X-ray measurements of the mass-loss rates of hot, massive stars

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The radiative driving mechanism of the supersonic winds of hot, massive stars is inherently unstable, resulting in strong shocks that produce X-rays with L_X ~ 10^-7 L_bol, with X-ray emitting shocked material thought to be embedded throughout the wind in the dominant cool component. OB star winds with mass loss rates of order 10^-6
M_solar / year are marginally optically thick to X-rays, resulting in differential absorption of X-rays between the front and back hemispheres of the wind, and thus asymmetric, blue-shifted line profiles. The degree of asymmetry is a sensitive probe of the areal density of the wind, and thus of the mass-loss rate. Because the X-ray
absorption is a result of the continuum photoelectric opacity of inner-shell electrons of metals, it is relatively insensitive to wind ionization state. Because the asymmetry is diagnostic of absorption and not emission, it is also insensitive to microclumping effects. This suggests the potential use of the X-ray diagnostic as a benchmark for mass-loss rates derived from other diagnostic methods. However, there are possible sources of significant systematic error in the X-ray measurements, including profile shape changes due to macroclumping (porosity), and resonance scattering in strong resonance lines of dominant charge states. Recombination of He++ may also affect the opacity at longer wavelengths.