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Multi-dimensional Simulations of Mixing in Classical Novae

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Classical novae are explosive phenomena that take place in stellar binary systems. They are powered by mass transfer from a low-mass, main sequence star onto a white dwarf. The material piles up under degenerate conditions until a thermonuclear runaway ensues. The energy released by the suite of nuclear processes operating at the envelope heats the material up to peak temperatures about (0.1-0.4) GK. During these events, material enriched in CNO and other intermediate-mass elements, are ejected into the interstellar medium. To account for the gross observational properties of classical novae (in particular, a metallicity enhancement in the ejecta above solar values), numerical models assume mixing between the (solar-like) material transferred from the companion and the outermost layers (CO- or ONe-rich) of the underlying white dwarf. The origin of the large enhancements and inhomogeneous distribution of chemical species observed in high-resolution spectra of ejected nova shells has, however, remained unexplained for almost half a century. Here we investigate, with multi-D simulations, the role of Kelvin-Helmholtz instabilities as a natural mechanism for self-enrichment of the accreted envelope with core material. Such mixing also naturally produces large-scale chemical inhomogeneities. Both the metallicity enhancement and the intrinsic dispersions in the abundances are consistent with the observed values.