



# Vortex Flows and Related Numerical Methods

Edited by

J.T. Beale, G.-H. Cottet and S. Huberson

NATO ASI Series

Series C: Mathematical and Physical Sciences - Vol. 395

# Vortex Flows and Related Numerical Methods

edited by

**J.T. Beale**

Department of Mathematics,  
Duke University,  
Durham, North Carolina, U.S.A.

**G.-H. Cottet**

Laboratoire de Modélisation et Calcul,  
Université Joseph Fourier,  
Grenoble, France

and

**S. Huberson**

Université du Havre,  
Le Havre, France

*291/3608*      INSTITUT  
FÜR METEOROLOGIE U. KLIMATOLOGIE  
UNIVERSITÄT HANNOVER  
HERRENHAUSER STR. 2 - 30419 HANNOVER



**Kluwer Academic Publishers**

Dordrecht / Boston / London

Published in cooperation with NATO Scientific Affairs Division

## Table of Contents

Preface	vii
<b>Mathematical and numerical modeling of incompressible flows</b>	
Local spectral analysis of turbulent flows using wavelet transforms <i>C. Basdevant, V. Perrier, T. Philipovitch and M. Do Khac</i>	1
Operator splitting for Navier-Stokes and Chorin-Marsden product formula <i>J.T. Beale, C. Greengard and E. Thomann</i>	27
Velocity methods: Langrangian numerical methods which preserve the Hamiltonian structure of incompressible fluid flow <i>T.F. Butké</i>	39
Statistical mechanics for the vortex model <i>E. Caglioti</i>	59
On singular solutions of the Vlasov-Poisson equations <i>G. Majda</i>	67
Point vortices and localization in Euler flows <i>C. Marchioro</i>	77
Turbulence modeling for incompressible vortex flow <i>P. Pascual</i>	83
<b>Vorticity generation, wakes and boundary layers in two dimensions</b>	
Investigation of the use of the Prandtl/Navier-Stokes equation procedures for two-dimensional incompressible flows <i>C.R. Anderson and M. Reider</i>	105
Vorticity boundary conditions for the Navier-Stokes equation in velocity-vorticity formulation <i>O. Daube</i>	117
A coupled potential-boundary layer calculation method for unsteady flows around airfoils <i>M. Kermarec, A.F. Decaix, P. Renon, D. Favier and C. Maresca</i>	129
Viscous simulation of wake patterns <i>R. Krasny</i>	145
<b>Contour dynamics and vortex methods</b>	
The vorton methods <i>F. Alkema, F.T.M. Nieuwstadt and E. Van Groesen</i>	153
Numerical simulation of unsteady flows behind cylindrical structures using a finite difference-particle superposition algorithm <i>F. Cassot and S. Huberson</i>	159

Moment accelerated contour surgery <i>D.G. Dritschel</i>	171
Direct numerical simulations using vortex methods <i>P. Koumoutsakos and A. Leonard</i>	179
Numerical study of the motion and deformation of two-dimensional bubbles by a vortex method <i>H. Kudela</i>	191
A hybrid vortex method with deterministic diffusion <i>H.N. Najm</i>	207
A slightly diffusive contour dynamics <i>G. Riccardi and R. Piva</i>	223
<b>Computations of three dimensional incompressible flow</b>	
Model coherent structure dynamics: vortex reconnection, core dynamics and interaction with turbulence <i>F. Hussain and M.V. Melander</i>	239
The nonlinear dynamics of a jet shear layer with swirl <i>E. Meiburg and J.E. Martin</i>	265
Dynamics of vortex tubes in three-dimensional turbulence <i>M. Meneguzzi and A. Vincent</i>	279
Numerical simulation of axisymmetric vortex sheet roll-up <i>M. Nitsche</i>	293
Free vortex rings, analogies and differences between vorticity and a passive scalar <i>P. Orlandi and R. Verzicco</i>	303
<b>Compressible and reacting flows</b>	
Turbulent eddy structures, combustion and chemical reactions <i>J.P. Chollet</i>	315
Vortex generation and evolution in numerical simulation of transitional shear flows <i>P. Comte, E. David, F. Ducros and Y. Fouillet</i>	325
Stability analysis of differentially-heated asymmetric vorticity layers <i>O.M. Knio and A.F. Ghoniem</i>	341
A particle in cell method for the 2-D compressible Euler equations <i>S. Mas-Gallic, M. Louaked and O. Pironneau</i>	373