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Unconditional Stability for Multistep Imex Schemes

In this talk we introduce a new class of linear multistep ImEx schemes that have very good unconditional stability properties. Unconditional stability is a desirable property of a time stepping scheme, as it allows the choice of time step solely based on accuracy considerations. Of particular interest are problems for which both the implicit and explicit parts of the ImEx splitting are stiff. Such splittings can arise, for example, in variable-coefficient problems, or the incompressible Navier-Stokes equations. To characterize the new ImEx schemes, we introduce an unconditional stability region, which plays a role analogous to that of the stability region in conventional multistep methods. We show how this region may be characterized through the use of a conformal mapping. Moreover, we will show how the new diagrams explain the fundamental stability restrictions of the well-known semi-implicit backward differentiation formulas (SBDF). We further show that the new ImEx coefficients can overcome the limitations of SBDF, and highlight their utility with several examples arising from partial differential equations: such as variable diffusion, advection diffusion and, time permitting a time dependent Stokes equation.