Timing and Spectral Properties of HMXB Pulsar Cen X-3

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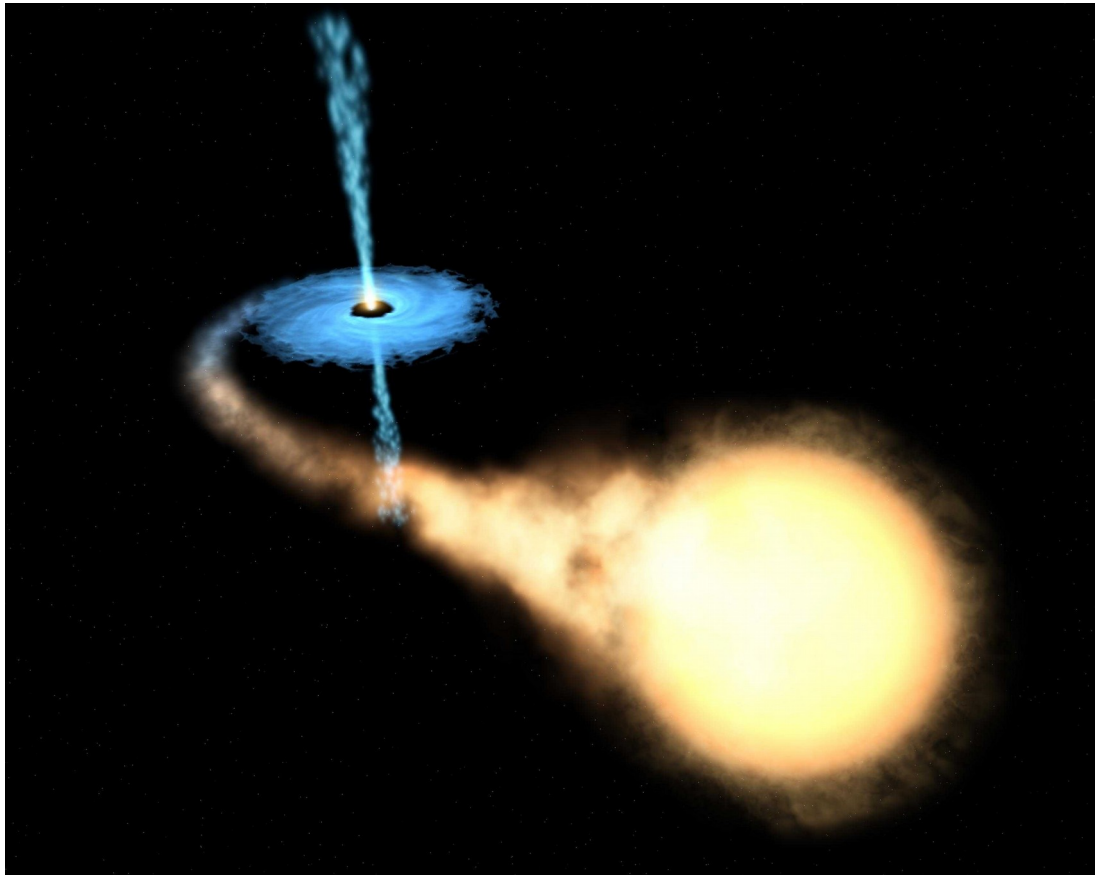
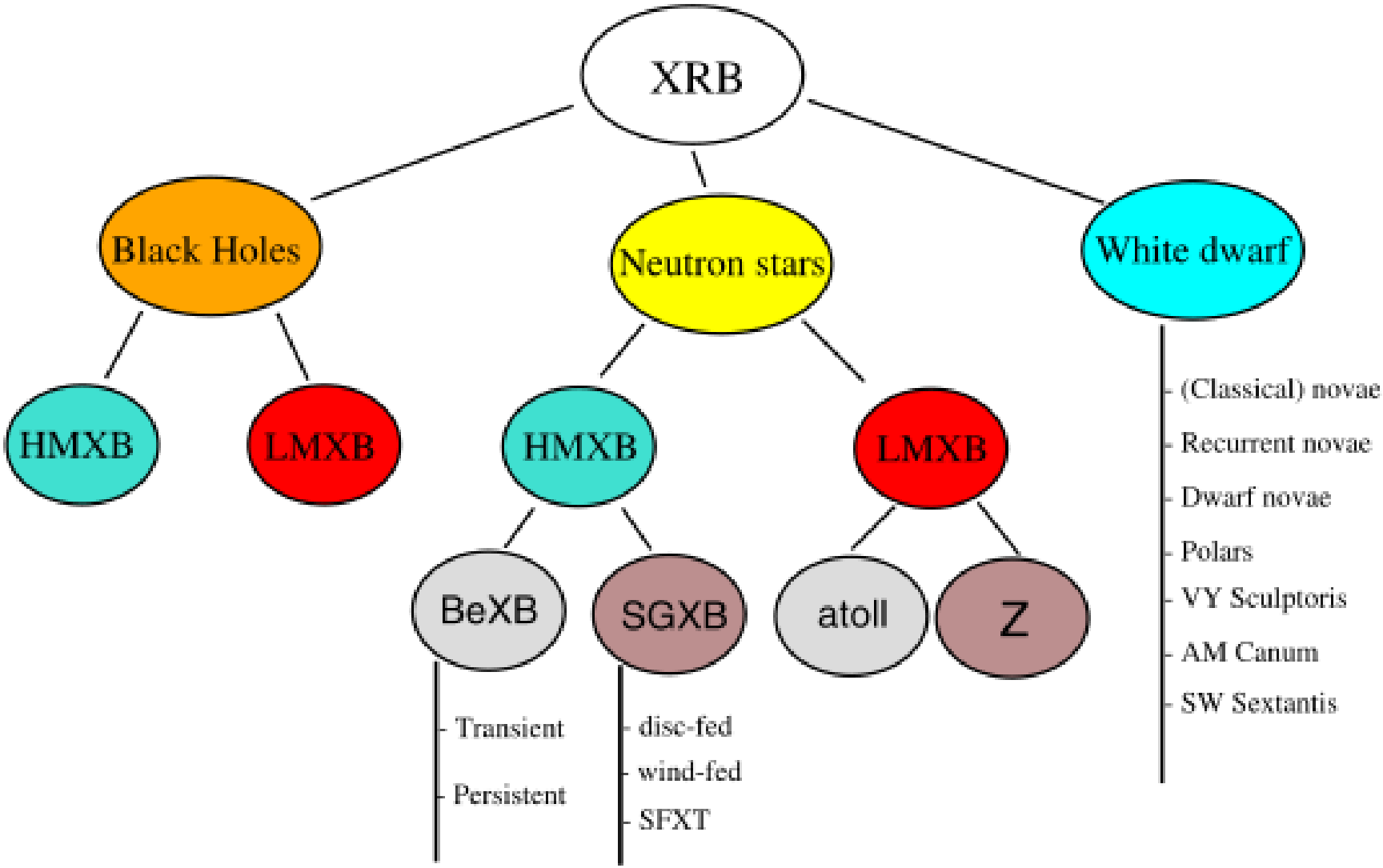
X-ray Binaries

