CENTRAL SCHEMES: A POWERFUL BLACK-BOX SOLVER FOR NONLINEAR HYPERBOLIC PDES

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The talk will be focused on non-oscillatory central schemes, which are simple, efficient, highly accurate and robust Godunov-type finite-volume methods for general hyperbolic systems of conservation laws. I will first show their derivation and then several recent applications.

I will first give a brief description of Godunov-type finite-volume methods for general hyperbolic systems of conservation laws. These methods consist of two types of schemes: upwind and central. My lecture will focus on the second type -- non-oscillatory central schemes.

Godunov-type schemes are projection-evolution methods. In these methods, the solution, at each time step, is interpolated by a (generically discontinuous) piecewise polynomial interpolant, which is then evolved to the next time level using the integral form of conservation laws. Therefore, in order to design an upwind scheme, (generalized) Riemann problems have to be (approximately) solved at each cell interface. This however may be hard or even impossible.

The main idea in the derivation of central schemes is to avoid solving Riemann problems by averaging over the wave fans generated at cell interfaces. This strategy leads to a family of universal numerical methods that can be applied as a black-box-solver to a wide variety of hyperbolic PDEs and related problems. At the same time, central schemes suffer from (relatively) high numerical viscosity, which can be reduced by incorporating of some upwinding information into the scheme derivation -- this leads to central-upwind schemes, which will be presented in the lecture.

During the talk, I will show a number of recent applications of the central schemes.