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DISCONTINUOUS GALERKIN METHODS IN SOLID MECHANICS

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Abstract. Some problems in Solid and Structural mechanics require special care when analyzed via finite element approximations. Typical examples are problems that involve kinematic constraints, such as in incompressible elasticity or Reissner-Mindlin plate models, and problems involving moving boundaries, such as evolving cracks, phase transition interfaces or shape optimizations. Nonlinearities in the material behavior only exacerbate these difficulties, and immediately rule out many of the proposed solutions.
In this talk I will show how under these circumstances Discontinuous Galerkin methods provide an attractive and advantageous alternative. The overarching idea I will convey is that by relaxing the constraint of having continuous displacements across element boundaries, Discontinuous Galerkin methods are able to impose other kinematic constraints in the problem and still provide accurate solutions. I will demonstrate it by showcasing the performance of a class of Discontinuous Galerkin methods we introduced in a variety of circumstances. First, in nonlinear elasticity problems involving different kinematic constraints. Second, in a class of immersed boundary methods, which sidestep the need for automatic remeshing in problems with evolving boundaries by embedding the boundary in any mesh. And finally, in the accurate solution of the stress and displacement fields around cracks when cracks are "embedded" in the mesh, as in extended finite element methods. In all cases I will comment on recent convergence results we obtained. I will conclude the talk by briefly commenting on an adaptive stabilization technique we created to enhance the robustness of the method in highly nonlinear problems. Some of these ideas carry over to a wider variety of popular methods in Solid Mechanics, such as Enhanced Strain Methods.