GenEO Spectral Coarse Space
Robust Preconditioner and Coarse Model

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Abstract: Computer simulations have become a vital tool in science and engineering, necessitating the efficient solution of partial differential equations on modern parallel computing architectures. The go-to approach for speeding up such solvers is preconditioning. However, a preconditioner's effectiveness depends highly on the problem's structure.

In many real-world engineering problems, particularly in aerospace applications, the simulation of modern composite materials introduces strong anisotropies and parameter contrasts. Those lead to many preconditioners becoming inefficient or even entirely useless.

In the past, such issues have been overcome by constructing hand-crafted problem-specific preconditioners exploiting prior knowledge about the individual simulation problem. This is clearly neither an efficient nor a generally applicable approach.

The topic of this talk is the GenEO coarse space which automatically extracts relevant structure from a given problem by solving eigenproblems on each subdomain of a domain decomposition. In conjunction with a Schwarz type preconditioner, this leads to a highly scalable method that is robust with respect to parameter contrasts and anisotropies, without requiring any user intervention.

Further, the automatic computation of the most relevant components of a problem makes the GenEO space an interesting choice in multiscale applications, allowing to reduce a strongly structured problem to a far smaller number of degrees of freedom.

A modular high-performance implementation in the DUNE framework will be presented as well as a real-world large-scale aerospace application simulating carbon fiber materials.

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