Thin accretion disks have fat atmospheres: the interpretation of X-ray line spectra

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Abstract

The observed X-ray lines from low-mass X-ray binaries have a likely origin in an accretion disk atmosphere and corona. We present synthetic, high resolution X-ray spectra detailing the recombination emission from an entire disk. We found a new feedback mechanism operating between the neutron star illumination and the disk flaring geometry, making the atmosphere larger and the emission lines brighter than would otherwise be predicted. We are able to reproduce the emission lines in LMXBs thus far observed with Chandra and XMM-Newton, including their absolute luminosities. High inclination, eclipses and dips may enhance the detectability of spectral lines, or isolate a particular region of the disk emission. In the model, the line equivalent widths have a pronounced inclination dependence, and surprisingly, the line luminosity is roughly linear with the accretion rate. All ionization parameters are present at most disk radii, due to the large optical depth of the atmosphere at small grazing angles. As such, the observed ionization parameter distribution teaches us about the vertical stratification of the atmosphere, which is the key to understand its energetics and dynamics.

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