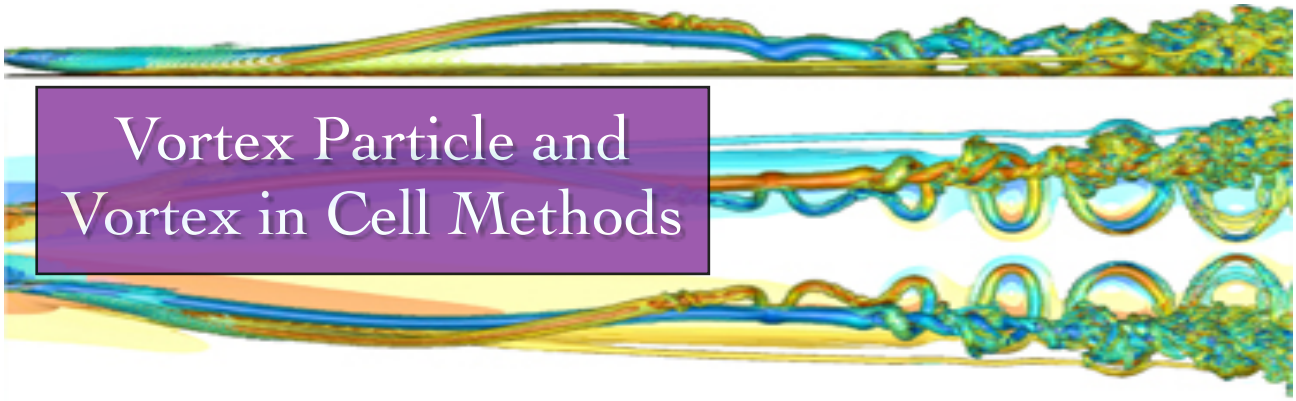
Third European SCAT Workshop & Summer School
in partnership with IRPHE and CNRS

"Vortices and Vortex Sheets: theories, numerics and applications"



One of a series of mini-courses taking place 4-10 June 2007, Centre IGESA

Description

The course will present both the theoretical and practical aspects of simulating unsteady 3-D incompressible vortical flows (also turbulent flows) using the "vortex particle" method. The "vortex-in-cell" version of the method is also presented. Those methods can be used for direct numerical simulation (DNS) at moderate Reynolds number and for large-eddy simulation (LES, thus with added subgrid-scale modelling) at high Reynolds number.

Lecturer

Prof Gregoire Winckelmans, Université Catholique de Louvain, Belgium

Syllabus

Basics of the vortex particle method (1 hr)

- Vortex "particles": concept and definition; regularization functions (vortex "blobs"), associated Green's function for the Poisson equation that determines the stream function (also Biot-Savart) and its fast evaluation (using fast multipole methods, also parallel).
- Need for particle "redistribution" in such Lagrangian method: redistribution schemes using a underlying regular lattice.
- Diffusion: the particle strength exchange (PSE) scheme.
- Enforcing the no-slip condition at solid boundaries: evaluation of the required vorticity flux, using a boundary element method (BEM), and distribution of this flux to the neighbor particles.
- Ensuring that the 3-D vorticity field remains divergence free for all times: reprojection scheme.

Vortex-in-Cell (VIC) method (0.5 hr)

- Resolution of the Poisson equation using a fact grid solver.

- What is then Eulerian (stretching, diffusion), what remains Lagrangian (convection).
- VIC method combined with the parallel fast multipole (PFM) method, to allow for efficient large-scale domain decomposition simulations

Example of results (0.5 hr):

- LES of a thin vortex ring at Re=25000: instability, turbulence and decay (Fig. 1).
- Simulation of flow past bluff-bodies: detached eddy simulation (DES) of the flow past a simplified truck in ground effect; LES of the flow past a hemisphere at Re=3000 (Fig. 2).
- Simulations of wake vortices produced by wings; also cases in ground effect: time-developing and space-developing (Fig. 3).

