Measuring mass-loss rates and constraining shock physics using X-ray line profiles of O stars from the Chandra archive

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We quantitatively investigate the extent of wind absorption signatures in the X-ray grating spectra of all non-magnetic, effectively single O stars in the Chandra archive via line profile fitting. Under the usual assumption of a spherically symmetric wind with embedded shocks, we confirm previous claims that some objects show little or no wind absorption. However, many other objects do show asymmetric and blue shifted line profiles, indicative of wind absorption. For these stars, we are able to derive wind mass-loss rates from the ensemble of line profiles, and find values lower by an average factor of 3 than those predicted by current theoretical models, and consistent with H-alpha if clumping factors of f_cl ~ 20 are assumed. The same profile fitting indicates an onset radius of X-rays typically at r ~ 1.5 Rstar, and terminal velocities for the X-ray emitting wind component that are consistent with that of the bulk wind. We explore the likelihood that the stars in the sample that do not show significant wind absorption signatures in their line profiles have at least some X-ray emission that arises from colliding wind shocks with a close binary companion. The one clear exception is zeta Oph, a weak-wind star that appears to simply have a very low mass-loss rate. We also reanalyse the results from the canonical O supergiant zeta Pup using a solar-metallicity wind opacity model and find Mdot = 1.8 X 10^{-6} solar masses per year, consistent with recent multi-wavelength determinations.

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