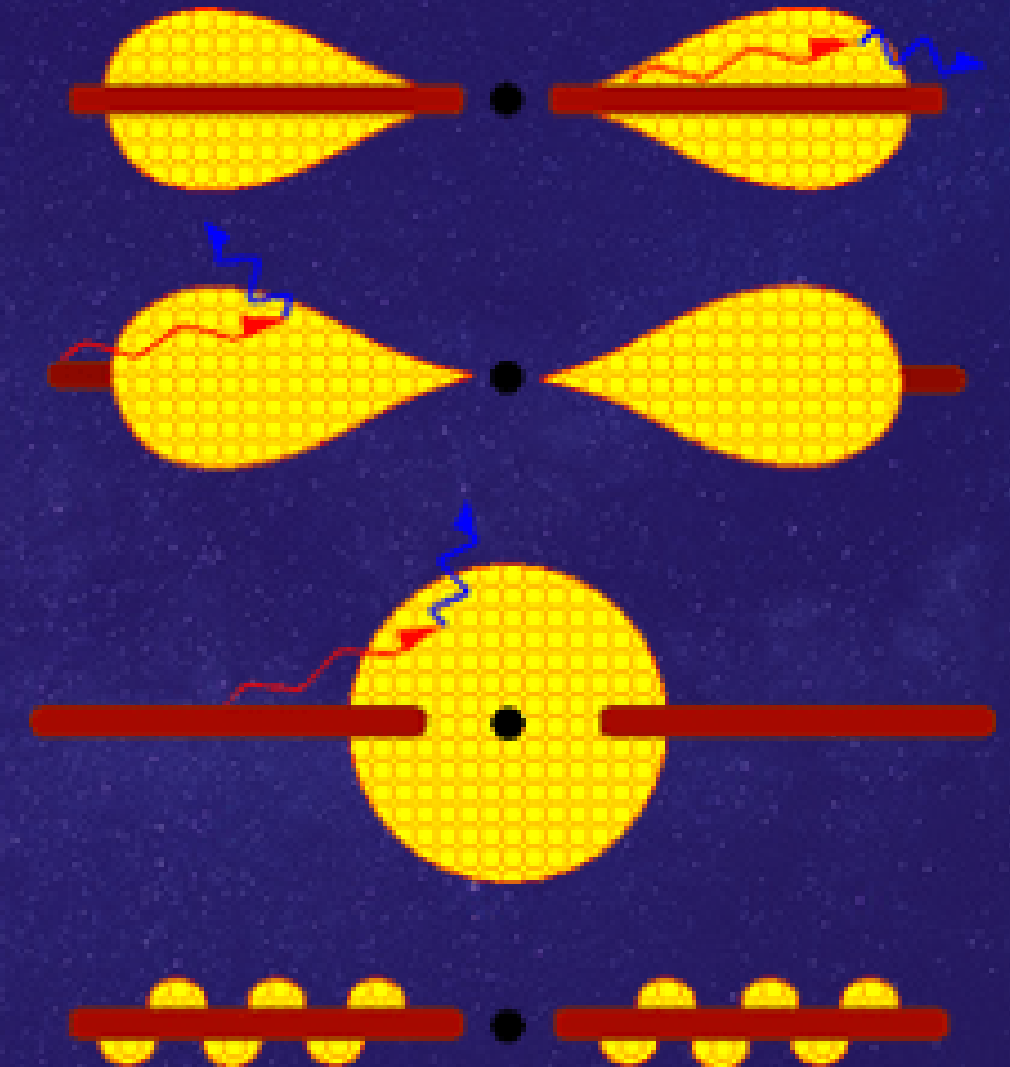
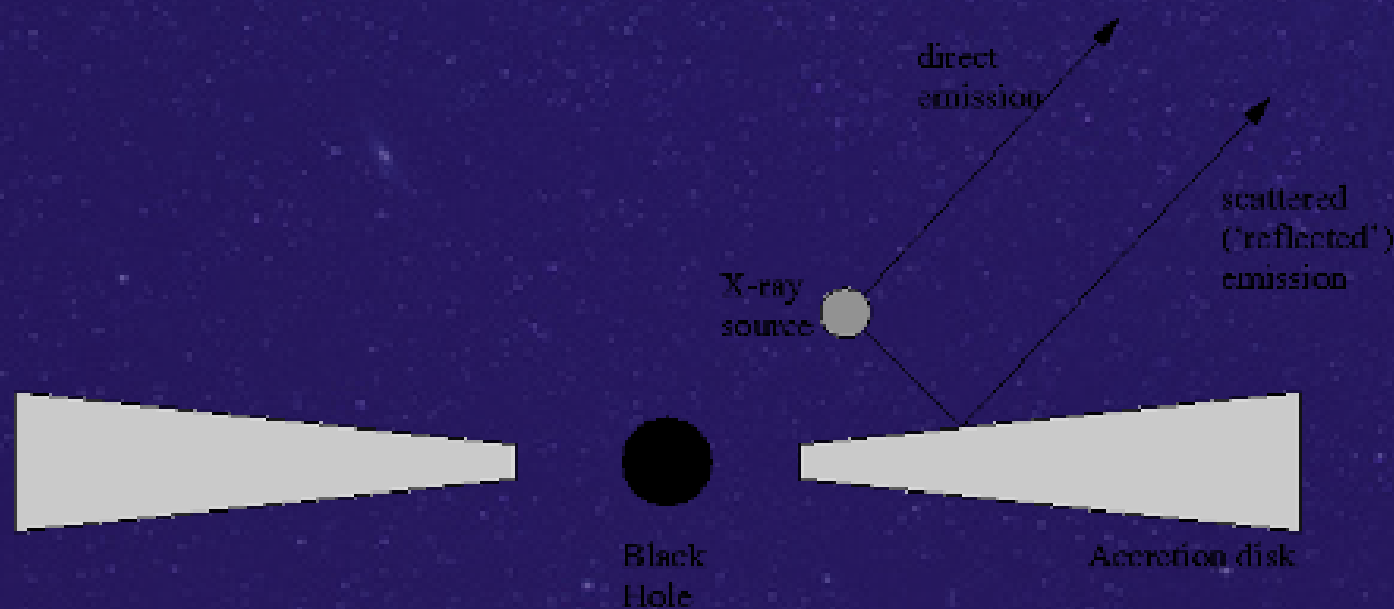
- ★ Sometimes an absorber does not cover the X-ray continuum source completely
- ★ It is like a cloud covering the Sun





