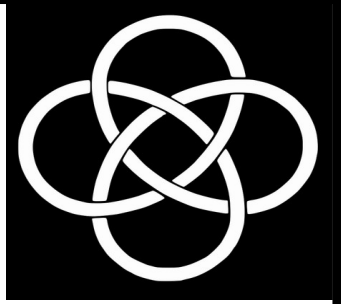
2nd China-India Workshop on High Energy Astrophysics



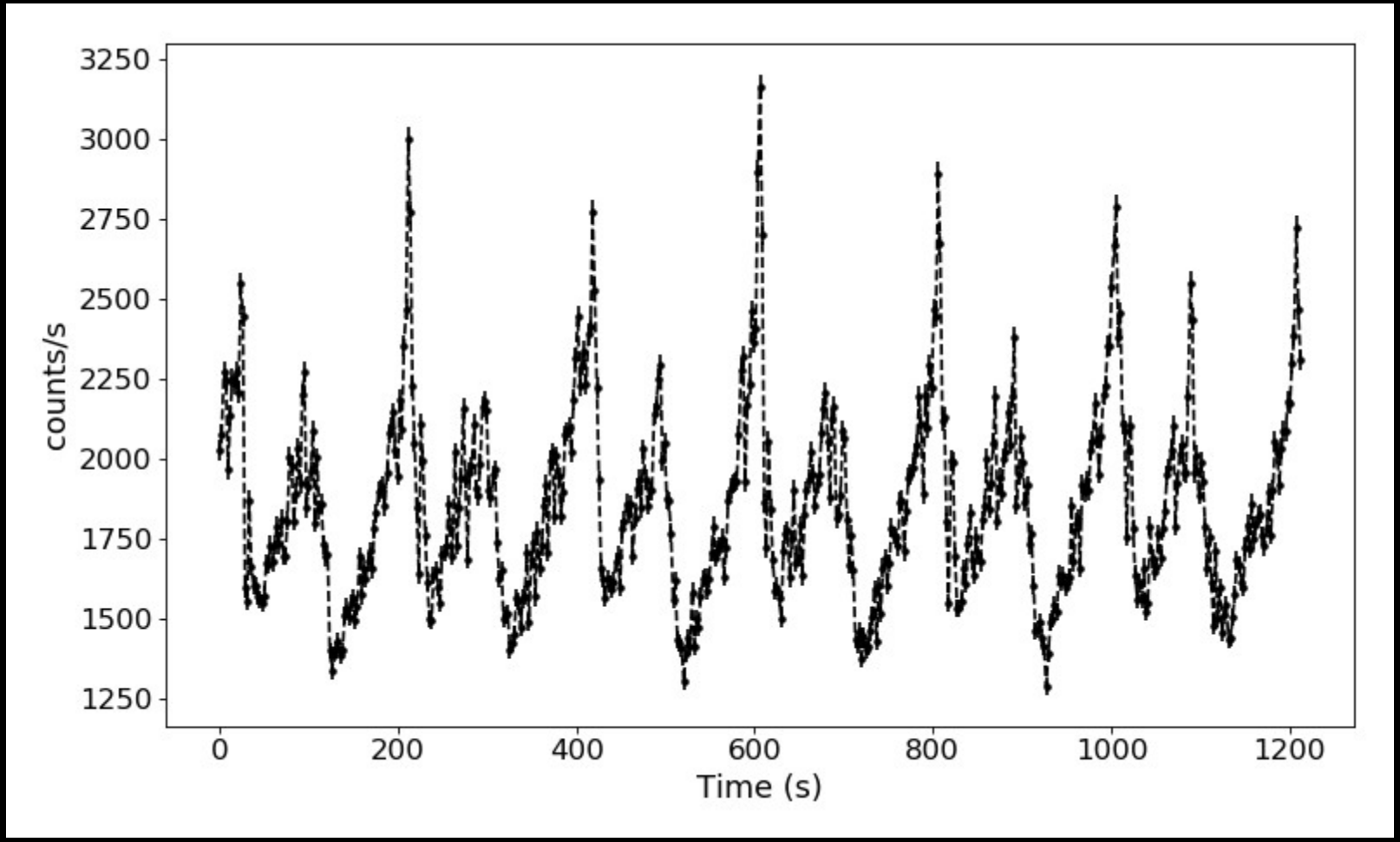
Time-resolved spectroscopy on the heartbeat state of GRS 1915+105

