The outflowing corona in MAXI J1820+070

- You et al., 2021, NC
  - arXiv:2102.07602
- http://youbei.work/research/

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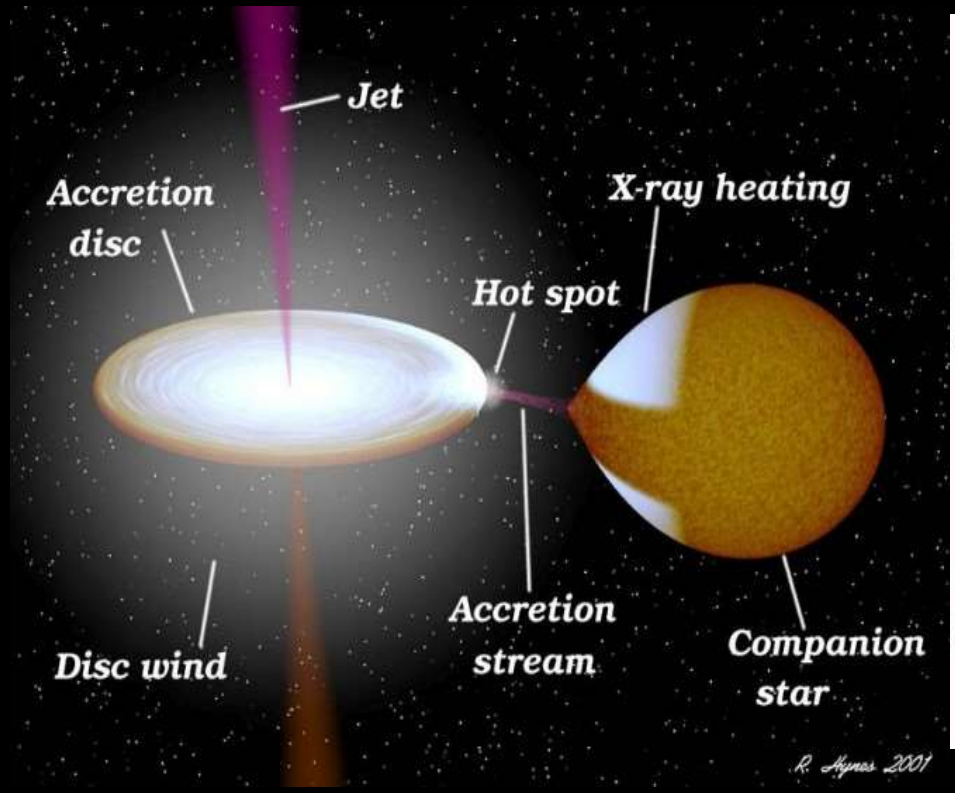
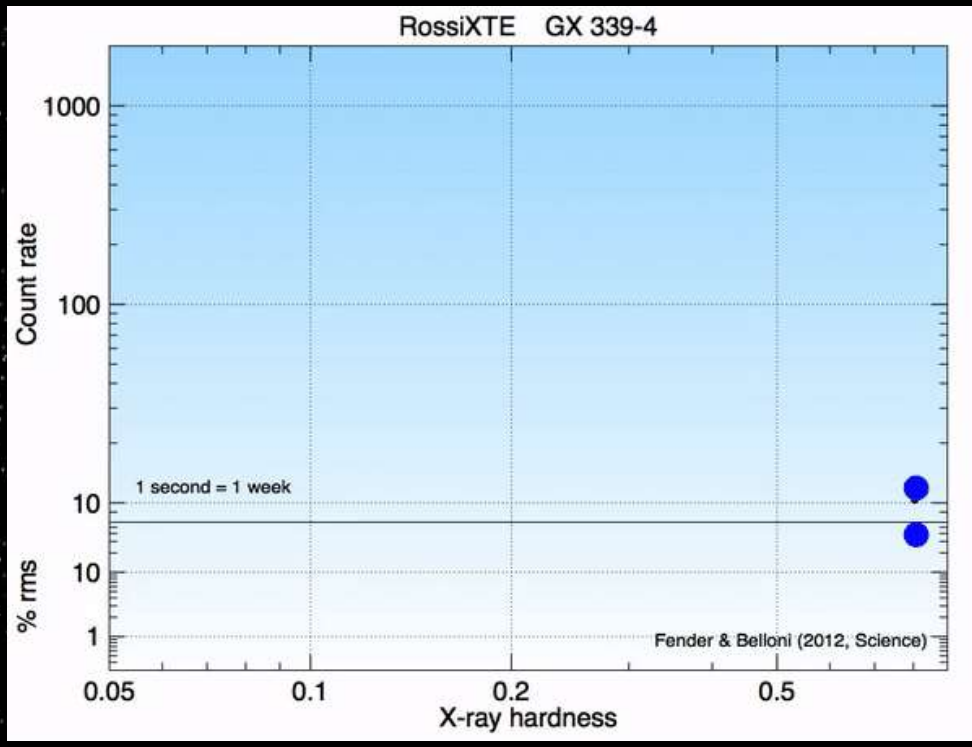
武汉大学 (Wuhan University)

X射线天文学60周年及中国X射线天文研究，2022年6月15-18，北京

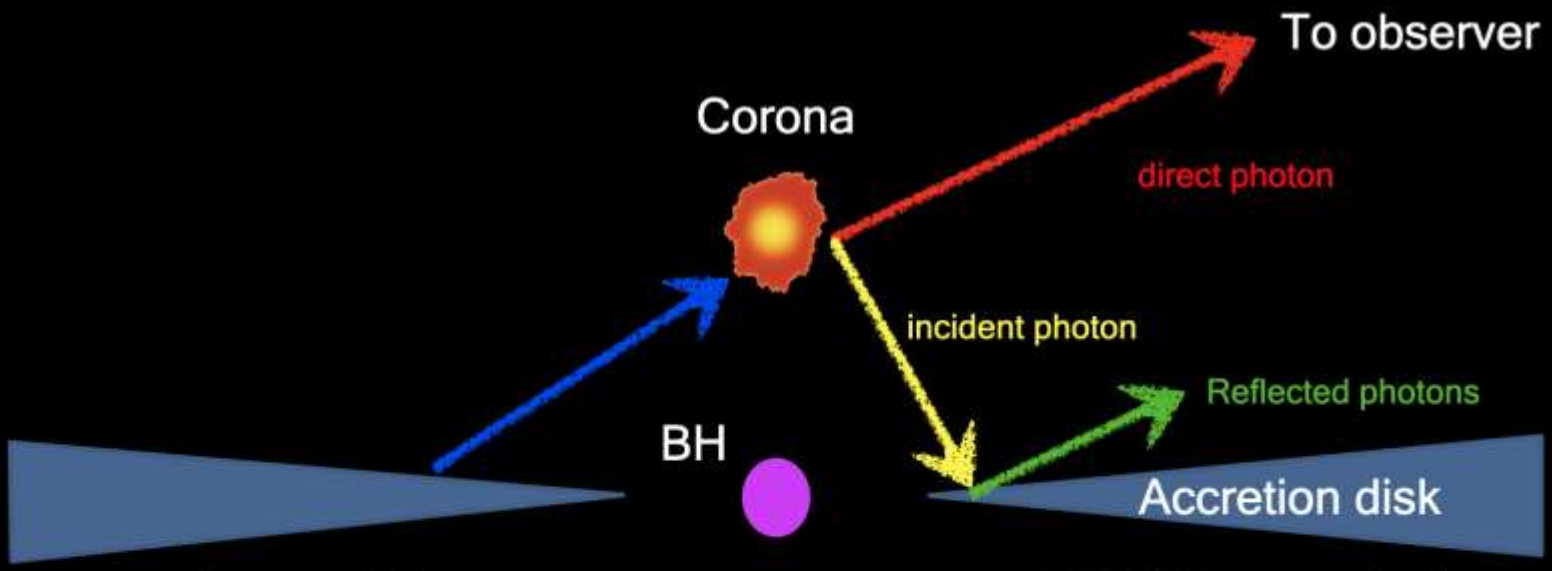
BH X-ray Binary during an outburst

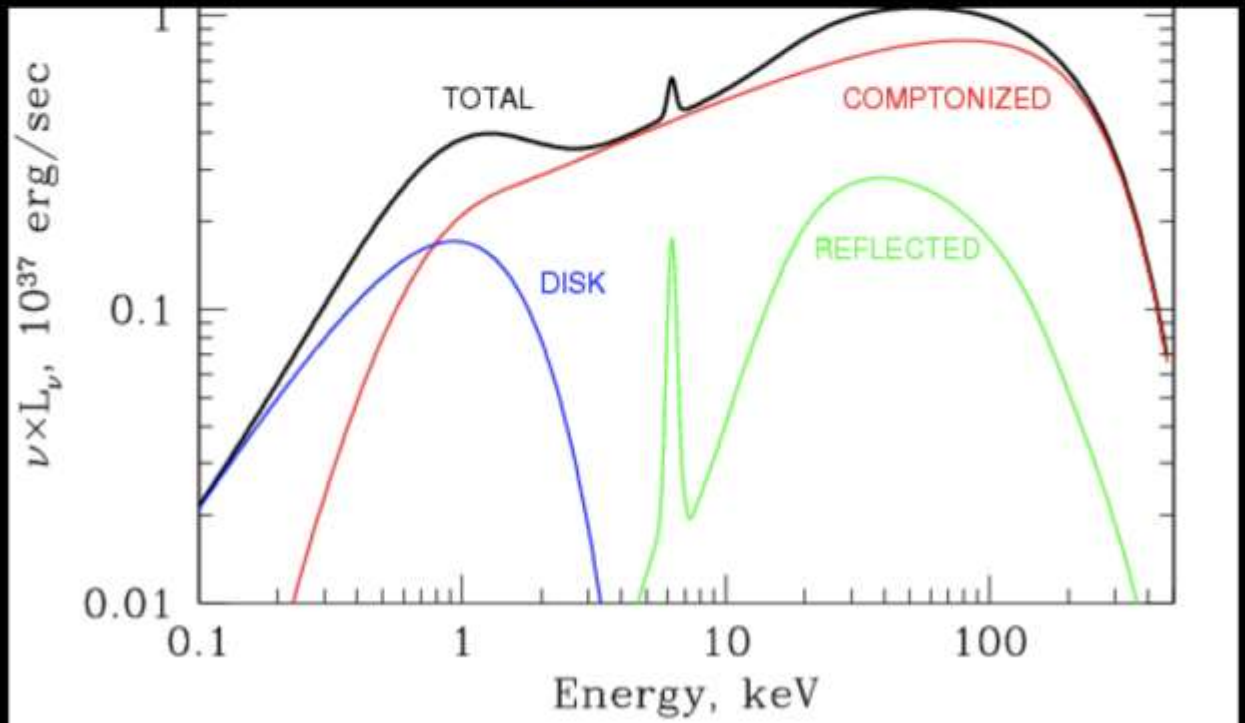




Hardness Intensity Diagram (HID), Fender +'12

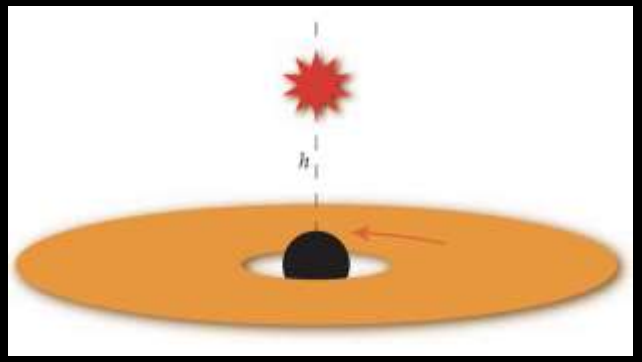
The accretion disk-corona

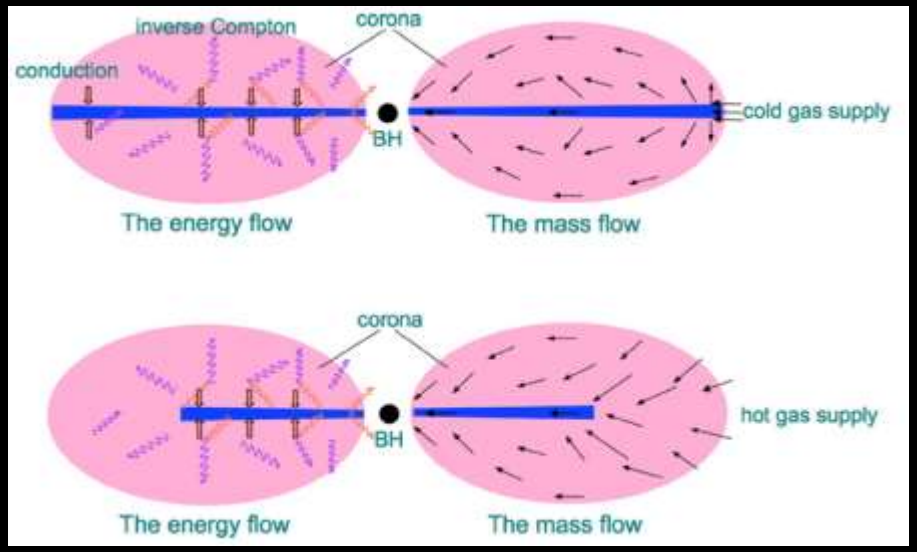




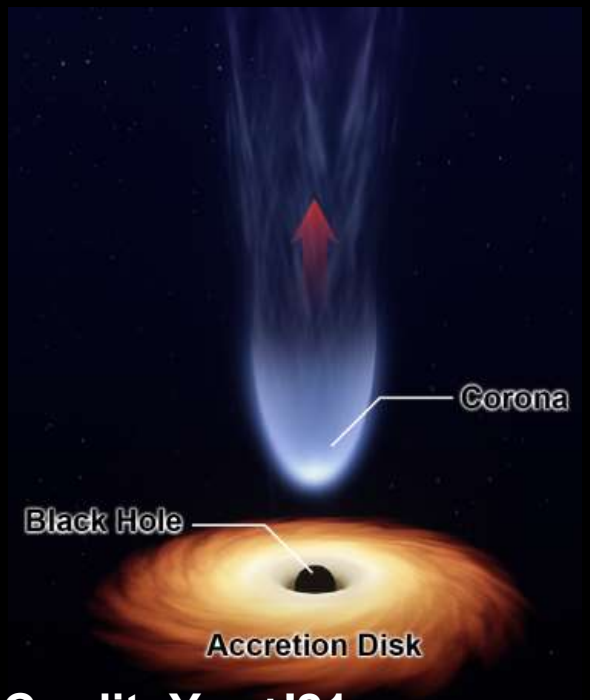
The geometry of the disk-corona

- Lamp-post / jet-like corona (Markoff+'05, Fabian+12)

