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Zoom-in hydrodynamics simulations of binary mass transfer

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Most massive stars form in binary or even multiple systems. During their evolution, these binaries almost inevitably undergo a critical phase where the binary members exchange mass. It has been shown that this mass transfer plays a crucial role in shaping the evolution of both stars and is responsible for many fascinating astrophysical phenomena currently being observed, such as the formation of gravitational wave sources and the recently detected enigmatic quasi-periodic eruptions at galactic centers. Despite its importance, mass transfer remains one of the main uncertainties in binary stellar evolution and is typically modeled by simplified prescriptions. Although mass transfer is an intrinsically 3D phenomenon with possible nonlinear hydrodynamical effects, it has been predominantly studied analytically due to the high computational costs of numerical simulations for mass transfer. By adopting a novel approach enabling us to accurately simulate gas streams in 3D near the Lagrangian point with the hydrodynamics code Athena++, we investigate the properties of transferred mass over a wide range of mass ratios and overfilling factors. In this talk, I will present the results of the simulations and discuss astrophysical implications for the stability of mass transfer and the electromagnetic emission from transients involving mass transfer.

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