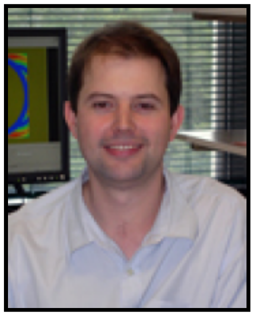

CCT Colloquium Series

Advances in Wave Propagation with the Discontinuous Galerkin Method

Tim Warburton, Rice University

Assistant Professor, Department of Computational and Applied Math

Johnston Hall 338
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Abstract:
A range of important features relating to the practical application of discontinuous Galerkin (DG) method for wave propagation will be discussed. Recent investigations of the spectral properties of the discrete discontinuous Galerkin operators have revealed important connections with their continuous Galerkin counter parts. Theoretical and numerical results will be shown which demonstrate the correct asymptotic behavior of these methods and controls spurious solutions under mild assumptions. Given the suitability of DG for solving Maxwell's equations and their ability to propagate waves over long distance, it is natural to seek effective boundary treatments for artificial radiation boundary conditions. A new family of far field boundary conditions will be introduced which gracefully transmit propagating and evanescent components out of the domain. These conditions are specifically formulated with DG discretizations in mind, however they are also relevant for a range of numerical methods. There is an Achilles heel to high order discontinuous Galerkin methods when applied to conservation laws. The methods are typically constructed with polynomial field representations and unfortunately these suffer from excess maximum gradients near the edges of elements. I will describe a simple filtering process that allows us to reduce these anomalous gradients and provably yield a dramatic increase in the maximum allowable time step. Finally, I will discuss progress in using a posteriori error estimates for mesh adaptivity and demonstrate guaranteed error reduction on refinement for some model (static) problems. These results indicate a need for very fine local refinement of meshes to accurately capture solution singularities. I will show a very simple approach for local time stepping with discontinuous Galerkin methods in order to practically use such meshes in time-domain computations.

Speaker's Bio:
Tim Warburton started his academic career as an undergraduate at Oxford University studying maths. Subsequently he studied for a PhD, advised by Karniadakis, in the Division of Applied Math at Brown University. His thesis work focused on the development of high order finite element methods for computational fluid dynamics. After post doctoral stints in the Computing Laboratory at Oxford University, and with Hesthaven at Brown University he spent three years as an assistant professor in the Department of Mathematics and Statistics at the University of New Mexico. Tim is currently an assistant professor in the Department of Computational and Applied Math at Rice University. Over the last decade Tim has developed and analyzed discontinuous Galerkin methods for the time-domain Maxwell's equations. He has recently extended this research agenda to include the development of high order, local artificial radiation boundary conditions to provide closure for external scattering simulations. Tim's work has been funded by the AFOSR, ARO, NSF ITR, NSF DMS, and Sandia National Laboratory. He has also contributed to the development of the Nektar, USEMe, and Sledge++ software for high order finite element and discontinuous Galerkin methods on unstructured and mixed element meshes.