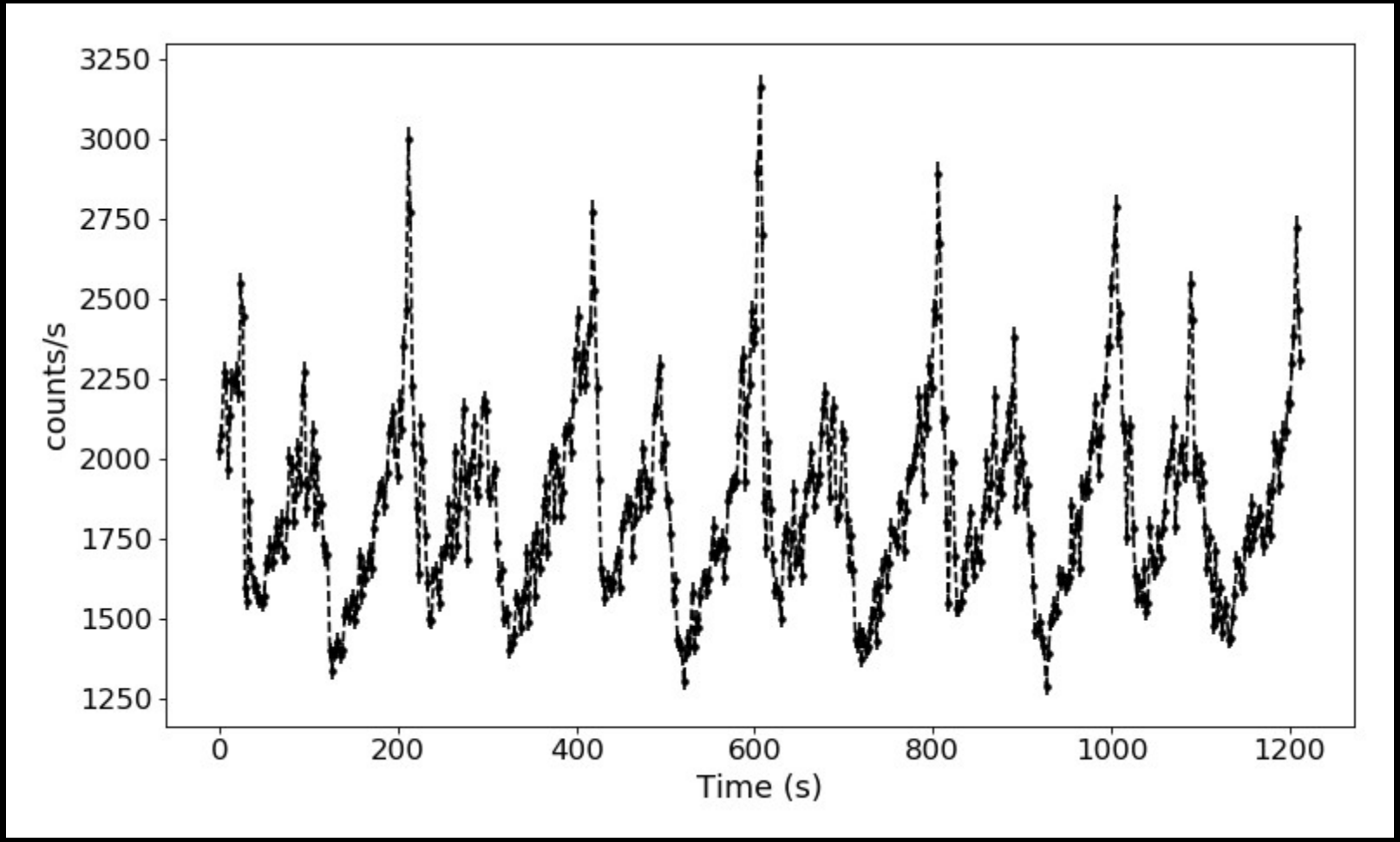
10th Dec 2021

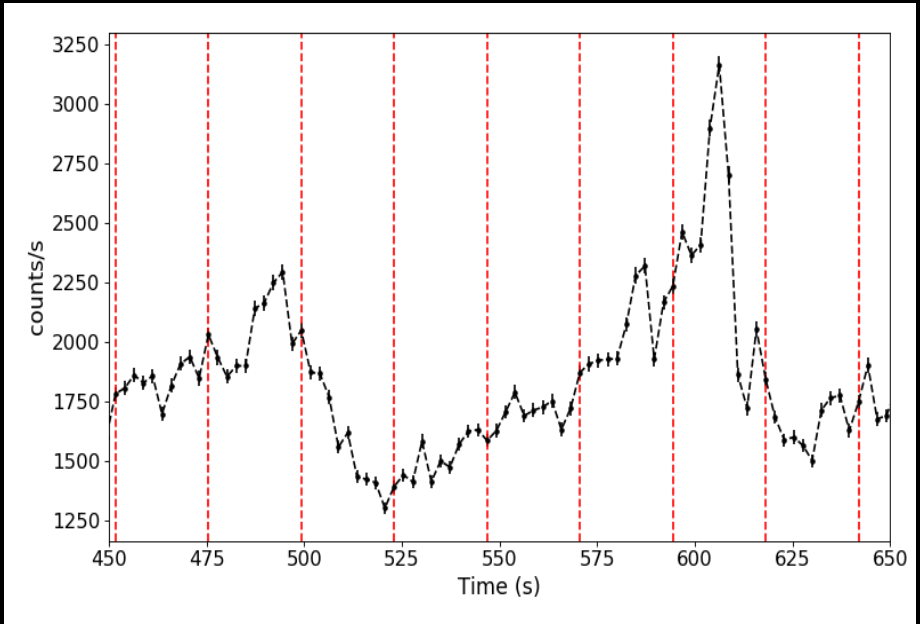
Authors: Divya Rawat, Ranjeev Misra, Pankaj Jain, J. S. Yadav
Affiliation: Inter-University Center for Astronomy and Astrophysics, India

