

# Grétar Tryggvason

Department of Mechanical Engineering  
Worcester Polytechnic Institute  
100 Institute Road  
Worcester, MA 01609-2280  
Tel.: (508) 831-5759 (direct line: (508) 831-5534)  
FAX: (508) 831-5680  
e-mail: gretar@wpi.edu  
www: <http://www.me.wpi.edu/Tryggvason>

## Education

Ph.D.	Brown University, Division of Engineering	1985
Sc.M.	Brown University, Division of Engineering	1982
B.S.	University of Iceland, Mechanical Engineering	1980

## Professional Experience

2000 - Professor and Head, Department of Mechanical Engineering.  
Worcester Polytechnic Institute, MA

1999 Visiting Scientist, University of Paris VI, France, 4/19-5/8

1998 Visiting Professor, Institut Universitaire des Systèmes Thermiques Industriels (IUSTI), University of Aix-Marseille, France, 4/15-5/15

1994 Visiting Research Associate, Caltech, 1/1-5/31 (Sabbatical)

1993 - 1997 Associate Chairman, Department of Mechanical Engineering and Applied Mechanics. University of Michigan, Ann Arbor

1991 - 1996 Visiting Research Position, Institute for Computational Mechanics in Propulsion, NASA Lewis Research Center, every summer.

1985 - 2000 Professor of Mechanical Engineering and Applied Mechanics.  
University of Michigan, Ann Arbor. (Assistant Professor, 1985-1991;  
Associate Professor, 1991-1997; Professor, 1997-2000)

1984 - 1985 Associate Research Scientist, Courant Institute of  
Mathematical Sciences, New York University.

## Honors and Awards

WPI Sigma Xi Outstanding Senior Faculty Research Award, 2006

The 2005 Computational Mechanics Award from the Computational Mechanics  
Division of the Japan Society of Mechanical Engineers (JSME)

Elected Fellow of the American Society of Mechanical Engineers, 2005

Elected Fellow of the American Physical Society (Division of Fluid Dynamics), 2000

College Award for Service, University of Michigan, 2000

Best Paper Award. ASEE Annual meeting (with D. Tilbury and S.L. Ceccio), 1997

Departmental Award for Service, University of Michigan, 1996

Departmental Award for Research, University of Michigan, 1991

Predocctoral Geophysical Fluid Dynamics Fellow, Woods Hole Oceanographic  
Institution, 1983

Brown University Fellowships, 1980, 1981, and 1983

Thor Thors Special Contribution Award (The American-Scandinavian Foundation),  
1980

Fulbright travel grant, 1980

## PROFESSIONAL ACTIVITIES

### Journal Editorships

2006 Associate Editor, Journal of Applied Fluid Mechanics  
2002 - Editor-in-chief, Journal of Computational Physics  
2002 - Associate Editor, International Journal of Multiphase Flow  
1992 - 2002 Associate Editor, Journal of Computational Physics

### Major Committee Assignments at the University of Michigan

#### University:

Member of a “Peer Evaluation of Teaching” team 1994-1995.  
Rackham Divisional Board, member, 1991-1993

#### Engineering College:

FIPSI Math Group, 1998-2000  
ABET Working Group, 1997-1999.  
Curriculum 2000 Task force, 1995-1996  
Member of a group visiting the Technical University of Delft and the Technical University of Warsaw, spring 1996.  
Undergraduate Curriculum Review committee (appointed member), 1995-1996  
Member of six tenure committees, 1992, 1994, 1995, 1996/7, 1998, 1999. Chaired five of those.  
College Rule Committee (elected member). The committee never met and I resigned after a year when I went on a sabbatical leave.  
Review Committee for CAEN (Computer Aided Engineering Network), appointed member, winter 1991.  
Review Committee for LaSC (Laboratory for Scientific Computing), appointed member, summer and fall 1990.

#### Mechanical Engineering Department:

Advisory Committee, elected member, 1992-1993 (stepped down when appointed associate chairman). Elected again 1998.  
Planning Committee, member, 1992-1998  
Committee on instruction, member, Spring 1990.  
Ad Hoc departmental review committee, member, Spring 1990

I also served on the graduate committee for the Applied Mechanics Program and the admission and financial aid committee for the Mechanical Engineering Program, ran the seminar program in the thermal-fluid division, gave the preliminary examination regularly, and supervised the construction of a long range teaching plan for the fluids group.

### **Administrative Duties at the University of Michigan**

Associate Chairman, MEAM, 1993-1997  
 ME Director of Undergraduate Studies, 1992-1993  
 Leader of ABET preparation teams, 1993 and 1999

Lead undergraduate curriculum reforms in ME 1993-1998 and in that capacity served on various temporary curriculum review committees and chaired the Departmental Curriculum committee.

### **Major Committee Assignments at Worcester Polytechnic Institute**

Ad-hoc group developing a proposal for a Robotics Engineering Degree at WPI, 2006.  
 Associate Director, Program in Robotics Engineering, 2007-  
 Co-chair of a committee on the first year experience 2006. Appointed  
 Ad-hoc group developing a proposal for granting B.A. Degrees at WPI. Fall 2005.  
 Commission to examine the role of the Fine and Liberal Arts at WPI, 2004/05.  
 Appointed.  
 Enrollment team to examine admission policies, 2004/2005. Appointed.  
 President Search Committee, 2003/2004. Appointed.  
 Search Committee for a new Head for the Physics Department, 2003/2004. Appointed.  
 Undergraduate Outcomes Assessment Committee (UOAC), 2003-05. Elected.  
 Student Outcomes Assessment Steering Committee (SOASC). 2001-2003. Appointed.  
 Campus Master Plan Working Committee 2002/2003. Appointed.  
 Space Committee, 2002/2003. Appointed.

### **Society Memberships and Activities**

Member: Association of Chartered Engineers in Iceland, 1987-1992; American Physical Society (Division of Fluid Dynamics, Fellow since 2000), since 1982; Society for Industrial and Applied Mathematics; Sigma Xi; American Association for the Advancement of Sciences; American Society of Mechanical Engineers, since 1991 (Fellow since 2005); American Society of Engineering Education, since 1998.

- Conference Chair. 2008 International Mechanical Engineering Education Conference (ASME). Galveston, Texas. April 4 - 8, 2008.
- Presentation on “Service and Outreach” at a Mini-Symposium for New and Prospective Faculty Members at the 2006 ASME IMECE in Chicago, IL, November 7, 2006.
- Appointed member of the Program Committee of the Division of Computational Physics of the American Physical Society 2004/05
- Elected member-at-large, APS-Division of Fluid Dynamics Executive Committee, 2003-2006
- Member of the ASME Multiphase Flow Technical Committee, Vice Chair 2000-02; Chair 02-04.
- Lead organizer of a symposium on “Numerical Methods for Multiphase Flows” at the ASME Fluid Dynamics Division Summer meeting 2000, 2002, 2004, and 2006.
- Co-organized an “Open Forum for Multiphase flow” at the ASME Fluid Dynamics Division Summer meeting for 1996, 1997, and 1998.
- Co-organized a forum on “Advances in Numerical Modeling of Free Surface and Interface Fluid Dynamics” at the ASME Fluid Dynamics Division Summer

meeting since 1995.

- Co-organized a symposium on “Bubbles and Vortices near a Free Surface” at the ASME Fluid Dynamics Division Summer meeting for 1993
- I regularly chair sessions at meetings such as those of the Division of Fluid Dynamics of the APS, SIAM, and ASME.

### **Panel and Panel Review Activities**

- Member of an IGERT Advisory Group at LSU, Dec. 1, 2006
- Member of a review team for the Illinois DOE ASCI center, Oct. 20 & 21, 2005
- NASA Multiphase Flow and Heat Transfer proposal review pane, Jan. 10-11, 2005
- Member of a review team for the Illinois DOE ASCI center, Oct. 26 & 27, 2004
- Member of a review team for Centre de Mathématiques et Leurs Applications at the Ecole Normale Supérieure de Cachan, September 29, 2004.
- Member of a review team for the Illinois DOE ASCI center, Oct. 14 & 15, 2003
- Testified before a subcommittee of the US Department of Energy Basic Energy Science Advisory Committee (BESAC), on April 1, 2004 in Chicago.
- DOE—NERI review panel, March 18-19, 1999 and March 8-9, 2001
- NSF Career Review Panel, November 17-18, 2000
- DOE Computational Science Initiative Panel on January 23-24, 1998
- NSF CAREER award review panel, January 16-17, 1997
- DARPA/NSF workshop on “OPAL” on June 2-3, 1997
- NSF proposal review panel, February 8-9, 1996.
- DOE Review panel, chair, spring 1993

Review manuscripts for the Journal of Fluid Mechanics, the Physics of Fluids, Chemical Engineering Science, International Journal of Multiphase Flows, the Journal of Computational Physics and others; book proposals for various publishers; proposals for the National Science Foundation, the Petroleum Research Fund, the Department of Energy and others.