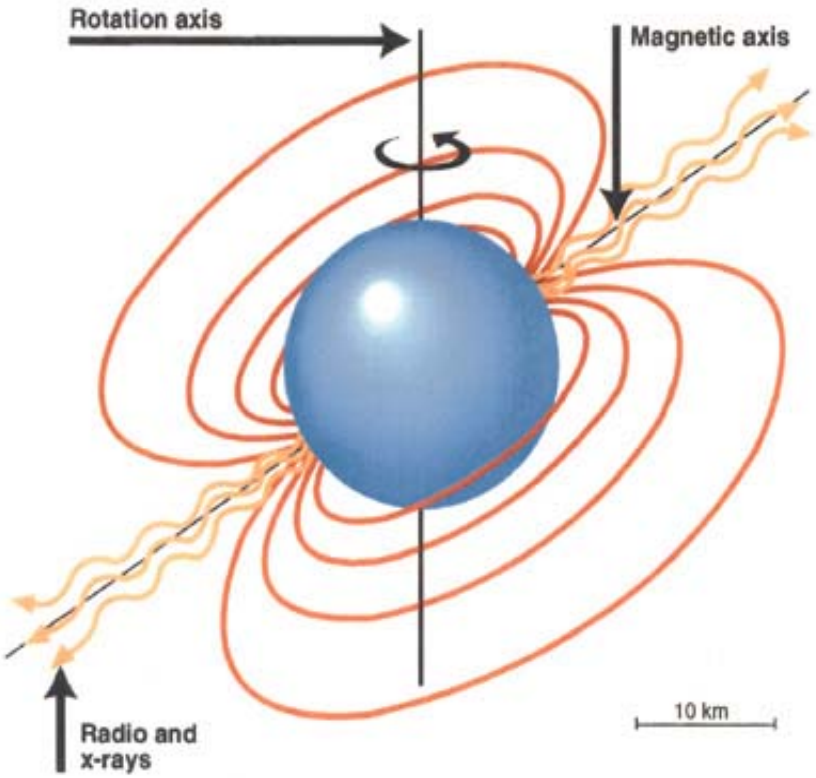


- It is believed that most of the galactic X-ray sources are X-ray binaries, in which a normal star and a compact object rotate around a common center of mass.
- X-rays originate from material falling from the **normal star** onto the **compact object** through accretion.
- Some of these galactic X-ray sources are highly variable; in fact, some sources appear in the sky, remain bright for a few weeks, and then fade again from view. Such sources are called "**X-ray Transients**".

Classification of X-ray Binaries



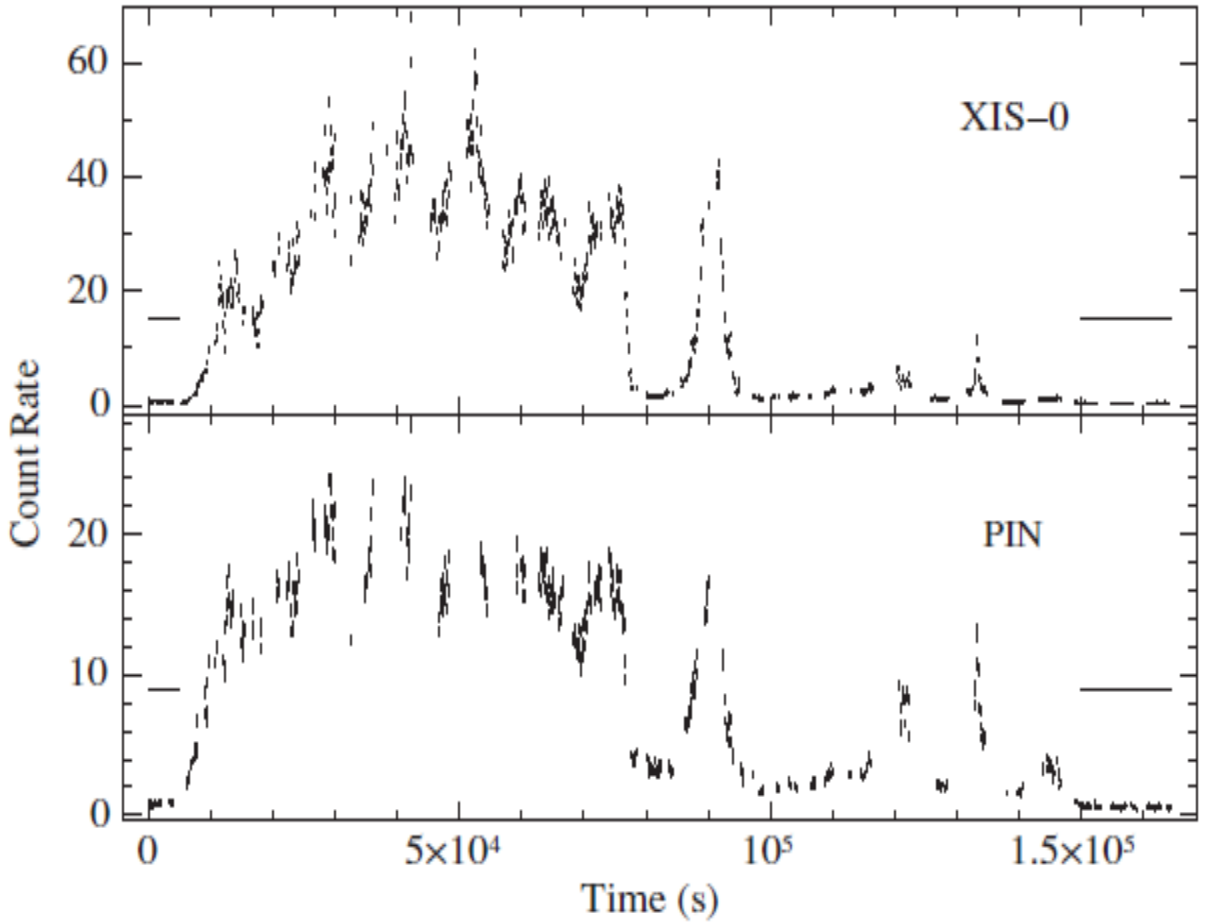
Accretion Powered Pulsars



- Rotating neutron star.
- Strong magnetic field
  ~10^{12} G
- Flow couples to the magnetic field at Alfven radius.
- Chanelling of matter along the magnetic field lines
- Formation of accretion column
- Emission from polar cap region & pulsations

