



A Gallery of Fluid Motion

Edited by M. Samimy, K.S. Breuer, L.G. Leal and P.H. Steen

CAMBRIDGE

A Gallery of Fluid Motion

M. Samimy,

The Ohio State University

K. S. Breuer,

Brown University

L. G. Leal,

University of California at Santa Barbara

P. H. Steen

Cornell University

D III 288

Dk: 551.511.3, 551.510.522, 551.511.6, 551.511.1

352/4214 INSTITUT
FÜR METEOROLOGIE U. KLIMATOLOGIE
UNIVERSITÄT HANNOVER
HERRENHÄUSER STR. 2 · 30419 HANNOVER



CAMBRIDGE
UNIVERSITY PRESS

Contents

The year in which the winning entry was published in *Physics of Fluids* is given in square brackets.

Introduction

1 Jets and mixing layers

- M. M. KOOCHESFAHANI AND P. E. DIMOTAKIS
Laser-induced fluorescence measurements of the composition field in a liquid mixing layer [1986]
- M. GHARIB AND P. DERANGO
Flow studies of a two-dimensional liquid film jet [1988]
- E. VILLERMAUX, H. REHAB, AND E. J. HOPFINGER
Shear instabilities in the near field of coaxial jets [1998]
- D. E. PAREKH, W. C. REYNOLDS, AND M. G. MUNGAL
A bifurcating air jet [1987]
- T. LOISELEUX AND J.-M. CHOMAZ
Breaking of rotational symmetry in a swirling jet experiment [2000]
- T. F. FRIC AND A. ROSHKO
Views of the transverse jet near field [1988]
- S. P. GOGINENI, M. M. WHITAKER, L. P. GOSS AND W. M. ROQUEMORE
Dynamics of jet in cross flow [1995]
- S. WERNZ AND H. F. FASEL
Vortex motion in an unsteady forced wall jet [1996]
- S. GOGINENI, C. SHIH, AND A. KROTHAPALLI
Comparison of transitional free jet and wall jet [1993]

2 Vortices

- J. M. LOPEZ AND A. D. PERRY
Periodic axisymmetric vortex breakdown in a cylinder with a rotating end wall [1992]
- P. KOUMOUTSAKOS AND A. LEONARD
Flow past an impulsively started cylinder [1995]
- M. P. ESCUDIER
Swirling flow in a cylindrical container [1985]

ix	G. J. F. VAN HEIJST, R. C. KLOOSTERZIEL, AND C. W. M. WILLIAMS Formation of a tripolar vortex in a rotating fluid [1991]	15
2	H. HIGUCHI AND H. BALLIGAND Vortex structure behind a disk started from rest [1992]	16
3	M. VISBAL Computed unsteady structure of spiral vortex breakdown on a delta wing [1997]	17
4	G. D. MILLER AND C. H. K. WILLIAMSON Free flight of a delta wing [1995]	18
5	H. HIGUCHI Aircraft trailing vortices and downwash phenomenon [1993]	19
6	F. M. PAYNE, R. C. NELSON, AND T. T. NG Vortex breakdown on a delta wing [1986]	20
7	Q. RAHAMAN, A. ALVAREZ-TOLEDO, B. PARKER, AND C. M. HO Interaction of two-dimensional wakes [1988]	21
8	T. LEWEKE, M. PROVANSAL, D. ORMIÈRES, AND R. LEBESCOND Vortex dynamics in the wake of a sphere [1999]	22
9	J. C. OWEN, A. A. SZEWCZYK, AND P. W. BEARMAN Suppression of Kármán vortex shedding [2000]	23
10	G. J. F. VAN HEIJST AND J. B. FLÓR Colliding dipolar vortices in a stratified fluid [1990]	24
12	C. SEREN, M. V. MELANDER, AND N. J. ZABUSKY Asymmetric vortex merger [1987]	25
13	P. PETITJEANS Visualizations of vortex filaments [1998/2002]	26
14	R. HANCOCK Visualization of "vaporlines" emanating from water droplets [1992]	27

