UME Seminar

Some recent developments in high-order PDE solvers with minimal numerical pollution errors for time-dependent waves & transport in solids, fluids & their interactions

applications to geophysics & biomedicine

Dr. Faisal Amlani
LMPS, ENS Paris-Saclay

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Amphi 104 - Pôle Mécanique
Seminar webpage link

Abstract

This talk surveys recent efforts to study a variety of time-dependent wave propagation and transport phenomena via the development of fast, high-order solvers for their corresponding hyperbolic and parabolic partial differential equations (PDEs). The underlying framework is based on an "extension" approach for the high-order trigonometric interpolation of non-periodic functions (i.e., mitigating the notorious Gibbs "ringing" effect), enabling stable, explicit, FFT-speed solvers on general geometries that faithfully preserve the dispersion and diffusion characteristics of the underlying continuous operators (i.e., incurring essentially no numerical pollution errors over long distances and long times). Some recent developments in the construction of such interpolations are briefly discussed, including new discrete constructions as well as a newly-introduced (more general) continuous framework based on smooth transition (blend-to-zero) operators, from which matrix-free extensions follow.
Such solvers additionally serve as scientific computing tools for investigating physical mechanisms that require faithful resolution over long distances and long times. With an eye towards mutual validation of both simulation and experiment, their efficacy is demonstrated herein through some of the collaborative problems that have inspired them, including those in geophysics (dynamic earthquake effects on tsunami generation) and those in biomedicine (closed-loop cardiovascular hemodynamics, physiological transport, and ongoing efforts towards patient-specific digital twins, where such solvers act as forward models within PDE-constrained optimization).

About the speaker

Faisal Amlani is a CNRS researcher at the Laboratoire de Mécanique Paris-Saclay (LMPS). His research focuses on applied mathematics and computational mechanics, specializing in high-order numerical methods for partial differential equations, reduced-order modelling, wave propagation, and computational physiology.