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On the spreading layer emission in luminous accreting neutron stars

Revnivtsev M., Suleimanov V., Poutanen J.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Emission of the neutron star surface potentially contains information about its size and thus of vital importance for high-energy astrophysics. In spite of the wealth of data on the emission of luminous accreting neutron stars, the emission of their surfaces is hard to disentangle from their time-averaged spectra. A recent X-ray transient source XTE J1701-462 has provided a unique data set covering the largest ever observed luminosity range for a single source and showing type I (thermonuclear) X-ray bursts. In this paper, we extract the spectrum of the neutron star surface (more specifically, the spectrum of the boundary layer between the inner part of the accretion disc and the neutron star surface) with the help of maximally spectral model-independent method. We show compelling evidences that the energy spectrum of the boundary layer stays virtually the same over factor of 20 variations of the source luminosity. It is rather wide and cannot be described by a single-temperature blackbody spectrum, probably because of the inhomogeneity of the boundary layer and a spread in the colour temperature. The observed maximum colour temperature of the boundary/spreading layer emission of kT~2.4-2.6 keV is very close to the maximum observed colour temperature in the photospheric radius expansion X-ray bursts, which is set by the limiting Eddington flux at the neutron star surface. The observed stability of the boundary layer spectrum and its maximum colour temperature strongly supports theoretical models of the boundary/spreading layers on surfaces of luminous accreting neutron stars, which assume the presence of a region emitting at the local Eddington limit. Variations in the luminosity in that case lead to changes in the size of this region, but affect less the spectral shape. Elaboration of this model will provide solid theoretical grounds for measurements of the neutron star sizes using the emission of the boundary/spreading layers of luminous accreting neutron stars. © 2013 The Authors. Published by Oxford University Press on behalf of the Royal Astronomical Society.

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Keywords

Accretion, accretion discs-stars, Binaries-X-rays, Neutron-X-rays, Stars