### **Other Service**

- Chair. Governing Board of the International Conference of Multiphase Flow, 2007-2010.
- Vice Chair, International Scientific Committee (ISC) of the International Conference on Multiphase Flows (ICMF) 2007.
- Ph.D. Examiner. Brown University, 2005.
- Ph.D. Examiner. Ecole Normale Supérieure de Cachan, France, 2004.
- Elected member of the Governing Board of the International Conference of Multiphase Flow, 2004-2007. Elected vice-chair of the Board.
- Ph.D. Dissertation Reader. University of Twente, 2004. Due to conflict with another commitment I could not attend the defense but provided written questions
- Member of the International Scientific Committee (ISC) for the International Conference on Multiphase Flows (ICMF-2004). May 31-June 3, Yokohama, Japan.
- Ph.D. Examiner. University of Alberta, 2003.
- International Scientific Advisory Member. International Conference on Scientific & Engineering Computation (IC-SEC) 2002, 3-5 December, Singapore.
- Member of an HDR (Habilitation à Diriger des Recherches) examination committee, University of Marseilles, 2001.

- Member of the International Scientific Committee (ISC) of the International Conference on Multiphase Flows (ICMF-2001), New Orleans in May 2001.
- Member of the International Scientific Advisory Committee for MULTIPHASE FLOW 2001. Orlando, FL, 14-16 March 2001
- Ph.D. Examiner. University of Marseille, 1997.
- Ph.D. Dissertation Reader. Princeton University, 1997.
- Member of a large number of Ph.D. Dissertation committees at the University of Michigan (1985-2000) and WPI (2000 onward).

Every year I write a large number of evaluation letters for tenure and promotion at various universities in the US and abroad. I have also nominated and supported the nomination of a number of people for the status of Fellow of APS and ASME, as well as for various awards and prizes.

### Consulting

Fluid Sciences Inc., Summer 1986 and 1987.

Expert witness in the U.S. Federal Court in Ann Arbor. Fall 1989.

Institute for Computational Mechanics in Propulsion, NASA Lewis, since 1991-97

Ford Motor Company, 1992-95

Gas Research Institute, 1994-99

Detroit Edison, 1996 & 97

NBG Technologies Inc. A small company that I co-owned with W.D.A. Dahm. The company was build around software developed under Gas Research Institute funding and provided service to gas utilities. For about two years (1998-2000) the company had an office with two full time employees.

Other minor advising, such as evaluating patents, business plans, feasibility of ideas, etc.

### TEACHING

#### Ph. D. Committees Chaired

1. Dequan Yu: *Numerical Simulations of Vortex Interactions with a Free Surface*. Department of Mechanical Engineering, University of Michigan 1990.

2. Salih Ozen Unverdi: *Numerical Simulations of Multi-Fluid Flows*. Department of Mechanical Engineering, University of Michigan 1990.

3. Museok Song: *Vortex Ring Interactions with a Free Surface*. Department of Naval Architecture, University of Michigan 1991. (Co-Chair with G. Meadows)

4. Elizabeth A. Ervin: *Full Numerical Simulations of Bubbles and Drops in Shear Flow*. Department of Mechanical Engineering, University of Michigan 1993.

5. Mohammad Reza Heyranni-Nobari: *Numerical Simulations of Drop Collisions and Coalescence*. Department of Mechanical Engineering, University of Michigan 1993.

6. Chester H..H. Chang: *A Local Integral Model of Chemically Reacting Flows, Including Finite Rate Effects*. Department of Aerospace Engineering, University of

- Michigan 1994. (Co-Chair with W.J.A. Dahm).
7. Yi-Jou Jan: *Computational Studies of Bubble Dynamics*. Department of Mechanical Engineering, University of Michigan 1994. (Co-Chair with S.L. Ceccio)
8. Asghar Esmaeeli: *Numerical Simulations of Bubbly Flows*. Department of Mechanical Engineering, University of Michigan 1995.
9. Selman Nas: *Computational Investigation of Thermocapillary Migration of Bubbles and Drops in Zero Gravity*. Department of Aerospace Engineering, University of Michigan 1995.
10. Saeed Mortazavi: *Computational Investigation of Particulate Two-Phase Flows*. Department of Aerospace Engineering, University of Michigan 1995. (Co-Chair with W.J.A. Dahm).
11. Faical Tounsi: *Numerical Simulations of the Interactions of Vortices with Density Interfaces*. Department of Mechanical Engineering, University of Michigan 1995.
12. Damir Juric: *Computations of Phase Change*. Department of Mechanical Engineering, University of Michigan 1996.
13. Nallan C. Suresh: *Modeling of Natural Gas Flames*. Department of Mechanical Engineering, University of Michigan 1997. (Co-Chair with W.J.A. Dahm).
14. Jaehoon Han: *Numerical Studies of Drop Motion in Axisymmetric Geometry*. Department of Mechanical Engineering, University of Michigan 1998. (Co-Chair with S.L. Ceccio).
15. Judy Hweina Che: *Numerical Simulations of Complex Multiphase Flows: Electrohydrodynamics and Solidification of Droplets*. Department of Mechanical Engineering, University of Michigan 1999 (Co-chair with S.L. Ceccio).
16. Bernard Bunner: *Numerical Simulations of Gas-Liquid Bubbly Flows*. Department of Mechanical Engineering, University of Michigan 2000.
17. Khaled Sbeih: *Vortex Sheet Calculations of Unsteady Flows*. Department of Mechanical Engineering, University of Michigan 2000. (Co-Chair with W.J.A. Dahm).
18. Nabil Zahran Al-Rawahi: *Numerical Simulations of Dendritic Solidification with Convection*. Department of Mechanical Engineering, University of Michigan 2002.
19. Warren B. Tauber: *Numerical Simulations of Atomization through Nonlinear Behavior of a Sheared Immiscible Fluid Interface*. Department of Mechanical Engineering, University of Michigan 2002.
20. Mark Joseph Stock: *A Regularized Inviscid Vortex Sheet Method for Three Dimensional Flows With Density Interfaces*. Department of Aerospace Engineering,

University of Michigan 2006. (Co-Chair with W.J.A. Dahm).

21. Souvik Biswas: *Direct Numerical Simulation and Two-Fluid Modeling of Multi-Phase Bubbly Flows*. Department of Mechanical Engineering, Worcester Polytechnic Institute 2007.

### **Current Ph.D. Students at WPI**

Siju Thomas. *Computations of Droplets*.

Xiaochuan “Lydia” Shi. *Droplet dynamics*. Co-advised with J. Blandino.

### **Courses Taught at the University of Michigan**

*Undergraduate Courses:* Thermodynamics (taught 3 times, total of 108 students); Fluid Mechanics (taught 5 times, total of 220 students); Fluid Mechanics II (taught once, 16 students); Design & Manufacturing I (co-taught 7 times, total of 1108 students); Design II (taught once, 14 students).

*Graduate Courses:* Dynamics of Inviscid Fluids (taught 4 times, total of 35 students); Fluid Mechanics; (taught once, 14 students); Computational Fluid Dynamics (taught 13 times, total of 252 students);

### **Courses Taught at WPI**

*Undergraduate Course:* Heat Transfer (taught once, 70 students); Thermodynamics (taught once, 100 students);

*Graduate Courses:* Computational Fluid Dynamics (taught 5 times, total of 74 students);

### **Undergraduate Special Projects Directed**

#### **University of Michigan**

M. Lasken. ONR Sponsored Summer study, 1991

A. Kotlyer. NSF Sponsored High school student, 1993-94. Work Study, 1994-96.

C. Dulin. UROP (Undergraduate Research Opportunity Program), 1994-95

T. Neubecker. UROP, 1994-95

L. Delfin. UROP, 1994-95

R.L. Smiertka. UROP, 1995-96

Joon Kwak. UROP, 1996

Gregory Sabo. UROP, 1998-99

Tina Ong. 1999-2000

All projects involved graphics for Computational Fluid Dynamics

#### **Worcester Polytechnic Institute**

Senior Project: *SAE Chassis Design*. Kristian K. Bleasdel, Sarah J. Grenier, Daryl W. Moss, and Francis D. Rzegocki, Spring 2001.

Senior Project: *The 2002 WPI-SAE CAR. Aerodynamics*: Christopher R. Cammack and David M. Lenhardt. *Chassis Design*: Joshua A. Beauvais and Alexander M. Clifford. *Power Train*: John R. Escolas, Michael K. Krager, and Adam D. Strelczuk. Spring 2002

Senior Project: *Heat Exchanger Design for 5KW SOFC APU*. Kelly A. Jaramillo and Christopher G. Greene. Fall 2001

- Senior Project: *DES/MFG Fiber optic Drawing Drum*. Curtis L. Britton and Ronald M. Wright. Spring 2002
- Junior Project: *Geothermal Energy in Iceland*. Timothy B. Baird, Chun-Shek Chan, and Peter G. C. Kast. Summer and Fall 2002
- Junior Project: *Marketing the 2002 WPI Racecar*. Christopher R. Cammack, Chad F. Derosier, Schuyler J. Ortega, Steven W. Tipa, and Neil R. Whitehouse. Spring 2002
- Senior Project: *Modeling an MPBR core using FLUENT*. Benjamin T. Parks and James A. Beaudoin. Fall 2002
- Senior Project: *EVI-Hybrid Car Design*: Eric Johnson, Justin Wheeler, David Sama, and Joseph Murphy. Two students from ME, two from EE. Co-advised with Prof. A. E. Emanuel. Spring 2003
- Senior Project: *Constellation-X SXT Trade Study and Design*. David Belliveau and Conway Chuong. Project done at GSFC. Co-advised with Prof. F. Looft. Fall 2002
- Senior Project: *Remotely Operable Micro Environmental Observatory*. Jeffrey R. Blair (ME 04 Provost's MQP Award). Spring 2004.
- Senior Project: *Odor Management in Human Waste Receptacles*. Stephen Walasavage. Spring 2005.
- Senior Project: *Tutorials for CFD Modeling of Fluid Flow*. Gary B. DeBlois. Spring 2005.
- Junior Project: *Anaerobic Digestion for the Treatment of Biomass*. Gregory Cole, Daniel Rapp, and Anthony Vello. Spring 2005.
- Senior Project: *Adhesive Mounting of Sensitive Optical Components for a Spaceflight Application*. Wesley Culver, Justin Rockwell, Rebecca Ziemba. C-advisor. Project done at the MIT Lincoln Laboratory. Fall 2005.
- Senior Project: *Computations of Fire Suppression by Mist*. Carl Nelson, Ashley Poulin, and Jonathan Sikes. Co-advised with Prof. J. Barnett. Fall 2005 and Spring 2006.
- Senior Project: *Simulations of Crowd Actions in Response to Emergencies and Dangers (SCARED)*. Jason Allukian, Andrew Biery, Nate Birmingham, Kevin Mullins. Co-advised with Prof. J. Barnett. Fall 2005 and Spring 2006.
- Junior Project: *Sustainability*. Kaes Sullivan-Keizer, Fall 2006 and Spring 2007
- Senior Project: *Hydroponics*. Kaes Sullivan-Keizer, Fall 2006 and Spring 2007
- Senior Project: *Re-engineering the EVI*. Shane Slocum. Fall 2006 and Spring 2007

