

Toward efficient solvers using block-epsilon circulant preconditioning on modern integrated CPU-GPU systems

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This work explores an efficient parallel implementation of block epsilon-circulant (BEC) preconditioning for time-dependent partial differential equations (PDEs). BEC preconditioning delivers fast and mesh-independent convergence for block-Toeplitz-type space-time linear systems arising from all-at-once discretization and shares the same context of the ParaDiag method. This work focuses on implementation optimization on the recently introduced integrated CPU-GPU systems, particularly the NVIDIA Grace-Hopper Superchip (which integrates CPU and GPU memory and features seamless interconnect via NVLink-C2C). The two dominant kernels, which are one-dimensional FFTs and complex-valued linear solvers, are expected to accelerate on these systems. Numerical experiments present strong scaling and parallel performance for 2D diffusion or advection-diffusion problems.