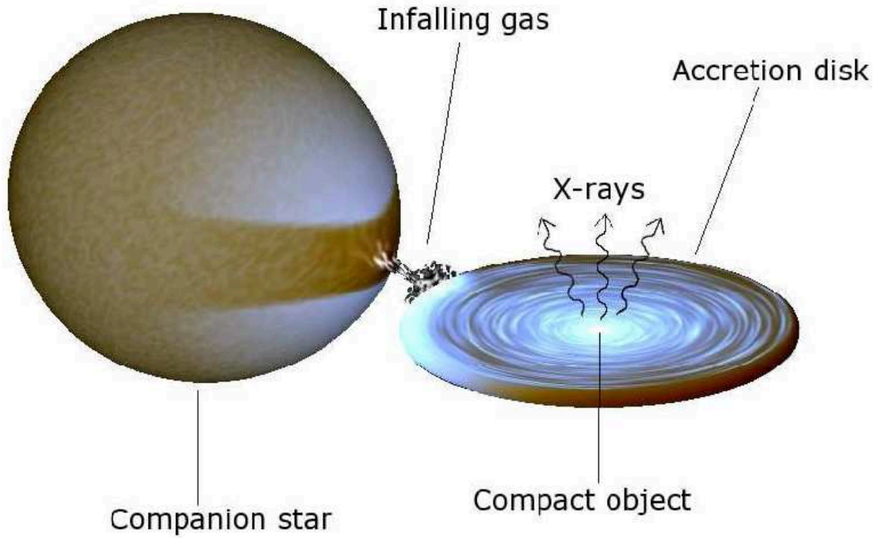


# The Origin of super-Eddington Flares in the high-mass X-ray binary LMC X-4

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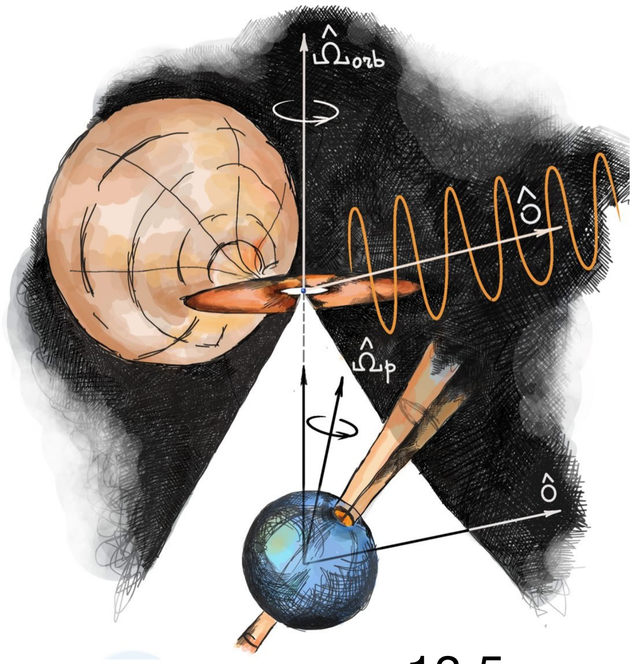
