Numerical homogenization methods for long time wave propagation in locally periodic media

Author and Presenter:

Timothée Pouchon (EPF Lausanne, Switzerland)

Co-author:

Assyr Abdulle (EPF Lausanne, Switzerland)

Abstract: The approximation of the wave equation in heterogeneous media is challenging. Indeed, to be accurate, standard numerical methods require a grid that resolves the fine scale of the medium, leading to a prohibitive cost. Homogenization theory provides an effective equation that does not depend on the fine scale. Based on this equation, numerical homogenization methods approximate the effective wave at an affordable cost. However, at large timescales, the original wave exhibits a dispersive behaviour at the macroscopic scale, which is not captured by the homogenized equation.

In this talk, we introduce a family of effective equations that describe these long time effects in locally periodic media [3, 4]. Based on these effective models, we design efficient numerical homogenization methods for long time wave propagation. Furthermore, we provide a long time a priori error analysis of the finite element heterogeneous multiscale method, proposed in [1, 2], for locally periodic media.

References

[1] A. Abdulle, M.J. Grote, and C. Stohrer. *FE heterogeneous multi-scale method for long-time wave propagation*, C. R. Math. Acad. Sci. Paris, **351**:495-499, 2013.

[2] A. Abdulle and T. Pouchon. *A priori error analysis of the finite element heterogeneous multiscale method for the wave equation over long time*, SIAM J. Numer. Anal., **54**:1507-1534, 2016.

[3] A. Abdulle and T. Pouchon. *Effective models for the multidimensional wave equation in heterogeneous media over long time and numerical homogenization*, Math. Models Methods Appl. Sci., **26**:2651-2684, 2016.

[4] A. Abdulle and T. Pouchon. *Effective models for long time wave propagation in locally periodic media*, To appear, 2017 .