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**Non-Galerkin Coarse-Grid Operators for Parallel
Algebraic Multigrid**

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While algebraic multigrid (AMG) has been effectively implemented for parallel machines, challenges remain, especially when moving to exascale. In particular, as problem size and the corresponding number of multigrid levels both increase, it is typical for the density of coarse-grid operators to also increase. This coarse-grid fill-in is a result of the standard Galerkin coarse-grid operator, $A_{coarse} = P^T A P$, where P is the prolongation (i.e., interpolation) operator. This triple matrix product can increase the density by coupling most distance-two and many distance-three connections in the graph of A . The result is that as problem size increases, denser coarse-grid matrices are produced, and the communication pattern and overall parallel AMG scheme become less efficient. To address this, we consider a general stencil collapsing technique that eliminates non-zeros in the Galerkin operator. The chosen sparsity pattern is based on distance-two connections in the graph of A . The collapsing technique is general, in that it can be adjusted to the specific problem type through user-provided near nullspace modes, e.g., the constant for diffusion and rigid-body-modes for elasticity. The resulting method produces a non-Galerkin coarse-grid and is effective at controlling coarse-grid density and maintaining good AMG convergence rates. The talk concludes with supporting parallel numerical results.