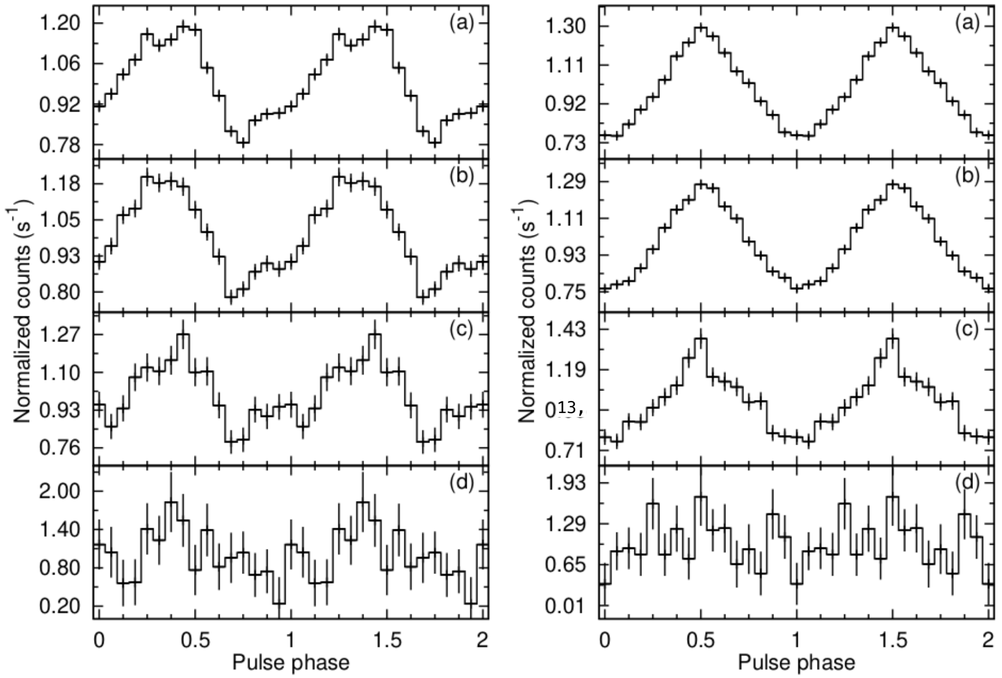
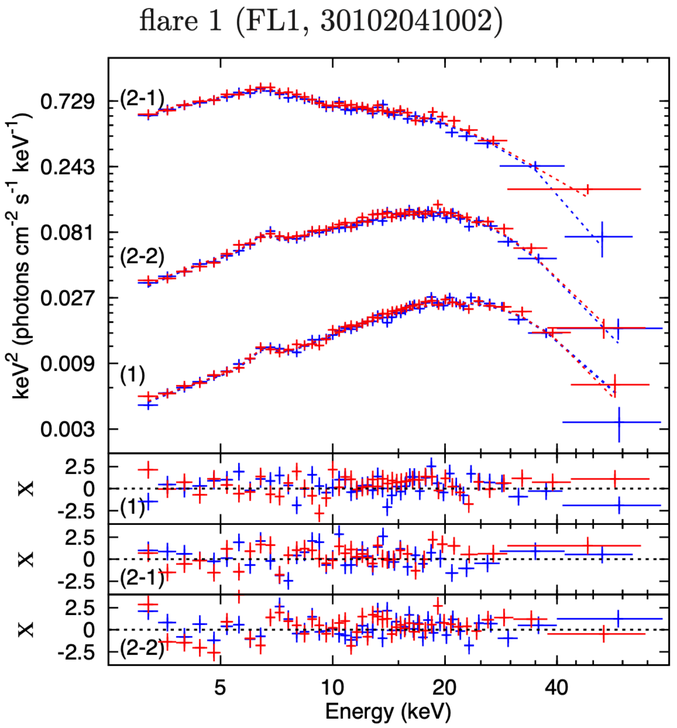
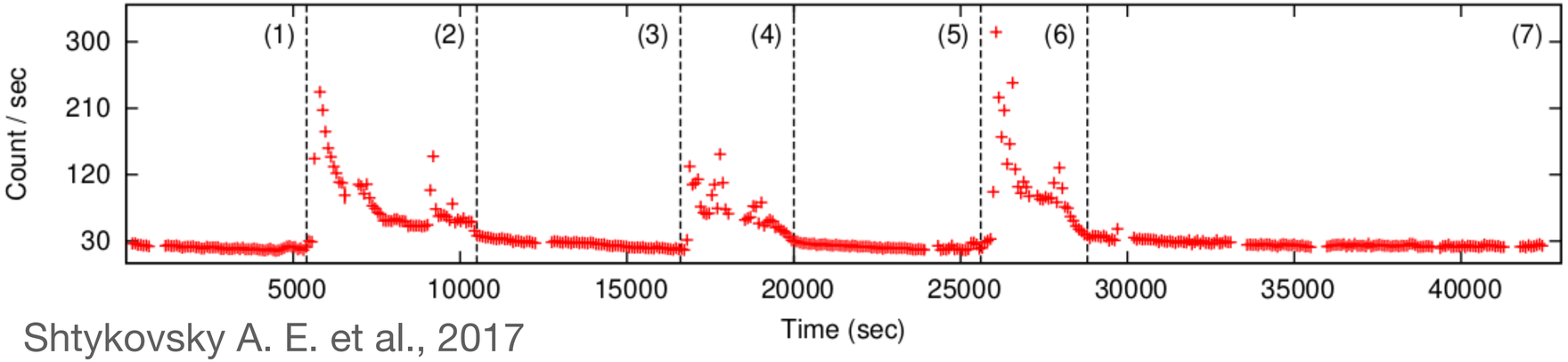
# High-mass X-ray binary LMC X-4