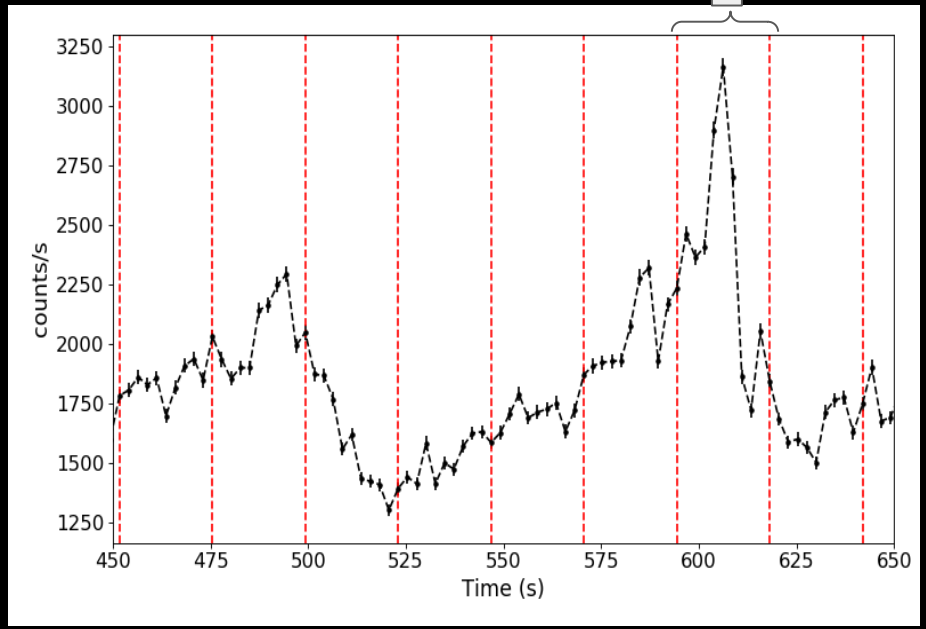
Introduction to GRS 1915+105

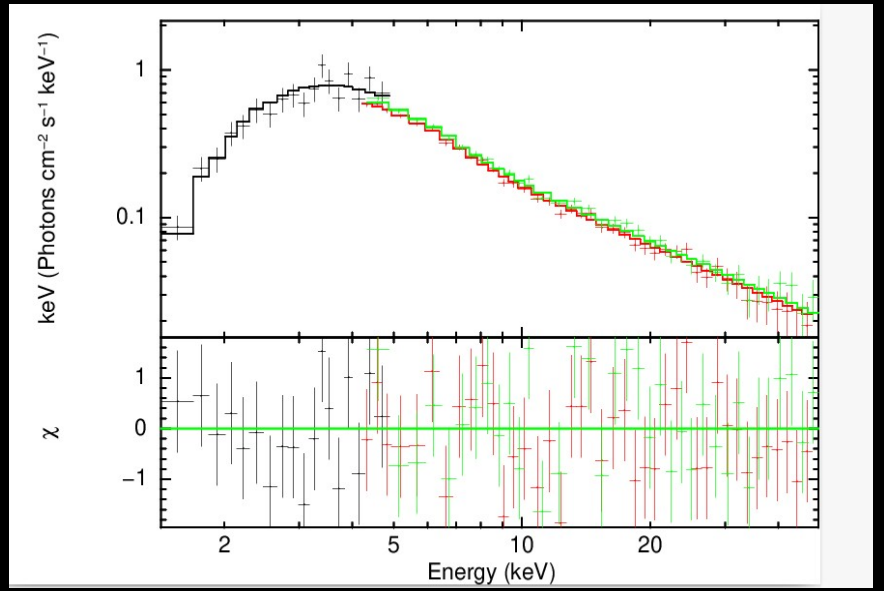
- GRS 1915+105 is a Galactic microquasar with a black hole of mass 12.4 $M_{\odot}$ (Reid et al. 2014) .
- Discovered in 1992 with 'WATCH' onboard the GRANAT satellite.
- It is placed at a distance of 8.6 kpc with orbital period of 34 days (Reid et al. 2014 and references therein).
- X-ray light curve of GRS 1915 +105 is classified into 14 different classes by Belloni et al. 2000.


3250
3000
2750
2500
2250
2000
1750
1500
1250
counts/s
0
200
400
600
800
1000
1200
Time (s)

