Time-Parallel IMEX Time Integration based on Spectral Deferred Correction

Abstract

The Spectral Deferred Corrections (SDC) method, introduced by Dutt, Greengard, and Rokhlin in 2000, has inspired the development of numerous time-parallel algorithms. These algorithms leverage parallelism either across the time step (e.g., PFASST, RIDC) or across the stage (e.g., ParaDiag, Diagonal SDC). Beyond its potential for time parallelism, SDC also provides a framework for designing arbitrarily high-order semi-implicit time-integration schemes. These methods can be seamlessly applied to first-order ODE systems with arbitrary mass matrices -- systems that commonly arise, for example, when solving incompressible flows or time-dependent solid mechanics.

In this talk, I will review recently introduced time integrators relying on SDC to enable small scale time-parallelism, and their combination with space-parallel codes to increase their parallel efficiency and reduce simulation time for large problems. I will also present recent algorithmic innovations in developing new SDC-based scheme that can compete with actual state-of-the-art time stepping scheme in term of stability, accuracy and time-to-solution.