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

FAST SPECTRAL SOLVERS WITHOUT LINEAR REFERENCE MEDIUM

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Key words: *Computational Homogenization, High Contrast, FFT*

In the field of computational homogenization of periodic representative volume elements (RVE), over the last two decades, fast Fourier transform (FFT)-based spectral solvers have emerged as a promising alternative to the finite element method (FE). Most of these spectral methods are based on the work of Moulinec and Suquet [1] and split an RVE's mechanical response into the response of a linear reference medium and a periodic fluctuation due to heterogeneities. The main advantage of this formulation over FE is that it can be both significantly faster and have a much smaller memory-footprint. The two main problems are 1) the choice of the linear reference medium, which is typically based on heuristics, is not trivial and has a strong impact on the method's convergence (A bad choice can render the method non-convergent), and 2) convergence is not necessarily uniformly. Numerous studies have suggested mitigations to both of these problems (e.g. [2]), but they have remained substantial disadvantages compared to the more expensive, but also more robust FE.

Recent work by Zeman et al. [3] proposes a new formulation for spectral solvers which dispenses with the linear reference problem and converges unconditionally. We present μSpectre, an open HPC implementation of this novel method and use it to show that the new approach is much more computationally efficient than its linear reference medium-based predecessors, converges in the presence of arbitrary phase contrast - including porosity - without Gibbs ringing artifacts.

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