High mass X-ray binary pulsar Cen X-3

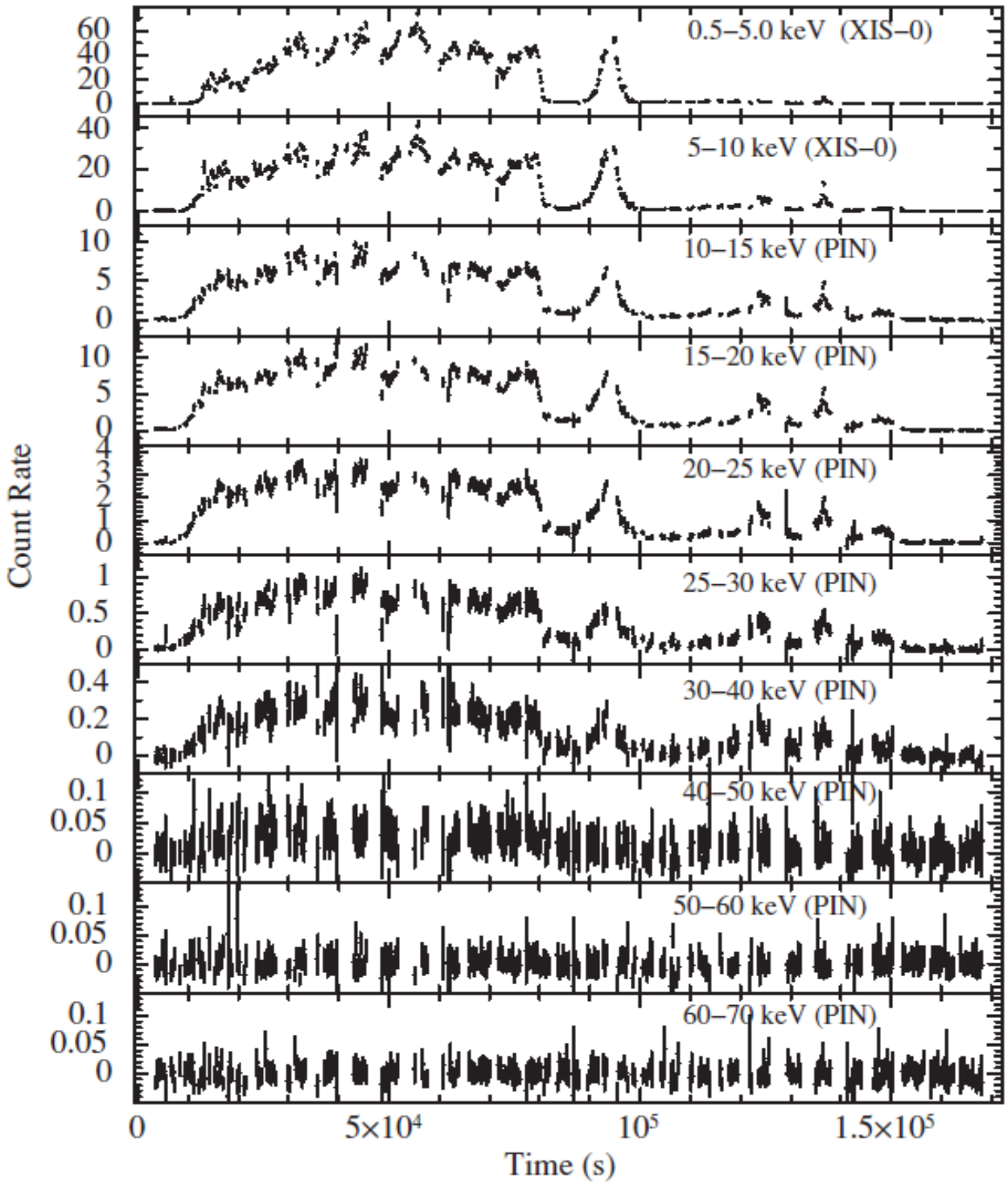
- Spin period of pulsar 4.79 s.
- Orbital period of 2.1 d
- O type supergiant optical companion.
- Cyclotron line at ~30 keV
- Light curve shows **extended dips** which are rare in HMXBs



