What Helium-II Emission Lines Can (and Can't) Tell Us About the Most Massive X-ray Binaries

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High mass X-ray binaries (HMXBs), in which either a neutron star or a black hole accretes material from a massive stellar companion, represent a critical phase of massive star evolution: their current properties are the result of the orbital and mass-exchange history of the progenitor binary, and their ultimate fate is to form millisecond pulsars, short gamma-ray bursts, or double-compact object systems capable of producing detectable gravitational waves. HMXBs containing a black hole and a Wolf-Rayet donor are the "holy grails" of massive star evolution, but such systems are exceedingly rare and determining the masses of the binary components is notoriously difficult. I will discuss recent multiwavelength observing campaigns of two "twin" black hole + Wolf-Rayet HMXBs (NGC 300 X-1 and IC 10 X-1), with a particular emphasis on the role that the He II 4686 and 1640 emission lines play in helping us understand the system geometries and interactions between the black hole accretion disk and the donor star wind. Although the He II 4686 had previously been used to infer the black hole masses in IC 10 X-1 and NGC 300 X-1, we demonstrate that the He II 4686 emission line exhibits a phase shift relative to the predicted orbital motions of the Wolf-Rayet donors in both systems. Furthermore, the line profiles vary in skewness and kurtosis throughout the binary orbit. We suggest that this variability is the result of the blending of two (or more) He II components, each originating from separate locations within the binary system (one from the Wolf-Rayet wind, and one from a hotspot on the accretion disk around the black hole).