13.5s



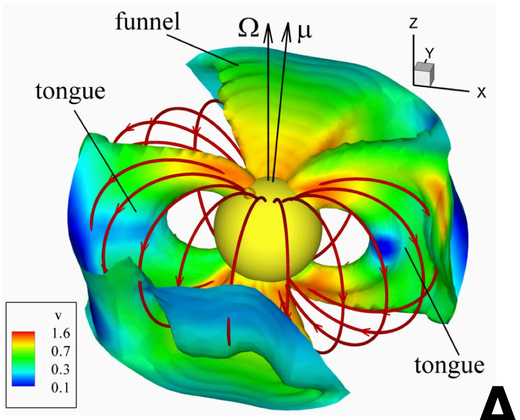




Shtykovsky A. E. et al., 2017

$$L = (3-4)\cdot 10^{38}\ \text{erg s}^{-1}$$

**Flares:** $10^{39} - 10^{40}$ **erg s**$^{-1}$

Kulkarni A., Romanova M., 2008

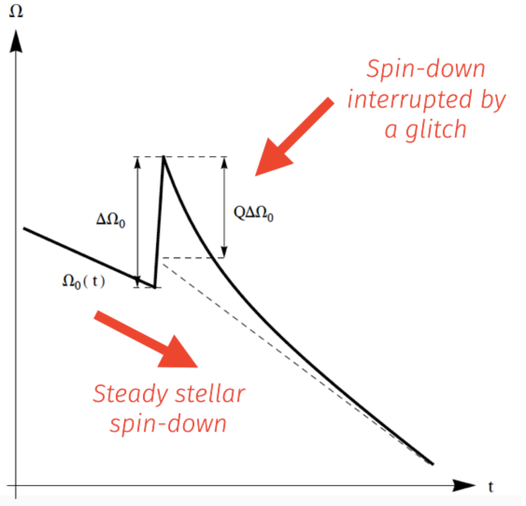