### Short Courses and Workshops Taught

Three lectures given as part of “29<sup>th</sup> Computational Fluid Dynamics Lectures.” February 23-27, 1998. Von Karman Institute for Fluid Dynamics, Belgium.

Two lectures given as part of “Short Course on Modeling and Computation of Multiphase Flow, Part IIB: Multiphase flow CFD.” Every year 1999-2006: March 8-12, 1999; March 20-24, 2000; March 19-23, 2001; March 18-22, 2002; March 24-28, 2003; March 22-26, 2004; March 14-18, 2005; March 20-24, 2006. ETH, Zurich, Switzerland.

Co-principal Lecturer. “Suivis d’interfaces,” INRIA Rocquencourt, France, May 3-6, 1999. Several lectures.

Lectures given as part of “Experiments, Modeling, and Numerical Calculation for

Dispersed Multiphase Flow,” ERCOFTAC Summer school, July 16-19, 2001, Merseburg, Germany.

Lecture given as part of “Ecole d’été sur la modélisation des fronts et interfaces,” Ile de Porquerolles, France, June 26-July 2, 2005.

Two lectures given as part of “CFD of Multifluid Flows.” May 21-24, 2007. Von Karman Institute for Fluid Dynamics, Belgium.

### **Postdoctoral Advisees and funded visiting research professors**

S. Ozen Unverdi  
Saeed Mortazavi  
Asghar Esmaeeli  
Mei Zhuang  
Shunji Homma  
Yumin Yang  
Arturo Fernandez, 2000-03  
Jiacai Lu, 2001-

## **RESEARCH**

### **Book**

A. Prosperetti and G. Tryggvason (editors and main contributors). “Computational Methods for Multiphase Flow.” Cambridge University Press, 2007.

### **Patents**

“A Local Integral Method for Computations of Molecular Mixing and Chemical Reactions.” With W.J.A. Dahm. Issued Dec. 10, 1996. Patent No. 5,583,789.

“Method and Apparatus for Obtaining Species Concentrations and Reaction Rates in a Turbulent Reacting Flow.” With W.J.A. Dahm. Issued June 17, 1997. Patent No. 5,640,331.

### **Articles in Refereed Journals**

1. G. Tryggvason and H. Aref. “Numerical Experiments on Hele Shaw Flow with a Sharp Interface.” *J. Fluid Mech.* 136 (1983), 1-30.
2. H. Aref and G. Tryggvason. “Vortex Dynamics of Passive and Active Interfaces.” *Physica D*, 12D (1984), 59-70.
3. G. Tryggvason, and H. Aref. “Finger Interaction Mechanisms in Stratified Hele Shaw Flow.” *J. Fluid Mech.* 154 (1985), 284-301.
4. H. Aref, S.W. Jones and G. Tryggvason. “On Lagrangian Aspects of Flow Simulation.” *Complex Systems* 1 (1987), 545-558.
5. J. Glimm, J. Grove, B. Lindquist, O. McBryan and G. Tryggvason. “The Bifurcation of

- Tracked Scalar Waves.” *SIAM Journal on Scientific and Statistical Computing* 9 (1988), 61-79.
6. G. Tryggvason. “Numerical Simulation of the Rayleigh-Taylor Instability.” *J. Comput. Phys.* 75 (1988), 253-282.
  7. G. Tryggvason. “Deformation of a Free Surface as a Result of Vortical Flows.” *Phys. Fluids* 31 (1988), 955-957.
  8. G. Tryggvason. “Simulation of Vortex Sheet Roll-Up by Vortex Methods.” *J. Comput Phys.* 79 (1989), 1-16.
  9. W.J.A. Dahm, C.M. Scheil and G. Tryggvason. “Dynamics of Vortex Interaction with a Density Interface.” *J. Fluid Mech.* 205 (1989), 1-43.
  10. W. W. Willmarth, G. Tryggvason, A. Hirska and D. Yu. “Vortex Pair Generation and Interaction with a Free Surface.” *Phys. Fluids A* 1 (1989), 170-172.
  11. H. Aref and G. Tryggvason. “A Model of Rayleigh-Taylor Instability.” *Phys Rev Letters* 62 (1989), 749-752.
  12. G. Tryggvason and S.O. Unverdi. “Computations of Three-Dimensional Rayleigh-Taylor Instability.” *Phys Fluids A* 2 (1990), 656-659.
  13. D. Yu and G. Tryggvason. “The Free Surface Signature of Unsteady, Two-Dimensional Vortex Flows.” *J. Fluid Mech.* 218 (1990), 547-572.
  14. G. Tryggvason and W.J.A. Dahm. “An Integral Method for Mixing Chemical Reactions, and Extinction in Unsteady, Strained Diffusion Layers.” *J. Comb and Flames* 83 (1991), 207-220.
  15. G. Tryggvason, W.J.A. Dahm and K. Sbeih. “Fine Structure of Vortex Sheet Rollup by Viscous and Inviscid Simulations.” *ASME J. Fluid Engineering* 113 (1991), 31-36.
  16. C.H.H. Chang, W.J.A. Dahm and G. Tryggvason. “Lagrangian Model Simulations of Molecular Mixing, Including Finite Rate Chemical Reactions, in a Temporally Developing Shear Layer.” *Phys. Fluids A* 3 (1991), 1300-1311.
  17. G. Tryggvason, S.O. Unverdi, M. Song and J. Abdollahi-Alibeik. “Interaction of Vortices with a Free Surface and Density Interfaces.” *Lectures in Applied Mathematics* 28, (1991).
  18. S.O. Unverdi, G. Tryggvason. “A Front Tracking Method for Viscous Incompressible Flows.” *J. Comput. Phys.* 100 (1992), 25-37.
  19. G. Tryggvason, J. Abdollahi-Alibeik, W. Willmarth and A. Hirska. “Collision of a Vortex Pair with a Contaminated Free Surface.” *Phys. Fluids A* 4 (1992), 1215-1229.
  20. M. Song, L.P. Bernal and G. Tryggvason. “Head-on Collision of a Large Vortex Ring with

- a Free Surface.” *Phys. Fluids A* 4 (1992), 1457-1466.
21. S.O. Unverdi and G. Tryggvason. “Computations of Multi-Fluid Flows.” *Physica D* 60 (1992), 70-83.
  22. W.J.A. Dahm, C.E. Frieler and G. Tryggvason. “Vortex Structure and Dynamics in the Near Field of a Coaxial Jet.” *J. Fluid Mech.* 241 (1992), 371-402.
  23. M. Taeibi-Rahni, E. Loth and G. Tryggvason. “DNS Simulations of Large Bubbles in Mixing Layer Flow.” *Int. J. Multiphase Flow* 20 (1994), 1109-1128.
  24. P.-W. Yu, S.L. Ceccio, and G. Tryggvason. “The Collapse of a Cavitation Bubble in Shear Flows—A Numerical Study.” *Phys. Fluids* 7 (1995), 2608-2616.
  25. M.R. Nobari, Y.-J. Jan and G. Tryggvason. “Head-on Collision of Drops--A Numerical Investigation.” *Phys. Fluids* 8 (1996), 29-42.
  26. W.J.A. Dahm, G. Tryggvason and M. Zhuang. “Integral Method Solution of Time-Dependent Strained Diffusion-Reaction Equations with Multi-Step Kinetics.” *SIAM J. Appl. Math.* 56 (1996), 1039-1059.
  27. D. Juric and G. Tryggvason. “A Front Tracking Method for Dendritic Solidification.” *J. Comput. Phys.* 123 (1996), 127-148.
  28. M.R.H. Nobari, and G. Tryggvason. “Numerical Simulations of Three-Dimensional Drop Collisions.” *AIAA Journal* 34 (1996), 750-755.
  29. A. Esmaeeli and G. Tryggvason. “An Inverse Energy Cascade in Two-Dimensional, Low Reynolds Number Bubbly Flows.” *J. Fluid Mech.* 314 (1996), 315-330.
  30. E.A. Ervin and G. Tryggvason. “The Rise of Bubbles in a Vertical Shear Flow.” *ASME J. Fluid Engineering* 119 (1997), 443-449.
  31. B.S. Dooley, A.E. Warncke, M. Gharib, and G. Tryggvason. “Vortex ring generation due to the coalescence of a water drop at a free surface.” *Experiments in Fluids* 22 (1997), 369-374.
  32. E. Loth, M. Taeibi-Rahni, and G. Tryggvason. “Deformable Bubbles in a Free Shear.” *Int. J. Multiphase Flow* 23 (1997), 977-1001.
  33. Y. Yang and G. Tryggvason. “Dissipation of Energy by Finite Amplitude Surface Waves.” *Computers & Fluids* 27 (1998), 829-845.
  34. J. Qian, G. Tryggvason, and C.K. Law. “A Front Tracking Method for the Motion of Premixed Flames.” *J. Comput. Phys.* 144 (1998), 52-69.
  35. G. Agresar, J.J. Linderman, G. Tryggvason, and K.G. Powell. “An Adaptive, Cartesian, Front-Tracking Method for the Motion, Deformation and Adhesion of

