STAN

OR5 : Wave propagation and vibration dynamics for complex media

Activities

The objective of this research operation is to develop modelling and simulation methods for wave propagation phenomena in various complex media and for vibration dynamics. The complex propagation media to be considered can be of very different natures and scales: heterogeneous and anisotropic media such as polycrystalline materials; periodic or quasi-periodic media such as photonic crystals, metamaterials, or railways; problems arising from the coupling of propagation media of different natures, such as vibroacoustics.
The research efforts focus both on the development of reliable and efficient dedicated numerical modelling/simulation tools and on the application of these tools in order to propose an accurate and relevant analysis of the physical phenomena to be identified and quantified, as well as the underlying mechanisms involved.
Concerning the implementation of numerical tools, the aim is to develop solvers capable of simulating the propagation of broadband waves (MF and HF) and taking into account the multi-scale aspects of the propagation media. Both temporal (FEM, DGM, SEM, ...) and frequency (TVRC, SAFE, ...) approaches are considered. Parallel computation, a judicious coupling between the two types of temporal and frequency solvers, the application of model reduction methods (PGD, modal reduction, ...), constitute avenues to be exploited in order to develop a set of efficient algorithms/solvers for the direct or inverse resolution of wave and vibration problems.
Several fields of application are at the heart of the research work developed within this OR: non-destructive ultrasonic testing of polycrystalline materials or synthetic biological tissues, with the aim of characterising microstructures by waves and detecting defects; analysis of the effectiveness and design of phononic crystals or metamaterials with regard to wave attenuation and filtering; assistance in the design of devices for attenuating noise generated by train traffic on railways; vibratory and transient studies of aerospace and railway structures.

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