3 Patterns

G. E. KOPPENWALLNER AND D. ETLING Vortex flows paint themselves [1992]	29	Ph. MARMOTTANT AND E. VILLERMAUX Ligament mediated drop formation [2001]	46
C.-W. LEONG AND J. M. OTTINO Mixing in regular and chaotic flows [1989]	30	B. VUKASINOVIC, A. GLEZER, AND M. K. SMITH Vibration-induced droplet atomization [2000]	47
E. VILLERMAUX AND J. DUPLAT Mixture's route to uniformity by coalescence [2002]	31	A. LOZANO, C. J. CALL, AND C. DOPAZO Atomization of a planar liquid sheet [1994]	48
P. D. WEIDMAN, V. O. AFENCHENKO, A. B. EZERSKY, S. V. KIYASHKO, AND M. I. RABINOVICH The generation of two-dimensional vortices by transverse oscillation of a soap film [2002]	32	D. E. NIKITOPOULOS AND A. J. KELLY Formation of a net-negative charged liquid spray [2000]	49
E. BODENSCHATZ, S. W. MORRIS, J. R. DE BRUYN, D. S. CANNELL, AND G. AHLERS Hexagons and spirals in non-Boussinesq convection [1993]	33	D. FROST AND B. STURTEVANT Explosive boiling of a droplet at the superheat limit [1986]	50
C. F. CHEN Viscosity effects on the directional solidification of a NH_4Cl solution in a Hele-Shaw cell [1992]	34	M. M. WEISLOGEL AND S. LICHTER Water balloon rupture in low-g [1998]	51
F. ZOUESHTIAGH AND P. J. THOMAS Spiral patterns formed by granular media underneath a rotating fluid. Experiment vs. Computation [2000]	35	M. MANGA AND H. A. STONE Interactions between bubbles at low Reynolds numbers [1993]	52
G. GAUTHIER, P. GONDRET, F. MOISY, AND M. RABAUD Patterns between two rotating disks [2002]	36	J. BUCHHOLZ, L. SIGURDSON, AND B. PECK Bursting soap bubble [1995]	53
M. FERMIGIER AND P. JENFFER Sand ripples in a rotating tank [2002]	37		
E. TAN AND S. T. THORODDSEN The thistle crown [1998]	38		
B. VUKASINOVIC, A. GLEZER, AND M. K. SMITH Mode shapes of a sessile drop in forced vibration [2001]	39		
N. J. ZABUSKY AND W. TOWNSEND Naruto: Past and present [1997]	40		
R. A. HESS, N. J. BROCK, B. J. WEBER, L. W. CARR, AND M. S. CHANDRASEKHARA Dynamic stall – a holographic animation of compressible flow interferograms [1992]	41		

4 Drops and bubbles

S. CHANDRA AND C. T. AVEDISIAN The collision of a droplet with a solid surface [1990]	43
M. P. BRENNER, X. D. SHI, J. EGGERS, AND S. R. NAGEL The bifurcation of liquid drops [1995]	44
M. TJAHHADI AND J. M. OTTINO Breakup and dispersion of highly stretched droplets in a chaotic flow field [1990]	45

5 Complex fluids

I. ARANSON, D. BLAIR, AND P. VOROBIEFF Interface motion in a vibrated granular layer [1999]	55
G. METCALFE, T. SHINBROT, J. J. MCCARTHY, AND J. M. OTTINO Mixing patterns for surface dominated granular flows [1995]	56
J. S. OLAFSEN AND J. S. URBACH Crystallization in a 2D granular fluid [1999]	57
R. MIKKELSEN, M. VERSLUIS, E. KOENE, G.-W. BRUGGERT, D. VAN DER MEER, K. VAN DER WEELE, AND D. LOHSE Granular eruptions: Void collapse and jet formation [2002]	58
M. TIRUMKUDULU, A. TRIPATHI, AND A. ACRIVOS Particle segregation in monodisperse sheared suspension [1999]	59
J. H. WALther, S.-S. LEE, AND P. KOUMOUTSAKOS Simulation of particle laden flows using particle methods [2000]	60
I. EAMES AND S. B. DALZIEL Resuspension by an impacting sphere [1999]	61
S. L. ANNA, H. SPIEGELBERG, AND G. H. MCKINLEY Elastic instability in elongating fluid filaments [1997]	62
	64