- Circulating Cells.” *J. Comput. Phys.* 143 (1998), 346-380.
36. D. Juric and G. Tryggvason. “Computations of Boiling Flows.” *Int’l. J. Multiphase Flow* 24 (1998), 387-410.
37. A. Esmaeeli and G. Tryggvason. “Direct Numerical Simulations of Bubbly Flows. Part I—Low Reynolds Number Arrays.” *J. Fluid Mech.* 377 (1998), 313-345.
38. A. Esmaeeli and G. Tryggvason. “Direct Numerical Simulations of Bubbly Flows. Part II—Moderate Reynolds Number Arrays.” *J. Fluid Mech.* 385 (1999), 325-358.
39. B. Bunner and G. Tryggvason. “Direct Numerical Simulations of Three-Dimensional Bubbly Flows.” *Phys. Fluids* 11 (1999), 1967-1969.
40. M. Song and G. Tryggvason. “The Formation of a Thick Border on an Initially Stationary Fluid Sheet.” *Phys. Fluids* 11 (1999), 2487-2493.
41. M. Jaeger, M. Carin, M. Medale, and G. Tryggvason. “The Osmotic Migration of Cells in a Solute Gradient.” *Biophysical Journal* 77 (1999), 1257-1267.
42. J. Han and G. Tryggvason. “Secondary Breakup of Liquid Drops in Axisymmetric Geometry—Part I, Constant Acceleration.” *Phys. Fluids* 11 (1999), 3650-3667.
43. B. Bunner and G. Tryggvason. “An Examination of the Flow Induced by Buoyant Bubbles.” *Journal of Visualization* 2 (1999), 153-158.
44. W. Tauber; G. Tryggvason. “Direct Numerical Simulations of Primary Breakup.” *Computational Fluid Dynamics Journal.* 9(1), 2000.
45. S. Mortazavi and G. Tryggvason. “A numerical study of the motion of drops in Poiseuille flow. Part 1. Lateral migration of one drop.” *J. Fluid Mech.* 411 (2000), 325-350.
46. V. Ramachandran, R. Venkatesan, G. Tryggvason, and H. S. Fogler. “Low Reynolds Number Interactions Between Colloidal Particles Near the Entrance to a Cylindrical Pore.” *J. Colloid and Interface Science* 229 (2000), 311-322.
47. S. J. Chen, W. J. A. Dahm and G. Tryggvason. “Effects of heat release in a reacting vortex ring.” *Proc. Combust. Inst.* 28: Part 1 (2000), 515-520.
48. G. Tryggvason, B. Bunner, A. Esmaeeli, D. Juric, N. Al-Rawahi, W. Tauber, J. Han, S. Nas, and Y.-J. Jan. “A Front Tracking Method for the Computations of Multiphase Flow.” *J. Comput. Phys.* 169 (2001), 708–759
49. J. Han and G. Tryggvason. “Secondary Breakup of Liquid Drops in Axisymmetric Geometry—Part II. Impulsive Acceleration.” *Phys. Fluids* 13 (2001), 1554-1565.
50. G. Tryggvason, M. Thouless, D. Dutta, S. L. Ceccio, and D. M. Tilbury. “The New

- Mechanical Engineering Curriculum at the University of Michigan.” *Journal of Engineering Education* 90 (2001), 437-444.
51. J. Zhang, M.J. Miksis, S.G. Bankoff, and G. Tryggvason. “Nonlinear dynamics of an interface in an inclined channel.” *Phys. Fluids* 14 (2002), 1877-1885.
  52. N. Al-Rawahi and G. Tryggvason. “Computations of the growth of dendrites in the presence of flow. Part I—Two-dimensional Flow.” *J. Comput. Phys.* 180 (2002), 471–496.
  53. W. Tauber, S.O. Unverdi, and G. Tryggvason. “The nonlinear behavior of a sheared immiscible fluid interface.” *Phys. Fluids* 14 (2002), 2871-2885.
  54. B. Bunner and G. Tryggvason. “Dynamics of Homogeneous Bubbly Flows: Part 1. Rise Velocity and Microstructure of the Bubbles.” *J. Fluid Mech.* 466 (2002), 17-52.
  55. B. Bunner and G. Tryggvason. “Dynamics of Homogeneous Bubbly Flows. Part 2, Fluctuations of the Bubbles and the Liquid.” *J. Fluid Mech.* 466 (2002), 53-84.
  56. K. Sankaranarayanan, I.G. Kevrekidis, S. Sundaresan, J. Lu, and G. Tryggvason. “A comparative study of lattice Boltzmann and front-tracking finite-difference methods for bubble simulations.” *Int’l. J. Multiphase Flow* 29 (2003), 109-116.
  57. S. Nas and G. Tryggvason. “Thermocapillary interaction of two bubbles or drops.” *Int’l J. Multiphase Flows* 29 (2003), 1117–1135.
  58. G. Tryggvason, B. Bunner, A. Esmaeeli, and N. Al-Rawahi. “Computations of Multiphase Flows.” *Advances in Applied Mechanics* 39 (2003), 81-120.
  59. A. Esmaeeli and G. Tryggvason. “Computations of Explosive Boiling in Microgravity.” *Journal of Scientific Computing* 19 (2003), 163-182.
  60. B. Bunner and G. Tryggvason. “Effect of Bubble Deformation on the Stability and Properties of Bubbly Flows.” *J. Fluid Mech.* 495 (2003), 77-118.
  61. T.J. Hanratty, T. Theofanous, J.-M. Delhaye, J. Eaton, J. McLaughlin, A. Prosperetti, S. Sundaresan and G. Tryggvason. “Workshop Findings.” *Int’l. J. Multiphase Flow* 29 (2003) 1047–1059
  62. A. Prosperetti, and G. Tryggvason. “Appendix 3: Report of study group on computational physics.” *Int’l. J. Multiphase Flow* 29 (2003) 1089–1099
  63. G. Tryggvason, “Direct Numerical Simulations of Multiphase Flow.” *Multiphase Flow Science and Technology* 15 (2003), 255-265.
  64. Che, J., S. L. Ceccio, and G. Tryggvason “Computations of structures formed by the solidification of impinging molten metal drops,” *Applied Mathematical*

- Modelling*, 28 (2004) 127-144.
65. N. Al-Rawahi and G. Tryggvason. “Numerical simulation of dendritic solidification with convection: Three-dimensional flow.” *Journal of Computational Physics*. 194 (2004) 677–696
  66. A. Esmaeeli and G. Tryggvason. “A Front Tracking Method for Computations of Boiling in Complex Geometries.” *Int’l. J. Multiphase Flow*. 30 (2004) 1037–1050
  67. D. Dutta, D. E. Geister, and G. Tryggvason. “Introducing Hands-On Experience in Design/Manufacturing Education.” *International Journal of Engineering Education—Special issue on Manufacturing Engineering Education* 20 (4), 2004. 754-763.
  68. A. Esmaeeli and G. Tryggvason. “Computations of Film Boiling. Part I: Numerical Method” *International Journal of Heat and Mass Transfer* 47 (2004), 5451-5461.
  69. A. Esmaeeli and G. Tryggvason. “Computations of Film Boiling. Part II: Multi-mode Film Boiling.” *International Journal of Heat and Mass Transfer* 47 (2004), 5463-5476.
  70. G. Tryggvason, A. Esmaeeli, and N. Al-Rawahi. “Direct numerical simulations of flows with phase change.” *Computers & Structure*. 83 (2005) 445–453.
  71. G. Owies I. E. van der Hout, C. Iyer, G. Tryggvason, and S. L. Ceccio. “Capture and Inception of Bubbles Near Line Vortices.” *Physics of Fluids* 17, 022105 (2005) (14 pages)
  72. A. Koynov, G. Tryggvason, and J. G. Khinast. “Mass Transfer and Chemical Reactions in Bubble Swarms with Dynamic Interfaces.” *AIChE Journal* 10 (2005), 2786-2800.
  73. V.S. Warke, G. Tryggvason, and M.M. Makhlof. “Mathematical Modeling and Computer Simulation of Molten Aluminum Cleansing by the Rotating Impeller Degasser: Part I. Fluid Flow” *J. Mat. Proc. Tech.* 168 (2005), 112-118.
  74. S. Biswas, A. Esmaeeli, and G. Tryggvason. “Comparison of results from DNS of bubbly flows with a two-fluid model for two-dimensional laminar flows.” *Int’l J. Multiphase Flows* 31 (2005), 1036-1048.
  75. J. Lu, A. Fernandez, and G. Tryggvason. The effect of bubbles on the wall shear in a turbulent channel flow. *Physics of Fluids* 17, 095102 (2005) (12 pages)
  76. A. Esmaeeli and G. Tryggvason. “A DNS study of the buoyant rise of bubbles at  $O(100)$  Reynolds numbers.” *Physics of Fluids* 17, 093303 2005 (19 pages)
  77. A. Fernandez, J. Che, S.L. Ceccio, and G. Tryggvason, “The Effects of Electrostatic Forces on the distribution of Drops in a Channel Flow—Two-Dimensional Oblate