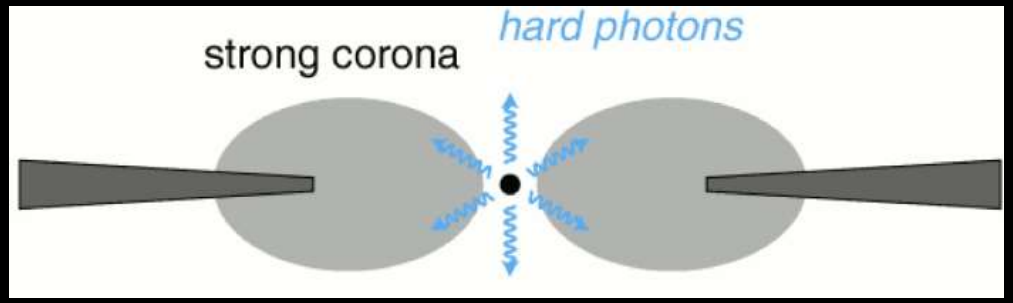




- inner disk + corona (Qiao+11;Liu+15)

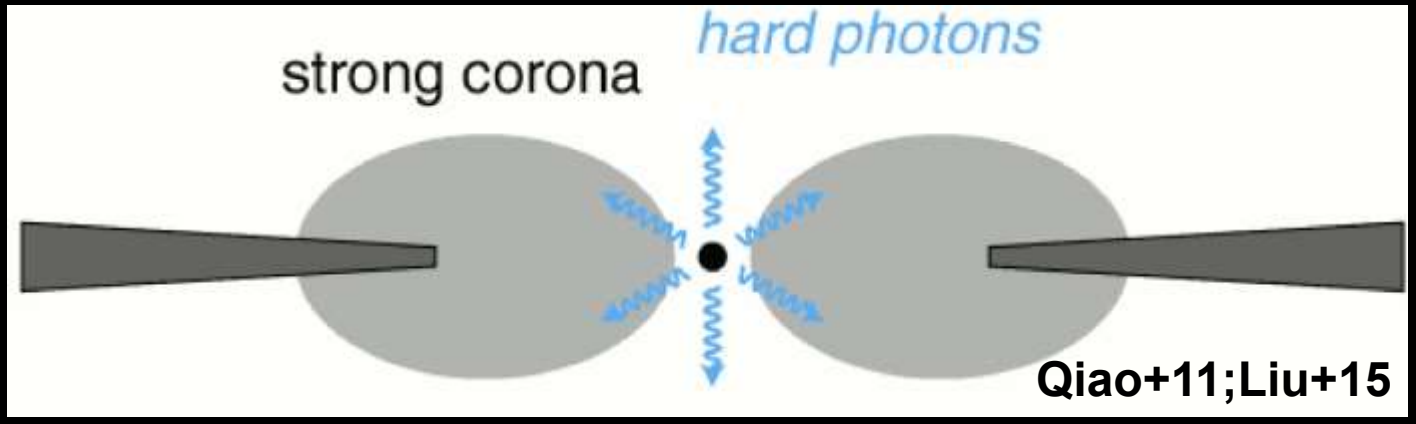


Credit: You+'21

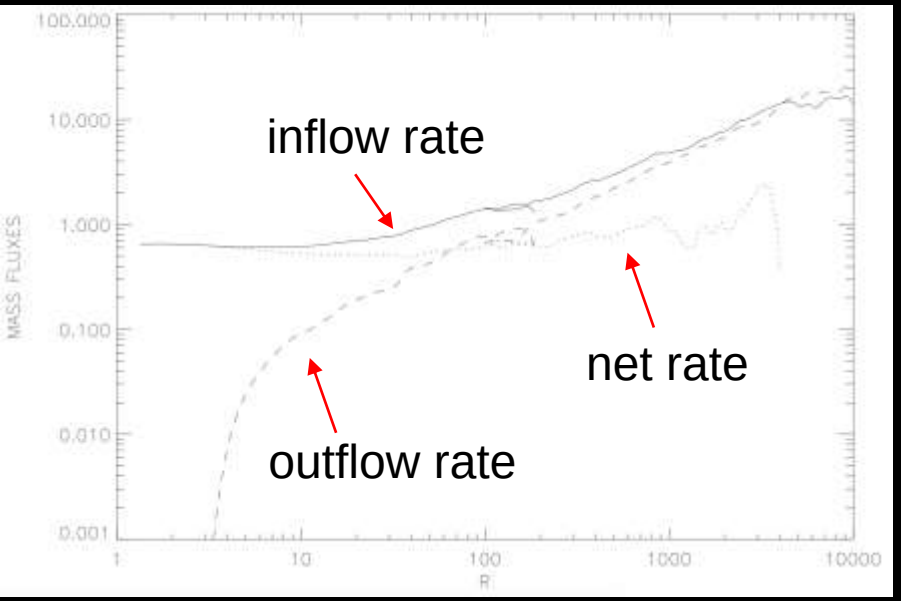


- Truncated disk + corona (Esin 1999;Done 2007)

The dynamics of the disk-corona



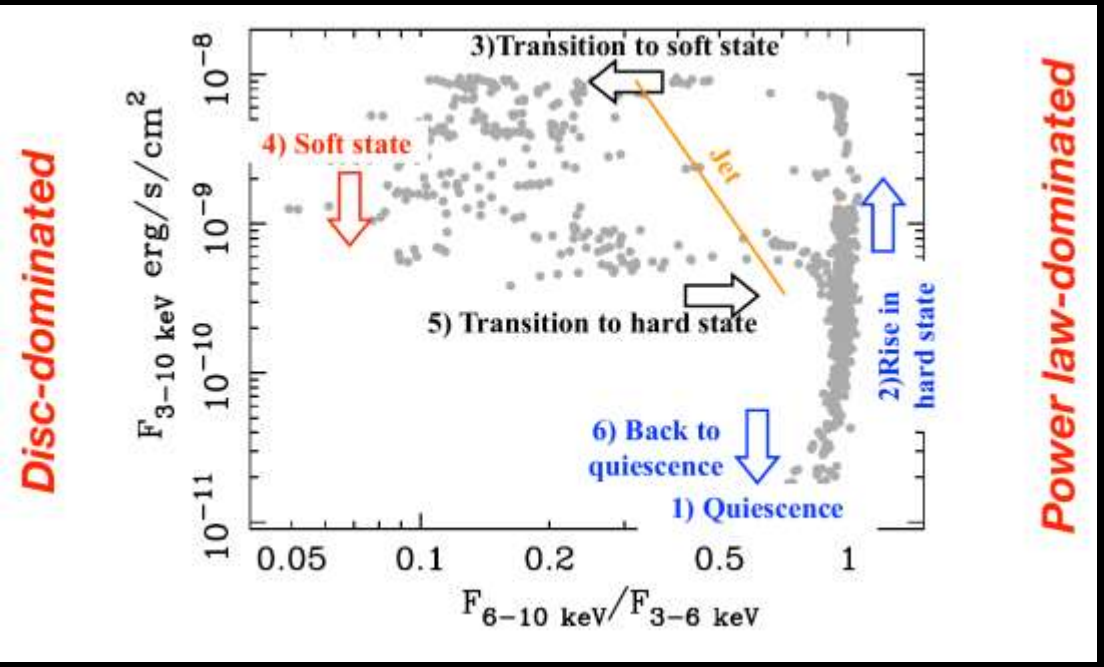
- **Bernoulli parameter of an ADAF is positive, the ADAF is likely to have an outflow**
- **Confirmed by numerical simulations / calculation and observations (Stone 1999 / 2001; McKinney 2006; Yuan et al. 2003; Bu et al .2009; Li & Cao 2009)**

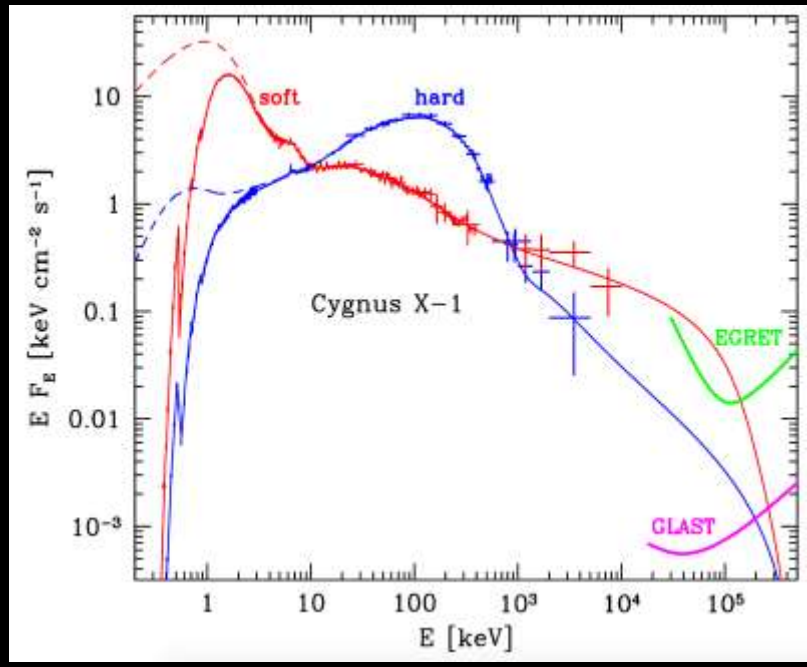


Yuan F., Wu MC., Bu DF., (2012)

BH X-ray Binary during an outburst

Zdziarski+'04;Remillard+'06; Done+'07;

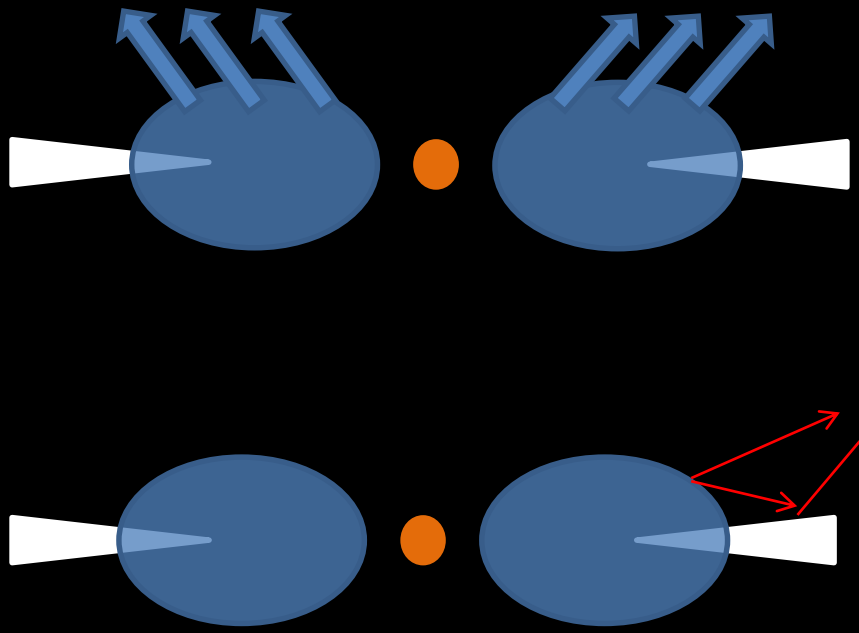


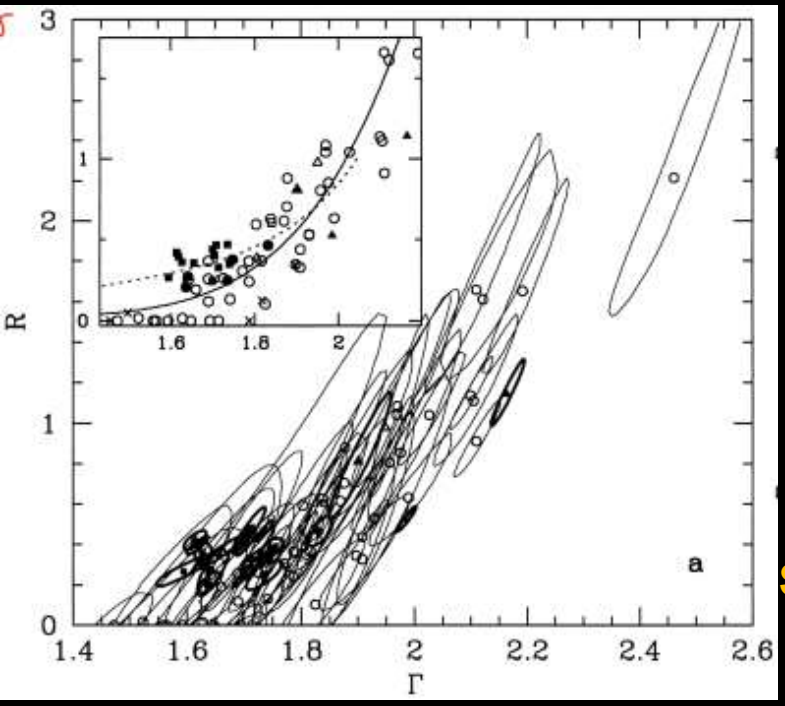


- The hard state is dominated by power-law emission from the corona
- The soft state is dominated by the thermal emisson from the disk

