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Special Guest Lectures

Towards time stable and high order accurate schemes for realistic

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Abstract:
For wave propagation problems, the computational domain is often large compared to the wavelengths, which means that waves have to travel long distances during long times. As a result, high order accurate time marching methods, as well as efficient high order spatially accurate schemes (at least 3rd order) are required. Such schemes, although they might be G-K-S stable (convergence to the true solution as delta x -> 0), may exhibit non-physical growth in time, for realistic mesh sizes. It is therefore important to device schemes, which do not allow a growth in time that is not called for by the differential equation. Such schemes are called strictly (or time) stable. We are particularly interested in efficient methods with a simple data structure that parallelize easily on structured grids. High order accurate finite difference methods fulfill these requirements. Traditionally, a successful marriage of high order accurate finite difference and strict stability was a complicated and highly problem dependent task, especially for realistic applications. The major breakthrough came with the construction (Kreiss et al., in 1974) of non-dissipative operators that satisfy a summation by parts (SBP) formulation, and later with the introduction of a specific procedure (Carpenter et al., in 1994) to impose boundary conditions as a penalty term, referred to as the Simultaneous Approximation Term (SAT) method. The combination of SBP and SAT naturally leads to strictly stable and high order accurate schemes for well-posed linear problems, on rectangular domains. During the last 10 years, the methodology has been extended to handle complex geometries and non-linear problems. In this talk I will introduce the original SBP and SAT concepts, and further discuss the status today and the focus on future applications. In particular I will discuss some recent developments towards time stable and accurate hybrid combinations of structured and unstructured SBP schemes, making use of the SAT method.

Speaker's Bio:
Ken Mattsson received his Ph.D. in scientific computing from Uppsala University in Sweden in 2003. He was a postdoctoral research fellow in the Department of Physics at the University of Florida in Gainesville. Mattsson is currently a postdoctoral research fellow at the Center for Turbulence Research (CTR) at Stanford University. His research interests are the following: time dependent wave propagation problems, high order finite difference methods, multi-physics and multi-solvers, nonlinear stellar pulsation, and turbulence research.