- Drops.” *Physics of Fluids* 17, 093302 (2005) (15 pages)
78. C.F. Delale S. Nas and G. Tryggvason. Direct Numerical Simulations of Shock Propagation in Bubbly Liquids. *Physics of Fluids*. 17, 121705 2005 (4 pages)
79. A. Koynov, G. Tryggvason, M. Schlüter, J. G. Khinast. “Mass Transfer and Chemical Reactions in Reactive Deformable Bubble Swarms.” *Appl. Phys. Lett.* 88, 134102 (2006) (3 pages)
80. S. Homma, J. Koga, S. Matsumoto, M. Song, and G. Tryggvason. “Breakup mode of an axisymmetric liquid jet injected into another immiscible liquid.” *Chemical Engineering Science*. 61, 3986-3996, 2006
81. S. Nas, M. Muradoglu and G. Tryggvason. “Pattern Formation of Drops in Thermocapillary Migration.” *Int’l J. Heat and Mass Transfer* 49 (2006) 2265–2276
82. J. Lu, S. Biswas, and G. Tryggvason. “A DNS study of laminar bubbly flows in a vertical channel.” *Int’l J. Multiphase Flow* 32 (2006), 643-660.
83. G. Tryggvason, A. Esmaeeli, J. Lu and S. Biswas Direct Numerical Simulations of Gas/Liquid Multiphase Flows. *Fluid Dynamics Research* 38 (2006), 660-681.
84. J. Lu and G. Tryggvason. “Numerical study of turbulent bubbly downflows in a vertical channel.” *Physics of Fluids* 18, 103302 (2006).
85. G. Tryggvason, A. Esmaeeli, J. Lu, S. Homma, and S. Biswas. Recent Progress in Computational Studies of Disperse Bubbly Flows. *Multiphase Flow Science and Technology* 18, 231-249, 2006.
86. R. F. Kunz, H. J. Gibeling, M. R. Maxey, G. Tryggvason, A. A. Fontaine, H. L. Petrie, S. L. Ceccio. Validation of Two-Fluid Eulerian CFD Modeling for Microbubble Drag Reduction Across a Wide Range of Reynolds Numbers. *Journal of Fluids Engineering* 129 (2007), 66-79.
87. J. Lu and G. Tryggvason. Effect of Bubble Size in Turbulent Bubbly Downflow in a Vertical Channel. *Chemical Engineering Science*. 62 (2007), 3008-3018.
88. R.K. Vuta, R. Lu and G. Tryggvason. A Two-dimensional Cell Motility Model. *J. Mathematical Sciences (Scientific Journals International)*. Volume 1, Issue 1 (2007) ([http://www.scientificjournals.org/j\\_of\\_math.htm](http://www.scientificjournals.org/j_of_math.htm))
89. S. Radl, G. Tryggvason and J. Khinast. Flow and Mass Transfer of Fully Resolved Bubbles in non-Newtonian Fluids. *AIChE Journal* 53 (2007), 1861-1878.
90. S. Biswas and G. Tryggvason. The transient buoyancy driven motion of bubbles across a two-dimensional quiescent domain. To appear in *the International Journal of Multiphase Flows*

91. M. Muradoglu and G. Tryggvason. A front-tracking method for computation of interfacial flows with soluble surfactants. To appear in *the Journal of Computational Physics*.

*Under Review:*

92. M. Stock, W. J. A Dahm and G. Tryggvason. Impact of a vortex ring on a density interface using a regularized inviscid vortex sheet method.
93. C.F. Delale and G. Tryggvason. Shock structure in bubbly liquids: Comparison of Direct Numerical Simulations and model equations.
94. L. Lu and G. Tryggvason. Effect of Bubble Deformability in Turbulent Bubbly Upflow in a Vertical Channel

### Chapters in Books

- J. Glimm, B. Lindquist, O. McBryan and G. Tryggvason, “Sharp and Diffuse Fronts in Oil Reservoirs: Front Tracking and Capillarity.” In *Mathematical and Computational Methods in Seismic Exploration and Reservoir Modeling*, ed. W.E. Fitzgibbon, SIAM, Philadelphia, (1985).
- G. Tryggvason, “Numerical Studies of Large Amplitude Instabilities.” In *Advances in Multiphase Flow and Related Problems*, ed. G. Papanicolau, SIAM, Philadelphia, p. 257-272, (1986).
- G. Tryggvason, “Vortex Dynamics of Stratified Flows.” In *Mathematical Aspect of Vortex Dynamics*, ed. R. Catfish, SIAM, Philadelphia, p. 160-270, (1988).
- G. Tryggvason, A. Esmaeeli, D. Juric, S. Nas and M. Saeed, “A Front-Tracking Method for Direct Simulations of Multiphase Flows.” In *Boundary Elements XVII*, edited by C.A. Brebbia, S. Kim, T. A. Osswald and H. Power, Comp. Mech. Pub., Southampton, pp. 653-660 (1995).
- G. Tryggvason and S.O. Unverdi. “The Shear Breakup of an Immiscible Fluid Interface.” In *Fluid Dynamics at Interfaces* (Proceedings of the C.S. Yih memorial symposium). W. Shyy and R. Narayanan, editors. Cambridge University Press, 1999.
- S. Guo, W.W. Schultz, and G. Tryggvason. “Numerical studies of contaminated surface deformation by a vortex pair.” In *Free surface flow with vorticity*. P. Tyvant, editor. Comp. Mech. Publ., 1998, p. 179-202.
- W. J.A. Dahm, G. Tryggvason, R. D. Frederiksen, and M. J. Stock. “Local Integral Moment (LIM) Simulations,” Chapter 4 in *Computational Fluid Dynamics in Industrial Combustion* (C.M. Baukal, Ed.), CRC Press, 2000.
- G. Tryggvason and B. Bunner. “Direct Numerical Simulations of Multiphase Flows.” In *Parallel Computational Fluid Dynamics. Trends and Applications*. Ed. C.B. Jensen

et al. pp. 77-84. Elsevier, 2001.

G. Tryggvason, B. Bunner, M.F. Goz, and M. Sommerfeld. "Direct numerical simulations of multiphase flow." In *Direct and Large-Eddy Simulations IV*. Ed. B.J. Geurts, R. Friedrich, and O. Metais. Kluwer Academic Publisher, 2002.

S. Homma, J. Koga, S. Matsumoto, and G. Tryggvason. "Formation of a Jet and its Breakup into Drops in Liquid-Liquid Systems." *Theoretical and Applied Mechanics*, Japan, Volume 51, 2003.

G. Tryggvason. "12.2.1 Bubble and Droplet Motion and Deformation" in *Handbook on Multiphase Flows* (C. Crowe, Editor). CRC Press, 2006.

### **Book Reviews**

Reviewed: *Fluid Dynamics and Transport of Droplets and Sprays* by W. Siringano. ASME Journal of Fluid Engineering, March, 2000.

### **Conference and Symposium Presentations/Papers**

G. Tryggvason and H. Aref, "Numerical Experiments on Statistical Fingering in Stratified Hele Shaw Flows", 35th Meeting of the American Physical Society, Div of Fluid Dynamics, Rutgers University, New Brunswick, NJ. Abstract in Bull. Amer Phys Soc 27: 1172, (1982).

G. Tryggvason and H. Aref, "Interface Dynamics by the Vortex-in-cell Method", XVI'th Intern. Congr. Theor. Appl. Mech., Lyngby, Denmark, (1984).

G. Tryggvason and H. Aref, "Vortex-in-Cell Calculations of Flows with Sharp Interfaces." 37th Meeting of the American Physical Society, Div of Fluid Dynamics, Brown University, Providence RI. Abstract in Bull. Amer. Phys. Soc. 29:1569, (1984).

G. Tryggvason, "Simulations of the Rayleigh-Taylor Instability by Front Tracking Methods." SIAM Spring Meeting, Pittsburgh. (1985).

G. Tryggvason, "Simulations of the Rayleigh-Taylor Instability by a Vortex Method." 38th Meeting of the American Physical Society, Div of Fluid Dynamics, Tucson, Arizona. Abstract in Bull. Amer. Phys. Soc. 30:1742, (1985).

G. Tryggvason, "Numerical Studies of Large Amplitude Instabilities of Fluid Interfaces." Invited Presentation. SIAM Workshop on Multiphase Flow, Leesburg, VA, (June 2-4, 1986).

G. Tryggvason, "Stratified Flow via Vortex Methods", Invited Presentation, Workshop on Computational Fluid Mechanics, Davis, CA, (June 17-18, 1986).

G. Tryggvason, "Numerical Studies of Instabilities of Fluid Interfaces." 10th U.S. National Congress of Applied Mechanics, Austin, TX, (June 16-20, 1986).

G. Tryggvason, "Numerical Simulations of Large Amplitude Rayleigh-Taylor Instability," SIAM National Meeting, Boston, MA (July 21-25, 1986).