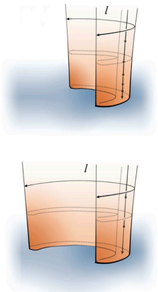

# LMC X-4 FLARES

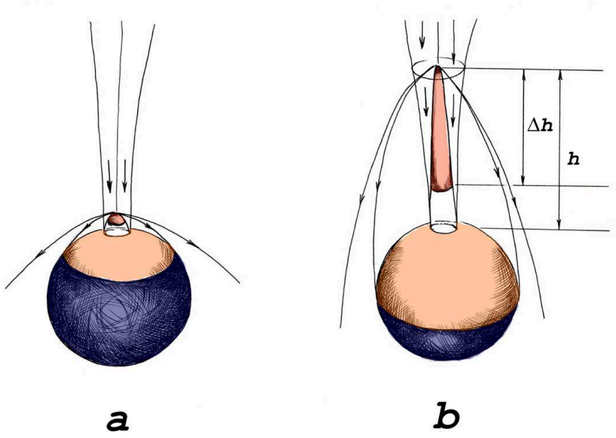
## Accretion process

## Internal NS processes

van Eysden et al., 2011



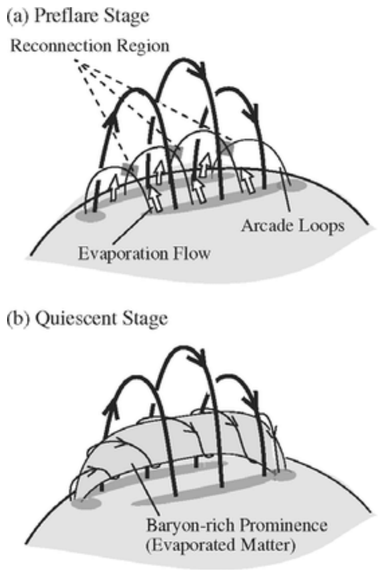


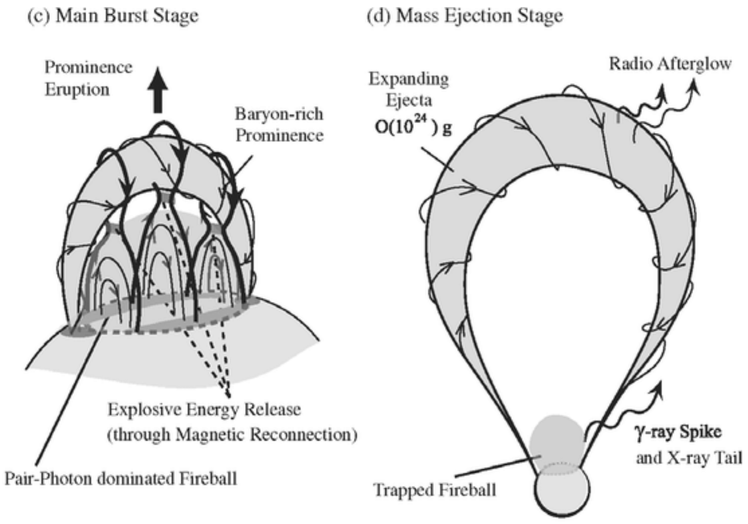

