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Structurally complete Riemann solvers for flows with non-ideal thermodynamics[1] JEREMY C. H. WANG, JEAN-PIERRE HICKEY, Mechanical and Mechatronics Engineering, University of Waterloo — Approximate Riemann solvers, such as the HLL and HLLC Riemann solvers, have been at been at the cornerstone of compressible fluid dynamics. The intercell flux is approximated based on the understanding of the wave configuration of the information transfer. We propose an extension to these approximate Riemann solvers to account for the spatially varying rarefaction wave solution which becomes important under non-ideal thermodynamics. At high pressures and temperatures, the rarefaction head and tail can move in opposite directions, thus enclosing the cell interface and determining the intercell flux. These conditions are typical of trans- and supercritical flows. Using a recently found analytical solution to the non-ideal gas rarefaction wave (Wang and Hickey, Phys. Fluid. 2020), we propose a Structurally Complete Riemann Solver (SCRS) which shows great accuracy benefits to the Riemann problem solution. SCRS shows notable improvements over traditional Riemann solvers in flows where the rarefaction and star-state regions of the Riemann solution are locally supersonic.

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