G. Tryggvason, "A Vortex Blob Method for Sharply Stratified Flow," 39th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstract in Bull. Amer. Phys. Soc. 31:1700 Columbus, OH, (Nov. 23-25, 1986).

G. Tryggvason, "Free surface/Vortex Interactions," Ship Wake Consortium Workshop, DTNSRDC, Washington, DC, (May 4-5, 1987).

G. Tryggvason, "Free surface/Vortex Interactions", Ship Wake Consortium Workshop, Univ of Michigan, Ann Arbor, (Sept.21-22, 1987).

G. Tryggvason and D. Yu, "Interaction of Vorticity and Density Interfaces", SIAM 35th Anniversary Meeting, Denver, CO, (October 12-15, 1987).

G. Tryggvason, D. Yu and S.W. Hong, "Interaction of Vorticity and Density Interfaces", 40th Meeting of the American Physical Society, Div. of Fluid Dynamics, Abstract in Bull. Amer. Phys. Soc., 32:2073. Eugene, OR, (Nov. 20-21, 1987).

G. Tryggvason, "Vortex Dynamics of Stratified Flows", Invited Presentation, SIAM Workshop on Mathematical Aspect of Vortex Dynamics, Leesburg, VA, (April 25-27, 1988).

G. Tryggvason, "On the Boundary Integral Formulation of Free Surface Problems", SIAM Annual Meeting, Minneapolis, MN, (July 11-15, 1988).

41th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer.Phys. Soc. 33, Buffalo, N.Y, (Nov. 23-25, 1988). Three talks:

G. Tryggvason, "On Boundary Integral Formulation of Sharply Stratified Flows."

G. Tryggvason, A. Hirs, W. Willmarth and D. Yu, "Interaction of a Vortex Pair with a Free Surface."

G. Tryggvason, M. Song and D. Yu, "Vortex Interaction with a Free Surface."

G. Tryggvason, "Fluid Mixing by Contour Dynamics." Symposium on Fractal Aspect of Materials Disordered Systems. Fall Meeting of the Material Research Society, Boston, MA. (Nov. 29-Dec. 2, 1988).

G. Tryggvason, "Computations of Vortex/Free Surface Interactions", ONR Workshop on Vortex/Free Surface Interactions, Ann Arbor, (March 9-10, 1989).

G. Tryggvason, "On Boundary Integral Formulation of Sharply Stratified Flows", 21 Midwestern Mechanics Conference, Houghton, MI, (August 13-16, 1989).

42th Meeting of the American Physical Society, Div of Fluid Dynamics, NASA, Abstracts in Bull. Amer.Phys. Soc. 34, Ames, CA, (Nov. 19-21, 1989). Two talks:

G. Tryggvason, M. Song and L. Bernal, "Vortex Interaction with a Free Surface."

G. Tryggvason and S.O. Unverdi, "Viscous Rayleigh-Taylor Instability."

G. Tryggvason, S.O. Unverdi and K. Sbeih, "Simulations of Incompressible Flows Containing Interfaces-using Front Tracking Methods", Regional Meeting of the American Mathematical Society, Manhattan, KA, (March 16-17,-1990).

- G. Tryggvason, "Full Simulations of Bubbly Flows", Invited presentation, ONR Workshop on Bubbly Flows, Miami, FL, (May 3-4, 1990).
- G. Tryggvason, J. Abdollahi-Alibeik, M. Song and S.O. Unverdi, "Interaction of Vortices with a Free Surface and a Density Interface," Invited presentation at the AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods, Seattle, WA, (June 18-29).
- G. Tryggvason, S.O. Unverdi and K. Sbeih, "Numerical Studies of Unsteady Vortex Layers," ASME Symp on Non-steady Fluid Mechanics, Toronto, Canada, (June 4-6, 1990).
- G. Tryggvason, "Computation of Vortex Sheet Roll-Up," Invited presentation in a Mini-symposium, SIAM Annual Meeting, Chicago, IL, (July 16-20, 1990).
- G. Tryggvason and S.O. Unverdi, "A Front Tracking Method for Incompressible Flows", SIAM Annual Meeting, Chicago, IL, (July 16-20, 1990).
- A. Hirs, G. Tryggvason, J. Abdollahi-Alibeik and W. W. Willmarth, "Measurement and Computations of Vortex Pair Interaction with a Clean or Contaminated Free Surface," 18th Symp on Naval Hydrodynamics, National Academy Press, Washington, DC, (1990).
- M. Song, N. Nachman, J.T. Kwon, L.P. Bernal and G. Tryggvason, "Vortex Ring Interaction with a Free Surface," 18th Symp on Naval Hydrodynamics, National Academy Press, Washington, DC (1990).
- G. Tryggvason, C.H.H. Chang and W.J.A. Dahm. "A Lagrangian Model for Simulating Combustion, Including Finite Rate Chemistry, in Complex Flows." Twenty-third Int'l Symposium on Combustion, Poster Paper P229, Combustion Institute, Pittsburg, PA, (1990).
- ASME Applied Mechanics Conference. Columbus OH, June 16-19, 1991. Two talks:  
Y.-J. Jan and G. Tryggvason, "Computational Studies of Contaminated Bubbles," Symp on Dynamics of Bubbles and Vortices Near a Free Surface," AMD Vol. 119 (Ed. Sahin and Tryggvason), pp. 46-59, ASME (1991).  
T. Faical, M. Song, S.O. Unverdi and G. Tryggvason, "Collision of Viscous Vortices with a Free Surface and Density Interfaces," Symp on Dynamics of Bubbles and Vortices Near a Free Surface," AMD Vol. 119 (Ed. Sahin and G. Tryggvason), p. 31-37, ASME (1991).
- G. Tryggvason and S.O. Unverdi, "Full Numerical Simulations of Multi-Fluid Flows, Invited presentation. IUTAM Symposium on the Fluid Dynamics of Mixing and Stirring, La Jolla, CA, (Aug. 20-24, 1990).
- G. Tryggvason, C.H.H. Chang and W.J.A. Dahm, "Lagrangian Model Simulations of Molecular Mixing, Including Finite Rate Chemical Reactions, in a Temporally Developing Shear Layer," invited poster presentation, IUTAM Symposium on the Fluid Dynamics of Mixing and Stirring, La Jolla, CA, (Aug. 20-24, 1990).
- G. Tryggvason and S.O. Unverdi, "Numerical Studies of Multi-Fluid Flows," American

Institute of Chemical Engineers, Annual Meeting, Chicago IL, (Nov. 11-16, 1990).

43th Meeting of the American Physical Society, Div of Fluid Dynamics, Cornell University, Abstracts in Bull. Amer. Phys. Soc. 35, Ithaca, NY, (Nov. 19-21, 1990). Four talks:

G. Tryggvason and S.O. Unverdi, "Numerical Simulations of Bubble Interactions."

G. Tryggvason and M. Song, "Free Surface Waves due to the Opening-Up of a Vortex Ring,"

G. Tryggvason, K. Sbeih and W.J.A. Dahm, "Numerical Simulations of Viscous and Inviscid Kelvin-Helmholtz Instability."

G. Tryggvason, C.H.H. Chang and W.J.A. Dahm, "Lagrangian Model Simulations of Molecular Mixing, Finite Rate Chemical Reactions, and Extinction in a Temporally Developing Shear Layer,"

G. Tryggvason, "Vortex Ring Interaction with a Free Surface," Invited presentation at an ONR 1991 Free Surface Vorticity Workshop in San Diego, (Feb. 25 - 26, 1991).

G. Tryggvason, "Computations of Multi-Fluid Flows," Invited presentation at the Center for Nonlinear Studies Annual Meeting at Los Alamos National Laboratory. May 20-24, 1991.

G. Tryggvason and S.O. Unverdi, "Mixing by Interfacial Instabilities," Invited presentation in a minisymposium on chaotic mixing at the ICIAM meeting in Washington, DC, (July 8-12, 1992).

G. Tryggvason, "Full Numerical Simulations of Multi-Bubble Flows," Invited talk in a Mini-Colloquium on Dispersed Two-Phase Flow at the First European Fluid Mechanics Conference, Cambridge, England, (Sept. 16-20, 1991).

44th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 36, Scottsdale, AZ, (Nov. 24-26, 1991). Three talks:

G. Tryggvason and Y.-J. Jan, "Computations of a Rising Bubble with Insoluble Surfactant."

G. Tryggvason and T. Faical, "Numerical Simulations of Vortex Ring and Density Interface Interaction."

G. Tryggvason, C.H.H. Chang and W.J.A. Dahm, "Local Integral Model Simulations of Chemically Reacting Flows."

G. Tryggvason, "Studies of Bubbly Flows," Invited talk at an ONR Workshop on Bubbly Flows in Santa Barbara, (Oct. 17-18, 1992).

G. Tryggvason, "Numerical Simulations of Contaminated Fluid Interfaces," Invited presentation at the Conference on Nonlinear Analysis and Computation at the University of New York, Stony Brook, (Nov. 21-22, 1991).

G. Tryggvason, "Numerical Studies of Drop Collision and Coalescence," Invited presentation at the NASA first Technology Interface Meeting for the Modular Containerless Processing Facility Project in Pasadena, CA, (January 13-15, 1992).

M. Song and G. Tryggvason, "Numerical Investigation of an Oblique Collision of a Vortex

Ring with a Clean Free Surface," 19th Symp on Naval Hydrodynamics, National Academy Press, Washington, DC, (1992).

