NEB-21

Contribution ID: **93** Type: **talk**

Symmetric methods for long-time integration of partial differential equations

Thursday 4 September 2025 16:05 (35 minutes)

We explore symmetric and discontinuous integrators for solving partial differential equations (PDEs) over long periods. Explicit solvers are Courant-limited and fail to preserve Noether symmetries, impacting their effectiveness in long-time integration scenarios. We thus explore symmetric (exponential, Padé, or Hermite) integrators, which are unconditionally stable and known to preserve certain Noether symmetries and phase-space volume, making them ideal for long-term computations. For linear hyperbolic or parabolic PDEs, these implicit integrators can be cast in explicit form, making them well-suited for long-time evolution. A matricization technique facilitates integration into a method-of-lines framework, enabling efficient parallelization on CPUs and GPUs.

We demonstrate the unconditional stability, efficiency and accuracy of symmetric methods in black hole perturbations in numerical general relativity and LISA source modelling. We extract Price tails and numerically simulate the Aretakis instability for extremal Kerr black holes. We also introduce methods for modeling discontinuities in linear hyperbolic or parabolic PDEs from distributional sources. In a method-of-lines context, this involves a discontinuous collocation method for spatial differentiation and a novel class of discontinuous time-steppers for temporal integration.

Primary author: Dr MARKAKIS, Charalampos (Stony Brook University & University of Illinois)

Presenter: Dr MARKAKIS, Charalampos (Stony Brook University & University of Illinois)

Session Classification: Afternoon