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Lagrangian Particle Tracking in a Discontinuous Galerkin Method for Hypersonic Reentry Flows in Dusty Environments[1] ERIC CHING, YU LV, MATTHIAS IHME, Department of Mechanical Engineering, Stanford University — Recent interest in human-scale missions to Mars has sparked active research into high-fidelity simulations of reentry flows. A key feature of the Mars atmosphere is the high levels of suspended dust particles, which can not only enhance erosion of thermal protection systems but also transfer energy and momentum to the shock layer, increasing surface heat fluxes. Second-order finite-volume schemes are typically employed for hypersonic flow simulations, but such schemes suffer from a number of limitations. An attractive alternative is discontinuous Galerkin methods, which benefit from arbitrarily high spatial order of accuracy, geometric flexibility, and other advantages. As such, a Lagrangian particle method is developed in a discontinuous Galerkin framework to enable the computation of particle-laden hypersonic flows. Two-way coupling between the carrier and disperse phases is considered, and an efficient particle search algorithm compatible with unstructured curved meshes is proposed. In addition, variable thermodynamic properties are considered to accommodate high-temperature gases. The performance of the particle method is demonstrated in several test cases, with focus on the accurate prediction of particle trajectories and heating augmentation.

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