Variance reduction approaches to control the fluctuations in random heterogeneous media

Frederic LEGOLL*

* Ecole des Ponts (Laboratoire Navier) and INRIA (MATHERIALS project team)
77455 Marne La Vallée, France
e-mail: frederic.legoll@enpc.fr, web page: http://navier.enpc.fr/LEGOLL-Frederic

ABSTRACT

Computing the homogenized properties of random materials is often very expensive. The full-field approach consists in considering a large RVE, and solving the equilibrium problem on that RVE, submitted to e.g. periodic boundary conditions. Because the RVE is finite, the obtained apparent effective properties are random, and therefore fluctuate from one realization of the microstructure to another.

We have recently introduced several efficient numerical approaches to reduce the statistical noise. These approaches allow to compute the expectation of the effective coefficients (for a given RVE size) in a more efficient manner than brute force Monte Carlo methods. They are often based on the use of a surrogate model, simple enough to allow for inexpensive computations, and close enough to the reference problem to improve the overall efficiency of the computational approach [1,2].

Besides the (averaged) behavior of the material response on large space scales (which is given by its homogenized limit), another question of interest is to understand how much this response fluctuates around its coarse approximation. More generally, we aim at understanding which parameters of the distribution of the material coefficients affect the distribution of the response, and whether it is possible to compute that latter distribution without resorting to a brute force Monte Carlo approach.

This talk, based on joint works with S. Brisard, C. Le Bris and P.-L. Rothé, will review the recent progresses made on these questions.

REFERENCES

[1] C. Le Bris and F. Legoll, “Examples of computational approaches for elliptic, possibly multiscale PDEs with random inputs”, *Journal of Computational Physics*, **328**, 455-473 (2017).

[2] X. Blanc, C. Le Bris and F. Legoll, “Some variance reduction methods for numerical stochastic homogenization”, *Philosophical Transactions of the Royal Society A*, **374**, 20150168 (2016).