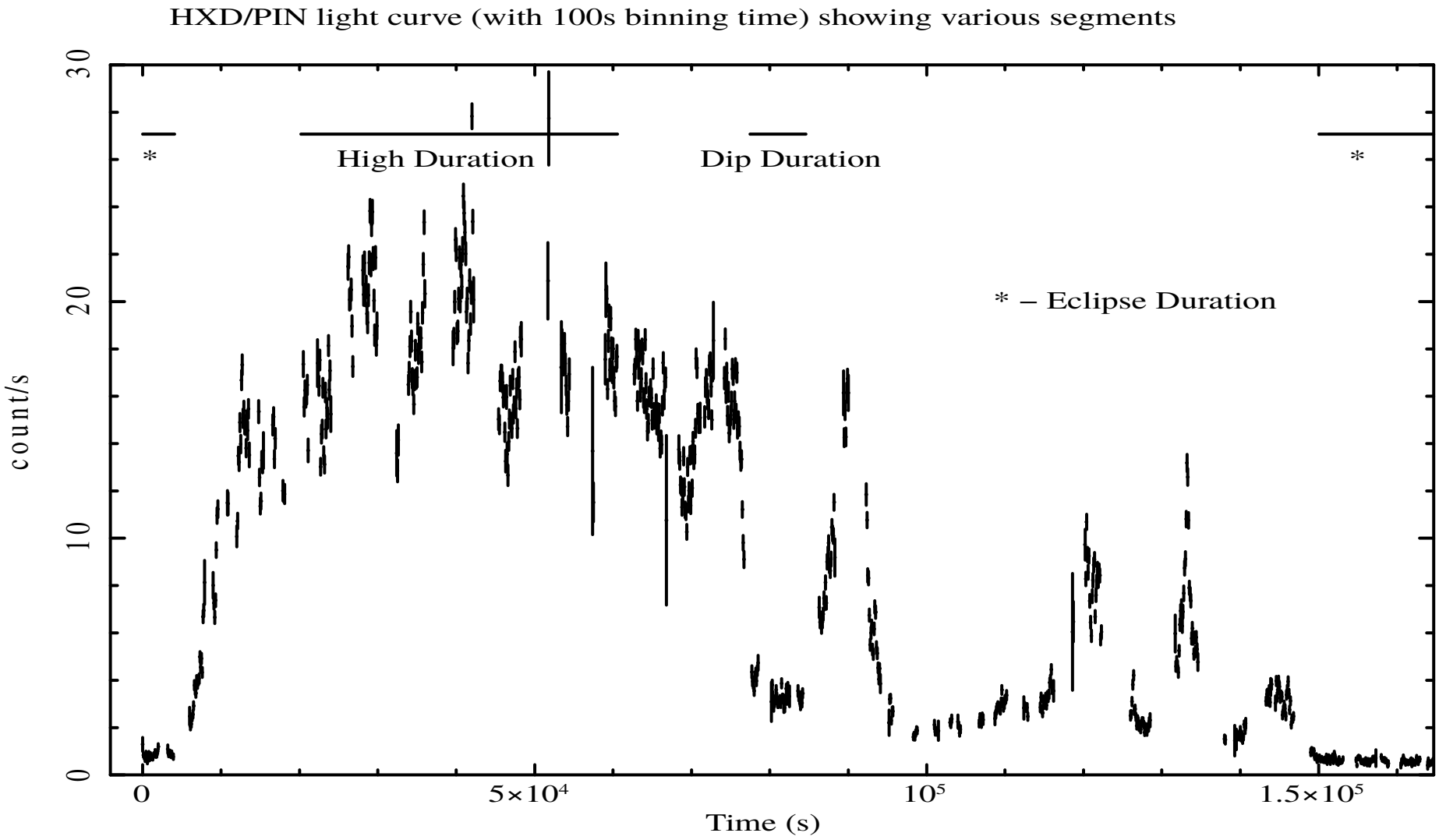
Soft and hard X-ray light curves of Cen X-3

Soft to hard X-ray light curves

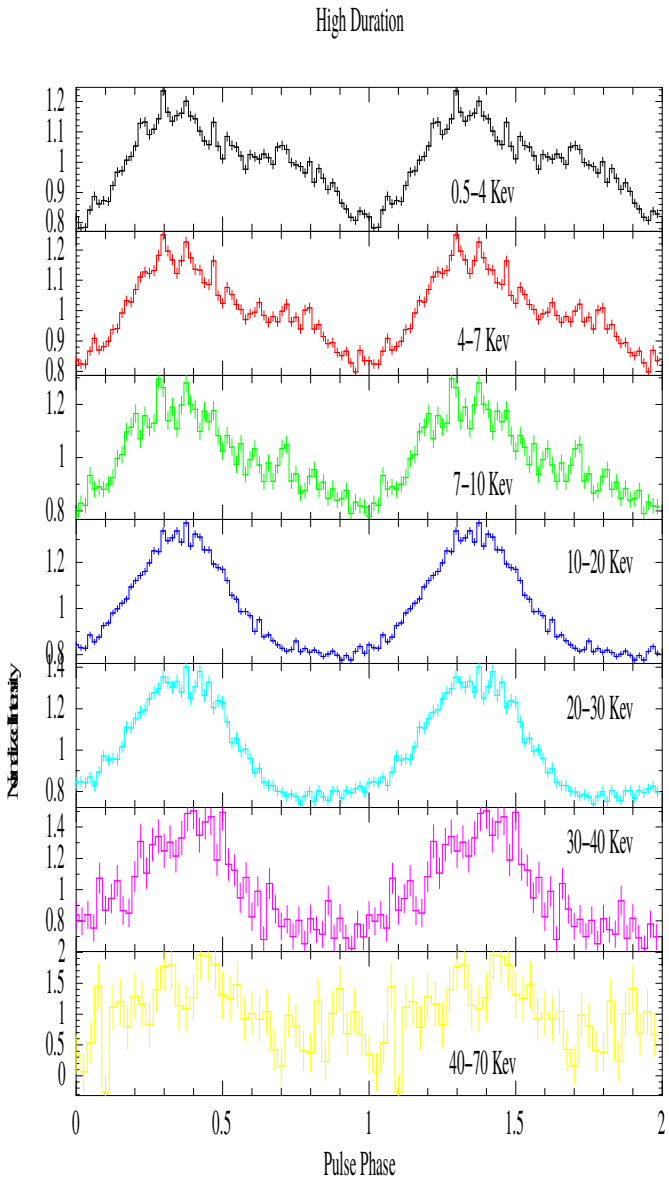
- One orbital light curve obtained from Suzaku observation.
- Several dip like features (flares) were clearly seen in soft to hard X-ray light curves up to 40 keV.