X. Chen et al., 2021

Mushtukov et al., 2013

Column leakage

Abolmasov, Lipunova, 2023

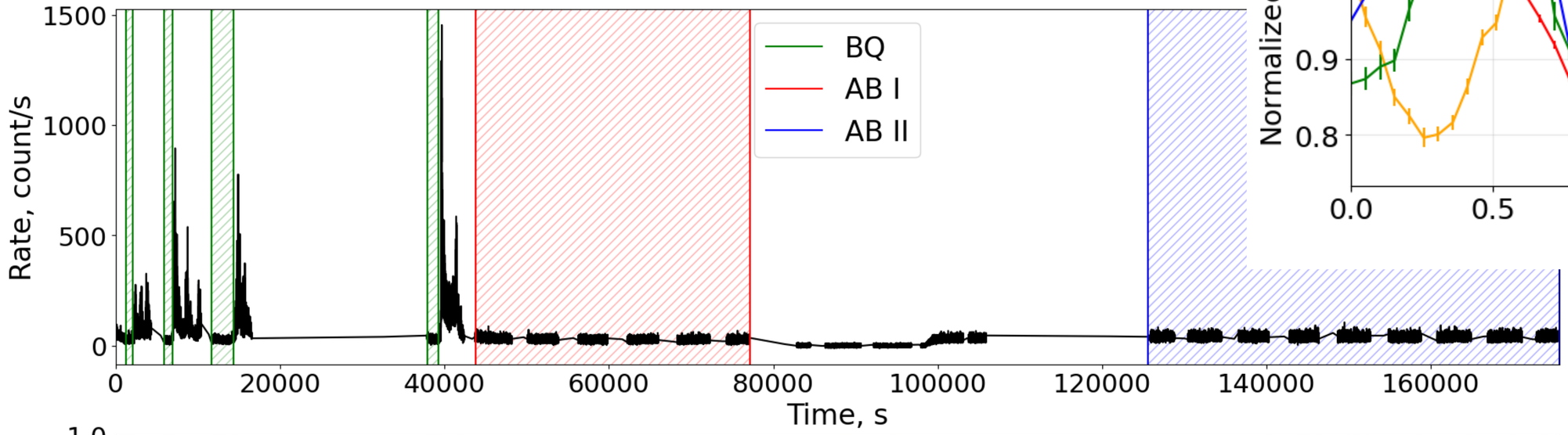


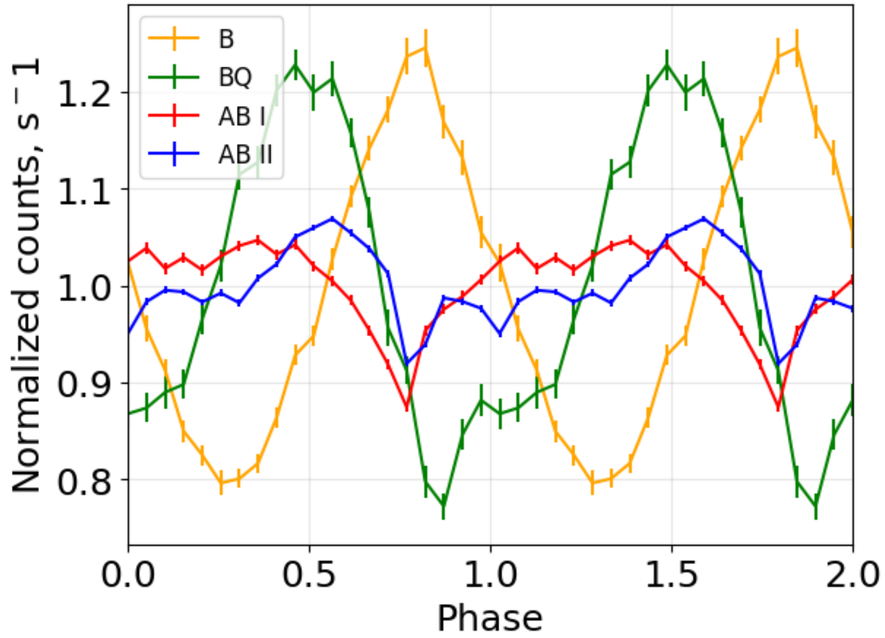



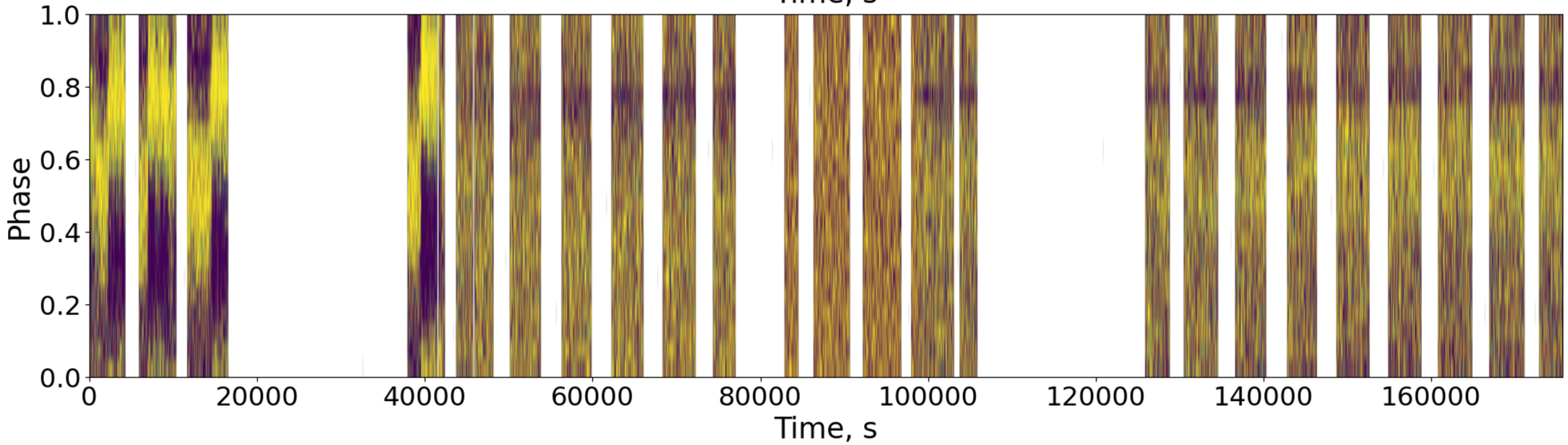

Masada You. et al., 2010