6 Flows with interfaces

A. E. HASHA AND J. W. M. BUSH Fluid fishbones [2002]

M. F. G. JOHNSON, M. J. MIKSIS, R. A. SCHLUTER, AND S. G. BANKOFF		W. M. ROQUEMORE, L. D. CHEN, J. P. SEABA, P. S. TSCHEN, L. P. GOSS, AND D. D. TRUMP Jet diffusion flame transition to turbulence [1987]	83
Fluid chains produced by obliquely intersecting viscous jets connected by a thin free liquid film [1996]	65	K. Y. HSU, V. R. KATTA, L. P. GOSS, D. D. TRUMP, L. D. CHEN, AND W. M. ROQUEMORE Flame-vortex interactions in a driven diffusion flame [1993]	84
I. L. KLIAKHANDLER, S. H. DAVIS, AND S. G. BANKOFF Viscous beads on thin vertical fiber [2001]	66	E. PFIZENMAIER, J. SIMON, AND P. A. MONKEWITZ Bouquet with bifurcating jet diffusion flame [1993]	85
B. J. FISCHER, A. A. DARHUBER, AND S. M. TROIAN Front propagation and branching dynamics in surfactant driven spreading [2001]	67	N. ASHGRIZ Flame impingements [1989]	86
T. MAXWORTHY A note on the nonlinear growth of a gravitationally unstable interface in a Hele-Shaw cell [1985]	68	T. ECHEKKI AND M. G. MUNGAL Particle tracking in a laminar premixed flame [1990]	87
R. BUCKINGHAM AND J. W. M. BUSH Fluid polygons [2001]	69	9 Instability	
S. T. THORODDSEN AND L. MAHADEVAN Shark-teeth pattern in coating flow inside a horizontally rotating cylinder [1996]	70	W. M. ROQUEMORE, R. L. BRITTON, R. S. TANKIN, C. A. BOEDICKER, M. M. WHITAKER, AND D. D. TRUMP Interaction of 2D wake and jet plume [1988]	89
A. A. VEDERNIKOV, B. SCHEID, E. ISTASSE, AND J. C. LEGROS Viscous fingering in miscible liquids under microgravity conditions [2001]	71	T. LEWEKE AND C. H. K. WILLIAMSON The long and short of vortex pair instability [1996]	90
7 Free surface interaction		C. E. NIEDERHAUS AND J. W. JACOBS Instability of an impulsively accelerated liquid/liquid interface [1998]	91
M. ERRICO Laminar jets can splash! [1986]	73	M. R. RUITH AND E. MEIBURG Breakdown modes of swirling jets with coflow [2002]	92
B. PECK AND L. SIGURDSON Impacting water drops [1992]	74	P. M. RIGHTLEY, P. VOROBIEFF, AND R. F. BENJAMIN Mushrooms and snakes: A visualization of Richtmyer-Meshkov instability [1997]	93
Y. ZHU, H. N. OĞUZ, AND A. PROSPERETTI Air cavity due to jet disturbance [1998]	75	J. M. SKOTHEIM AND J. W. M. BUSH Evaporatively driven convection in a draining soap film [2002]	94
B. W. ZEFF, J. FINEBERG, AND D. P. LATHROP Formation of a self-focusing singularity on a fluid surface [1999]	76	Y. COUDER Anomalous Saffman-Taylor fingering [1987]	95
D. CHIRICHELLA, R. GÓMEZ LEDESMA, K. KIGER, AND J. H. DUNCAN Air entrainment by a plunging jet translating over a free surface [2002]	77	C. D. ANDERECK AND H. L. SWINNEY Flows in the circular Couette system [1985]	96
L. SIGURDSON Atom bomb/water drop [1991]	78	10 Transition and turbulence	
L. L. SHAW, S. A. MUELDER, D. W. BAUM, AND K. A. WINER Hypervelocity explosive-driven metal jet in air [1994]	79	A. PRASAD AND C. H. K. WILLIAMSON A new mechanism for oblique wave resonance [1994]	98
D. LIEPMANN AND M. GHARIB The effect of the free surface on a round jet [1990]	80	W. S. SARIC Visualization of different transition mechanisms [1986]	99
8 Combustion		T. PEACOCK AND T. MULLIN The transition to turbulence in a microscopic fluid flow [2000]	100
A. YOSHIDA Wrinkled laminar flames [1989]	82		

A. DRAKE, R. V. WESTPHAL, R. A. KENNELLY, JR., AND D. M. DRIVER	
Interferometric skin friction footprint for a tripped boundary layer [1998]	101
J. H. DUNCAN, V. PHILOMIN, H. QIAO, AND J. KIMMEL	
The formation of a spilling breaker [1994]	102
M. A. RUTGERS, X.-L. WU, AND W. I. GOLDBURG	
The onset of two-dimensional grid generated turbulence in flowing soap films [1996]	103
G. ZOCCHI, E. MOSES, AND A. LIBCHABER	
Coherent structures in thermal turbulence [1991]	104
D. R. SABATINO AND T. J. PRAISNER	
The colors of turbulence [1998]	105
S. GOGINENI, R. RIVIR, D. PESTIAN, AND L. GOSS	
High free-stream turbulence influence on turbine film cooling flows [1996]	106
Y.-B. DU AND P. TONG	
Turbulent thermal convection over a rough surface [2000]	107
11 Compressible flows	
R. DARKE AND J. B. FREUND	
Mach wave radiation from a jet at Mach 1.92 [2001]	109
T. A. MANNING AND S. K. LELE	
Sound due to the interaction of shear-layer instability-waves and an oblique shock [1999]	110
B. YIP, K. LYONS, M. LONG, M. G. MUNGAL, R. BARLOW, AND R. DIBBLE	
Visualization of a supersonic underexpanded jet by planar Rayleigh scattering [1989]	111
J. W. JACOBS	
PLIF flow visualization of a shock-accelerated light gas cylinder [1989]	112
J. F. HAAS AND B. STURTEVANT	
Shock-induced deformation and mixing of a helium sphere immersed in air [1986]	113
M. WATANABE AND K. TAKAYAMA	
Converging cylindrical shock wave [1990]	114
H. KLEINE AND K. TAKAYAMA	
Combined schlieren and interferometry visualization of blast waves [2001]	115
Keyword Index	116