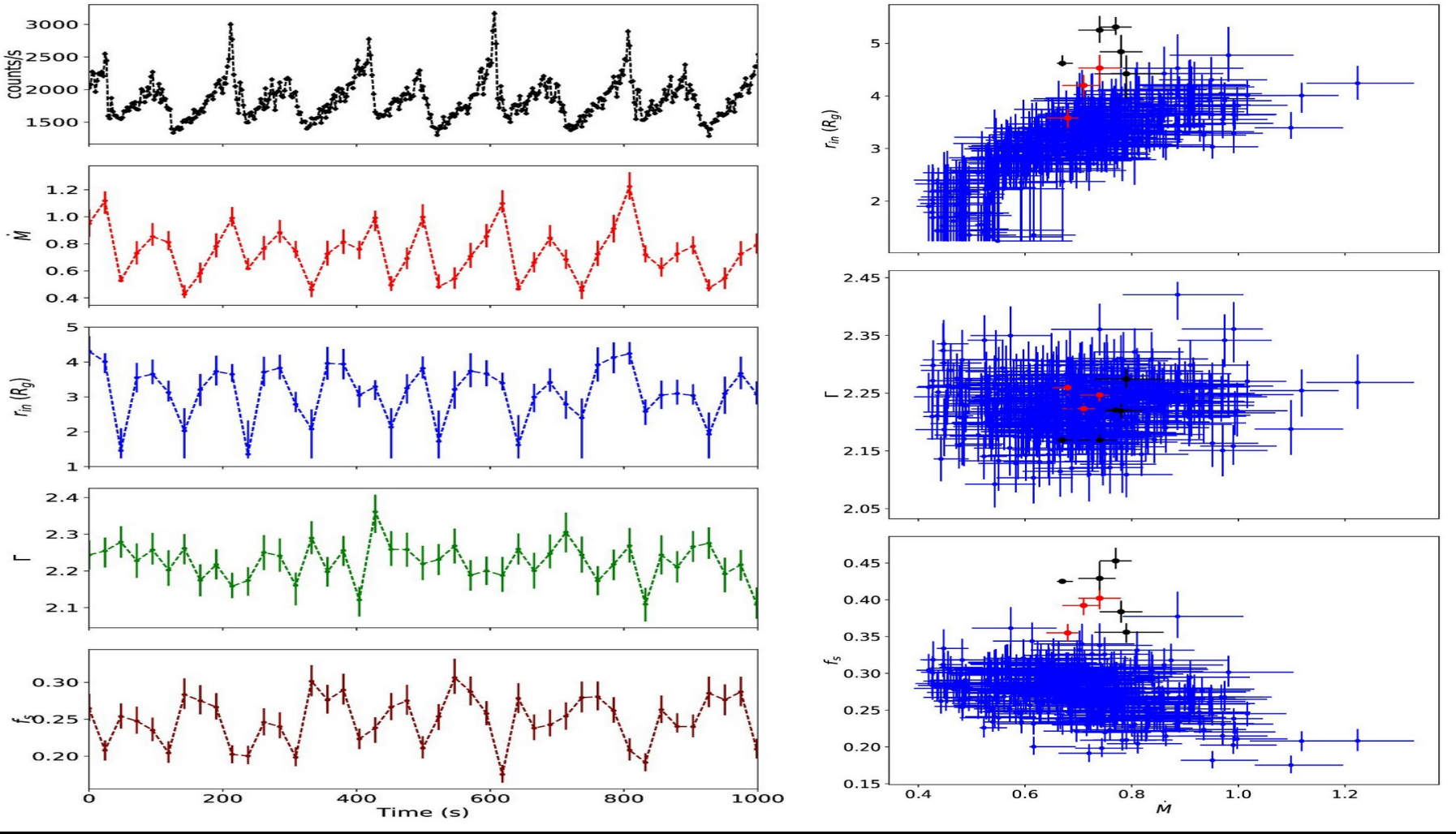

3250
3000
2750
2500
2250
2000
1750
1500
1250
counts/s
0
200
400
600
800
1000
1200
Time (s)


3250
3000
2750
2500
2250
2000
1750
1500
1250
counts/s
450
475
500
525
550
575
600
625
650
Time (s)





Xspec model=Tbabs*(simpl*kerrd)

