

TITLE: The Joys and Pains of Exponential Integration.

ABSTRACT: In recent decades exponential integration has gained traction as an alternative to implicit methods for integration of large-scale stiff systems of differential equations. For problems where an efficient preconditioner is difficult to construct or not available all together, exponential schemes can offer significant computational advantages compared to other state-of-the-art algorithms. In order to access the full computational benefits of the exponential approach, however, it is essential to use exponential integration for the appropriate forcing terms of the system being solved and to optimize the evaluations of exponential-like functions of large matrices. In this talk we will discuss various classes of time integrators where the exponential approach is employed partially or fully in advancing the forcing of the system. We will also talk about how exponential integration and efficient algorithms to approximate the matrix exponential can be combined to create an efficient integrator and what parallelization is possible within an exponential integrator. The computational savings of the exponential approach will be illustrated using application problems from several fields such as atmospheric modeling and plasma physics.