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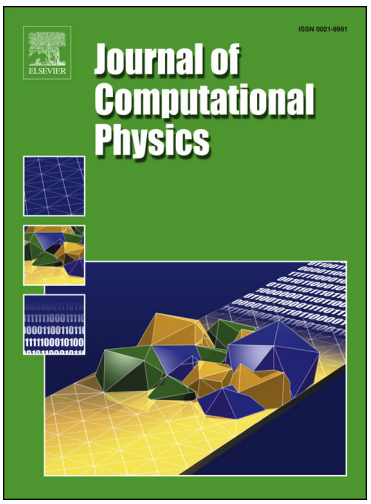

A Spectral Radius Scaling Semi-Implicit Iterative Time Stepping Method for Reactive Flow Simulations with Detailed Chemistry

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Highlights

- A spectral radius scaling semi-implicit time stepping scheme has been developed for simulating unsteady compressible reactive flows with detailed chemistry, in which the spectral radius in the LUSGS scheme has been augmented to account for viscous/diffusive and reactive terms.
- A scalar matrix is proposed to approximate the chemical Jacobian using the minimum species destruction timescale. Results show that the minimum species destruction time scale can well represent the smallest chemical time scale in reactive flows and the proposed scheme can significantly increase the allowable time steps in simulations.
- For the flame tests considered, the proposed semi-implicit scheme achieves second order of accuracy in time. Results show that the relative efficiency of different schemes depends on fuel mechanisms and flame tests. When the minimum timescale in reactive flows is governed by transport processes instead of chemical reactions, the proposed semi-implicit scheme is more efficient than the splitting scheme. Otherwise, the relative efficiency depends on the cost in sub-iterations for convergence within each time step and in the integration for chemistry substep.