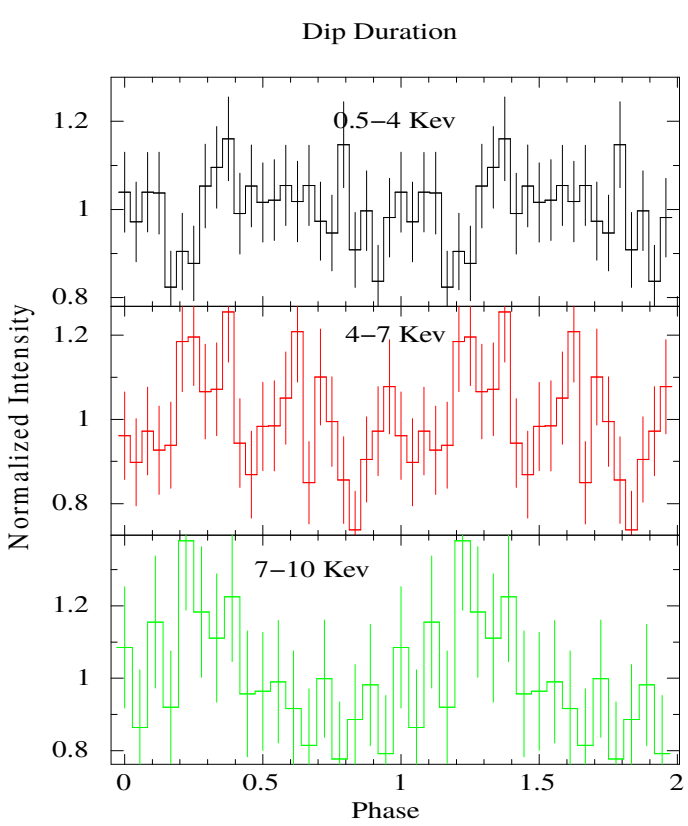


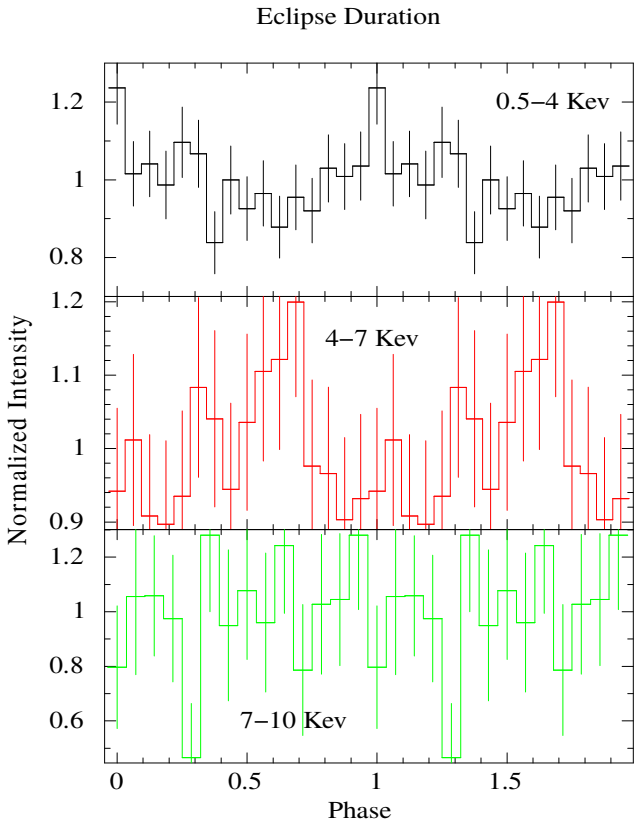
To understand the causes of these dip and flares at different orbital phases, we have performed time resolved spectroscopy.



Energy Resolved Pulse Profiles



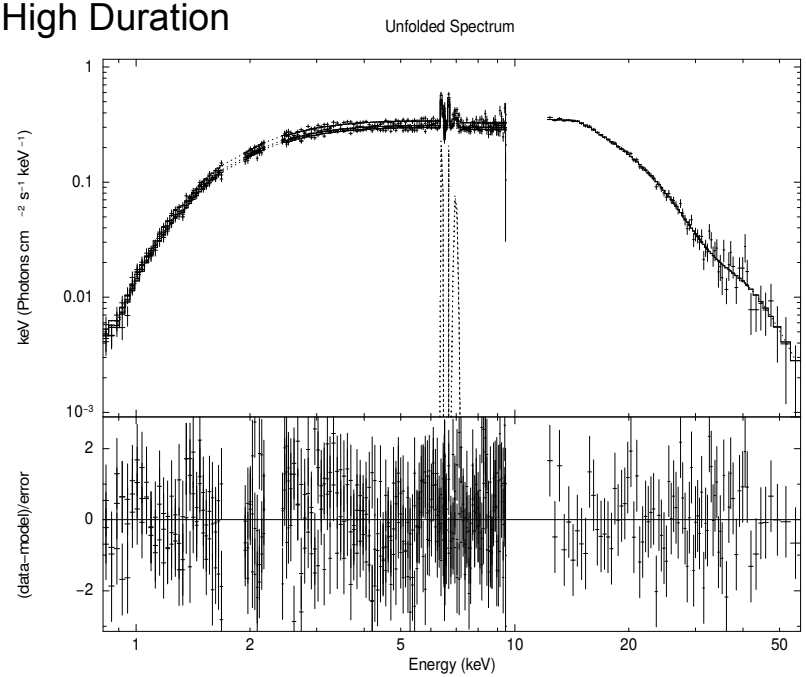




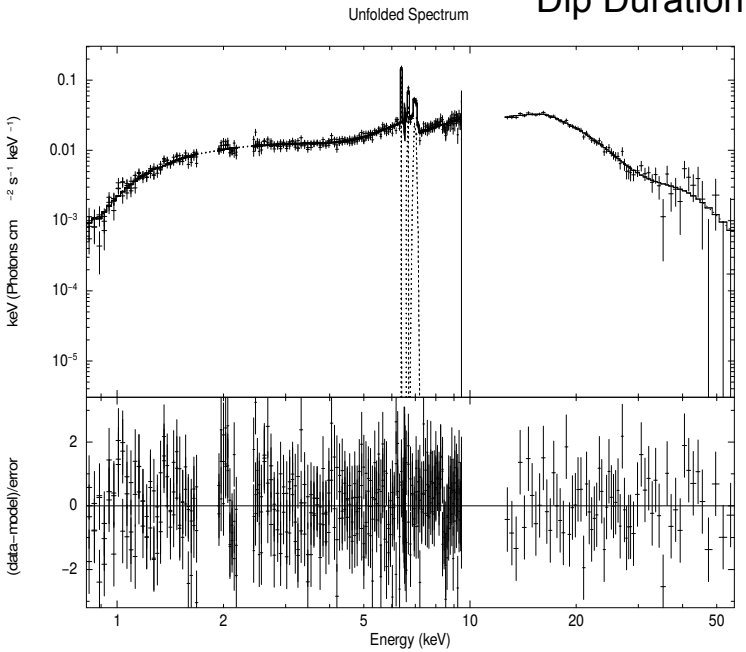
- Single peaked pulse profile during flaring states
- Reduced pulse fraction during dip region