Scenario I: Beloborodov (1999)

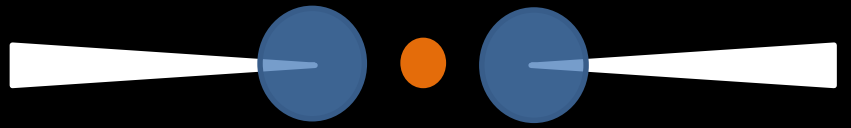
Evolution of the outflowing velocity of the corona



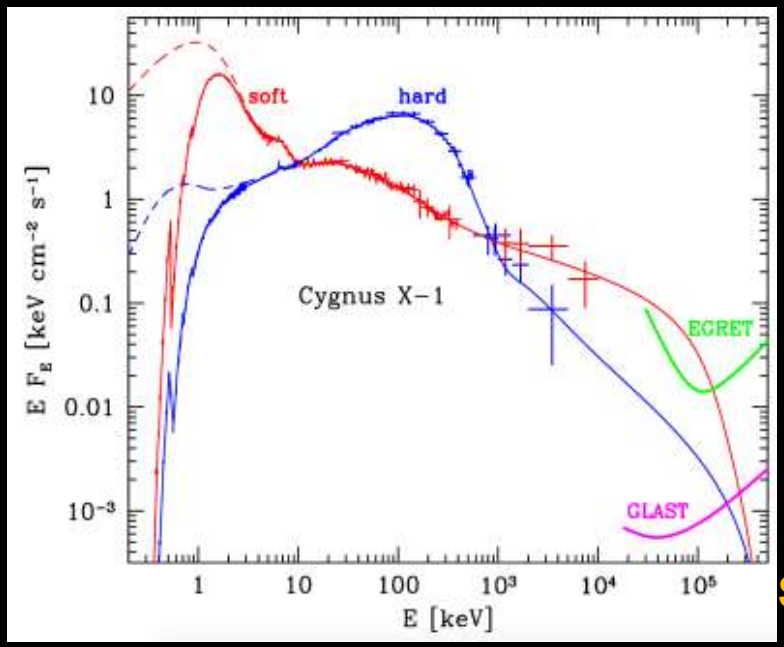


Scenario II: Zdziarski (1999)

Evolution of the truncation radius of the disk



Correlation between R and gamma, in BHXRBs and AGNs (Zdziarski+'99)



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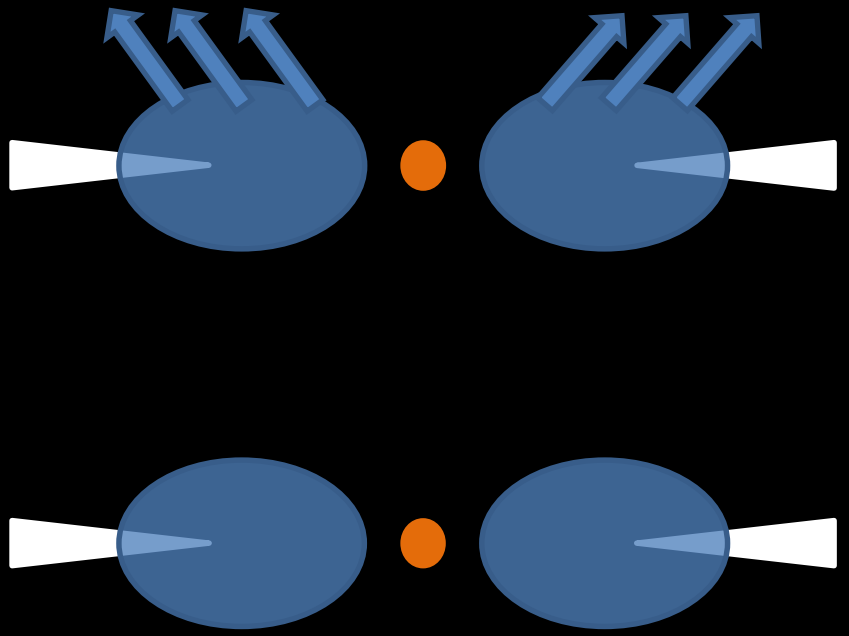

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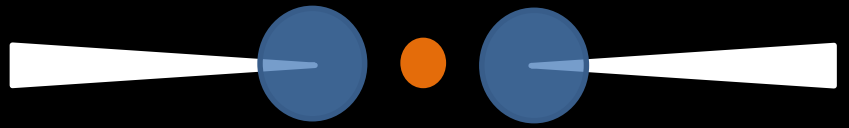


- **Still open questions:**
  - **The geometry and dynamics of the corona**
  - **Their evolutions during an outburst.**

- Studying geometrical and dynamic evolution of the disk-corona
  - AGN, e.g., TDE and changing-look
  - BHXRB, e.g., outburst

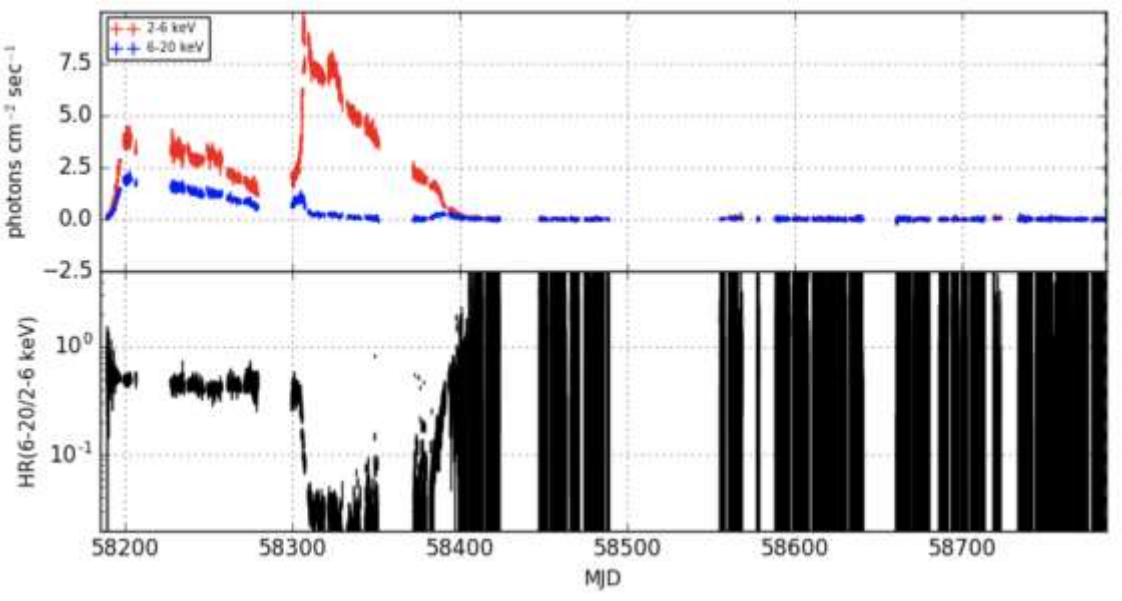
The outflowing corona in MAXI J1820+070

- Brief introduction to **MAXI J1820+070**
  - **timing analysis**
- Spectral analysis of **MAXI J1820+070**
- Co-evolution of the disk-corona of **MAXI J1820+070**

Observations of **MAXI J1820+070**

MAXI J1820+070 (ASASSN-18ey) is a **low-mass** black hole X-ray binary:

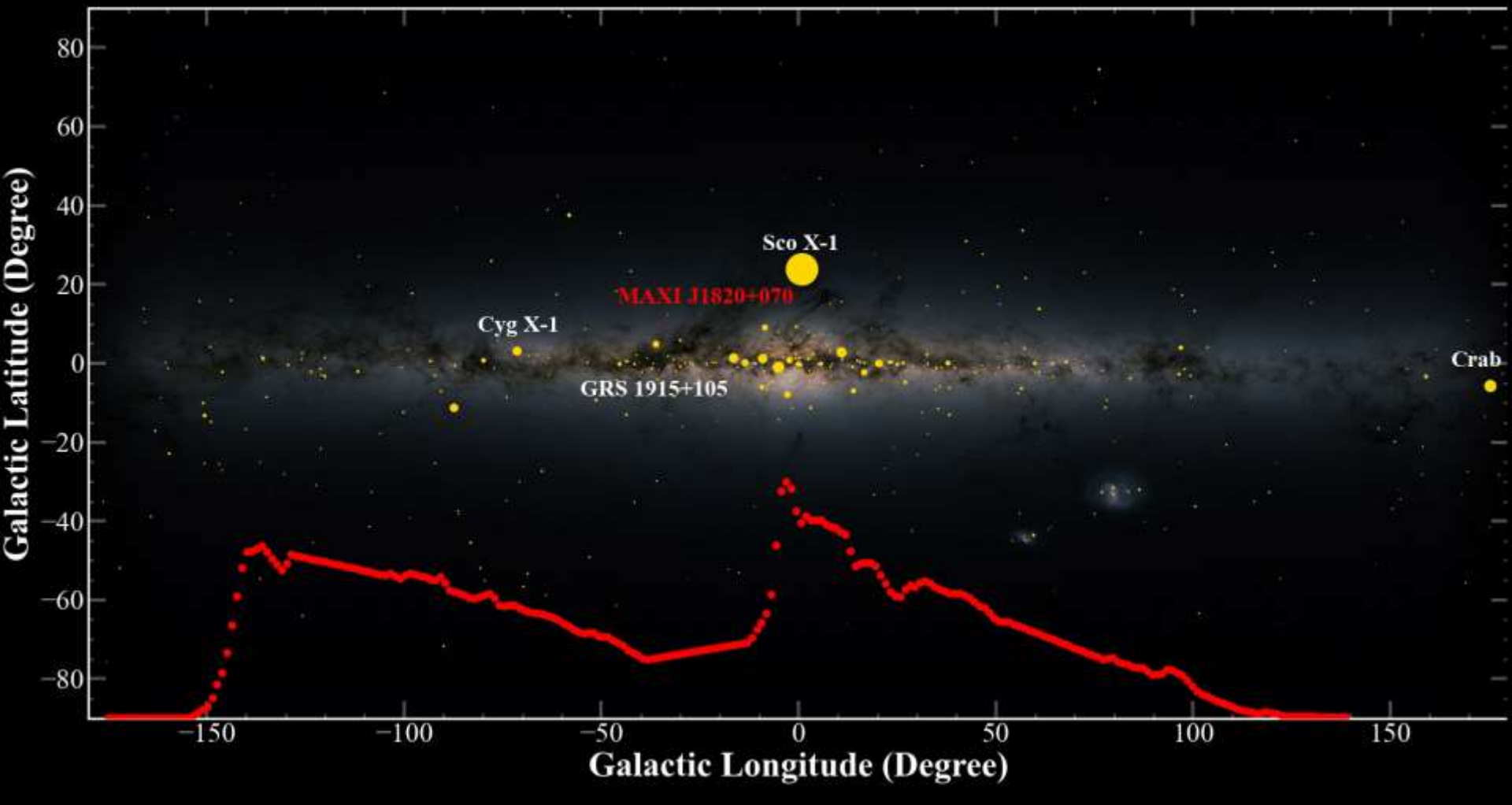
- Discoveried by MAXI on 11 March 2018 (Kawamura et al. ATel #11399)



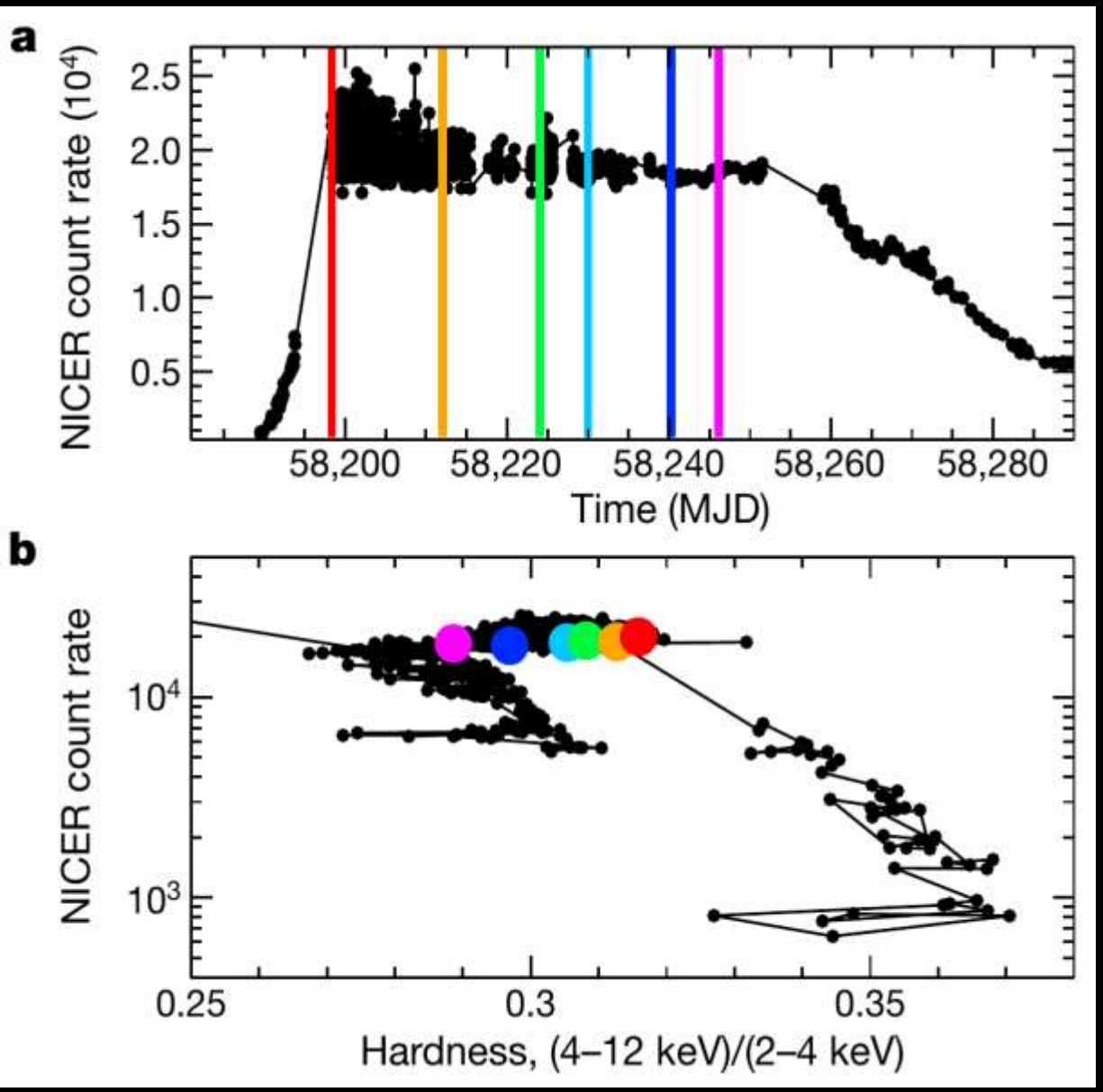
- Follow-up observations and studies:
  - Shidatsu (2019), Kara (2019), Buisson (2019), Wang Y-N (2020), Ma (2021), Zdziarski (2021), Wang J-Y (2021)