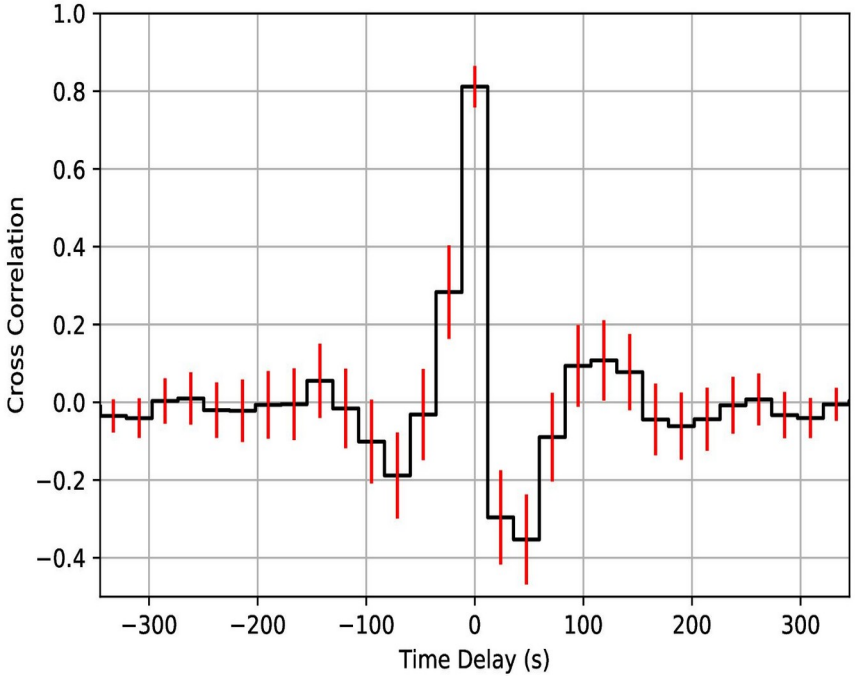


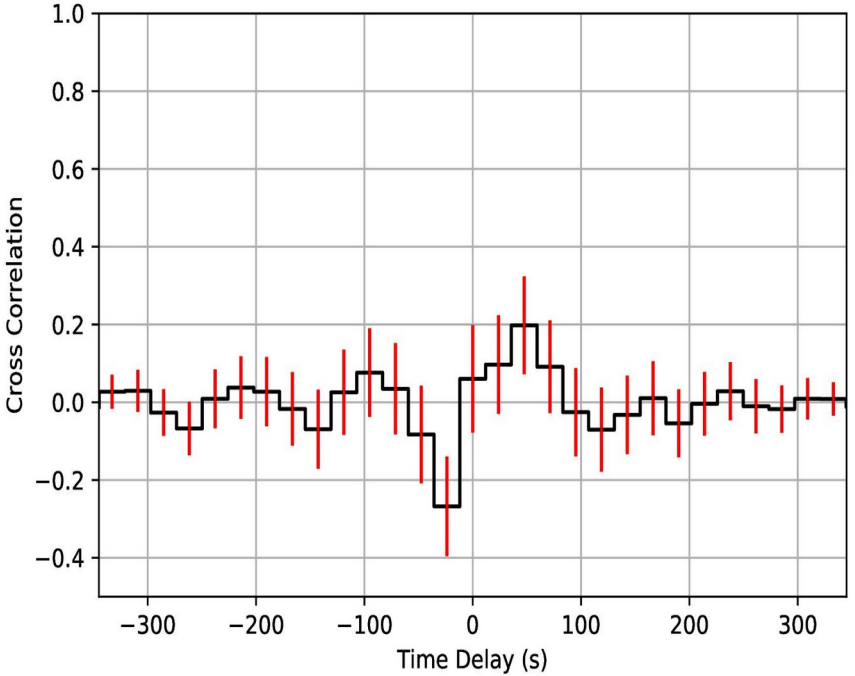
Rawat et al. 2021 (under review)

Correlation and Cross-Correlation function (CCF)

- Significance of correlation/anti-correlation using a Monte Carlo simulation technique.
- The correlations of rin and fs with accretion rate are highly significant ($r = 0.680$, $p=4.7\times10^{-58}$ and $r =-0.361$, $p = 6.3\times10^{-15}$ respectively).
- CCF between the time series were computed using the HEASOFT function crosscor.
- The time series were divided into 28 intervals of 16 bins with size of a bin=23.775 secs.

- Pair bootstrapping simulation: We simulated 10,000 pairs of time series using the Random Subset Selection (RSS) technique (Peterson et al. 1998) and CCF for each pair.
  The 90 % confidence interval was estimated using the simulated CCF distribution at each lag.