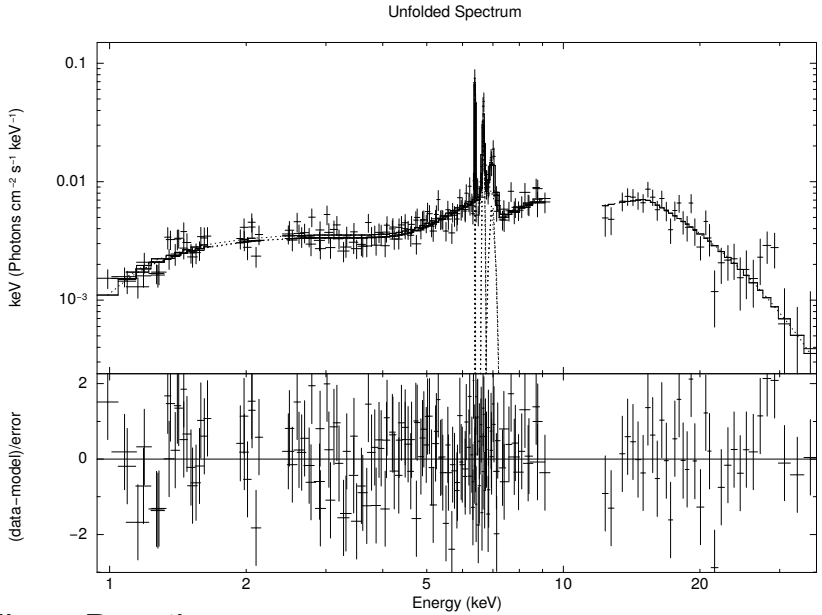
Models used in spectral fitting

High Duration



Dip Duration





Eclipse Duration

Fitted Spectra during different timing regions using Highecut model

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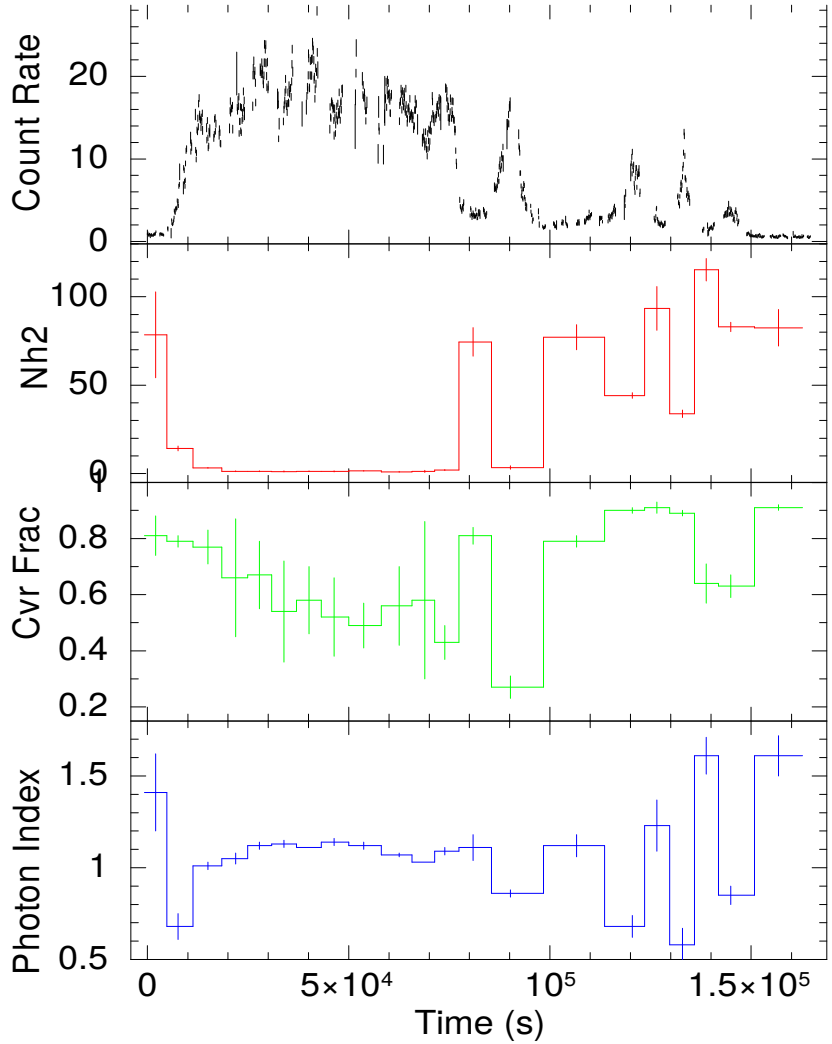
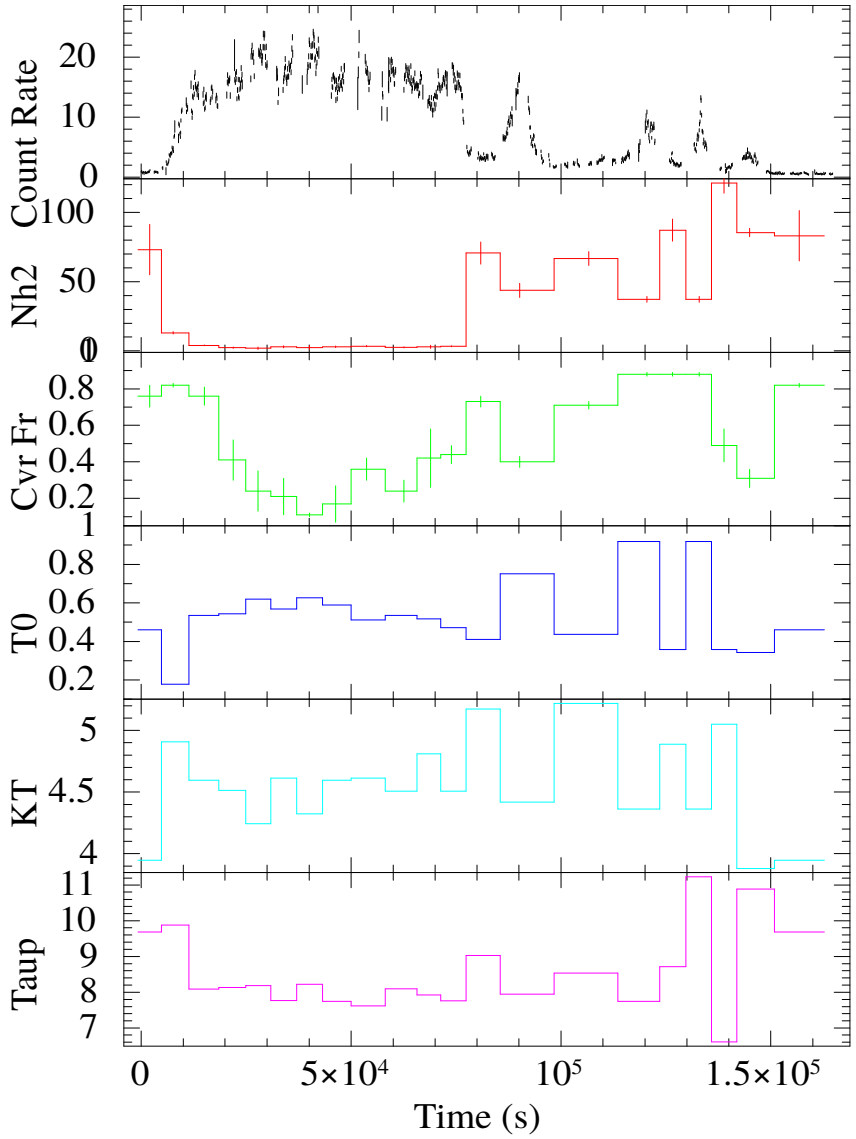
Spectral parameters from time resolved spectroscopy of Cen X-3