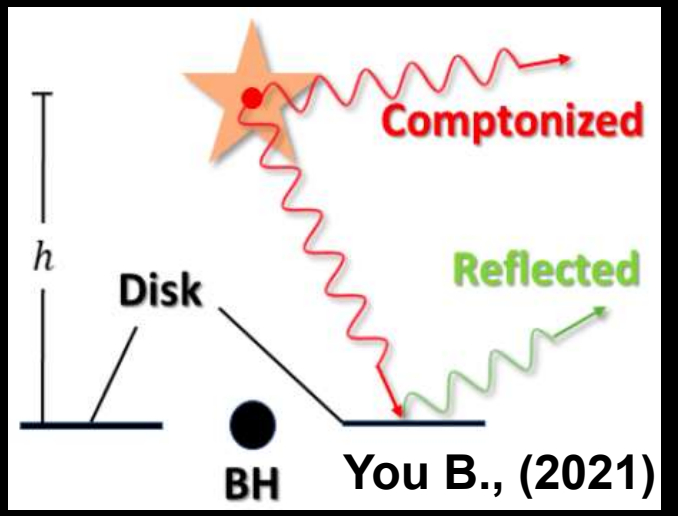
- System parameter:
  - D = 2.96 kpc, i = 63 (Atri 2020)
  - M > 7 Msun, if the inclination is large (Shidatsu 2019)

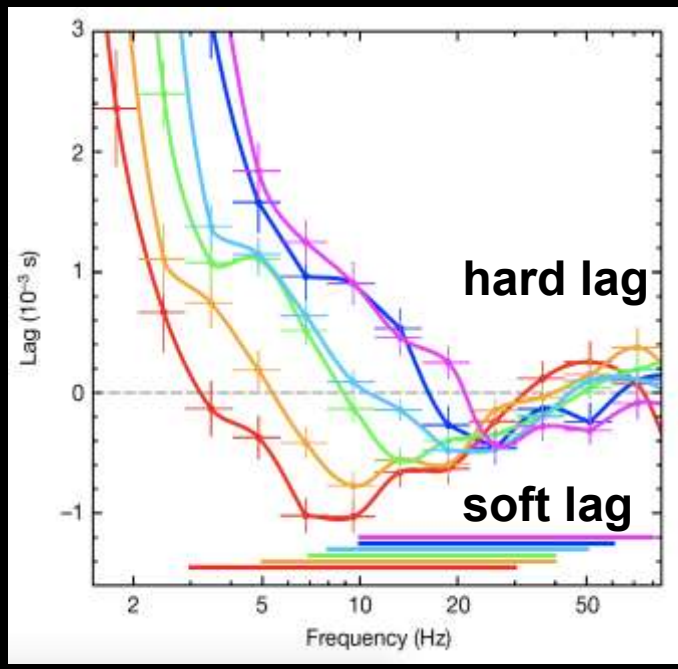
From Yan, Z (SHAO)



MAXI J1820+070: Timing analysis

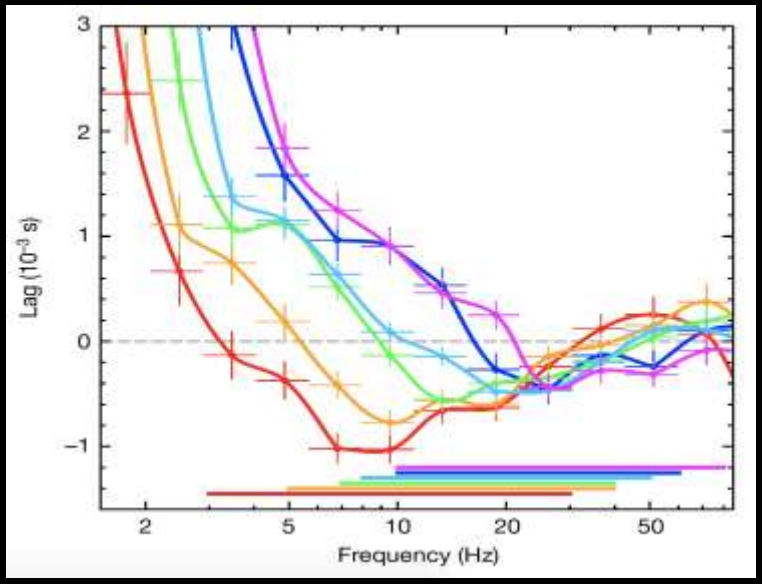


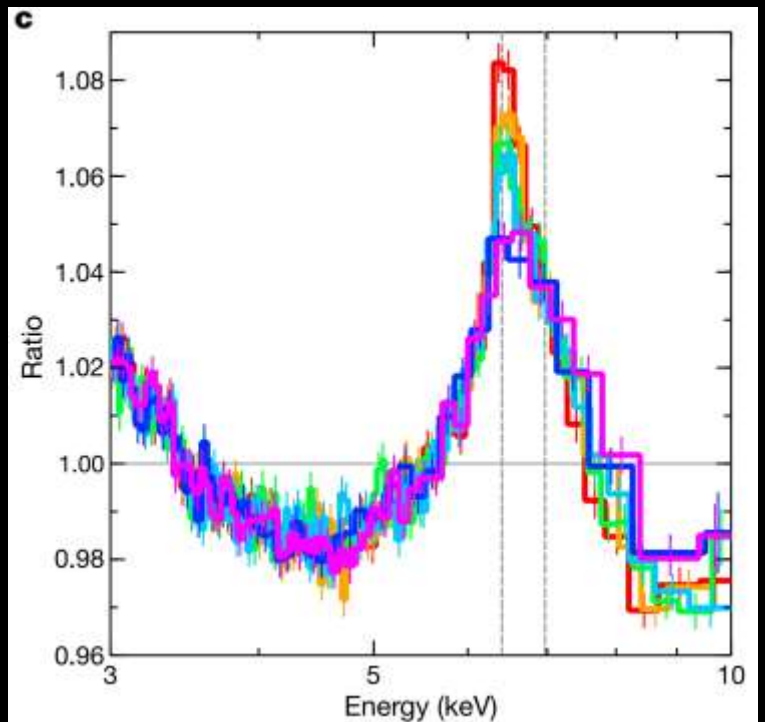


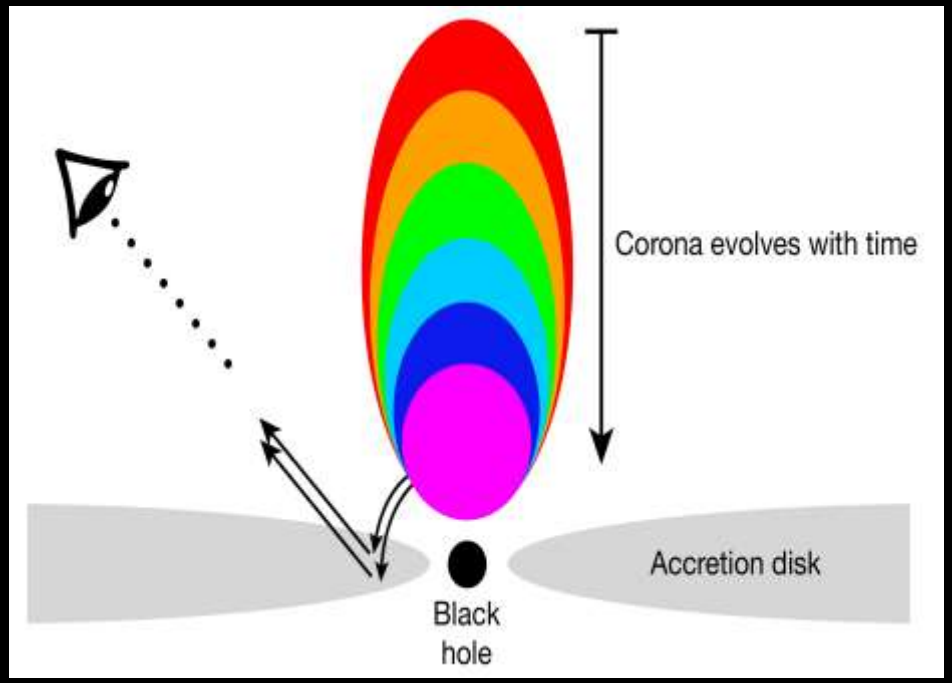


Kara+'19, Nature; NICER

MAXI J1820+070: Timing analysis



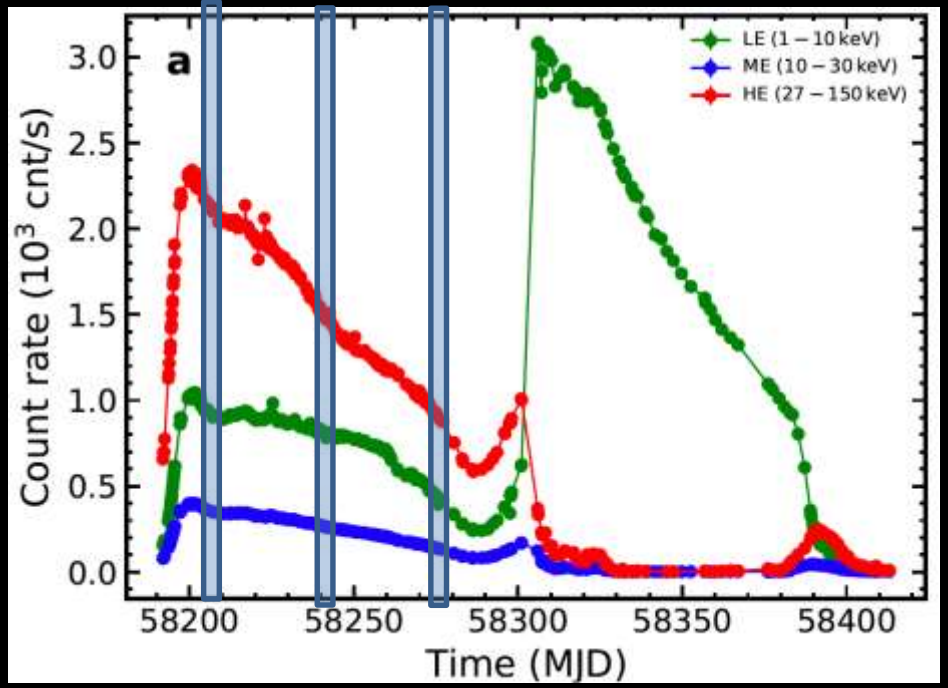


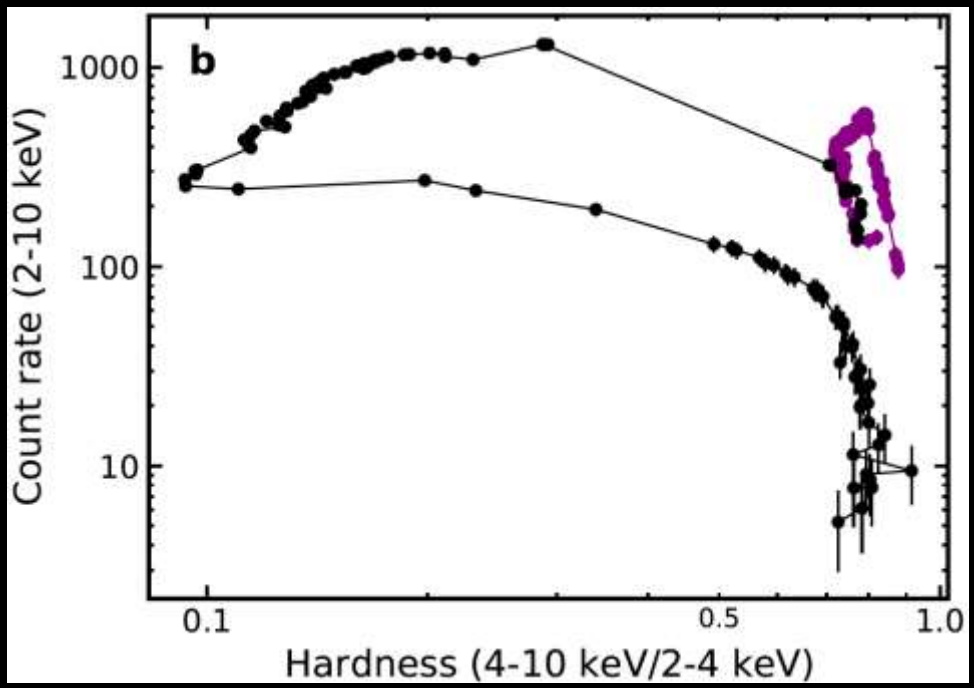


- The **reduction** of the **relative distance** between the disk and corona (Kara 2019, De Marco 2021)