# RXTE: P10135, 1996-08-19

## 2-60 kev




$$P \approx 13.509s$$

$$\dot{P} \approx 1.5 \cdot 10^{-9} ss^{-1}$$

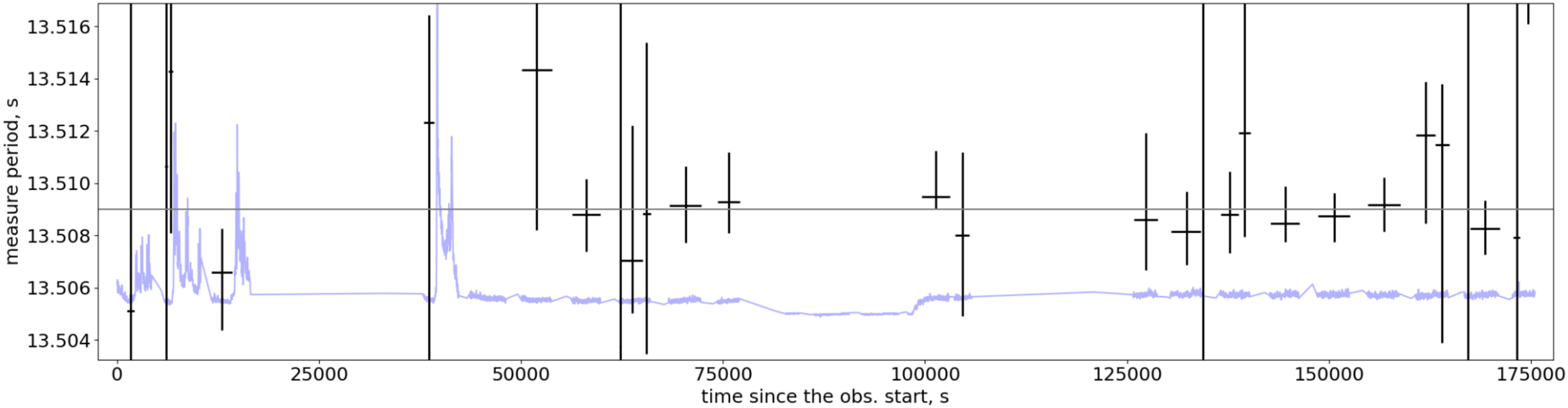
$$\log L = 2 \sum_{j=1}^{M} \sum_{k=1}^{N_f} \frac{|\,\tilde{r}_j(f_k) - \tilde{p}_j(f_k)\,|^2}{P(f_k)}$$