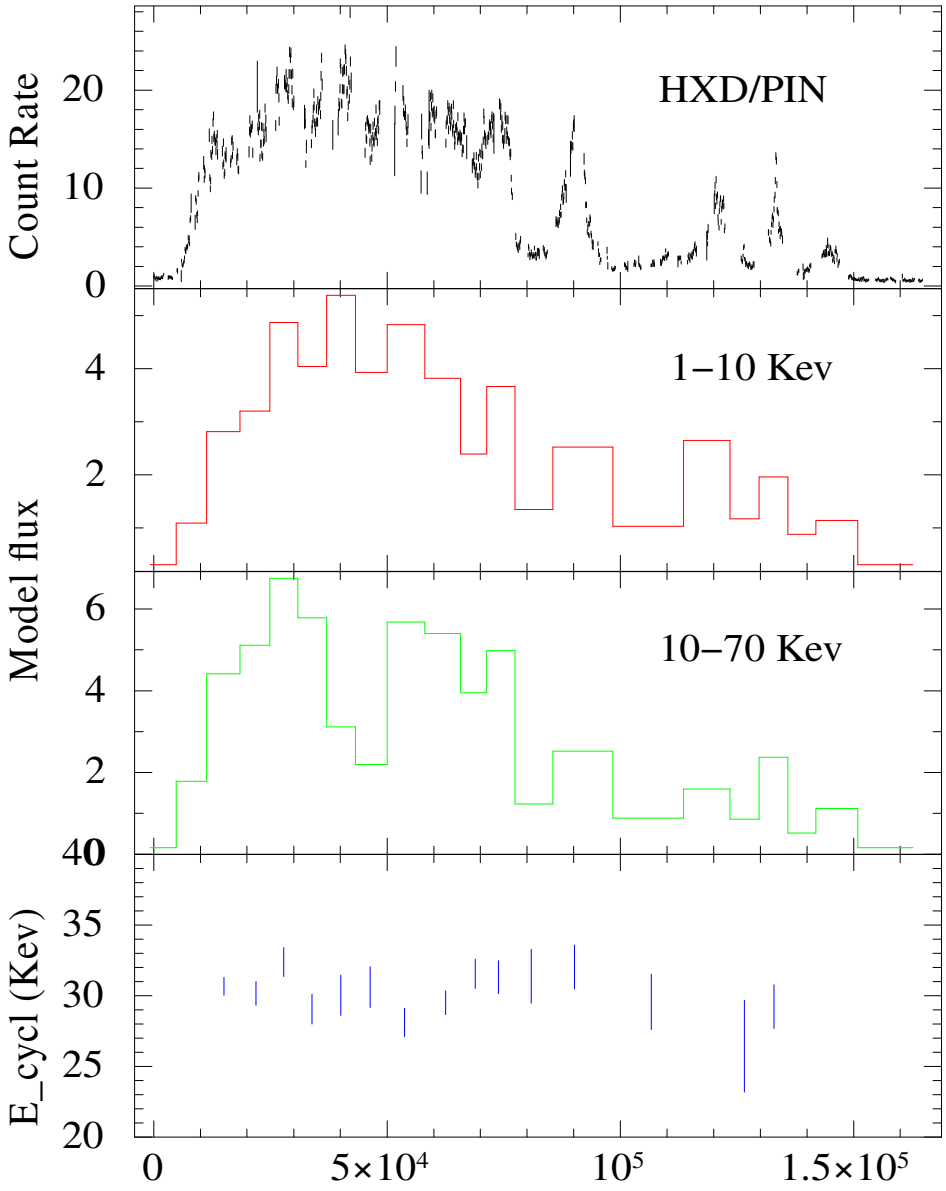
- 1-70 keV spectra described with the partial covering high energy cutoff power law model
- Emission lines at 6.4, 6.67 and 6.97 keV are detected in the spectrum.
- A cyclotron feature at 30 keV

Spectral parameters from time resolved spectroscopy of Cen X-3

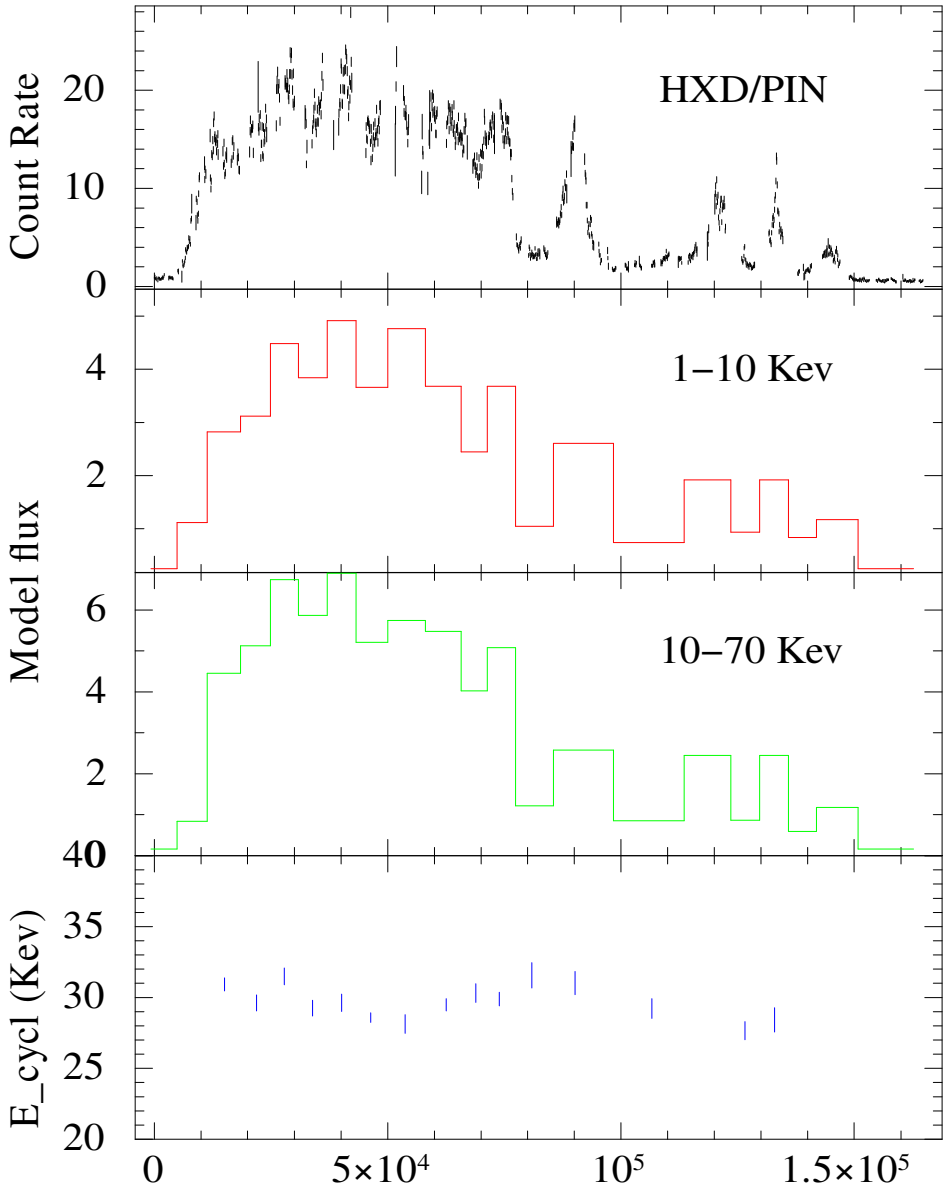
Spectra can be also explained with the CompTT continuum model in addition to other emission lines and cyclotron absorption feature



