Some New Developments In Spectral Element Methods For Incompressible Flows

Chuanju Xu
School of Mathematical Sciences, Xiamen University, China
cjxu@xmu.edu.cn

In this talk, we present some new developments in spectral element methods (SEM) for the unsteady Navier-Stokes equations. The main ingredients include: 1) a fast $P_N \times P_N$ spectral element solver using preconditioned Schur complement algorithm for the Navier-Stokes equations, and detailed comparison and discussion of some new approaches. The link of different methods will be clarified. The key feature of our method is that only one grid is needed for the velocity and pressure approximations. Although not yet proven by rigorous theoretical analysis, the stability and accuracy of this simple method are demonstrated by a series of the numerical experiment. 2) an efficient stabilization method, which consists in employing SVV technique in the standard SEM for accurate computations of high-Reynolds number flows. Our new formulation yields an algorithm which can be easily implemented and does not require additional computational time. 3) applications of the Legendre-SVV-SEM to the LES of turbulent flows. The SVV-SEM is used as a no-model approach, i.e. no modeling of the sub-grid scale tensor which results from the spatial filtering of the Navier-Stokes equations. Some simulation in the 3D driven cavity flow and the wake flow behind a circular cylinder give very satisfactory results.