SEARCHING FOR BLACK HOLES

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Final Report

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black hole, and evidence for its existence has been very difficult to find. This result was highlighted at a 1997 January AAS press conference, and has appeared in ApJ (Advection

Final Report: Searching for Black Holes


We report on x-ray observations of two soft x-ray transients (SXT) containing neutron stars, 4U 2129+47 and EXO 0748-676. Our emphasis is on the quiescent properties of these sources, but we make comparisons to their outburst properties as well.

The x-ray spectrum and lightcurve of the eclipsing Low-Mass X-ray Binary (LMXB) 4U 2129+47 is measured with the ROSAT PSPC during its current quiescent state. This is the first such measurement for an accretion disk corona x-ray binary in a low state: these observations may provide new insights into the structure of LMXBs in quiescence. The quiescent x-ray luminosity of \( \sim 10^{32.9}\) erg/s and blackbody temperature of \( kT \sim 0.22 \) keV are similar to other quiescent LMXB. The quiescent x-ray light curve appears to show orbital modulation, but the statistics are insufficient to distinguish between a v-shaped partial eclipse (as seen in the high state) or a total, square wave eclipse. The similarity in the luminosity and temperature to other (non-eclipsing) quiescent LMXB implies that the vertical structure in the disk which blocked our direct view of the neutron star in the high state has collapsed, and the neutron star is seen directly.

EXO 0748-676 was serendipitously observed with the Einstein IPC in quiescence before it was discovered as a bright transient with EXOSAT. Our re-analysis of this quiescent observation finds \( L_\nu \sim 10^{34.1}\), and blackbody temperature of \( kT \sim 0.21 \) keV, again similar to other LMXBs in quiescence.


We present spectroscopic observations of the X-ray transient XTE J1118+480 acquired during different epochs following the 2000 March outburst. We find that the emission line profiles show evident variations in their double-peak structure at time scales longer than the 4.1 hr orbital period. We suggest that these changes are due to a tidally driven precessing disk. Doppler imaging of the more intense Balmer lines and the He II \( \lambda 4686\) line show evidence of a persistent emission spot superposed on the disc. The Balmer Doppler maps on May 25 2000 shows an elliptical ring as expected for an eccentric disk. We discuss the possible nature of the optical flux in the system and conclude that it may be due to a viscously heated disk.

of the outburst, although we find the modulation during the initial rise to be somewhat faster at \( P \approx 18.5 \) hours. The optical initial rise preceded the X-ray (RXTE/ASM) rise by \( \sim 6 \) days. Utilizing this, we triggered six RXTE/PCA pointings before the source was detectable with the ASM. The source did not undergo spectral transitions during this time and the power density spectrum is typical of SXTs during the low hard state, exhibiting a \( 1/f \)-like noise for frequencies greater than the break frequency and a flat component for low frequencies.


Abstract

We present the first attempt to localize the IR counterpart of the recurrent, ultra soft X-ray transient 4U 1630-47. We have obtained two sets of K band images of this highly obscured region, during both outburst and quiescence. The recent radio position reported by Hjellming et al. (1999) allow us to perform accurate astrometry on the field. We discuss three stars which lie near the radio position: although two have colours which appear to be consistent with the reddening towards 4U 1630-47, neither are strongly variable. Deeper IR monitoring, during both outburst and quiescence, is required to reliably identify an IR counterpart.


We present photometry and spectroscopy of the soft x-ray transient Aql X-1. Optical photometry during an active state shows a strong (0.6 mag peak-to-peak) modulation at a period of 19 hours. Infrared (K'-band) photometry during a quiescent state limits any ellipsoidal variations to \( \pm 0.07 \) mag (peak-to-peak), which implies an inclination \( \leq 31 \) (90\% confidence limit). The low inclination is rather unexpected given the large photometric modulation seen in the active state. The upper limit to the equivalent width of the anomalous Li 6707A line is \( \leq 0.3 \)A, which is similar to the measured strength of this line in several other x-ray transients.


Abstract

We present J- and K'-band (1.95–2.35 \( \mu \)m) photometry of the quiescent X-ray nova
GS 2000+25, obtained in an attempt to constrain the mass of the compact object (MX). Combined with the mass function of 4.97 Msolar, the infrared light curves imply MX \( i = 11 \) Msolar (90% confidence level), regardless of the evolutionary state of the secondary, for a mass ratio \( q \) of \( 4 < q < 30 \). For a secondary mass in the range \( M_2 = 0.4 - 0.9 \) Msolar (as expected for a K dwarf companion), and assuming a negligible contribution from the disk at these wavelengths, we find MX \( = 8.5 \pm 1.5 \) Msolar and an inclination of 65 deg \( +/- 9 \) deg. The observed infrared color is consistent with that expected of a K dwarf secondary. If the accretion disk continuum is given by \( f_\lambda \lambda -1.8 \), as observed in other quiescent X-ray novae, we constrain the accretion disk contribution to the K' flux (independently of optical estimates) to \( i = 12\% \).


