04-7 IUTAM Symposium on Recent Advances in Disperse Multiphase Flow Simulation
Illinois, USA, October 04-07, 2004

a) Scientific Committee

S. Balachandar (Chair, USA), A. Prosperetti (USA), E.J. Hinch (UK), N. Kasagi (Japan), D.V. Khakhar (India), J. Magnaudet (France), H.K. Moffatt (UK), M. Reeks (UK), M. Sommerfeld (Germany).

b) Short summary of scientific progress achieved

Although many fluid mechanics and multiphase flow conferences usually feature several sessions devoted to computation in multiphase flow, this was one of the few symposia exclusively devoted to this activity. It was an opportunity to review a considerable amount of high-quality recent work on computational multiphase flow. It afforded an excellent picture of the contemporary activities in this field and prompted a series of reflections.

The symposium was punctuated by three special lectures. Hinch gave the opening lecture, where he set the right tone for the symposium with a discussion of the scaling of velocity fluctuations induced by sedimenting particles. Joseph, who summarized the current status of high-end scientific computations in multiphase flow research as it appeared to him from the talks presented at the symposium, gave the closing lecture. It was his opinion that the current width and depth of research bodes well for the future of computational multiphase flow. On Wednesday (Oct. 6th) the lunch was followed by Some reflections on multiphase flow by Hetsroni. His presentation ranged from some historical notes on boiling, dating back to the Bible and Homer, to reflections on scientific progress in boiling research, to recent statistics on papers published in the International Journal of Multiphase Flow.

Together with experiment and theory, computation has already been for a long time an integral component of multiphase flow research. A striking feature common to most papers presented at the symposium was the power, maturity and sophistication reached by this approach. A few papers conclusively demonstrated that, for some problems, computing is the only means by which key physical phenomena can be elucidated.

Over the last few years the computational capabilities of several groups have reached such a level of sophistication that we are now able to take a first-principles look at complex microphysics that arises in a variety of problems. Another significant advancement that was clear from the symposium was the use of molecular dynamics as a computational tool to access multiphase phenomenon that can only be addressed at the molecular scale. A good share of presentations dealing with solid particles was taken up by lattice-Boltzmann methods (LBM). It was clear that LBM has made significant advances over the last decade and offers an attractive approach to simulating complex

multiphase flow problems. The symposium showcased several other innovative numerical approaches, which offer great promise for addressing a variety of dispersed multiphase flow problems. The difficulties inherent in the fields of turbulence and multiphase flow in themselves make turbulent multiphase flow a truly grand-challenge problem. The importance of which was quite evident from the number of presentations that addressed this topic either directly or indirectly.

Two points were made abundantly clear at the IUTAM Symposium. In the first place, computational multiphase flow suscitates a strong interest in the fluid mechanics community -- a heartening corollary being that the quality of much of the work in this field is quite high. Secondly, for people like us who have been following developments in this discipline for many years, it was extremely gratifying -- and perhaps even somewhat surprising -- to gain such a palpable appreciation of the maturity of the field, its impressive development, and the level of complexity and detail that progress in hardware and algorithms currently permit. It is hard to imagine that an external observer coming to the meeting with misgivings about the usefulness of computing in multiphase flow would have left nurturing the same doubts.

c) Countries represented and number of participants

There were 48 oral presentations and an additional 17 poster papers.
The symposium attracted about 90 participants from fifteen different countries.
Argentina, China, France, Germany, India, Israel, Italy, Japan, The Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

d) Publication of Proceedings of the Symposium

The proceedings of the symposium will be published as, “Computational Approaches to disperse multiphase flow, Book by Springer Science and Business Media (former Kluwer Academic Publishers), The Netherlands. Editors are S. Balachandar and A. Prosperetti.

