Wind signatures in the x-ray emission line profiles of the late O supergiant zeta Orionis

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X-ray line profile analysis has proved to be the most direct diagnostic of the kinematics and spatial distribution of the very hot plasma around O stars. In this paper we apply several analysis techniques to the emission lines in the Chandra HETGS spectrum of the late-O supergiant zeta Ori (O9.7 Ib), including the fitting of a simple line-profile model. We show that there is distinct evidence for blue shifts and profile asymmetry, as well as broadening in the X-ray emission lines of zeta Ori. These are the observational hallmarks of a wind-shock X-ray source, and the results for zeta Ori are very similar to those for the earlier O star, zeta Pup, which we have previously shown to be well-fit by the same wind-shock line-profile model. The more subtle effects on the line-profile morphologies in zeta Ori, as compared to zeta Pup, are consistent with the somewhat lower density wind in this later O supergiant. In both stars, the wind optical depths required to explain the mildly asymmetric X-ray line profiles imply reductions in the effective opacity of nearly an order of magnitude, which may be explained by some combination of mass-loss rate reduction and large-scale clumping, with its associated porosity-based effects on radiation transfer. In the context of the recent reanalysis of the helium-like line intensity ratios in both zeta Ori and zeta Pup, and also in light of recent work questioning the published mass-loss rates in OB stars, these new results indicate that the X-ray emission from zeta Ori can be understood within the framework of the standard wind-shock scenario for hot stars.

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