Chandra X-ray Grating Spectrometry of Eta Carinae near X-ray Minimum: I. Variability of the Sulfur and Silicon Emission Lines

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We report on variations in important X-ray emission lines in a series of Chandra grating spectra of the supermassive colliding wind binary star Eta Carinae, including key phases around the X-ray minimum/periastron passage in 2003.5. The X-rays arise from the collision of the slow, dense wind of Eta Car with the fast, low-density wind of an otherwise hidden companion star. The X-ray emission lines provide the only direct measure of the flow dynamics of the companion's wind along the wind-wind collision zone. We concentrate here on the silicon and sulfur lines, which are the strongest and best resolved lines in the X-ray spectra. Most of the line profiles can be adequately fit with symmetric Gaussians with little significant skewness. Both the silicon and sulfur lines show significant velocity shifts and correlated increases in line widths through the observations.
The R = forbidden-to-intercombination ratio from the Si XIII and S XV triplets is near or above the low-density limit in all observations, suggesting that the line-forming region is >1.6 stellar radii from the companion star. We show that simple geometrical models cannot simultaneously fit both the observed centroid variations and changes in line width as a function of phase. We show that the observed profiles can be fitted with synthetic profiles with a reasonable model of the emissivity along the wind-wind collision boundary. We use this analysis to help constrain the line formation region as a function of orbital phase, and the orbital geometry.

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