Cyclotron line Variation with Luminosity



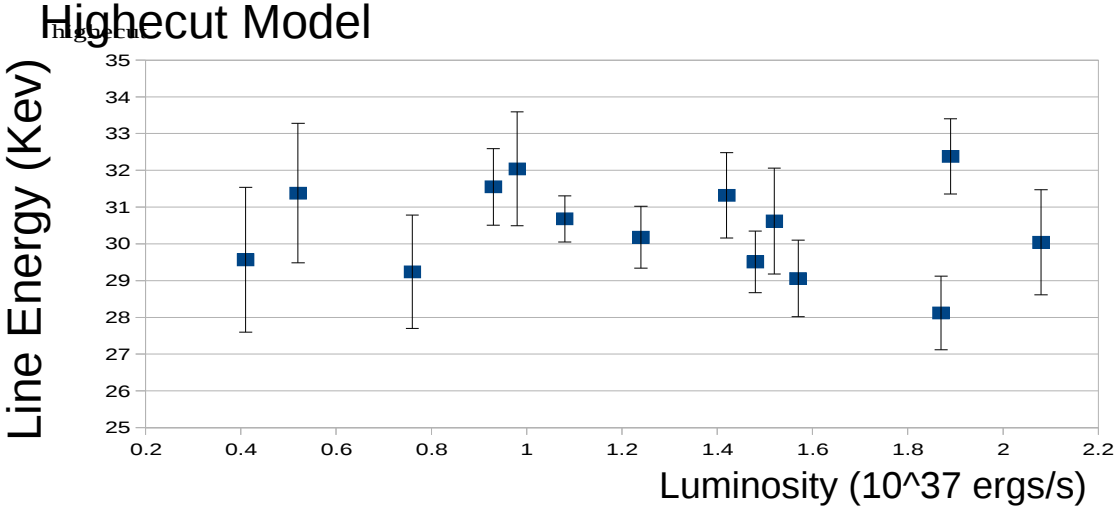
High energy cutoff model



CompTT model

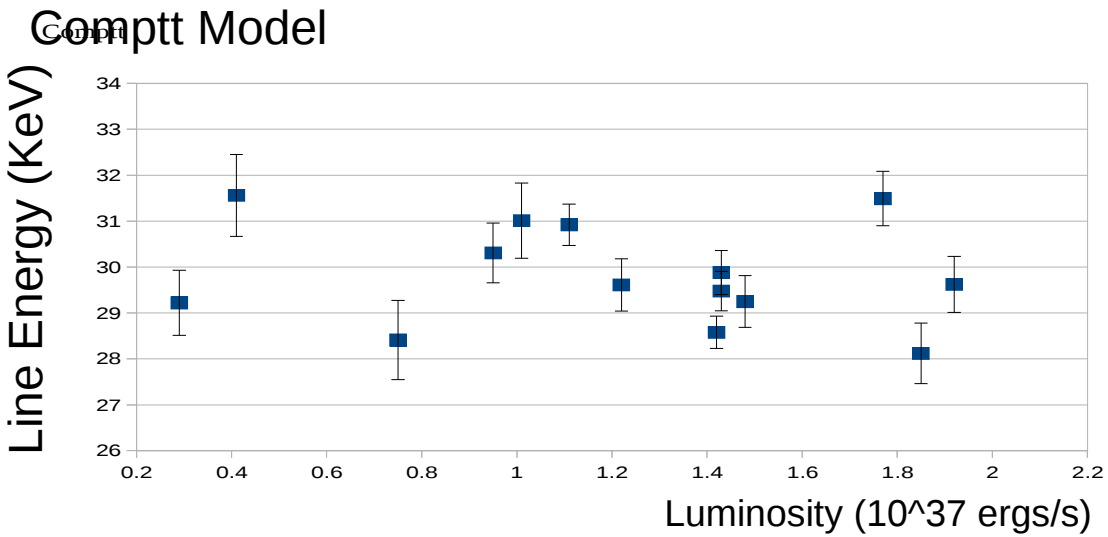
Cyclotron line Variation with Luminosity

Highecut Model



Cyclotron line energy is nearly constant with luminosity.

Comptt Model



Similar behaviour seen with HECut and CompTT models.

Summary and Conclusions

Partial covering absorbed powerlaw model along with high energy cut off fits well.

Apart from that Comptt model also fits well over the entire energy range of the spectrum.

Dipping activity detected in the light curve up to 40 keV.

Based on time resolved spectroscopy, we conclude that the dipping activity in Cen X-3 is caused by an obscuration of the neutron star by dense matter.

A presence of cyclotron line at 30 keV.

Although luminosity changing up an order of magnitude over the orbital phases, cyclotron line energy is found to be constant.

Future observations with Astrosat will be helpful for more detail studies of stellar wind mapping around the pulsar.

Thank you