MAXI J1820+070: Spectral analysis

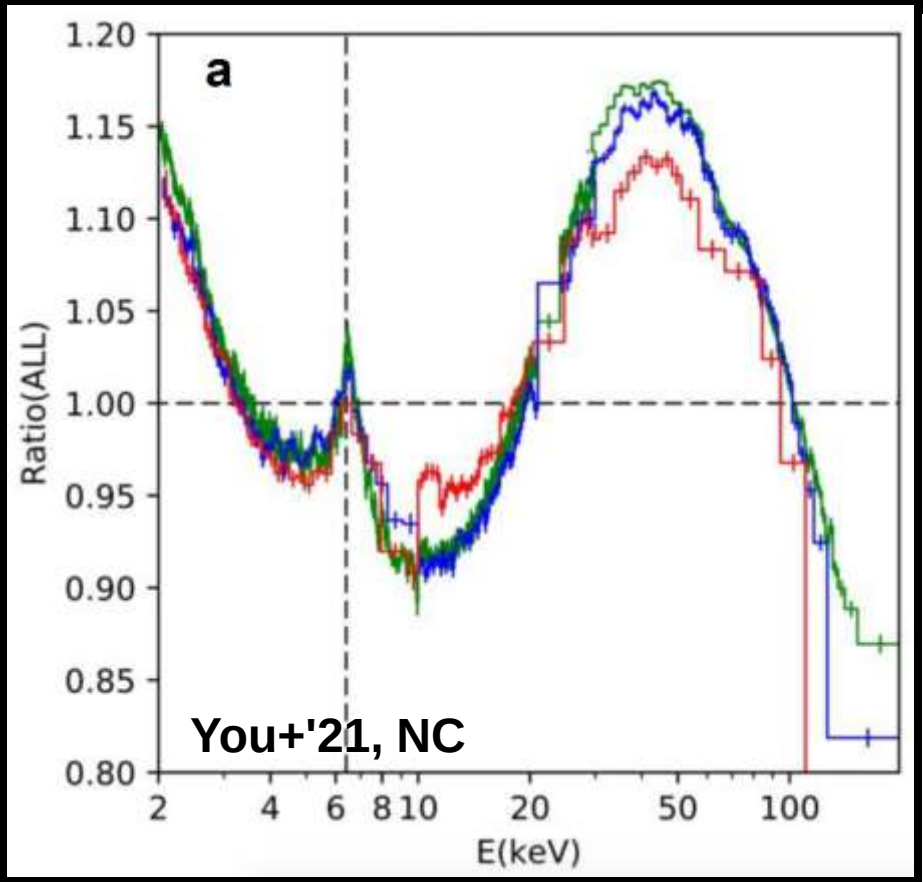
Hard X-ray Modulation Telescope(HXMT)

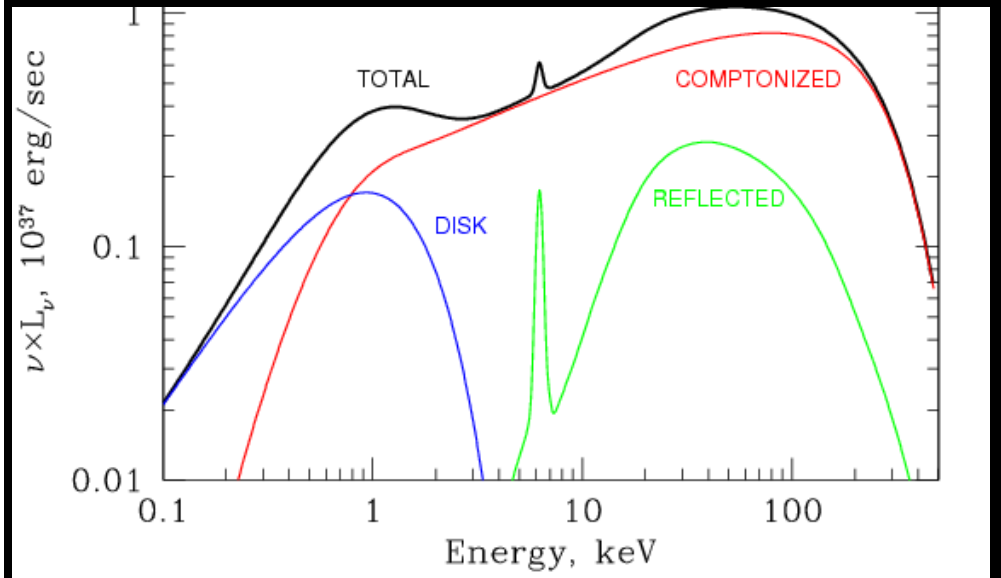


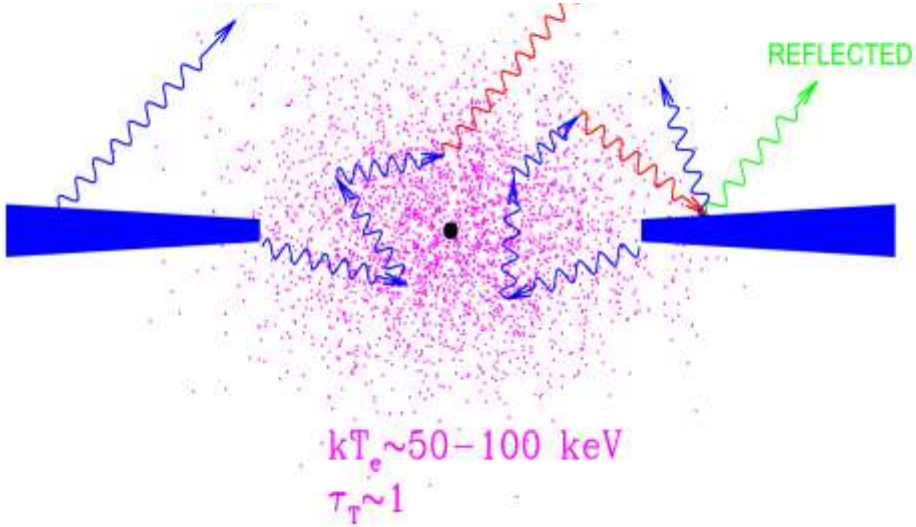


You, B et al., 2021, Nature Communications

MAXI J1820+070: Spectral analysis

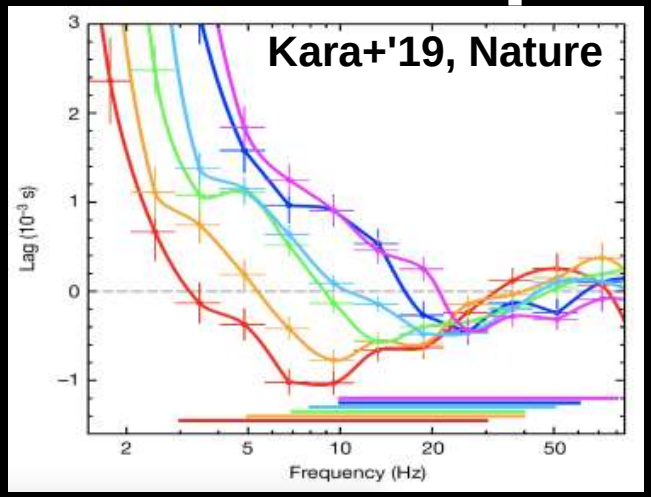


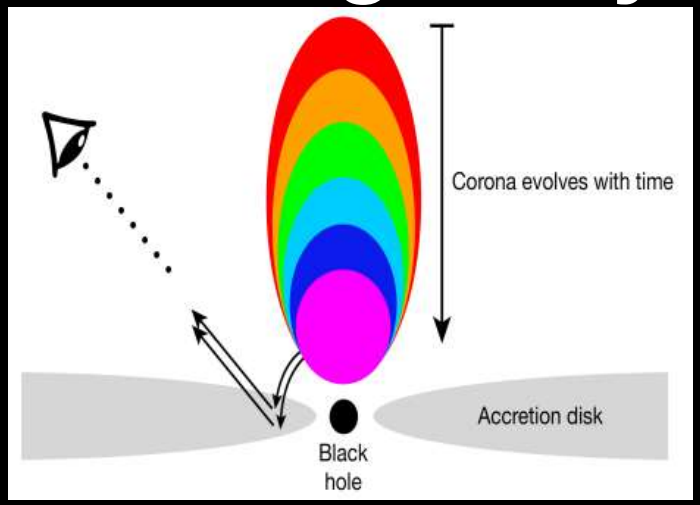




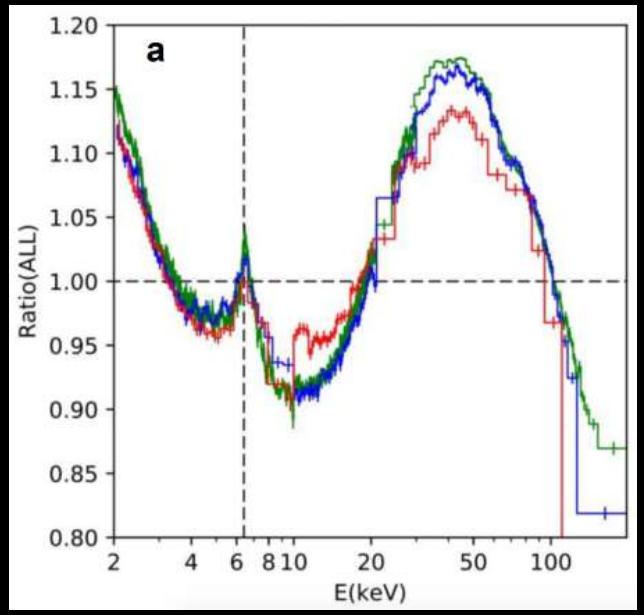
- Disk
- Comptonization
- Reflection

Review on Spectral-timing analysis





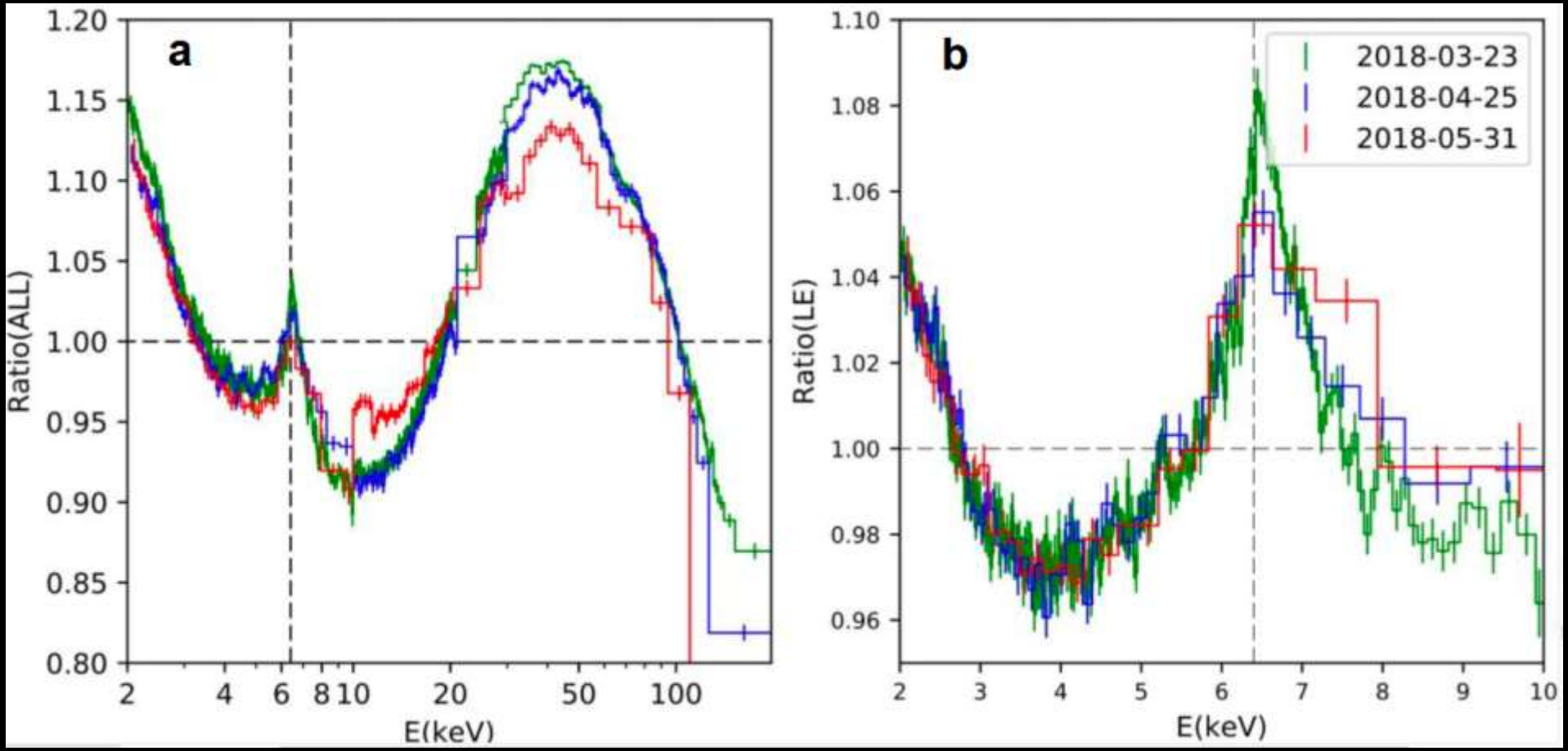
- The reduction of the relative distance between the disk-corona
  - The reflection fraction shoud increase !!!



