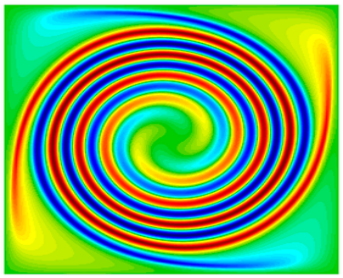
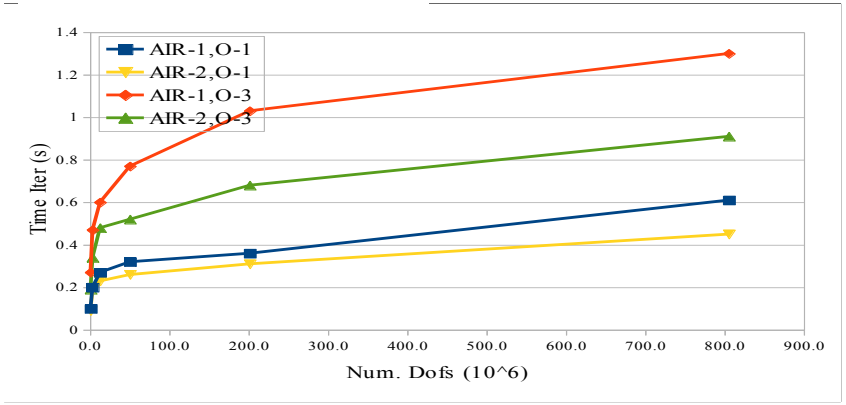
A New Algebraic Multigrid Solver for Nonsymmetric Problems



Using pAIR to solve non-symmetric linear systems from a time-dependent advection equation (solution pictured), discretized by DG (order 1 and 3) using MFEM.



Weak scalability (up to 16384 cores) of pAIR (with AMG restriction distance 1 and 2) for DG advection problem. Standard AMG, if combined with GMRES, can only solve the two smallest problems, but is much (~4x,~8x) slower.

Scientific Achievement

Developed new algebraic multigrid (AMG) method, pAIR (parallel Approximate Ideal Restrictions), capable of solving highly non-symmetric problems that conventional AMG methods are unable to solve or only solve poorly; integrated the new methods in hypre.

Significance and Impact

Nonsymmetric advection dominated problems, occurring e.g. in transport, often present a challenge for algebraic multigrid methods. The new AMG method enables significantly faster solution.

Research Details

pAIR is a localized multigrid reduction method that approximates the ideal restriction from a local neighborhood and uses a low-complexity interpolation. It has been implemented in hypre and tested on various nonsymmetric problems, leading to significant speedups and solving some problems that could not be solved with AMG before.

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Work was performed at LLNL