6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Efficient Iterative Solution of Anisotropic and Heterogeneous Problems with Applications to Composite Materials

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Keywords: *Heterogeneous Problems, High Performance Computing, Multiscale*

Finite element (FE) analysis has become a vital tool in science and engineering. However, the efficiency of solving FE problems depends strongly on the properties of the underlying partial differential equation. While methods allowing to solve large-scale FE problems in modern high-performance environments are well-established, the traditional approaches become inefficient or even break down entirely for strongly heterogeneous problems and anisotropies.

Recent developments in composite materials demand the efficient solution of such problems. Furthermore, fast methods are vital particularly when applying uncertainty quantification methods.

The topic of this talk is the GenEO spectral coarse space [1] which can be used to either construct preconditioners that perform well in these situations or to generate efficient coarse representations in multiscale applications.

A highly scalable implementation in the DUNE numerical framework will be presented as well as numerical results confirming the preconditioner's robustness. Finally, results from a real-world large-scale application in aerospace engineering [2] demonstrate the practical applicability.

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