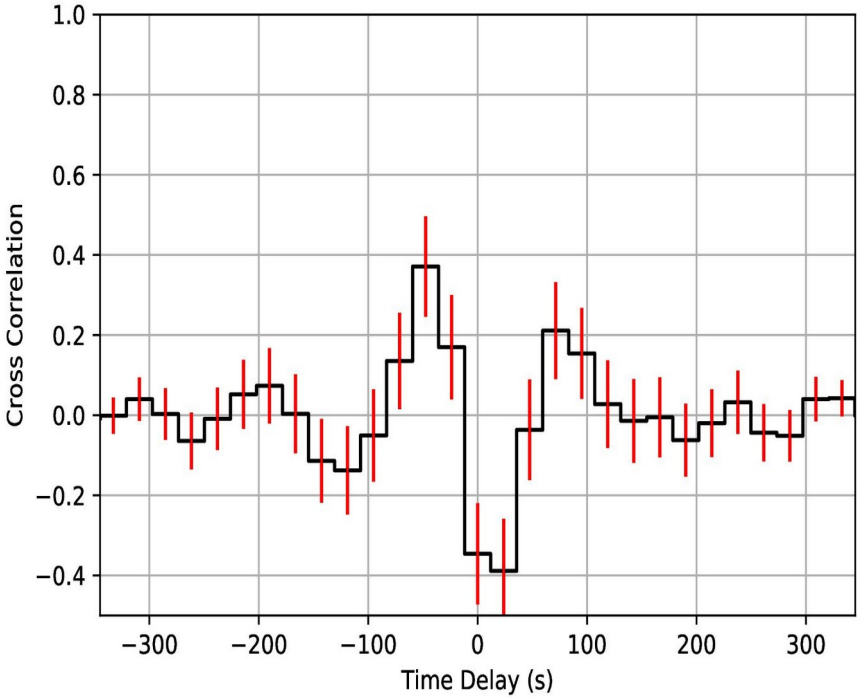


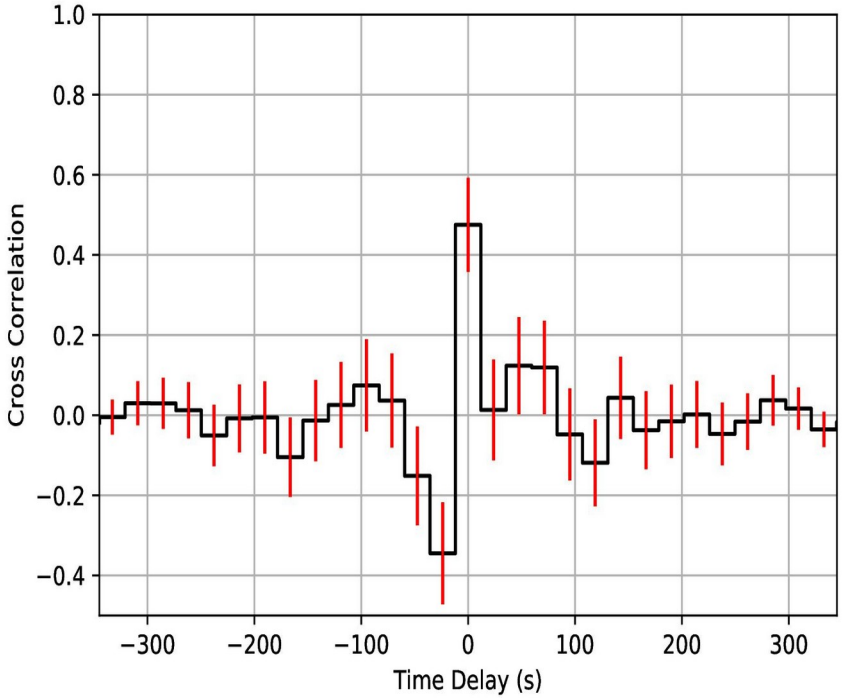


Rawat et al. 2021 (under review)

