A New Class of Optimal High-Order Strong-Stability-Preserving Time Discretization Methods

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Strong-stability-preserving (SSP) time discretization methods have a nonlinear stability property that makes them particularly suitable for the integration of hyperbolic conservation laws where discontinuous behaviour is present. Optimal SSP schemes have been previously found for methods of order 1, 2, and 3, where the number of stages s equals the order p. An optimal low-storage SSP scheme with $s = p = 3$ is also known. In this talk, we present a new class of optimal high-order SSP and low-storage SSP Runge-Kutta schemes with $s > p$. We find that these schemes are ultimately more efficient than the known schemes with $s = p$ because the increase in the allowable time step more than offsets the added computational expense per step. We demonstrate these efficiencies on a set of representative problems from compressible gas flows.