An Analytic Model of Quasi-periodic Accretion in Magnetized Compact Objects

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Abstract

The X-ray power spectra of sourcing magnetized compact objects (e.g. neutron stars and black holes) display distinctive time-dependent behaviours, including quasi-periodic oscillations (QPOs) with peak frequencies in integer ratios. We construct an idealized analytic model of the disk-magnetosphere interaction in such objects by spatially averaging the ideal magnetohydrodynamic equations at the disk-magnetosphere boundary to describe the coupling between the polar magnetic tower and coning magnetosphere, and disk corona systems identified in recent numerical simulations. The solutions to these equations display low frequency (kHz) periodic behaviour, including twin QPOs (with integer frequency ratio) under certain conditions.

X-ray Variability

Many varieties of variability are observed in the X-ray light curves of magnetized compact objects. Observations from a distributed array of X-ray telescopes (e.g. RXTE, Chandra, XMM-Newton, and NuSTAR) indicate four major classes: broad-band noise, quasiperiodic oscillations (QPOs), periodic variability, and flickering. We discuss the implications of the X-ray variability on the disk-magnetosphere interaction, and on the properties of the central black hole. We summarise the observations and models of the X-ray variability in magnetized compact objects.

Simulations of Propeller Regimes

Simulations of the disk-magnetosphere interaction in magnetized compact objects are used to study the properties of the central black hole. We discuss the results of simulations that model the accretion of gas onto a black hole, and the interaction of the accretion disk with the surrounding magnetic field. We also present new results from simulations of the accretion of gas onto a rotating black hole.

REFERENCES


Conclusion

By solving simplified MHD equations, we obtain low frequency periodic oscillations in a disk-magnetosphere system for the three cases above. The solutions obtained are explained by a set of MHD equations in the three cases. However, these results are derived from a single linear analysis of the oscillation period, and further work is needed to understand the role of non-linear effects in the oscillations.