CCF of r_{in} , and Γ with $\dot{M}$

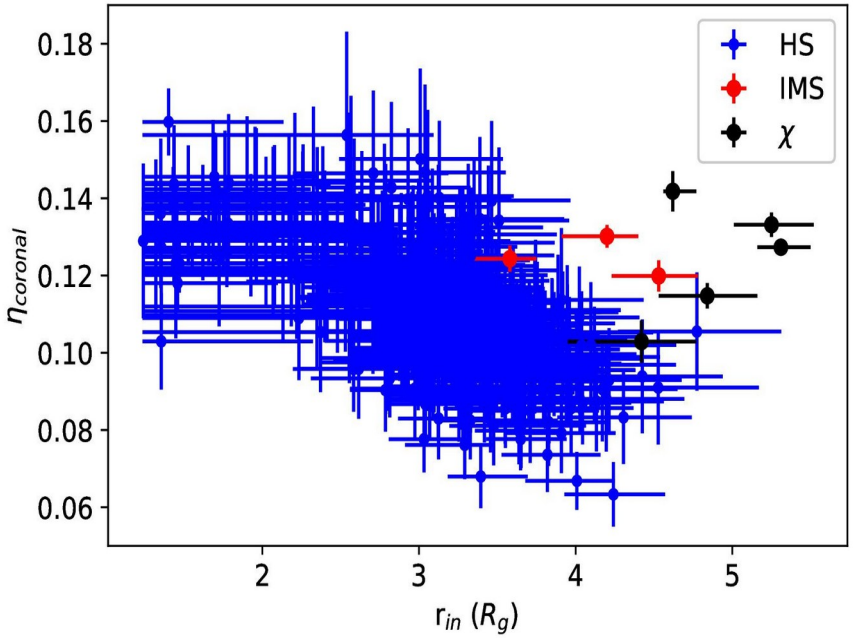
CCF of f_s with $\dot{M}$, and Γ

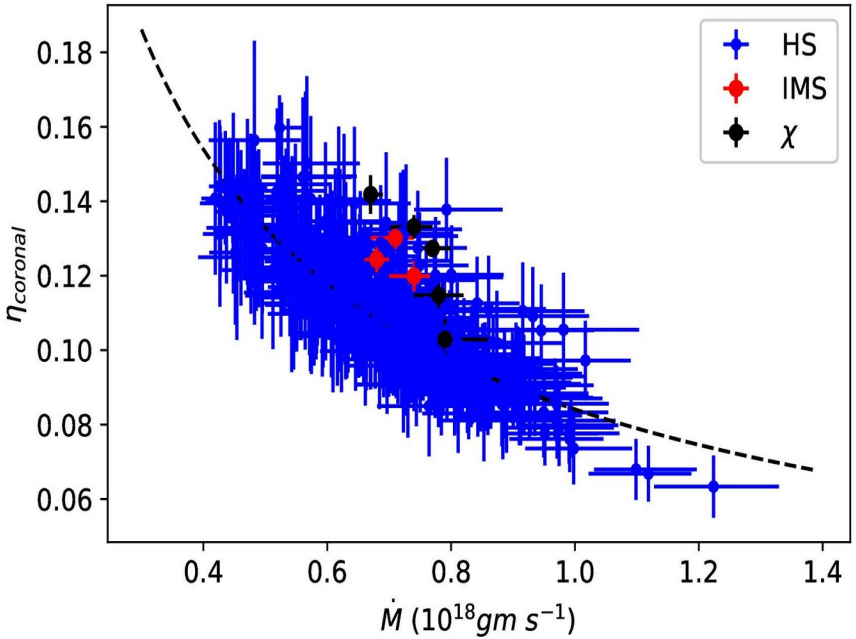




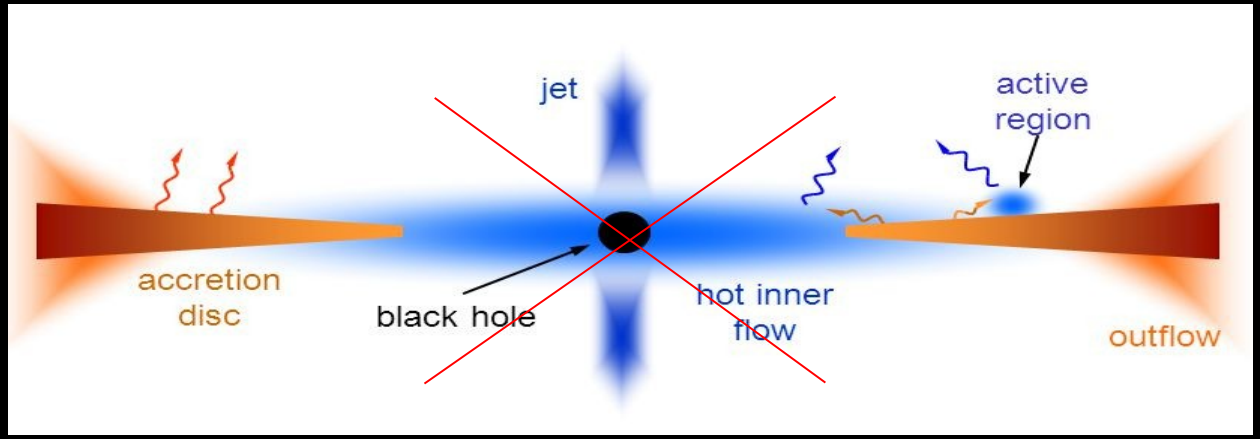
Rawat et al. 2021 (under review)

- Assuming the heating rate of the corona is equal to excess luminosity $L=L_c-f_sL_d$
  We define a coronal radiative efficiency as $\eta_{coronal}=L/\dot{M}c^2$
  The best fit curve gives $\eta_{coronal} \propto \dot{M}^{(-b)}$, with b = 0.66±0.02