You+'21, NC

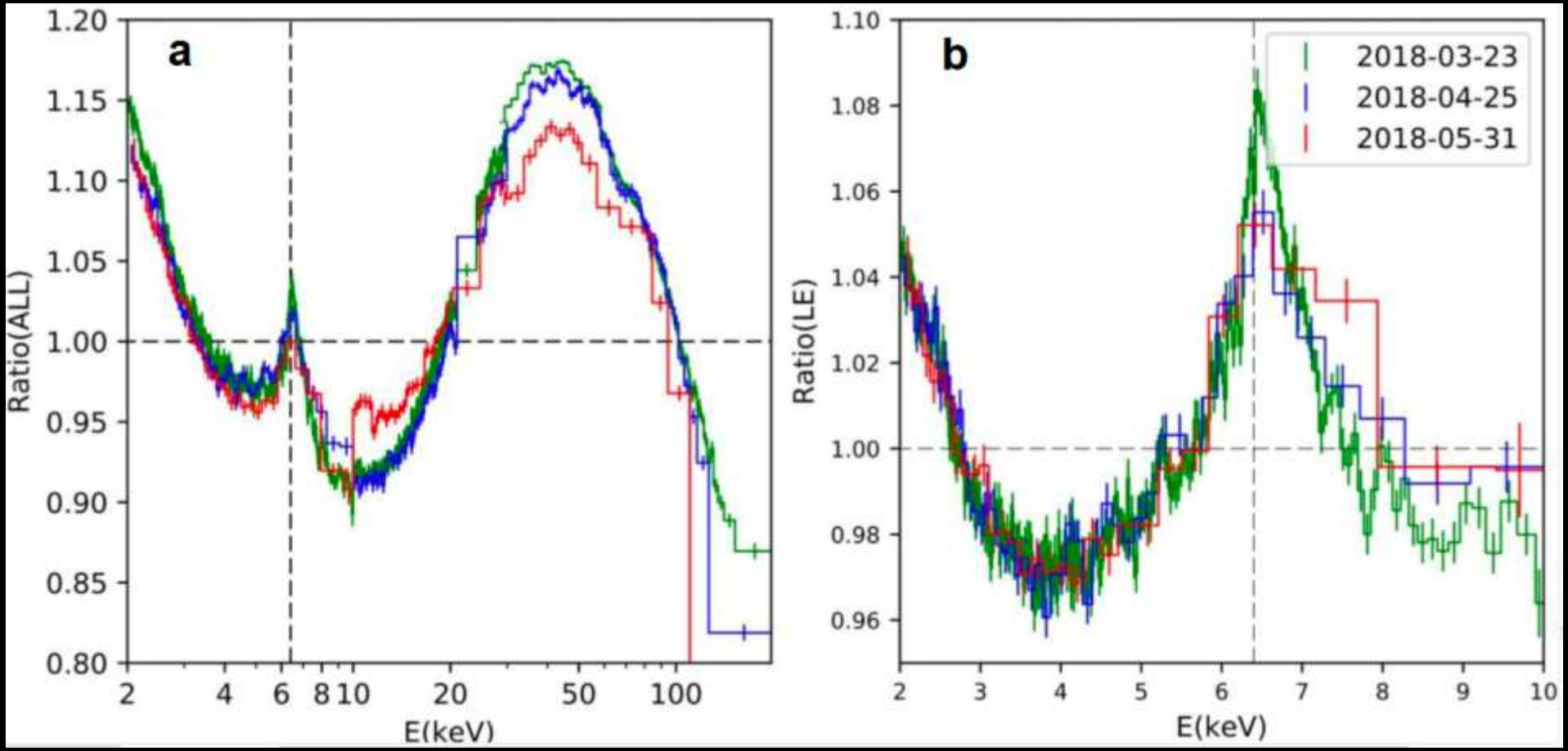
- The reflection hump relative to the Comptonization, decrease !!!

MAXI J1820+070: Spectral fitting



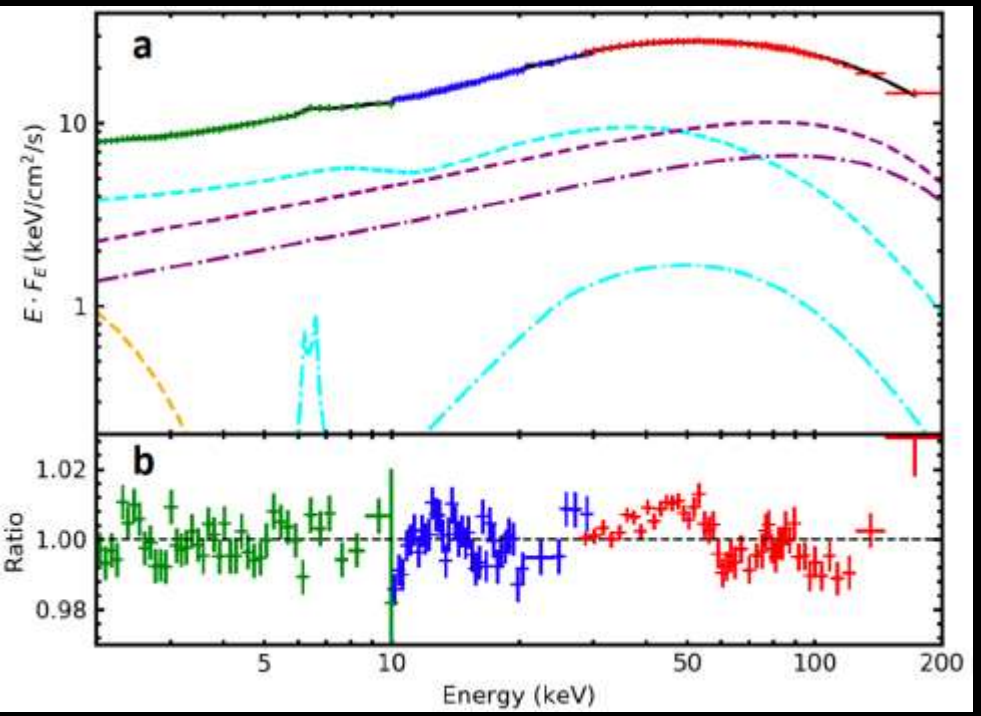
- **Disk:** diskbb
- **Comptonization:** nthcomp
- **Reflection:** relxill

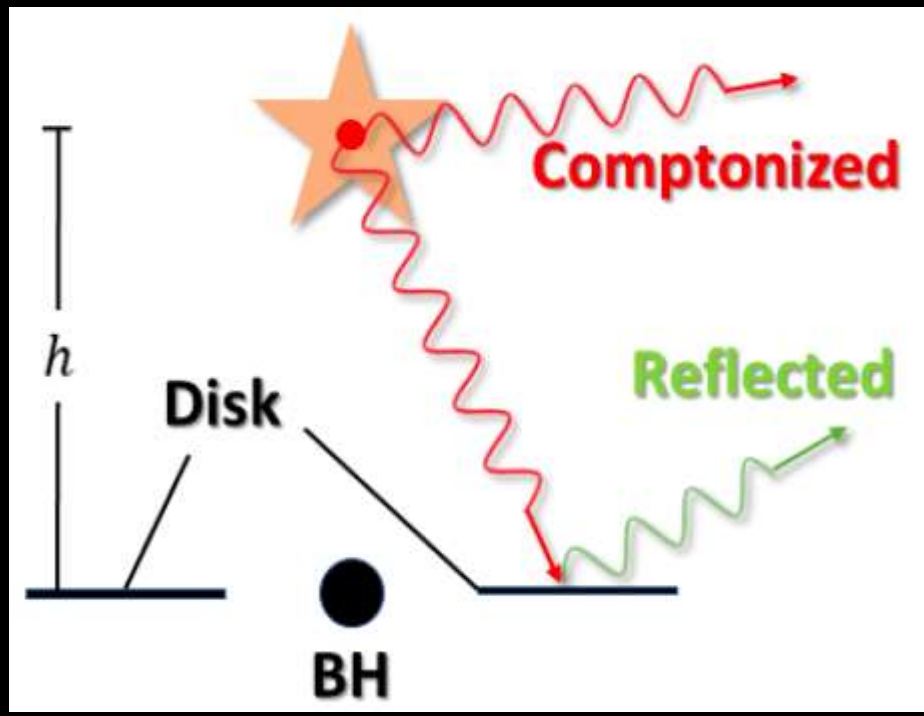
MAXI J1820+070: Spectral fitting



- Spectral model: tbabs*(diskbb+relxillCp+xillverCp)
  - Buisson (2019), Zdziarski (2021)
- Assume: a = 0.998, Rin = ISCO, i = 63
- Free paras: A_{Fe}, logxi, Te, Gamma, R_F etc

MAXI J1820+070: Spectral analysis





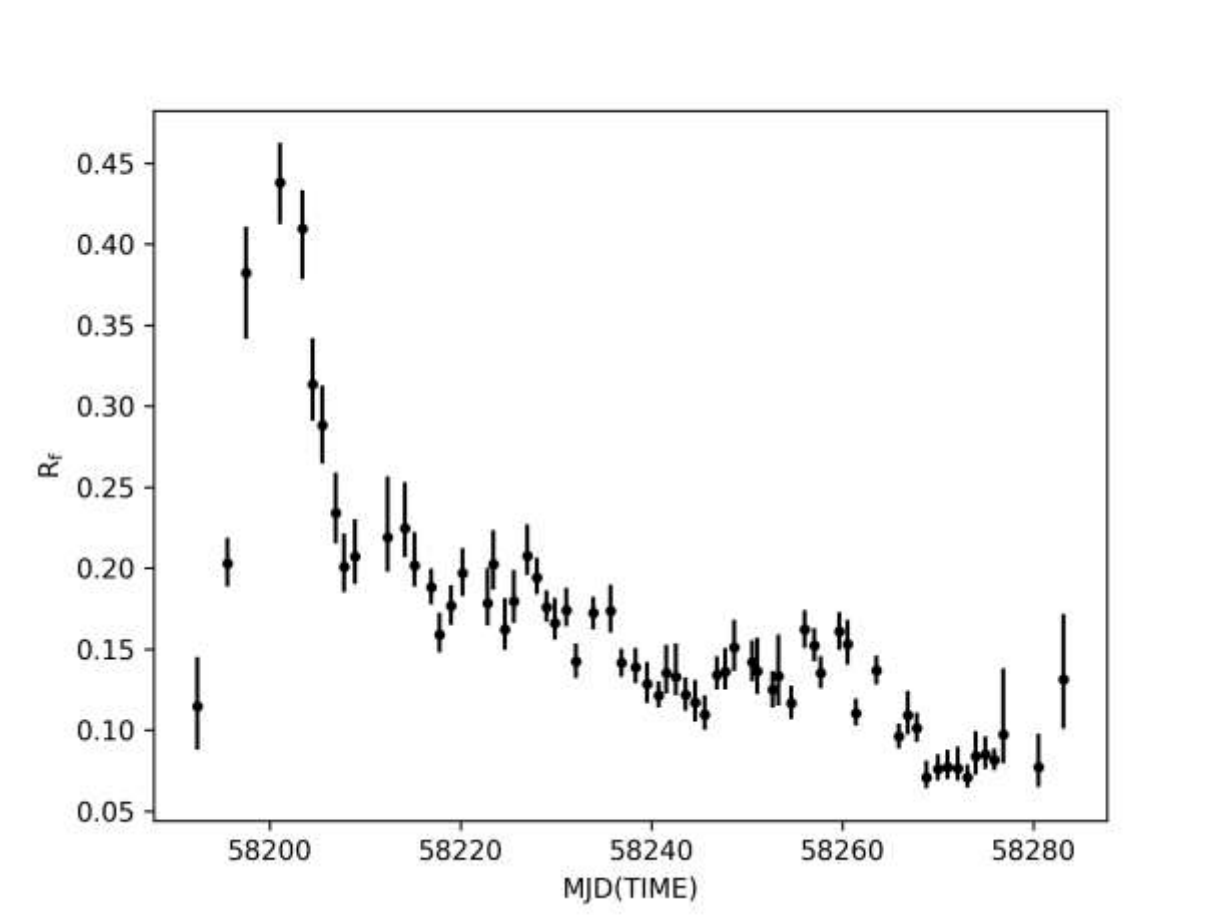
One of the important parameters of the reflection models:

