POLITECNICO DI TORINO

DISMA Dipartimento di Scienze Matematiche G. L. Lagrange

ECCELLENZA 2018 · 2022

Tuesday the 05 March 2019 at 10:30
Politecnico di Torino, DISMA, Aula Buzano (third floor)

Francesco BONALDI

Post-doctoral Researcher at MOX - Politecnico di Milano

Simulation of the elasto-acoustic coupling by a discontinuous Galerkin method on general meshes

Prof. Davide Carlo Ambrosi introduces the seminar

Abstract

This talk is focused on the development and analysis of a discontinuous Galerkin (dG) method on polygonal and polyhedral grids for the space discretization of an evolution problem modelling the coupled propagation of (visco)elastic and acoustic waves. Coupled elasto-acoustic wave propagation arises in several scientific and engineering contexts. In a geophysical framework, a first example one can think of is given by seismic events occurring near coastal environments; another important situation, where such a problem plays a major role, is the detection of underground cavities. Such coupling occurs in structural acoustics as well, when sensing or actuation devices are immersed in an acoustic fluid, and also in medical ultrasonics.

The reason for using polyhedral elements derives from the irregular geometry of the computational domain one has to deal with in practical applications. Indeed, considering a conforming triangulation would be computationally very expensive in those cases. On the other hand, using polyhedral elements the mesh generation process becomes far less demanding in terms of computational resources, and geometrical constraints can be reproduced to a reasonable extent of accuracy. No restriction is imposed on the number of faces each element can possess, and face degeneration under mesh refinement is allowed as well.

In the first part of this presentation, Dr Bonaldi will quickly outline the ideas for the proof of the existence and uniqueness of the solution in the continuous setting. Then, he will introduce the discrete framework, with a particular focus on the hypotheses on polyhedral grids, and will show a stability result for the semi-discrete problem in a suitable energy norm. Finally, he will provide hp-convergence results (with h et p denoting, as usual, the mesh size and the polynomial degree) for the error in the same energy norm. Besides, Dr Bonaldi will present numerical experiments in a two-dimensional setting to validate the theoretical results. In addition to convergence tests, a simulation of the effects of a point seismic source in the acoustic domain will be showcased as well.

In the second part, Dr Bonaldi present validation results in a three-dimensional context. He will first discuss numerical experiments that show the convergence of the method in both mathematical and physical test cases (hp-refinements in both conforming and nonconforming cases, and propagation of Scholte waves). Then, he will present a simulation of a point seismic source near a spherical underground cavity. In all of these cases, computations have been carried out thanks to code SPEED (http://speed.mox.polimi.it), jointly developed at MOX (Laboratory of Modeling and Scientific Computing) and DICA (Dipartimento di Ingegneria Civile e Ambientale), Politecnico di Milano.

This is joint work with Paola F. Antonietti and Ilario Mazzieri (MOX, Politecnico di Milano).

Biography

Francesco Bonaldi received his PhD in 2016 from the University of Montpellier, under the joint supervision of Giuseppe Geymonat (Ecole Polytechnique), Françoise Krasucki (Montpellier), and Marina Vidrascu (INRIA Paris). After a postdoctoral appointment working on Hybrid High-Order methods with Daniele A. Di Pietro (Montpellier), he moved to MOX, Politecnico di Milano in 2017 where he joined the SPEED group and where he is currently working as a postdoctoral fellow under the supervision of Paola F. Antonietti. From a general viewpoint, his scientific interests lie at the interface between Applied Mathematics and Continuum Mechanics, with a focus on multiphysics problems. Recently, he has been developing an interest in high-order nonconforming numerical methods, with applications to thin structures and the elasto-acoustic coupling.

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