S. Balachandar and A. Prosperetti, “Report on a Symposium on `Computational approaches to disperse multiphase flow”, will appear in Int. J. Multiphase Flow, 2005.

e) Financial supports

The symposium was sponsored by the following organizations:
- International Union of Theoretical and Applied Mechanics
- Department of Energy, Office of Basic Sciences
- University of Illinois, Urbana-Champaign, IL, USA
- Johns Hopkins University, Baltimore, MD, USA
- Argonne National Laboratories
- Kluwer Academic Publishers

We are grateful for the support of our sponsors.

f) Scientific program

Monday, October 4, 2004

Opening Lecture: J.E. Hinch, E.Guazzelli, L. Bergougnoux & Students, "*Fluctuations in the velocities of sedimenting particles*"
D.L. Koch, G. Subramanian, R. Verberg, H. Xu, and M. Louge, *"Momentum, heat and mass transport in sheared suspensions at moderate Reynolds and Stokes numbers"*

I. Eames, M. Gilbertson, J.B. Flor and V. Roig, *"Lagrangian aspects of multiphase and multibody flows"*
.B. McLaughlin, S.S. Suppiah, N. Moumen, and R.S. Subramanian, *"Molecular dynamics simulations of drop motion on uniform and non- uniform solid surfaces"*
Z.G. Feng and E.E. Michaelides, *"Proteus-a new computational scheme for deformable particles and particle interaction problems"*
A. Hölzer and M. Sommerfeld, *"Determination of resistance coefficients for non-spherical particles in laminar and turbulent flow by LBM"*
T.N. Dinh, R.R. Nourgaliev and T.G. Theofanous, *"Treatment of particle collisions and particle collective behavior in high-speed particulate flow"*

T.J. Hanratty and Y. Mito, *"Use of a stochastic method to describe dispersion and deposition"*
A. S. Sangani, K. Shah and S. Ozarkar, *"Couette flow of bubble suspensions"*
H.H. Hu and A. Perrin, *"Simulations of particulate flows using explicit MacCormack scheme"*
J.K. Eaton and J.C. Segura, *"On momentum coupling methods for calculation of turbulence attenuation in dilute particle-laden gas flows"*
T. Kajishima, *"DNS of collective behavior of solid particles in a homogeneous field - Influences of Reynolds number, loading ratio and particle rotation"*

B. Shotorban and F. Mashayek, *"On stochastic modeling of heavy particle dispersion in large-eddy simulation of two-phase turbulent flows"*
K. Squires and O. Simonin, *"Fluid-particle and particle-particle interactions in turbulent channel flow"*
M. Picciotto, A. Giusti, C. Marchioli and A. Soldati, *"Deposition, preferential distribution and resuspension of micro-particles in turbulent boundary layer"*
L.R. Collins and S.L. Rani, *"Numerical study of aerosol particle segregation in homogeneous turbulent flows"*
M. Uhlmann and A. Pinelli, *"Performance of various fluid-solid coupling methods for DNS of particulate flow"*

Tuesday, October 5, 2004

M.W. Reeks, *"Simulation of particle diffusion, segregation, and intermittency in turbulent flows"*

J. Derksen and S. Sundaresan, *"A numerical study of planar wave instabilities in liquid-fluidized beds"*
C.K. Aidun and E.J. Ding, *"Direct simulations of particle near contact and application to dynamics of particle settlement based on the lattice-Boltzmann method"*
J. Lee and A.J.C. Ladd, *"Numerical simulations of particle suspensions in a rotating flow"*

G. Tryggvason, J. Lu, A. Esmaeeli and S. Biswas, *"Direct numerical simulation of bubbly flows"*
S. Krishnan, S. Marella, H. Liu and H.S. Udaykumar, *"A sharp-interface Cartesian grid method for computations of droplet impact and spreading on surfaces of arbitrary shape"*
D. Lakehal and P. Liovic, *"Large eddy simulation of steep water waves"*
Y. Matsumoto, T. Uda and S. Takagi, *"The effect of surfactant on the rising motion of a bubble"*
G. Riboux, F. Risso and D. Legendre, *"Liquid velocity fluctuations induced by large-Reynolds-number rising bubbles"*

J. Wang, *"Ultrafast X-radiography high-pressure high-speed fuel sprays"*
E.K. Longmire, *"Planar velocimetry measurements in particle-laden flows in support of numerical simulations"*