- **The reflection fraction:**

$$R_f = \frac{counts - to - disk}{counts - to - infi}$$

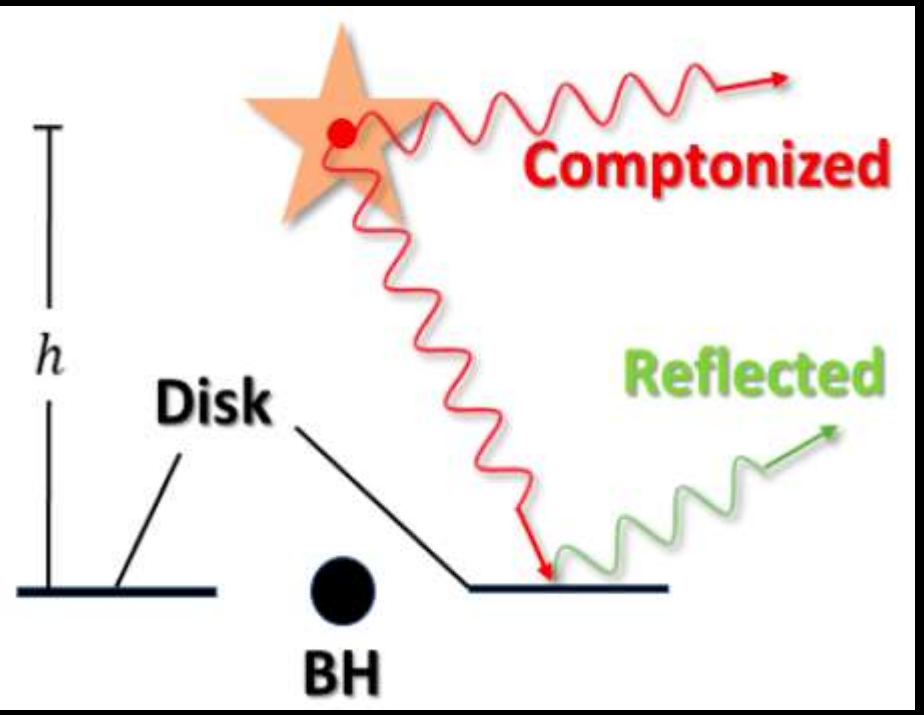
MAXI J1820+070: Spectral analysis

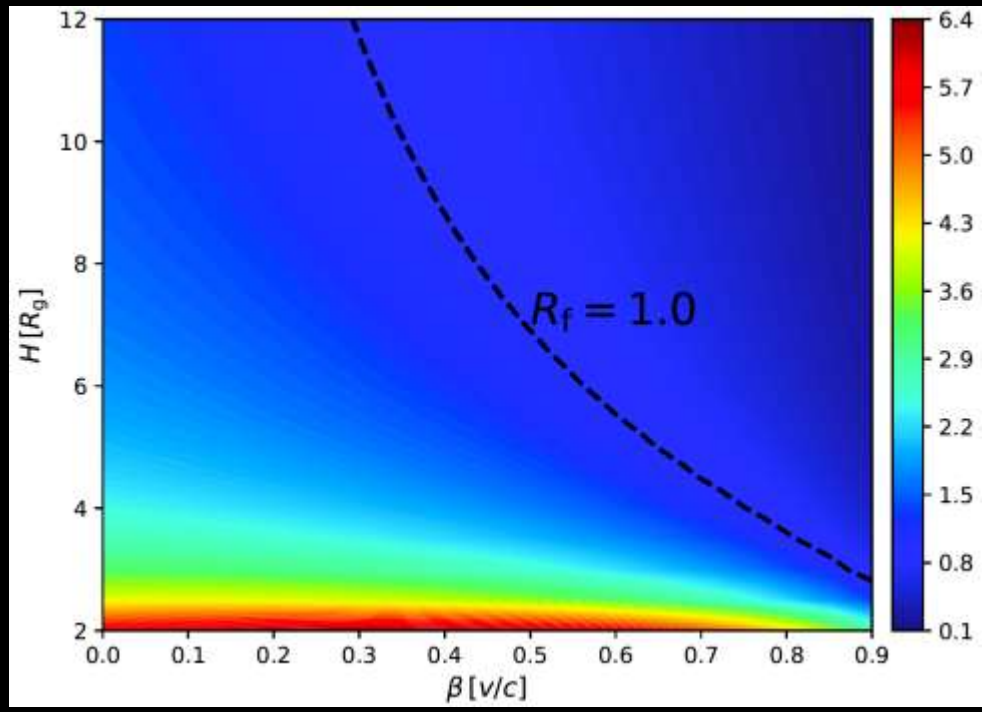
But...



- **The reflection fraction DECREASES as the corona contracts !!!**
  - **Less (coronal) photons hit the disk**

MAXI J1820+070: Interpretation





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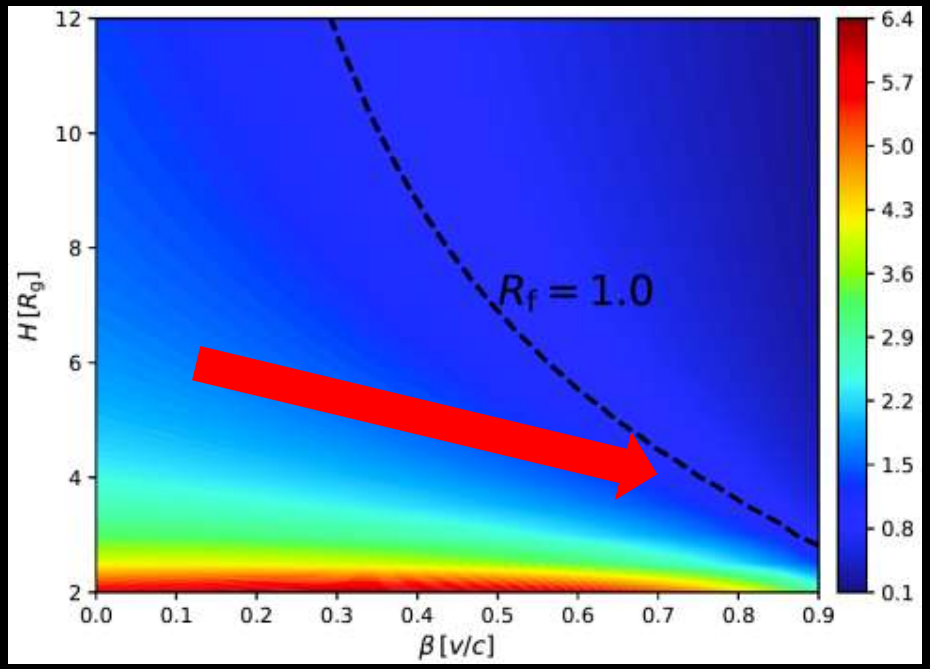
- The reflection fraction depends on both the height and the velocity

MAXI J1820+070: jet-like corona

Beaming effect

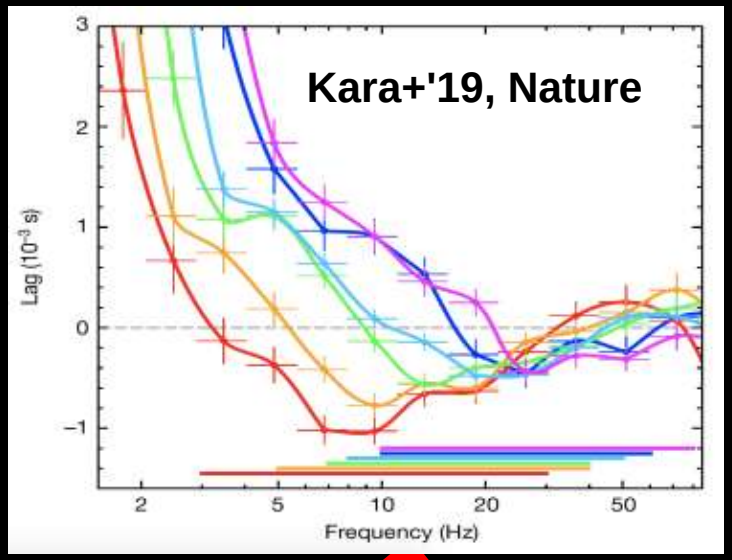
Light-bending effect

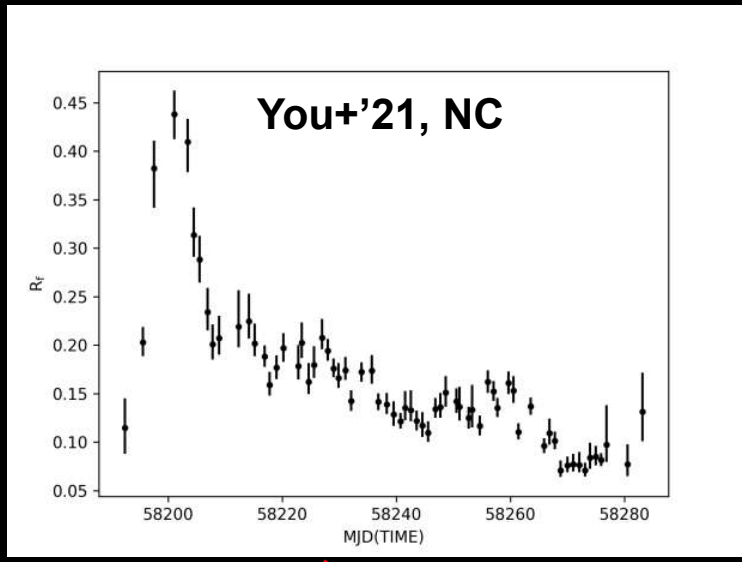


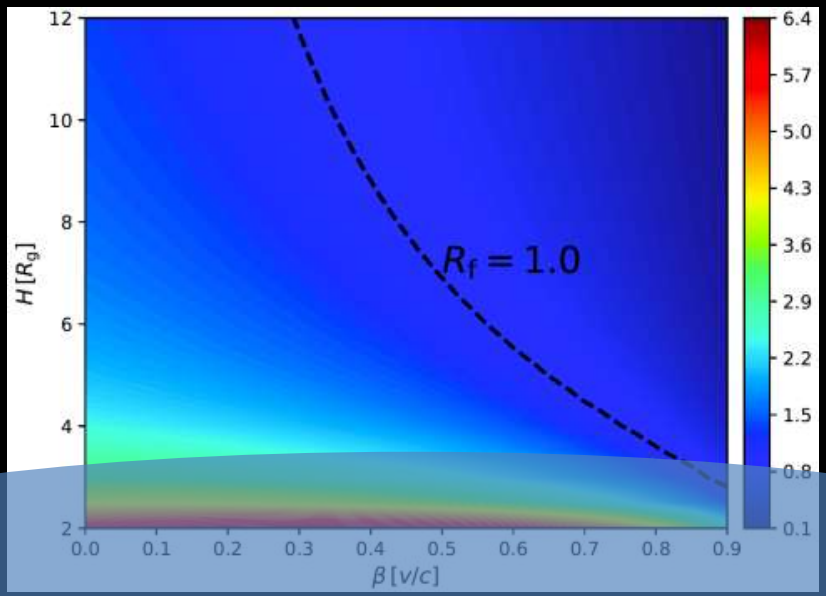
You+'21,NC

B&Z+'77, B&P+'82, Markoff+'05, Shen & Gu 20, Chen & Zhang'20

MAXI J1820+070: jet-like corona

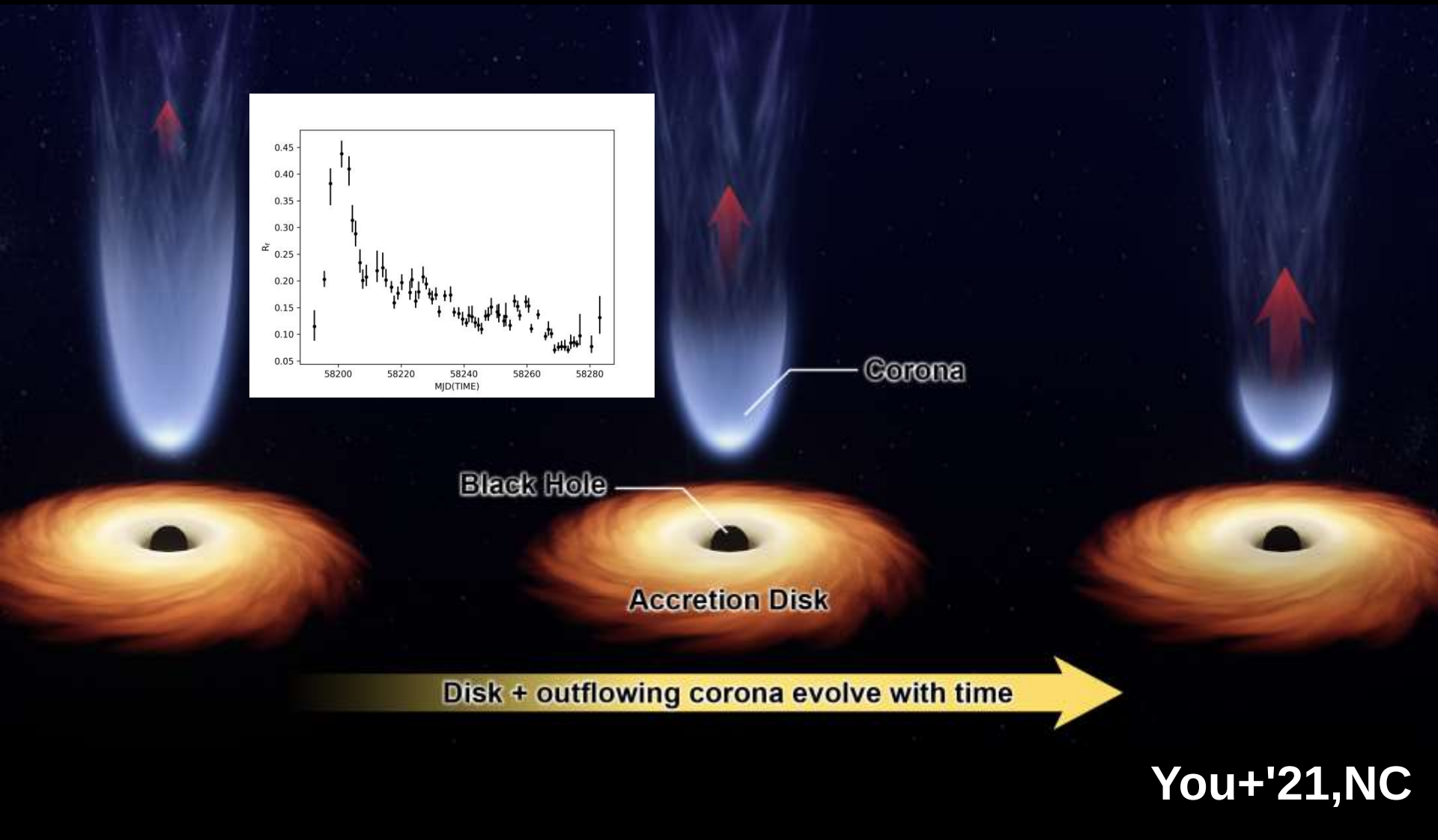






MAXI J1820+070: jet-like corona

- As the corona is contracting (closer to the disk),
  the corona is outflowing faster and faster !



