An Adaptive Newton Div-Curl Least-Squares Finite Element Method for the Cahn-Hilliard Equation

Chad Westphal
Wabash College, USA

In this talk we present recent results on a new least-squares finite element approach for the Cahn-Hilliard equation for binary phase separation. As a fourth-order evolution equation derived from the gradient flow of an energy functional, the Cahn-Hilliard equation remains a computationally challenging nonlinear problem which is fundamental in a wide range of applications. We discretize in time with both implicit backward Euler and Crank-Nicolson, and in space we use a least-squares reformulation and an outer Newton-like linearization at the continuous level to define a well-posed sequence of div-curl systems. Numerical results show promising results: quadratic convergence of the nonlinear iteration in a small number of steps, and optimal discretization convergence rates with respect to both time and space. Adaptivity in time and space, mass conservation, and energy dissipation are also detailed for a range of test problems.