Poster Introduction @ 7mins each

B.J. O'Donnell and B.T. Helenbrook, *"Drag modeling using proper orthogonal decomposition"*
T.L. Bocksell and E. Loth, *"Numerical simulation of turbulent particle diffusion"*
S.V. Apte, K. Mahesh, and T. Lundgren, *"Accounting for finite size effects in large-eddy simulations of two-phase flows"*
A. Prosperetti and Z. Zhang, *"The PHYSALIS method for the numerical simulation of fluid-particle interaction"*
R. IJzermans, R. Hagmeijer, H. Hoeijmakers, *"Particle accumulation in high-speed swirling disperse multiphase flow"*
C. Narayanan and D. Lakehal, *"Preferential accumulation of particles and mechanisms of particle–phase fluctuation generation in turbulent mixing layers"*
T.M. Burton, *"Investigation of point force turbulence modification"*
M. Cantero, S. Balachandar, M. Garcia, J. Ferry, *"Large scale simulations of cylindrical particulate density currents using equilibrium Eulerian approach"*
G. Pianet, E. Arquis and S. Vincent, *"3D instationary simulation of particle sedimentation toward high regimes"*
J.R. Schmidt, J.O.L. Wendt and A.R. Kerstein, *"Prediction of particle-laden turbulent channel flow using one dimensional turbulence"*
C. You and Y. Qiu, *"Numerical simulations of viscous. Incompressible flows using meshless method"*

Wednesday, October 6, 2004

V.K. Dhir, *"Numerical simulation of evolving and merging vapor-liquid interfaces during nucleate boiling"*
S. Chen, X. Nie and M. Robbins, *"Multiscale simulation of micro- and nano-fluidics"*
M.R. Maxey, D. Liu, S. Dong and G.E. Karniadakis, *"New advances in force-coupling method: from micro to macro"*
N.A. Patankar, N. Sharma and Y. Chen, *"Direct numerical simulation of the Brownian motion of particles using fluctuating hydrodynamic equations"*

S. Zaleski, *"High resolution simulations of two-phase mixing layers and ligament formation"*
J.S. Curtis, *"Gas-particle flows: some next steps in CFD model development"*
E. Meiburg, F. Necker, C. Haertel, and L. Kleiser, *"High resolution simulations of particle-driven gravity currents"*
S. Elghobashi, *"On the drag reduction in a mirobubble-laden spatially-developing turbulent boundary layer"*
R.R. Nourgaliev, T.N. Dinh, and T.G. Theofanous, *"The "Characteristics-Based Matching (CBM)" method for treatment of high-impedance interfaces in compressible disperse multiphase flows"*

Poster Introductions @ 7mins each

X. Li and K. Sarkar, *"Finite Reynolds number two-phase flow with drops"*
J.C. Wells, H.V. Truong and G. Tryggvason, *"Use of variable-density flow solvers for fictitious-domain computations of dispersed solid particles in turbulent flows"*
M. Muradoglu and M.B. Soydan, *"Computational modeling of bio-fluid mechanics of white blood cells"*
C.F. Delale, S. Nas and G. Tryggvason, *"Numerical simulation of shock propagation in bubbly liquids by the front tracking method"*
J.M. Pérez and A. Pinelli, *"Evaluation of closure laws for the Eulerian formulation of fluid-solid flows through linear stability analysis"*
P. Singh and D.D. Joseph, *"Fluid dynamics of floating particles"*
T.N. Randrianarivelo, S. Vincent, O. Simonin and J.P. Caltagirone, *"A direct numerical simulation approach dedicated to the analysis of 2D fluidized beds"*
M. Muradoglu, U. Olgac and A.D. Kayaalp, *"A finite-volume/front-tracking method for computations of dispersed multiphase flows in complex geometries"*

Thursday, October 7, 2004

L.M. Portela, *"Simulation of dispersed multiphase flows using near-far field decomposition techniques"*
V. Badalassi and S. Banerjee, *"Dispersed phase coarsening pf phase-separating binary fluids under shear"*
V. Kumaran, *"Dynamics of the particle phase in a turbulent gas-solid suspension"*

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S. Takagi, G. Kikugawa and Y. Matsumoto, *"A molecular dynamic study on the energy structure of nanobubbles"*
J. Bec, *"Multifractal clusters of inertial particles in smooth flows"*

J.Brady, *"From proteins to peas: diffusion across scales"*
J. Magnaudet, *"Struggling with boundary layers and wakes of high-Reynolds-number bubbles"*
T.G. Theofanous, T.N. Dinh and R.R. Nourgaliev, *"Compressible multi-hydrodynamics: emergent needs, approaches and status"*
Closing Lecture: B.H. Yang, J. Wang, D.D. Joseph, H.H. Hu, T.W. Pan and R. Glowinski, *"Migration of a sphere in tube flow"*

Report composed by S. Balachandran