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A superconvergent local discontinuous Galerkin method for the sine-Gordon equation.

In this talk, we present a superconvergent and energy-conserving local discontinuous Galerkin (LDG) method for the sine-Gordon equation. We prove the L^2 stability, the energy conserving property, and error estimates for the LDG scheme. The L^2 errors are shown to converge with the optimal order $O(h^{p+1})$, when piecewise polynomials of degree at most p are used. We further identify a special numerical flux and a suitable projection of the initial conditions for the LDG scheme to prove superconvergence toward particular projections of the exact solutions. We apply our superconvergence results to prove that the significant parts of the discretization errors for the LDG solution and its spatial derivative are proportional to (p+1)-degree right and left Radau polynomials, respectively. This result is used to construct asymptotically exact a posteriori error estimates by solving a local steady problem on each element. Finally, we prove that these a posterior error estimates for the solution and its derivative converge to the true spatial errors in the L^2-norm under mesh refinement. Several numerical results are presented to validate the superconvergence results and the asymptotic exactness of our a posteriori error estimates under mesh refinement. (Received January 16, 2016)