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Ananda Deepika Bollimpalli - X-ray variability in compact objects

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Compact objects like neutron stars and black holes exhibit X-ray variability on different time scales and the key processes responsible for this variability differ depending on the type of the compact object and the time scale of the variability. Spectral-timing analysis of X-ray bursts in accreting neutron star systems shows periodic intensity variations which are termed as burst oscillations. We explore a new possibility of understanding these burst oscillation frequencies in the context of the radial oscillations of "levitating atmospheres". There is plenty of observational evidence that some neutron star systems reach super-Eddington luminosities, either through the accretion of matter onto the stellar surface or by thermonuclear burning. Stars with such high luminosities are shown to harbor levitating atmospheres, supported by the radiation pressure from the star at a certain height above the stellar surface. We study the oscillations of these radiation-supported atmospheres to find a family of relativistic eigenmodes and eigenfrequencies of the radial oscillations. The frequency of these oscillations depends on the stellar parameters and varies with the stellar luminosity/ flux. We also find that damping due to radiation drag limits the frequency of these oscillations introducing a characteristic maximum in the frequencies. Both the maximum frequency and the frequency variation with the flux can be used to determine the mass and radius of the neutron star. In addition to the stellar parameters, observation of the variation of the oscillation frequencies with flux would allow us to estimate the stellar luminosity and therefore the distance to the source with an accuracy of a few per cent.

Extensive studies of X-ray timing analysis have shown that black-hole X-ray binaries exhibit extreme variability in X-rays on short time scales in the so-called hard state. Various characteristics of these X-ray variability are well interpreted by inward propagating fluctuations in mass accretion rate. In this work, we try to compare the accretion rate profiles from GRMHD simulations of a geometrically thick and optically thin advection dominated flow (ADAF) to those predicted by the phenomenological model of Mahmoud, Done & De Marco (2019) to better understand the underlying physical process in the accretion disks. We find the power-spectra and the time lags generated from GRMHD accretion rate curves to be inconsistent with the model-fitted data. We speculate that the GRMHD case shows a rather different phenomenon, perhaps related to the B-field fluctuations, whereas the model-fitted data are instead dominated by the propagating small fluctuations.

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