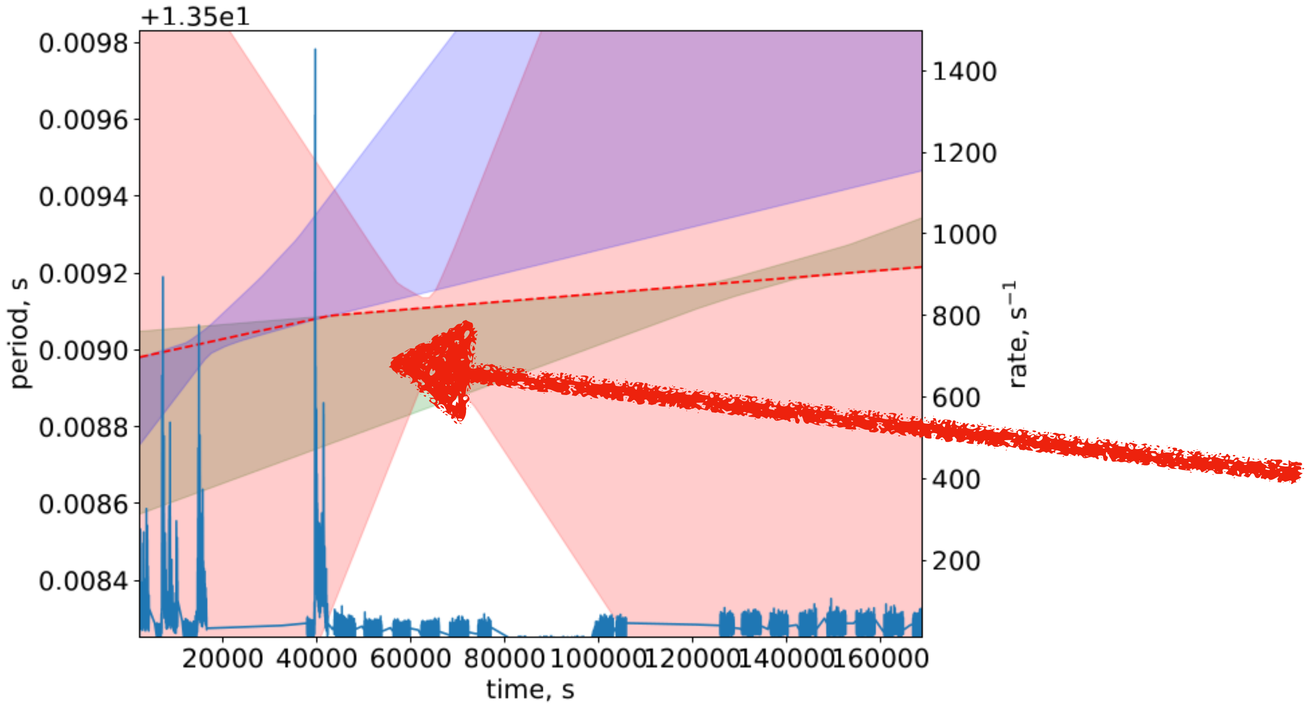
$$\tilde{p}(f) = FFT(p(t)) \cdot \sqrt{\frac{2\Delta t}{N}}$$

$$P(f_k) = P_s(f_k) * P_p(f_k) - P_s(f_k)$$

The noise spectrum $P(f_k)$ takes into account both photon statistics and incoherent variability.

