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## High order finite difference methods for wave propagation in discontinuous media

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**Abstract:**
In many applications, like general relativity, seismology and acoustics, the underlying equations are systems of second order hyperbolic partial differential equations. However, with very few exceptions, the equations are rewritten and solved on first order form. There are three obvious drawbacks with this approach, namely 1. We double the number of unknowns, 1. We might introduce spurious oscillations (due to unresolved features), and 1. We need twice as many grid points (both in time and in each of the spatial dimensions) to obtain the same accuracy. The reasons for solving the equations on first order form are probably due to the fact that computational methods for first order hyperbolic systems are very well developed, and they are naturally more suited for complex geometries. In this talk we present high order finite difference approximations that have been derived for the second order wave equation with discontinuous coefficients, on rectangular geometries. The discontinuity is treated by splitting the domain at the discontinuities in a multi block fashion. Each sub domain is discretized with compact second derivative summation by parts operators and the blocks are patched together to a global domain by using the projection method. This guarantees a conservative, strictly stable and high order accurate scheme. The analysis is verified by numerical simulations in two spatial dimensions. The extension to more complicated problems, including complex geometries is an ongoing project and will be discussed.

**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.