Proposition de post-doc FMJH en "Mathématiques du calcul scientifique et de l'ingénierie"

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Title: Multiscale approaches for Optimizing Materials Microstructures

Applied Motivation for the Research: Customized Materials

Keywords: multiscale problems, multiscale finite element methods, microstructure optimization, homogenization, reduced models, material design, microstructure control, architectured materials

The team has extensive expertise in developing and implementing numerical simulation methods dedicated to multiscale problems. In such a context, a single solution to the problem already requires considerable computational time; therefore, an optimization loop requiring a series of successive solutions for varying parameters describing the characteristics of the medium may be computationally prohibitively expensive. The focus of the proposed postdoc position will be to explore how to numerically adjust the parameters of a microstructure to optimize the macroscopic response of the material under consideration. The model problem chosen will be the diffusion equation with a heterogeneous, multiscale diffusion coefficient, in order to address the practical issue of improving thermal conductivity; however, there is no reason to believe that other physical phenomena (such as those modeled by hyperbolic equations, for example) could not eventually be studied. In practice, the equation will be simulated using multiscale finite element methods (MsFEM), and the goal of the work will be to understand how best to precompute in an off-line stage a set of microstructures for subsequent use in an online, optimization loop that identifies, in silico, the best candidate materials for performance optimization.

This work will build on a series of studies already conducted by the team, including several doctoral theses and postdoctoral research projects. Scientific supervision may involve Frédéric Legoll (Laboratoire Navier, Ecole des Ponts).

Examples of recent related publications

• C. Le Bris & F. Legoll, *Examples of computational approaches for elliptic, possibly multiscale PDEs with random inputs*, Journal of Computational Physics, 328 (2017), pp 455 - 473

• R. Biezemans, C. Le Bris, F. Legoll & A. Lozinski, *Non-intrusive implementation of Multiscale Finite Element Methods: an illustrative example*, Journal of Computational Physics, 477 (2023) 111914

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