The Discordance of Mass-Loss Estimates for Galactic O-Type Stars

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We have determined accurate values of the product of the mass-loss rate and the ion fraction of P^{4+}, Mdot q(P^{4+}), for a sample of 40 Galactic O-type stars by fitting stellar-wind profiles to observations of the P V resonance doublet obtained with FUSE, ORFEUS/BEFS, and Copernicus. When P^{4+} is the dominant ion in the wind, Mdot q(P^{4+}) approximates the mass-loss rate to within a factor of 2. Theory predicts that P^{4+} is the dominant ion in the winds of O7-O9.7 stars, though an empirical estimator suggests that the range from O4-O7 may be more appropriate. However, we find that the mass-loss rates obtained from P V wind profiles are systematically smaller than those obtained from fits to Halpha emission profiles or radio free-free emission by median factors of about 130 (if P^{4+} is dominant between O7 and O9.7) or about 20 (if P^{4+} is dominant between O4 and O7). These discordant measurements can be reconciled if the winds of O stars in the relevant temperature range are strongly clumped on small spatial scales. We use a simplified two-component model to investigate the volume filling factors of the denser regions. This clumping implies that mass-loss rates determined from "density squared" diagnostics have been systematically over-estimated by factors of 10 or more, at least for a subset of O stars. Reductions in the mass-loss rates of this size have important implications for the evolution of massive stars and quantitative estimates of the feedback that hot-star winds provide to their interstellar environments.

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