For more information, email info@scat-alfa.eu or visit www.scat-alfa.eu

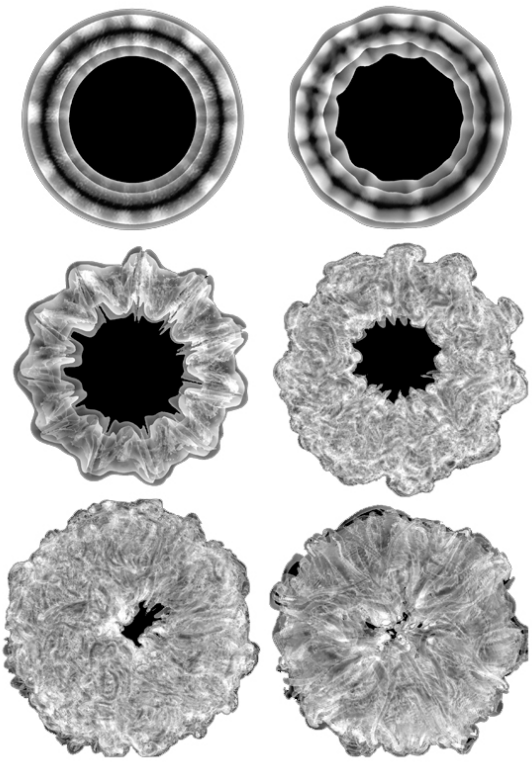


Fig. 1

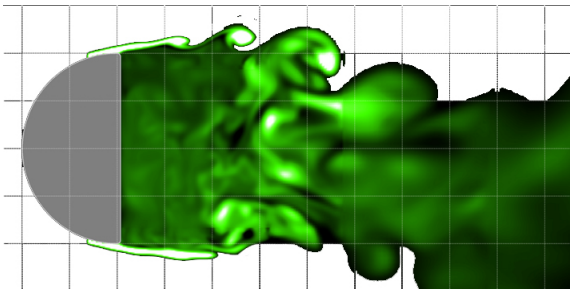


Fig. 2

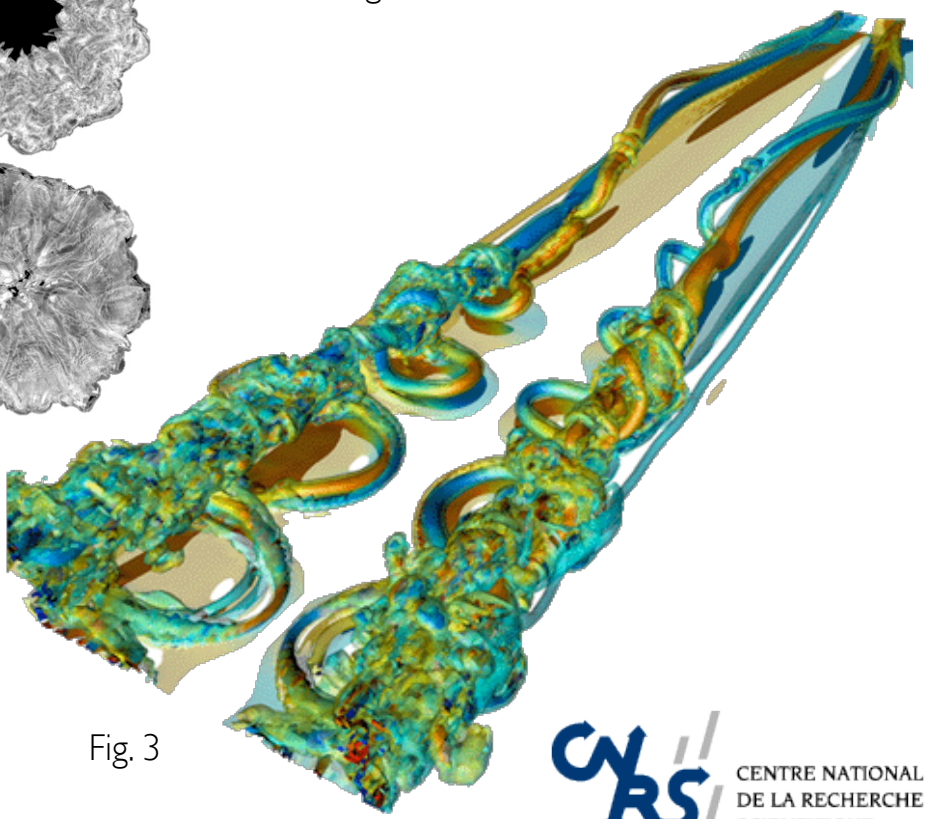


Fig. 3

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A project funded by EuropeAid