

Wind-driven angular momentum removal and X-ray ionization effects in Roche-lobe overflowing HMXBs

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We investigate the dynamical interaction between stellar winds and Roche-lobe overflow (RLO) streams in high-mass X-ray binaries using three-dimensional SPH simulations. We show that the donor wind can exert a strong dynamical influence on the accretion flow. In the absence of X-ray ionization, the wind interacts asymmetrically with the disk and carries retrograde angular momentum, resulting in a net removal of angular momentum and a reduction of the disk size. When X-ray photoionization is included, the response of the system becomes strongly non-monotonic. At high luminosity ($L_X = 10^{38} \text{ erg s}^{-1}$), wind acceleration is suppressed and the flow approaches the no-wind case. In contrast, at moderate luminosity ($L_X = 10^{37} \text{ erg s}^{-1}$), the system enters a qualitatively different accretion regime. In this regime, the partially ionized wind becomes dense and dynamically important, strongly perturbing the RLO stream. As a result, the accretion flow transitions from RLO-dominated to wind-dominated, and the RLO stream undergoes a dynamical bifurcation into low- and high-angular-momentum branches. This leads to suppressed disk formation despite the presence of a strong mass supply. These results demonstrate that moderate ionization can be more disruptive than both weak and strong ionization, providing a new mechanism regulating accretion flows in RLO HMXBs.