

## Enabling Incompressible Flow Simulations with Large Time Step Sizes

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Friday, February 5, 2010  
3:00 pm in Birck 1001

**Abstract:** In practical flow simulations the time step size is usually chosen based on considerations of accuracy and stability. The maximum time step size that can be used is oftentimes restricted by stability, which is especially the case as Reynolds number becomes large. With the often-used semi-implicit schemes, in which the nonlinear term of the Navier-Stokes equations is treated explicitly and the viscous term implicitly, at high Reynolds numbers the maximum allowable time step size dictated by the CFL number can be orders of magnitude smaller than the Kolmogorov time scale, which is the smallest time scale in turbulence. Therefore, the time step sizes with semi-implicit type schemes widely employed in current flow simulations can be overly small to be computationally efficient. On the other hand, fully implicit schemes exhibit favorable stability properties, but entail the iterative solution of nonlinear algebraic equations, rendering the overall approach less desirable.

In this talk I will discuss a new linearly implicit numerical scheme that allows the use of large time step sizes, one to two orders of magnitude larger than the maximum allowable time step size with semi-implicit type schemes. Some notable features of the scheme include: (1) it is a splitting type scheme, decoupling pressure and velocity solves; (2) it requires solving a linear convection-diffusion equation at each time step, involving no nonlinear algebraic solves. Several flow problems will be used to compare the time step sizes and computational cost between the new scheme and the semi-implicit scheme. This is a joint work with J. Shen.

**Bio:** Steven Dong is an assistant professor in the department of mathematics at Purdue University. His research interests include high-order methods and time integration algorithms for simulations of flows/structures and their interactions, turbulence problems and pattern formations, and high performance computing. Contact him at [sdong@math.purdue.edu](mailto:sdong@math.purdue.edu), or visit <http://www.math.purdue.edu/~sdong/> for more information.

