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Vortices for computing: the engines of turbulence simulation

Vortices have been described as the "sinews of turbulence" (Moffatt et al., 1994). They are also, increasingly, the computational engines driving numerical simulations of turbulence. In this talk I describe some recent advances in vortex-based numerical methods for simulating high Reynolds number turbulent flows. I focus on coherent vortex simulation (CVS), where nonlinear wavelet filtering is used to identify and track the few high energy multiscale vortices that dominate the flow dynamics. This filtering drastically reduces the computational complexity for high Reynolds number simulations. It also has the advantage of decomposing the flow into two physically important components: coherent vortices and background noise. In addition to its computational efficiency, this decomposition provides new insight into the structure and dynamics of high Reynolds number turbulence.