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DSMC Simulations of the Rayleigh-Taylor Instability in Gases
MICHAEL GALLIS, TIMOTHY KOEHLER, JOHN TORCZYNSKI, STEVEN PLIMPTON, Sandia National Labs — The Direct Simulation Monte Carlo (DSMC) method of molecular gas dynamics is applied to simulate the Rayleigh-Taylor instability (RTI) in atmospheric-pressure monatomic gases (e.g., argon and helium). The computational domain is a 1 mm $\times$ 4 mm rectangle divided into 50-nm square cells. Each cell is populated with 1000 computational molecules, and time steps of 0.1 ns are used. Simulations are performed to quantify the growth of a single-mode perturbation on the interface as a function of the Atwood number and the gravitational acceleration. The DSMC results qualitatively reproduce all observed features of the RTI and are in reasonable quantitative agreement with existing theoretical and empirical models. Consistent with previous work in this field, the DSMC simulations indicate that the growth of the RTI follows a universal behavior. For cases with multiple-mode perturbations, the numbers of bubble-spike pairs that eventually appear are found to be in agreement with theoretical results for the most unstable wavelength. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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