Dynamically Adaptive Refinement for Multiphysics and Multiscale Modeling

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Abstract: Except for a few relatively simple cases, a majority of multiphysics problems are very challenging for numerical modeling because most of them involve multi-spatial and temporal scales, which can vary over several orders of magnitude. Since the numerical modeling of multiphysics problems requires not only an accurate solution of all the individual physical fields involved, but also an accurate coupling of all these different physical fields, the multiscale problem has to be addressed in a coupled and often combined simulation. In such a simulation, the multi-spatial scales due to small geometrical features and fast spatial variations of the physical fields can be resolved either through fine geometrical meshes (*h*-refinement) or high polynomial orders (*p*-refinement). Similarly, the multi-temporal scales due to the complicated coupling and interaction of different physical fields can be resolved using either small time step sizes or high-order integration schemes. However, because of the dynamic nature of the physical fields and their interaction, the fast varied fields can evolve and propagate in both space and time. Consequently, both spatial and temporal refinements have to be performed in a dynamic fashion to achieve the best efficiency with a guaranteed accuracy. In this talk, we will discuss this problem and use the discontinuous Galerkin time-domain method as an example to illustrate the concept of dynamically adaptive refinement to tackle time-varying multiscale problems in highly challenging multiphysics modeling.

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