You+'21,NC

MAXI J1820+070: ADAF-like corona

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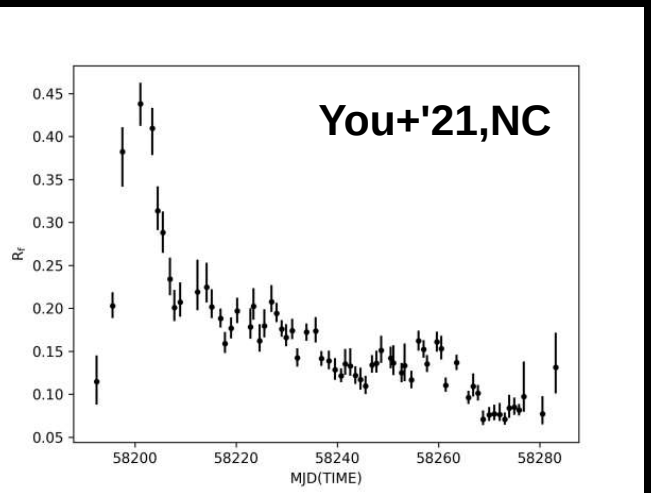
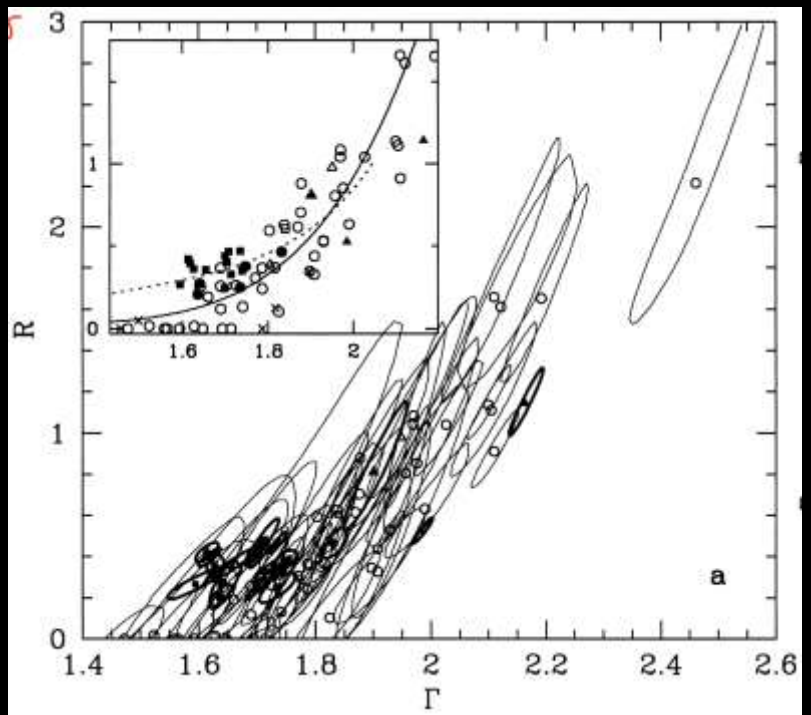
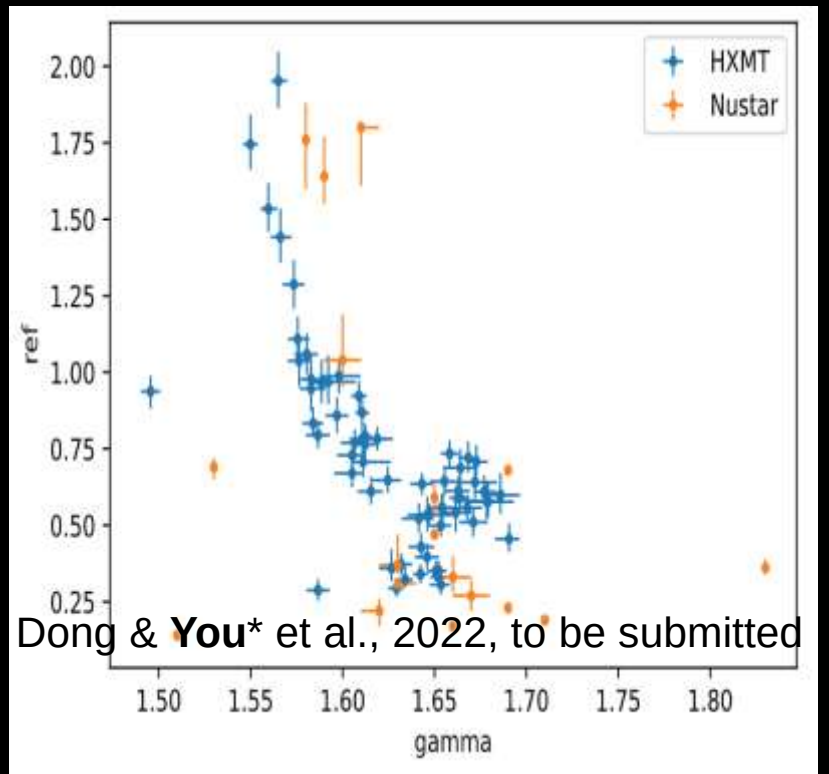


Discussion: MAXI J1820+070

- **What we know :**
  - The **relative geometry** of the disk-corona:
    - The disk-corona may contract (Kara 2019, De marco 2021)
  - The **dynamic** of the corona:
    - The corona may be dynamic, i.e.,outflowing faster(You 2021, NC)

(Zdziarski+'99)





Dong & **You*** et al., 2022, to be submitted

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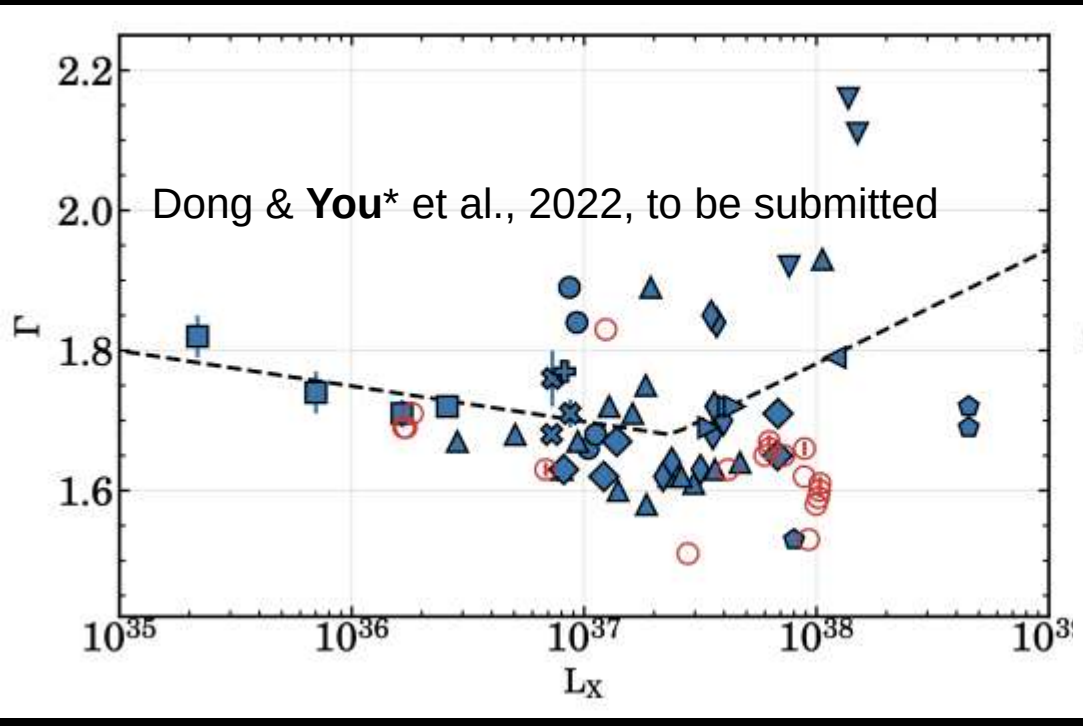
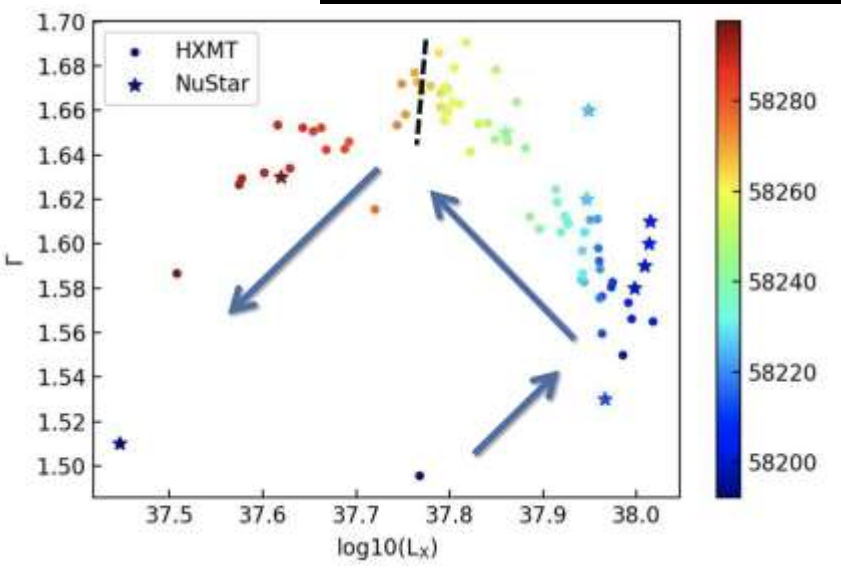
  - The **dynamic** of the corona:
    - The corona may be dynamic, i.e.,outflowing faster(You 2021, NC)





Discussion: MAXI J1820+070

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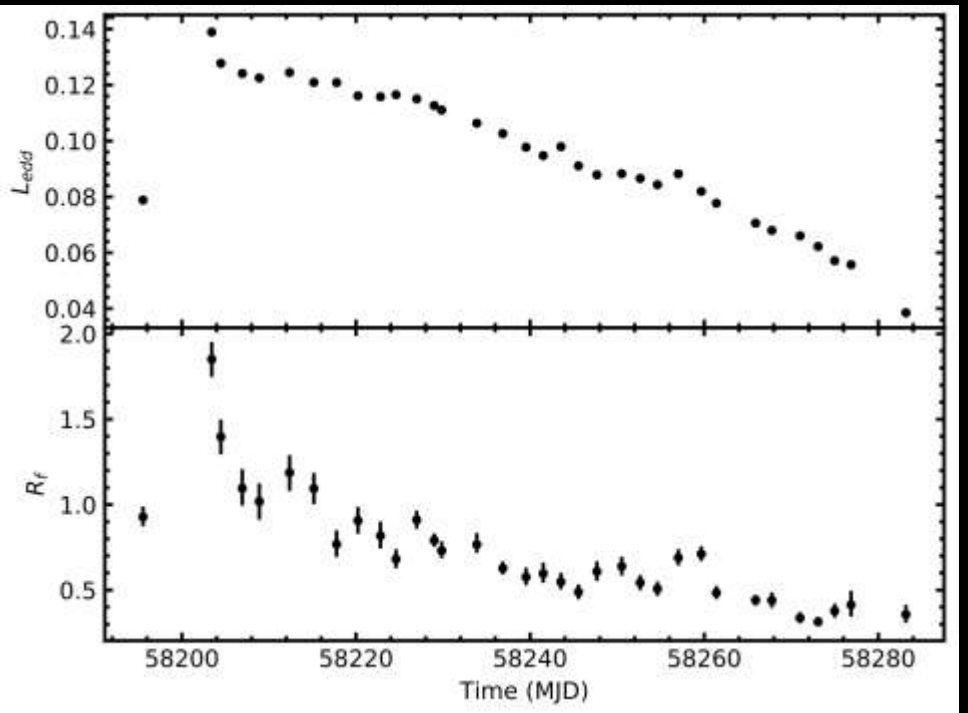
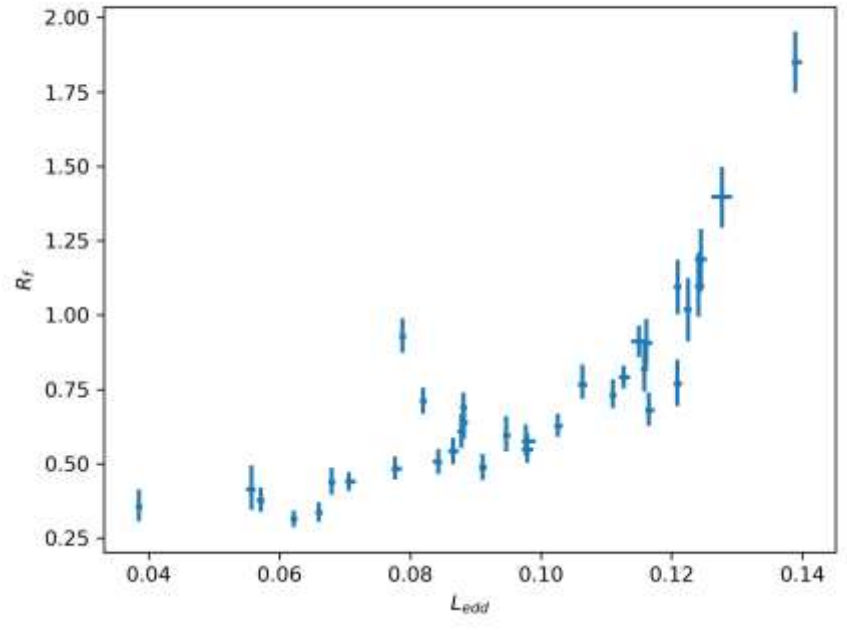


Dong & **You*** et al., 2022 , to be submitted



Discussion: MAXI J1820+070

- **What we know :**
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- **What we want to know :**
  - If those evolutions exist in supermassive BHs, e.g., TDEs and changing-look AGNs
    - If yes, big success to accretion-ejection theory
    - If no, a good point to study what matters ?