High Order Semi-Implicit Time Discretization and Local Discontinuous Galerkin Methods for Phase Field Models

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In this talk, we present the local discontinuous Galerkin (LDG) methods for a series of phase field models. The phase field models are PDEs containing high order spatial derivatives, which leads to the severe time step restriction of explicit time discretization methods to maintain stability. Due to this, we introduce semi-implicit first order time discretization methods which are based on the convex splitting principle of a discrete energy and prove the corresponding unconditional energy stabilities. To improve the temporal accuracy, a novel high order semi-implicit Runge-Kutta method and a novel semi-implicit spectral deferred correction (SDC) method combining with the first-order convex splitting method are adopted for the phase field models. The equations at the implicit time level are nonlinear and we employ an efficient nonlinear multigrid solver to solve the equations. Numerical results are also given to illustrate that the combination of the LDG method for spatial approximation, high order semi-implicit time marching methods with the multigrid solver provides an efficient and practical approach when solving the phase field models.