Abstract Submitted
for the SHOCK05 Meeting of
The American Physical Society

Consistent thermodynamic derivative estimates for tabular equations of state. GARY DILTS, Los Alamos National Laboratory — A valid fluid equation of state must satisfy the thermodynamic differential conditions of consistency (derivation from a free energy) and stability (positive sound speed squared). Typical software interfaces to tabular equations of state based on polynomial or rational interpolants compute derivatives of pressure and energy and may enforce the stability conditions, but do not enforce the consistency condition and its derivatives, which is important for the computation of dimensionless quantities associated with more sensitive artificial viscosities and Riemann solvers that accurately model shock structure in regions near phase transitions. We describe a new type of table interface derived from a constrained local least squares regression technique. Application to several SESAME tables shows the consistency condition can be satisfied to round-off with third-order accuracy. An improvement of 14 orders of magnitude over conventional derivatives is demonstrated, although the new method is two orders of magnitude slower, due to solving an 11-dimensional nonlinear system. The new approach can be used to construct consistent and stable tables of derivatives, however.

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Date submitted: 01 Apr 2005 Electronic form version 1.4