Applied Mathematics

CRM-McGill Applied Mathematics Seminar

April 2, 2006, 2:35 pm Monday
At McGill, Burnside Hall 1205

"Mimetic Finite Difference Methods"

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Coffee and refreshments will be served after the seminar

Abstract:

Mimetic Finite Differences (MFD)are relatively new numerical techniques that have already been applied to the solution of problems of continuum mechanics, electromagnetics, gas dynamics and linear diffusion. They may be classified as standing in between Mixed Finite Element Methods and Finite Volumes. The idea behind MFD is to define the discrete operators by imposing that the essential properties of the underlying differential operators are preserved. For instance, when applied to linear diffusion problems written in mixed form, the discrete (mimetic) differential operators are defined so that the Green's formula holds at the discrete level. In this way, conservation laws and solution symmetries are embedded in the method. A crucial property of MFD is that very general polyhedral mesh elements can be handled, allowing for non-convex, degenerate polyhedrons, and polyhedrons with curved faces. The flexibility in the mesh design gives an obvious advantage in the treatment of complex solution domains and heterogeneous materials. Moreover, allowing non-matching, non-convex mixed types of elements facilitates adaptive mesh refinement, particularly in the coarsening phase, making it a completely local process. The talk will overview the definition and features of MFD concentrating on linear diffusion problems. We shall demonstrate through extensive numerical examples the flexibility of the method, and present our recent analysis on the method's superconvergence properties and their use in a-posteriori error estimation. Finally, we shall outline recent developements on the extension of the method to the stable solution of convection-dominated diffusion problems.