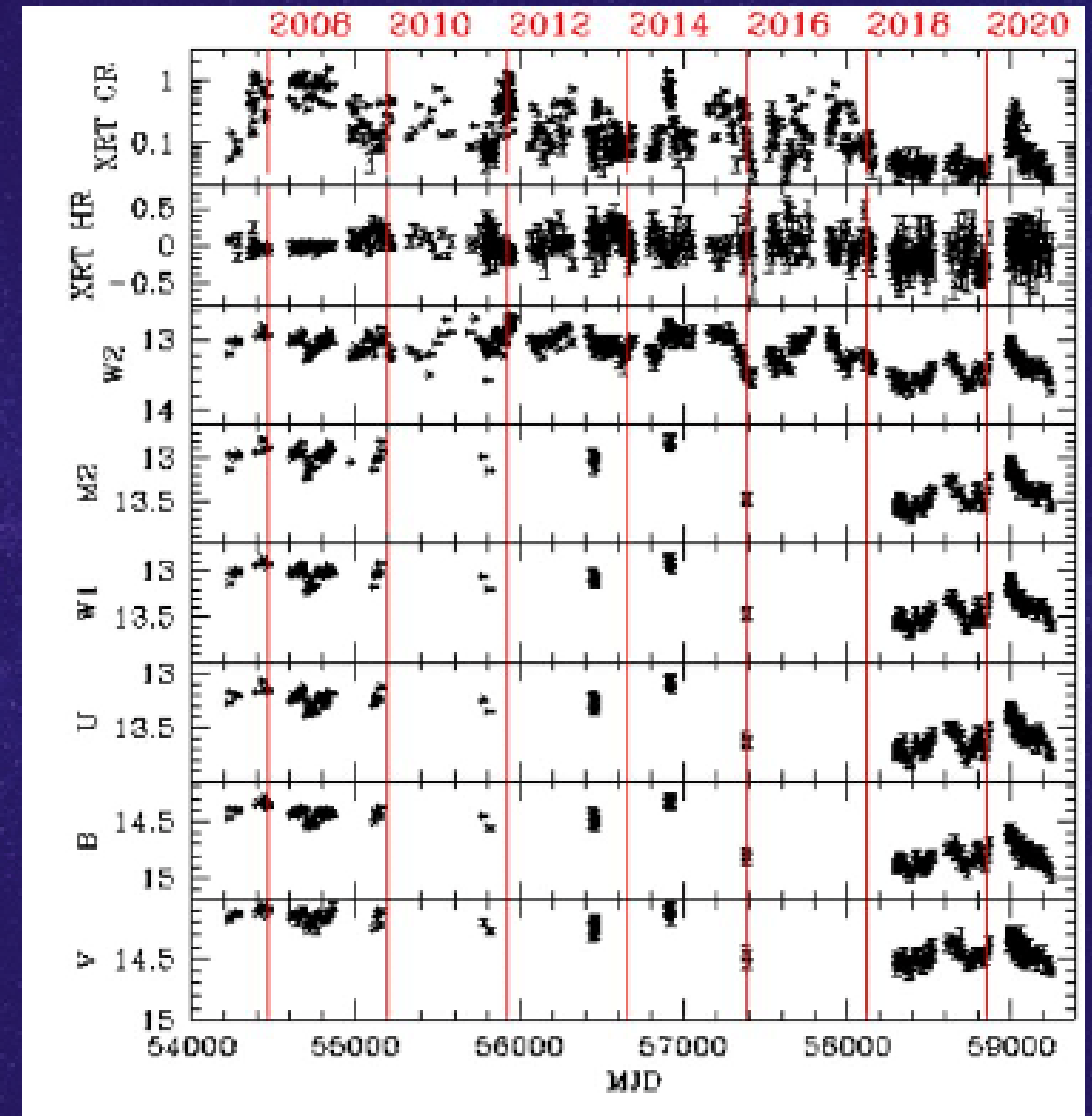
# Hard X-ray spectra in non-beamed AGN can also be produced by X-ray reflection

- Model originally proposed by A. Fabian in 1989
- X-ray emission reflects on accretion disk
- Inverse Compton scattering in Corona



# Conclusion

- ★ Long term monitoring is super useful
- ★ AGNs can be used as cosmological probes



Mrk 335

# RESOURCES

Grupe, D., Dr., Wills, B. J., Leighly, K. M., & Meusinger, H. (2004). A complete sample of Soft X-Ray-selected agns. I. the data. The Astronomical Journal, 127(1), 156-179. doi:10.1086/380233

Rosswog, S., & Brüggen, M. (2007). Introduction to high-energy astrophysics. Cambridge: Cambridge University Press.





THANK YOU!