Line-driven ablation of circumstellar disks: I. Optically thin decretion disks of classical Oe/Be stars

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The extreme luminosities of hot, massive stars drive strong stellar winds through UV line-scattering. For OB stars with an orbiting circumstellar disk, we explore the effect of such line-scattering in ablating disk material, initially focusing on the marginally optically thin decretion disks of classical Oe and Be stars. For this we apply a multi-dimensional radiation-hydrodynamics code, assuming optically thin ray tracing for the stellar continuum and a multi-ray Sobolev treatment of the line transfer. This accounts for desaturation of line-absorption by Keplerian shear in the disk, and associated driving by non-radial photons. Results show dense, intermediate-speed surface ablation, consistent with the strong, blue-shifted absorption seen in UV wind lines of Be shell stars. The asymptotic ablation rate is typically an order-unity factor times the stellar wind mass loss rate, leading to disk destruction times of order months to years for Be disks, consistent with observations. The much stronger radiative forces of O stars reduce this time to order days, making sustaining a disk difficult, and so providing a natural explanation for the rarity of Galactic Oe stars. Additionally, the weakened line-driving at lower metallicity implies both a reduction in the winds that help spin-down stars from near-critical rotation, and in the ablation of decretion disks, thus providing a natural explanation for the higher fraction of Classical Be stars, and the presence of Oe stars, in the Magellanic Clouds. We conclude with a discussion of future extensions to study line-driven ablation of denser, optically thick, accretion disks around pre-main-sequence massive stars.

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