G. Tryggvason, Y.-J. Jan, A. Esmaeeli and S.O. Unverdi, "Full Simulations of Multi-Bubble Flows." In *Proceedings of Second International Symposium on Propeller and Cavitation*, Hangzhou, China, Sept. 1-4, 1992.

45th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 37, Tallahassee, Florida, (Nov 22-24, 1992). Five talks:

G. Tryggvason and E. Ervin, "Bubbles rising in a Vertical Shear."

G. Tryggvason and A. Esmaeeli, "Computations of a Rising Bubble Cloud."

G. Tryggvason, and S. Nas, "Computational Investigation on Thermal Migration of Bubbles and Drops."

G. Tryggvason and M.R. Nobari, "Head-on Collision of Drops."

G. Tryggvason and Y.-J. Jan, "Computational Studies of Surfactant Effect on the Interaction Between Several Bubbles."

G. Tryggvason "Studies of Bubbly Flows," ONR Workshop on Dynamics of Bubbly Flows, RPI, Troy, NY, July 19-20, 1993.

G. Tryggvason, Presentation at a NASA Workshop, Lewis Research Center, Cleveland, OH, June 15, 1993.

A. Esmaeeli, E.A. Ervin and G. Tryggvason, "Numerical Simulations of Rising Bubbles." In *Proceedings of the IUTAM Conference on Bubble Dynamics and Interfacial Phenomena*. Proceedings of an IUTAM Symposium held in Birmingham, U.K., 6-9 Sept. 1993. Ed.: J.R. Blake, J.M. Boulton-Stone and N.H. Thomas. pp. 247-255.

S. Nas and G. Tryggvason, "Computational Investigation of the Thermal Migration of Bubbles and Drops." In *AMD 174/FED 175 Fluid Mechanics Phenomena in Microgravity*, Ed. Siginer, Thompson and Trefethen. pp. 71-83. ASME (1993). Presented at the ASME 1993 Winter Annual Meeting.

46th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 38, Albuquerque, NM, Nov. 21-23, 1993. Three talks:

G. Tryggvason and S. Nas "Computational Investigation on Thermal Migration of Bubbles and Drops."

A. Esmaeeli and G. Tryggvason "Numerical Simulation of Bubbly Flows."

M.R. Nobari and G. Tryggvason "Coalescence of Initially Stationary Drops."

The 32th AIAA Aerospace Sciences Meeting, Reno, NV, Jan. 10-13, 1994. Three papers:

L.P. Bernal, P. Maksimovic, F. Tounsi and G. Tryggvason, "An Experimental and Numerical Investigation of Drop Formation by Vortical Flows in Microgravity," AIAA 94-0244.

N.C. Suresh, W.J.A. Dahm and G. Tryggvason, "LIM Modeling of Chemical Reactions in Spatially and Temporally Developing Shear Flows," AIAA 94-0870.

M.R.H. Nobari and G. Tryggvason, "Numerical Simulations of Drop Collisions," AIAA 94-0835.

G. Tryggvason, "Full Simulations of Multiphase Flows," ASME Summer Meeting, Lake Tahoe, NV, June 19-23, 1994.

G. Tryggvason, "A Front Tracking Method for Viscous, Incompressible, Multi-Fluid Flows," SIAM Annual Meeting, San Diego, CA, July 25-29, 1994

P. Yu, A. Esmarelli, S. L. Ceccio, and G. Tryggvason. "Direct Simulations of Bubbly Flows." 20th Symposium on Naval Hydrodynamics, Santa Barbara, August 1994. Proceedings, pp. 209-221. National Academy Press, Washington, DC, (1994).

47th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 39, Atlanta, GA, Nov. 20-22, 1994. Four talks:

B. Dooley, A. Warncke, M. Gharib, and G. Tryggvason "Vortex Ring Generation due to the Coalescence of a Water Drop at a Free Surface."

N.C. Suresh, W.J.A. Dahm, and G. Tryggvason "Local Integral Momentum Simulations of Mixing and Nonequilibrium Chemistry in Complex Shear Flows."

S. Mortazavi and G. Tryggvason "The Fluidization of Drops in a Shear Flow."

A. Esmarelli and G. Tryggvason "Numerical Simulation of Bubbly Flows."

D. Juric and G. Tryggvason, "Full Simulations of Flows with Phase Change," AIAA 95-0700. 33rd AIAA Aerospace Sciences Meeting, NV, Jan. 9-12, 1995.

G. Tryggvason. "Direct numerical simulations of multiphase flows using a front tracking/finite difference method." Invited mini-symposium presentation. 3rd. National Congress on Computational Mechanics, Dallas, TX, June 12-14, 1995.

S.O. Unverdi, Y. Yang, and G. Tryggvason "Energy Dissipation for Finite Amplitude Surface Waves," 48th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 40: 1928, Irvine, CA, Nov. 19-21, 1995.

G. Tryggvason "Computations of Underhood Flows. "The Best of German/American Automotive Technology, Faunhofer USA," Conference. Troy, MI, July 27-28, 1995.

ASME Winter Annual Meeting, San Francisco, CA, Nov. 12-17, 1995. Three talks:

D. Juric and G. Tryggvason, "A Front-Tracking Method for Liquid-Vapor Phase Change," in *Advances in Numerical Modeling of Free Surface and Interface Fluid Dynamics*, edit by Raad, Huang, and Tryggvason. FED-Vol. 234, ASME, pp. 141-148 (1995).

M. Taeibi-Rahni, E. Loth, and G. Tryggvason, "Unsteady Forces on Large Spherical and Ellipsoidal Bubbles," in *Gas Liquid Flows*, edited by Rohatgi, O'Hern, Shoukri, and Fukano. FED-Vol. 225, ASME, pp. 9-16 (1995).

D. Juric and G. Tryggvason, "Direct Numerical Simulations of Flows with Phase Change," AIAA 96-0857, 34th AIAA Aerospace Sciences Meeting, Reno, NV, Jan. 15-18, 1996.

A. Esmarelli and G. Tryggvason. "Direct Simulations of Multiphase Flows" in Proceeding of the 8th Workshop on Two-Phase Flow Predictions, M. Sommerfeld, Editor, 1996. Invited

lecture, Merseburg, Germany, March 26-29, 1996.

A. Esmaeeli, G. Tryggvason, and V. Arpaci. "Thermal Migration of Bubbles Toward a Fluid Interface." AICHE Symposium Series of the 31st National Heat Transfer Conference, Editor M. El-Genk, Vol. 92, pp. 100-109. AICHE, 1996.

G. Tryggvason and D. Juric, "Boiling and Solidification by a Front Tracking/Finite Difference Method." Invited mini-symposium presentation. SIAM Annual meeting, Kansas City, Missouri, July 22-26, 1996.

D. Juric and G. Tryggvason, "Computations of Film Boiling," in *Advances in Numerical Modeling of Free Surface and Interface Fluid Dynamics*, Editors by P. E. Raad, T. T. Huang, and G. Tryggvason, FED-Vol. 238, pp 341-347. ASME, 1996.

A. Esmaeeli and G. Tryggvason. "Dynamics of Polydispers Bubbly Flows in Periodic Domains." in *Advances in Numerical Modeling of Free Surface and Interface Fluid Dynamics*, Editors by P. E. Raad, T. T. Huang, and G. Tryggvason, FED-Vol. 238, pp 375-383. ASME, 1996.

G. Tryggvason, D. Juric, J. Han, and S.L. Ceccio. "Direct Numerical Simulations in Material Processing," in *Space Processing of Materials*, Narayanan Ramachandran, Editor, Proc. SPIE 2809, 178-184 (1996). Invited participation in a mini-symposium. SPIE meeting Denver Colorado, August 4-9, 1996.

G. Tryggvason, "Direct Simulations of Multiphase Flows: Invited presentation in a symposium on Free Surface/Interface problems at the 19th International Congress of Theoretical and Applied Mechanics. Kyoto, Japan, 25-31 August, 1996.

G. Tryggvason, "Drop deformation and Coalescence in Shear Flows." Invited lecture, EUROMECH Colloquium on Interfacial Instabilities, Paris, France, September 11-13, 1996.

G. Tryggvason, "Restructuring the Mechanical Engineering Curriculum—The Michigan Program." Workshop on the ME curriculum for the next twenty five years, Boston, MA Oct. 7-8, 1996.

The 1996 International Mechanical Engineering Congress & Exposition, Atlanta, Georgia, November 17-22, 1996. Two papers

D. Juric and G. Tryggvason, "Numerical Simulations of Phase Change in Microgravity,"  
A. Esmaeeli, G. Tryggvason, and V. Arpaci. "Thermal Migration of Bubbles in Zero Gravity."

