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Across the Eddington boundary: examining disc spectra at high accretion rates

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There are now strong arguments that many ultraluminous X-ray sources (ULXs) are powered by super-Eddington accretion on to stellar remnant black holes. However, a key remaining question is: how are the classic sub-Eddington and new super-Eddington accretion states related? In an attempt to answer this, we present results from a systematic analysis of samples of the brightest thermal dominant (TD) black hole binaries (BHBs) and the faintest ULXs in the 0.3–10 keV band pass. We have previously shown that the faintest ULXs tend to have X-ray spectra that are disc-like, but broader than expected for thin accretion discs (broadened disc, or BD, spectra). Here we report that the TD BHB spectra are similar in shape to the BD ULXs in the 0.3–10 keV band, and differ only in luminosity, by a factor of $\sim$ 10. This broadening may have been missed in previous studies that looked primarily above $\sim$ 2 keV. As the Eddington ratios of the TD BHBs are well constrained to moderate values, known effects are not expected to produce such broad spectra. This implies there may be a missing physical mechanism in our best accretion disc models. We discuss the implications of our results for the BD ULXs. If they were at similar Eddington ratios to the TD BHBs, then they would most likely contain massive stellar remnant black holes. However, this would require that they were all at close to maximal spin. Instead, the BD ULXs could simply be a high Eddington ratio extension of the TD state.

Author: SUTTON, Andrew (NASA Marshall Space Flight Center)

Presenter: SUTTON, Andrew (NASA Marshall Space Flight Center)

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