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High-order conservative and accurately dissipative numerical integrators via finite elements in time

Thursday, 4 April 2024 16:30 (30 minutes)

Numerical methods for the simulation of integrable systems with conservative properties are known to exhibit greater accuracy and physical reliability, in particular over long durations. One important class of schemes is that of Gauss methods, a class of symplectic Runge–Kutta methods. In this talk we propose an alternative, general framework for the construction of conservative schemes via finite elements in time and the systematic introduction of auxiliary variables. For linear problems with quadratic invariants, the scheme is provably equivalent to Gauss methods. However, the alternative framework extends to nonlinear systems with potentially multiple non-quadratic invariants. The framework also allows for the construction of numerical methods that accurately preserve dissipation structures, e.g. energy dissipation in the incompressible Navier–Stokes equations. We demonstrate the ideas by devising novel schemes that exactly conserve all known invariants of Hamiltonian systems with high-order invariants, and mass–and energy–conserving schemes for the compressible Navier–Stokes equations. This talk complements and extends the plenary talk given by Patrick Farrell.

Presenter: ANDREWS, Boris (University of Oxford)