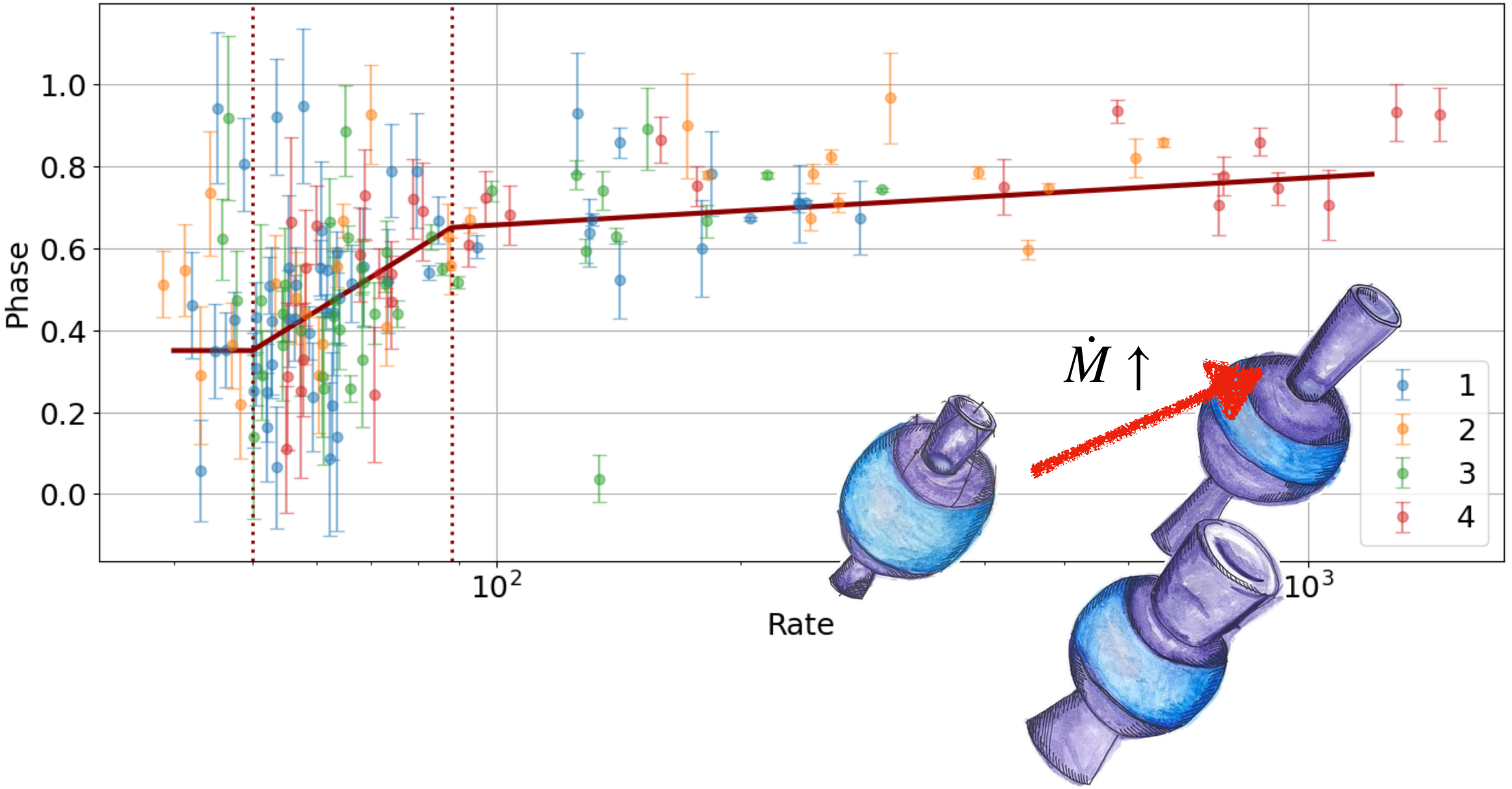
It is calculated as the convolution of the source's intrinsic variability spectrum $P_p(f_k)$ with the pulsation spectrum $P_s(f_k)$, followed by subtraction of the pulsating component




statistics in individual segments is insufficient to trace period changes, but we observe tentative signs of **larger period derivative** during the flares activity

probably, due to a change in the nature of the disk-magnetosphere interaction


Phase
1.0
0.8
0.6
0.4
0.2
0.0
$10^2$
$10^3$
Rate
$\dot{M}\uparrow$
1
2
3
4

# Conclusion

In particular, our analysis shows that changes in the pulse profile during flares occur **regularly**, which contradicts catastrophic models.

The flares are not caused by internal changes to the star but are instead driven directly by a **temporary increase in the accretion rate**, while the overall geometry of the accretion column remains stable.

We found tentative signs of **larger period derivative** during the flares activity

When the magnetosphere and the disk rotate almost synchronously, matter could accumulate at the inner disk until it penetrates the magnetosphere, after which a brief episode of accretion onto the star and ejection into the wind occurs, producing a **burst** (Romanova et al., 2018)

# Thank you for your attention!