How to distinguish neutron star and black hole X-ray binaries? Spectral index and quasi-periodic oscillation frequency correlation

Lev Titarchuk, Nickolai Shaposhnikov

http:/xxx.lanl.gov/abs/astro-ph/0503081

Recent studies have revealed strong correlations between 1–10 Hz frequencies of quasiperiodic oscillations (QPOs) and the spectral power law index of several Black Hole (BH) candidate sources when seen in the low/hard state, the steep power-law (soft) state, and in transition between these states. In the soft state these index-QPO frequency correlations show a saturation of the photon index ~ 2.7 at high values of the low frequency ν_L. This saturation effect was previously identified as a black hole signature. In this paper we argue that this saturation does not occur, at least for one neutron star (NS) source 4U 1728–34, for which the index monotonically increases with ν_L to the values of 6 and higher. We base this conclusion on our analysis of ~ 1.5 Msec of RXTE archival data for 4U 1728–34. We reveal the spectral evolution of the Comptonized blackbody spectra during the source transitions from the hard to soft states. The hard state spectrum is a typical thermal Comptonization spectrum of the soft photons which originate in the disk and the NS outer photospheric layers. The hard state photon index is ~ 2. The soft state spectrum consists of two blackbody components which are only slightly Comptonized. Thus we can claim (as expected from the theory) that in NS sources thermal equilibrium is established for the soft state. To the contrary in BH sources, the equilibrium is never established due to the presence of the BH horizon. The emergent BH spectrum, even in the high/soft state, has a power law component. We also identify the low QPO frequency ν_L as a fundamental frequency of the quasi-spherical component of the transition layer (presumably related to the corona and the NS and disk magnetic closed field lines). The lower frequency ν_{SL} is identified as the frequency of oscillations of a quasi-cylindrical configuration of the TL (presumably related to the NS and disk magnetic open field lines). We also show that the presence of Fe K_α emission-line strengths, QPOs, and the link between them does not depend on radio flux in 4U 1728–34.