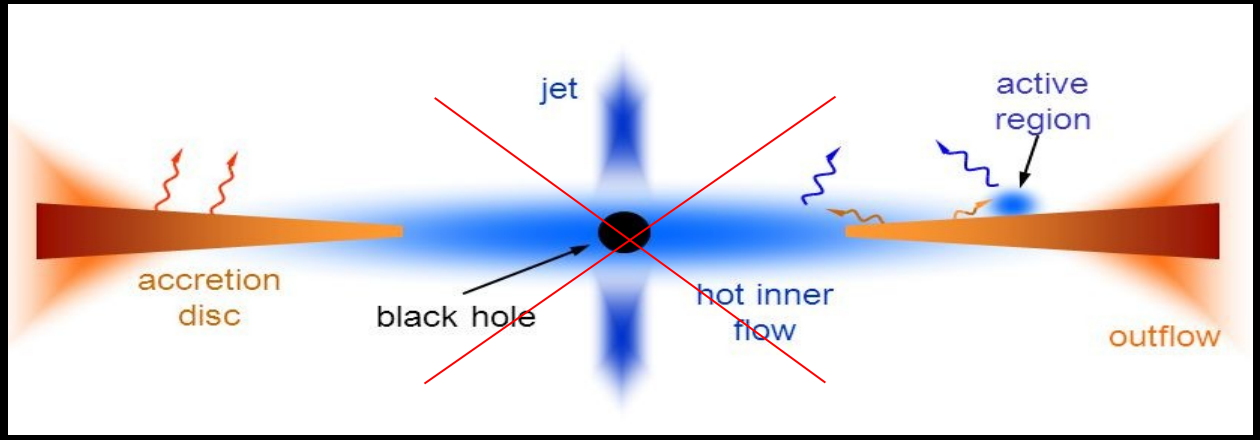


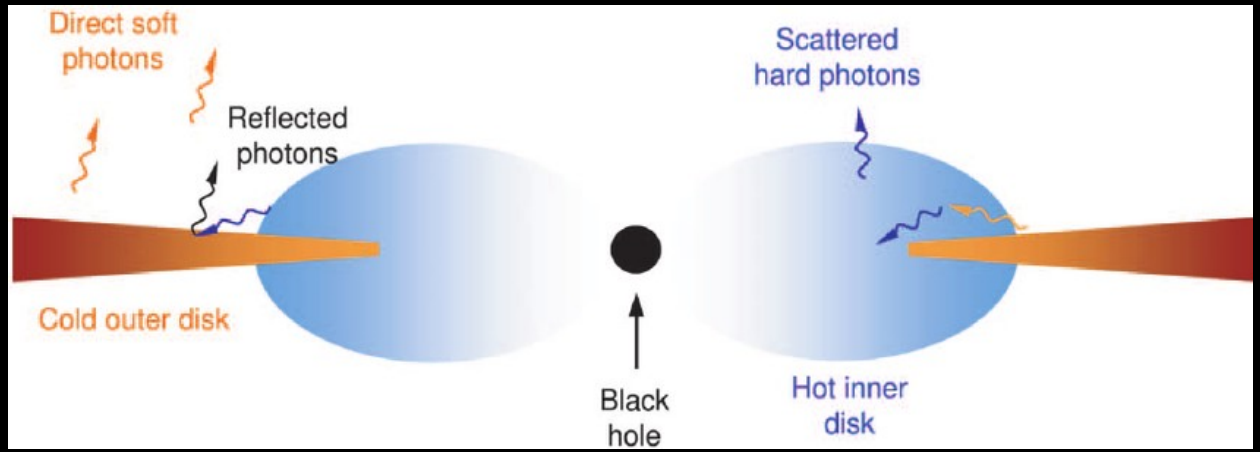


Rawat et al. 2021 (under review)

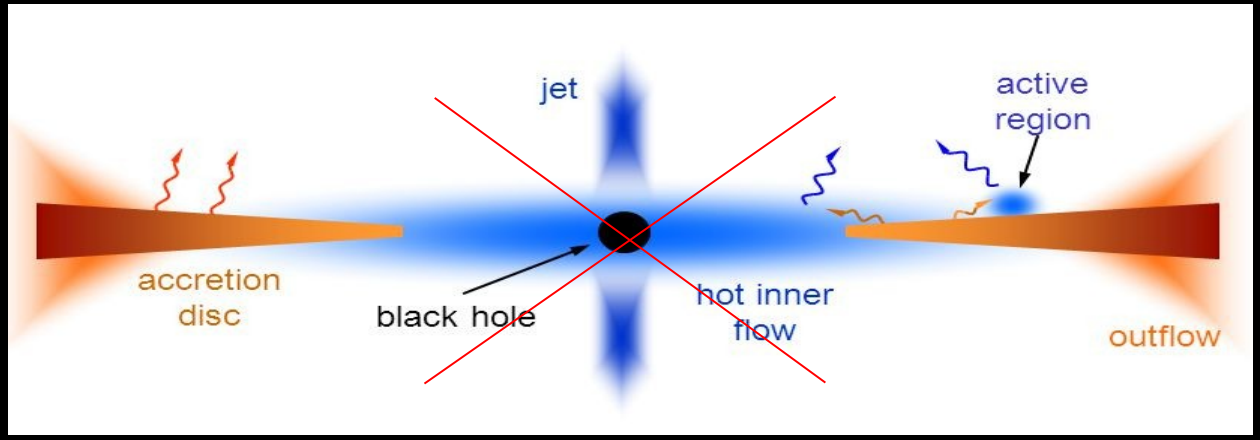


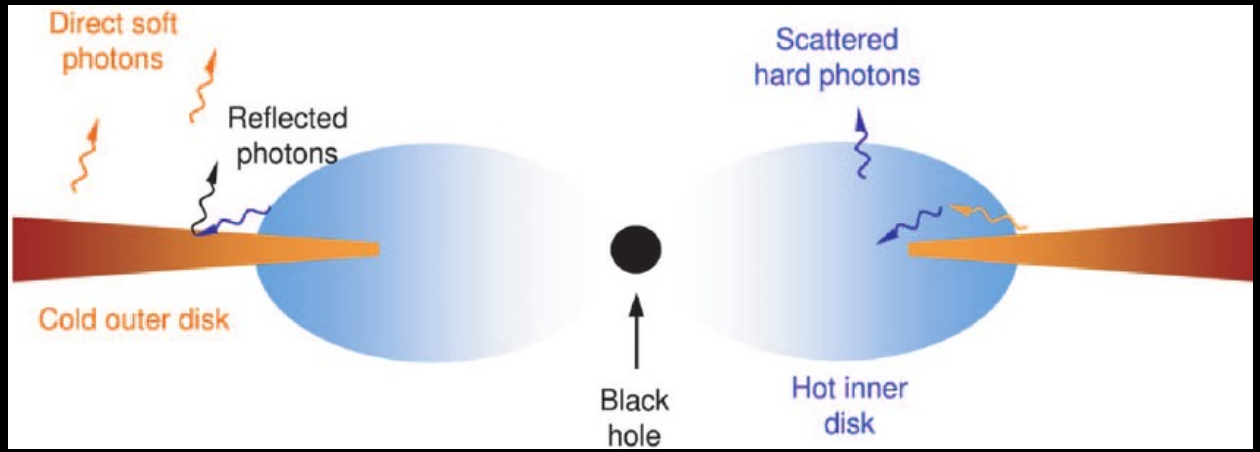
Credits: webpage





Credits: webpage





Credits: webpage

Summary and Conclusion

- The oscillation can be described as coordinated variations of the accretion rate, comptonized flux, and the inner disk radius.
- The measured efficiency $\propto \dot{M}^{-2/3}$ argues against the emission being from an inner hot flow.
- Alternatively, the coronal emission could be from a corona located above and below the standard disc, where a fraction of the gravitational energy released is dissipated in the corona.
- Another different and interesting interpretation would be if the corona is being powered by the spin of the black hole.

Thank You for your attention!