Thin accretion disks of neutron stars influenced by the relativistic Poynting-Robertson effect.

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Abstract

Accretion structures in the vicinity of neutron stars are significantly influenced by the radiation emitted from the surface of stars and from the boundary layer. Apart from the radiation pressure, the accreted matter is also affected by the Poynting-Robertson effect, which causes angular momentum loss and therefore acts as an additional source of viscosity in the disk. Using numerical simulations, we studied the influence of the Poynting-Robertson effect on the thin accretion disks in accreting binary systems with a neutron star. In the parallelized simulation code, we implement the complete general relativistic description of the Poynting-Robertson effect including the influence of density redistribution on the optical depth of the disk. The motion of matter in the disk thus results from a complex interplay of strong gravitational field, the Poynting –Robertson effect, radiation pressure and disk viscosity.

The results we obtained demonstrate that the presence of even constant star's luminosity qualitatively influences the distribution of mass density in thin disks and can create strong inhomogeneous structures of the disk. The spectral properties of such disks are therefore necessarily different from a standard quasi-Keplerian case. In particular, using relativistic ray-tracing, we demonstrate how radiation of neutron star influences the broadening of k-alpha line of the disk. We further modelled the disk behaviour during a thermonuclear burst, when the luminosity of a neutron star is close to the Eddington limit. The Poynting –Robertson effect significantly determines the reaction of the disk and the profile of the accretion flow during the burst.

Keywords: accretion disk, neutron star, Poynting Robertson effect, numerical relativity, LMXBs

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