Task 2.2.3

Numerical Flowfield Computation by Simplified Methods

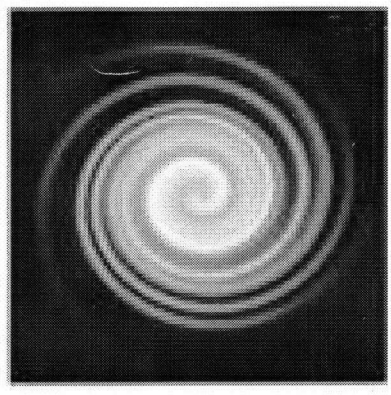
Adaptation of 3D Vortex Filament Methods

D. MARGERIT

A. GIOVANNINI

P. BRANCHER

http://www.maths.warwick.ac.uk/~dmargeri



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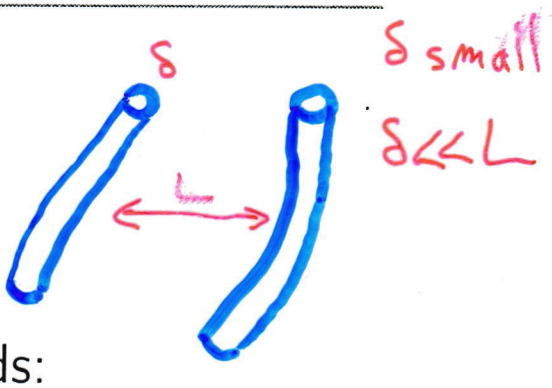
3D Numerical Vortex Method Techniques

1) Slender filament asymptotic equation of motion



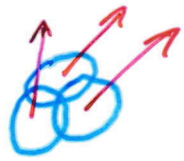
$\Longrightarrow$ Separated Slender Filaments
$\Longrightarrow$ No reconnection

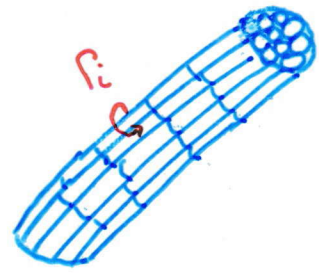
- Ad-hoc desingularization methods:
  An *ad-hoc parameter* has to be chosen.

- Callegari and Ting equation of motion (SIAM 78) :
  Derived from the Navier-Stokes Equations in the small core limit.
  Rem: Viscous or inviscid.

- Exact desingularization methods:
  The ad-hoc parameter is chosen to be equivalent to the Callegari and Ting equation.

2) Vortex Methods





$\Longrightarrow$ Discretisation of the vorticity field with Blobs or Filaments.

- Vortex Blob Methods:
  Equation for the *local strength*

- Vortex Filament Method:
  The local strength is automaticaly given by the link between points

Rem: Viscous diffusion is treated

- by a random walk
- by a deterministic technique

Rem: N-body problem $\Longrightarrow$ Fast solvers

- Vortex-in-Cell Methods
- Other tricks

Implementation of a Slender Vortex Filament Solver

1) Input:

Choice between:

- Initial position of the filaments
- Previous simulation data

2) Solver:

Slender vortex filament solver for *closed* filaments
Choice between:

- The Callegari and Ting Equation of motion
- $\neq$ exact desingularisation methods

3) Output:

- Run-time filaments drawing with OpenGL on a SGI station
- Movie of the simulation
- History data file
- Final condition data file

Movies

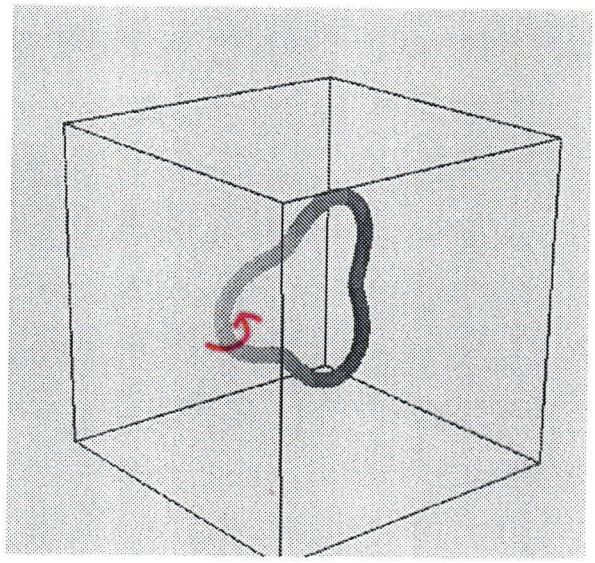


Figure 1:

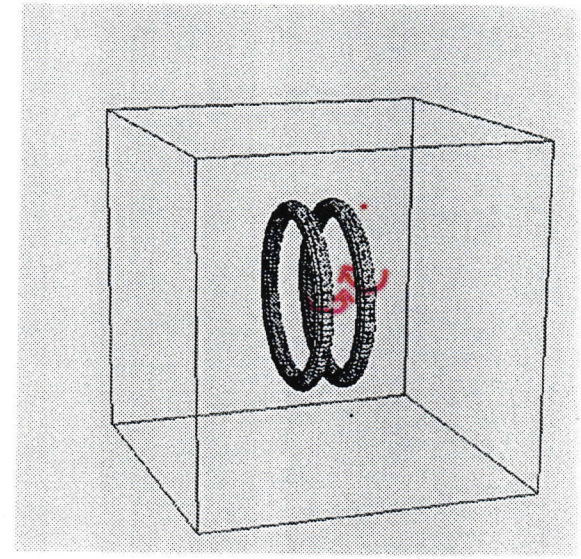


Figure 2:

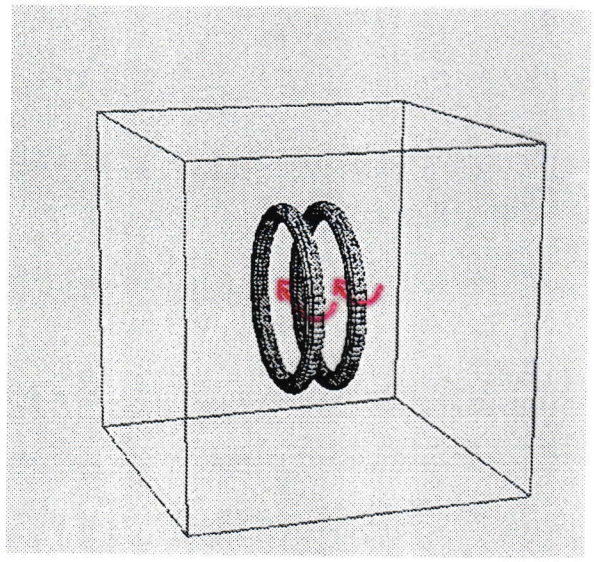
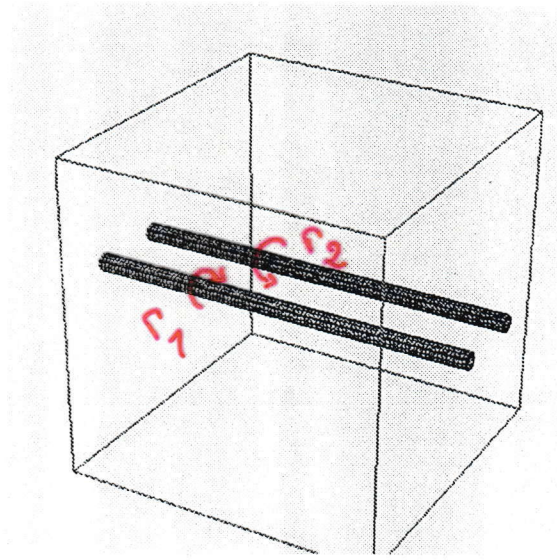


Figure 3:



http://www.maths.warwick.ac.uk/~dmargeri/movie$i$.html

Validation

Validation against a linear stability analysis of a preturbed circular vortex ring.

In progress

- Implementation for *open* filaments
- Validation against the linear stability analysis of two trailing vortices : Γ_1 , Γ_2 $\neq$ core structures.

  $\Longrightarrow$ Slender Vortex Filament Solver : closed or opened filament.
- Implementation of a *Vortex Filament Method*
- Validation against the slender vortex filament solver