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The XMM-Newton/RGS Spectra of the Millisecond X-ray Pulsar XTE J1751-305 in Outburst

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We have performed a preliminary analysis of the XMM-Newton Reflection Grating Spectrometer (RGS) spectra of the accreting millisecond X-ray pulsar XTE J1751-305 (Markwardt and Swank, 2002, and in't Zand et al. 2002, IAUC 7867; Ehle et al. 2002, IAUC 7872; Markwardt and Swank, 2002, IAUC 7876, Miller et al., 2002, ATEL 90). The observation started on 2002 April 07.52 and lasted for 36.0 ksec; these X-ray spectra represent the first to be obtained from such a source in outburst with a dispersive spectrometer. Herein we report on the time-averaged first-order spectra.

The RGS-1 and RGS-2 spectra are strongly truncated below approximately 0.8 keV (wavelengths longer than 15 Angstroms) due to absorption in the ISM. To examine the spectra in fine detail, we considered the first-order RGS-1 and RGS-2 spectra jointly in 3-Angstrom slices: 6-9 Angstroms, 9-12 Angstroms, and 12-15 Angstroms using local single-component models with ISM absorption edges fixed at solar values to characterize the continuum. Plots from this analysis may be obtained at:


With the requirement that any real emission or absorption lines be observed in both the RGS-1 and RGS-2 spectra, we find no evidence for strong spectral lines in the time-averaged dispersed spectra (dips or line-like features or breaks in the model are
Considering these results with those from the EPIC-pn (Miller et al., 2002, ATEL 90), we can compare XTE J1751-305 to similar systems: Asai et al. (2000, ApJS, 131, 571) report the detection of an Fe K line in the ASCA/GIS spectrum of the ultra-compact binary 4U 1820-30 (E = 6.6 +/- 0.1 keV, FWHM = 0.7 +0.2 -0.5 keV, EW = 31 +12 -11 eV). At this centroid energy, the 95% confidence upper-limit on a line with similar FWHM in the time-averaged EPIC-pn spectrum of XTE J1751-305 is only 6 eV.

At 42 minutes, the orbital period of the X-ray binary pulsar 4U 1626-67 is the same as for XTE J1751-305. Schulz et al. (2001, ApJ, 5363, 941) find strong, broadened emission lines from Ne IX and Ne X in a Chandra HETGS spectrum of 4U 1626-67 (for Ne X at 12.13 Angstroms: FHWM = 2860 +/- 330 km/s, Flux = 8.15 +/- 0.93 E-5 ph cm^-2 s^-1). Assuming a line with similar width within 0.1 Angstroms of 12.13 A, the 95% confidence upper-limit on the flux from a Ne X emission line in the time-average RGS spectra of XTE J1751-305 is 8.8 E-5 ph cm^-2 s^-1, but such a feature is only suggested at the 2.6 sigma level of confidence in XTE J1751-305.

Previous studies have found that Ne may be over-abundant in 4U 0614+091 (Juett et al., 2001, ApJ, 560, L59) and 4U 1626-67 (Schulz et al., 2001). The 95% confidence upper-limit on the abundance of Ne in the time-averaged RGS spectra indicates that Ne is 23% under-abundant in this system [we have assumed a solar abundance relative to hydrogen as per Morrison and McCammon (1983, ApJ, 270, 119) and cross-sections as per Verner et al. (1993, ADNDT, 55, 233)].

Miller notes that ATEL 90 should have included Michiel van der Klis (Univ. Amsterdam) in the author list.