49th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 41, Syracuse, NY, Nov. 24-26, 1996. Six talks:

M. Saeed and G. Tryggvason. "Numerical Simulations of Finite Reynolds Number Suspensions."

J. Han and G. Tryggvason. "A Numerical Study of the Secondary Breakup of Liquid Drops.

B. Bunner and G. Tryggvason. "Large Direct Simulations of Multiphase Flows."

- A. Esmaeeli and G. Tryggvason. "Deformation Induced Migration of Bubbles in Shear Flows."
- J. Che, J. Han, G. Tryggvason, and S.L. Ceccio. "Liquid Metal Drop Impingement
- S.O. Unverdi and G. Tryggvason. "Vortex Generation and Mass Transport by Gravity-Capillary Wave."
- G. Tryggvason. "Direct Numerical Simulations of Multiphase Flows." Institute for Multiphase Flow Science and Technology. Feb 28-March 1, 1997.
- ASME Fluids Engineering Division Summer Meeting, Vancouver, Canada, June 22-26, 1997. Three talks:
- B. Bunner and G. Tryggvason. "Simulations of Large Bubble Systems."
- J. Che, J. Han, G. Tryggvason, and S.L. Ceccio. "Impingement and Solidification of Liquid Metal Drops."
- E. Steinthorsson, K. Ajmani, G. Tryggvason, M. Benjamin. "Numerical Simulations of Multi-Fluid Flow in Fuel Atomizers."
- D. M. Tilbury, S. L. Ceccio, and G. Tryggvason. "Restructuring the Undergraduate Curriculum of the Mechanical Engineering and Applied Mechanics Department at The University of Michigan." ASEE Annual meeting, 1997.
- G. Tryggvason. "Numerical Studies of the Behavior of Drops in Microgravity." Invited talk. Gordon Research Conference, Henniker, NH, June 29-July 4, 1997.
- B. Bunner and G. Tryggvason. "Direct Simulations of Multi-Phase Flow," Proceedings of ISAC' 97 High Performance Computing on Multiphase Flow. Invited talk. Symposium held as a part of the JSME Centennial Grand Congress. Tokyo, Japan, July 17-19, 1997.
- 50th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. Nov, 1997. Five talks:
- J. Han and G. Tryggvason.
- B. Bunner and G. Tryggvason.
- J. Che and G. Tryggvason.
- M. Saeed and G. Tryggvason.
- S. Homma and G. Tryggvason.
- G. Tryggvason, B. Bunner, S. Mortazavi, & A. Esmaeeli "Direct Numerical Simulations of Dispersed Multiphase Flows," Proceedings of the 11 Japanese Symposium on CFD. Tokyo, Japan. December, 1997. Invited Opening Lecture.
- G, Tryggvason. Direct Numerical Simulations of Multiphase Flows. Plenary lecture at the 13-USNC. Gainesville, FL June 21-26, 1998
- Proceedings of the 1998 ASME Fluids Engineering Division Summer Meeting, Washington, D.C., June 21-25, 1998. Five papers:
- J. Che, S.L. Ceccio, and G. Tryggvason. "Computations of the Impingement and Solidification of Molten Metal Drops," FEDSM98-5215.
- W. Tauber, S.O. Unverdi, and G. Tryggvason. Formation of Drops by Interfacial

Shear. FEDSM98-5217.

B. Bunner and G. Tryggvason. "Direct Numerical Simulation of Large Three-Dimensional Bubble Systems." FEDSM98-5214

S. Homma, G. Tryggvason, J. Koga, and S. Matsumoto. "Formation of a Jet in Liquid-Liquid System and Its Breakup into Drops." FEDSM98-5216.

S. Mortazavi and G. Tryggvason. "Numerical Simulations of Drops in Channels." FEDSM98-5218.

G. Tryggvason. Simulation of Boiling. Poster presentation. NASA microgravity conference. August 12-14, 1998, Cleveland, OH.

Dutta, D., Geister, D., Tryggvason, G., "Introducing Hands-On Experiences in Design/Manufacturing Education" Proc of the SME Manufacturing Education for the 21st Century, San Digo, Oct 14-16, 1998, Vol 5, pp. 219-222

51th Meeting of the American Physical Society, Div of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. 43: 2030, Philadelphia, PA, Nov. 22-24, 1998. Five talks:

W. Tauber, S.O. Unverdi, and G. Tryggvason. The Shear Breakup of an immiscible fluid interface.

B. Bunner and G. Tryggvason. "Numerical Simulation of Three-Dimensional Bubbly Flows.

S. Mortazavi, G. Tryggvason and W.J.A. Dahm. A Vortex Method for Simulations of Three-Dimensional Jets.

J. Han and G. Tryggvason. Secondary Breakup of Liquid Drops in Axisymmetric Geometry.

S. Homma, G. Tryggvason, J. Koga, and S. Matsumoto. Breakup of Laminar Jet into Drops in Immiscible Liquid-Liquid Systems.

J. Che, S.L. Ceccio, and G. Tryggvason. "Computations of Structures Formed by the Solidification of Impinging Molten Metal Drops," Proc. of the 1999 TMS Annual Meeting, San Diego, California, Feb. 1999.

Tryggvason. Direct Numerical Simulations of Multiphase Flow. American Physical Society Centennial Meeting, Atlanta, GA. March 20-26, 1999. Invited talk in a special session organized by the computational physics division of APS at the APS Centennial meeting in Atlanta

B. Bunner and G. Tryggvason, "A Parallel Front-Tracking Method for the Simulation of Dispersed Multiphase Flows." Proceedings of the Ninth SIAM Conference on Parallel Processing for Scientific Computing, San Antonio, March 1999.

G. Tryggvason. "Direct Numerical Simulations of Dispersed Flow." 9<sup>th</sup> Workshop on Two-Phase Flow Predictions, Merseburg, Germany, April 13-16, 1999.

Tryggvason. Invited presentation on Direct Numerical Simulations of Atomization. 12<sup>th</sup> Annual Conference on Liquid Atomization and Spray Systems, Indianapolis, IN, May 16-19, 1999.

Tryggvason, G. and Bunner, B. (1999). "Direct Numerical Simulation of Many Bubbles." Presented at the 4th International Congress on Industrial and Applied Mathematics, Edinburgh, Scotland, July 1999.

The 3rd ASME/JSME Joint Fluids Engineering Conference, San Francisco, July 18-22, 1999. Three papers

W. Tauber and G. Tryggvason. "The Shear Breakup of Immiscible Round Jets."  
J. Han and G. Tryggvason "Numerical studies of the secondary breakup of drops."  
Iyer, C. O., Bunner, B., Ceccio S. L., and Tryggvason G. (1999). "Capture of a Bubble by a Concentrated Vortex."

G. Tryggvason. Direct simulations of multiphase flows. Invited talk. Interfaces for the 21 century. Monterey, CA. August 16-18, 1999.

W. Tauber and G. Tryggvason. "Computations of Atomization." Invited presentation at the 8th International Symposium on CFD (ISCFD), September 5-10, 1999, Bremen, Germany. W. Tauber gave the talk and received the best student talk prize.

Chen, S.J., Dahm, W.J.A. & Tryggvason. "Experimental Results on the Coupling Between Fluid Dynamics and Combustion in a Laminar Vortex Ring", AIAA Paper No. 2000-4333, 38th AIAA Aerospace Sciences Meeting, January 10 - 13, 2000, Reno, NV.

G. Tryggvason. Direct Numerical Simulations of Multiphase Flow. 2000 IMuST Annual Meeting. March 12-14, 2000, Santa Barbara, CA.

Göz, M. F., Sommerfeld, M., Bunner, B., and Tryggvason, G. (2000), "Direct numerical simulation of gas bubbles in a liquid — Effects of deformability and bidispersity." Proceedings of the Japanese-German Symposium on Multiphase Flow, Dresden, Germany.

G. Tryggvason & B. Bunner. Direct Numerical Simulations of Multiphase Flow. 11th International Conference on Finite Elements in Flow Problems. May 3, 2000. Austin, Texas

G. Tryggvason and B. Bunner. Direct Numerical Simulations of Multiphase Flows. Plenary lecture Parallel CFD 2000, May 22-25, 2000 in Trondheim, Norway. *In Parallel Computational Fluid Dynamics. Trends and Applications*. Ed. C.B. Jensen et al. pp. 77-84. Elsevier, 2001.

G. Tryggvason. Direct Numerical Simulations of Multiphase Flow. US-Japan Seminar, June 5 – 8, 2000, Santa Barbara, CA

ASME Fluids Engineering Division Summer Meeting, meeting June 11-15, 2000. Boston, MA. Two talks:

J. Han and G. Tryggvason "Energy transfer in the secondary breakup of liquid drops."

M. F. Göz, B. Bunner, M. Sommerfeld, and G. Tryggvason. "The unsteady dynamics of two-dimensional bubbles in a regular array."

G. Tryggvason. “Direct Numerical Simulations of Multiphase Flow.” IUTAM Symposium on Free Surface Flows at Birmingham, UK, July 10, 2000.

S.-J. Chen, W.J.A. Dahm, and G. Tryggvason. Effects of Heat Release in a Reacting Vortex Ring. 28 International Symposium on Combustion. Edinburgh, Scotland, 30 July-4 August 2000.

G. Tryggvason. Direct Numerical Simulations of Multiphase Flow. Invited Talk. Engineering Foundation Conference on Chemical Reaction Engineering VII: Computational Fluid Dynamics. August 6-11, 2000, Quebec City, Canada.

G. Tryggvason. Talk at the Fifth Microgravity Fluid Physics and Transport Phenomena Conference. August 9-11, 2000, Cleveland, Ohio.

20th International Congress of Theoretical and Applied Mechanics, Chicago, USA 27 August-2 September, 2000. Two talks:

G. Tryggvason and B. Bunner. “Direct numerical simulations of bubbly flows.”

W. Tauber and G. Tryggvason. “Numerical Simulations of Primary Atomization.”

G. Tryggvason. Workshop on Computing Flexible Internal Boundaries in Finite Reynolds Numbers Flows. Invited Talk. Biomechanics and Numerical Simulations of Venous Flow. Ermenonville castle, France, September 7-8, 2000

G. Tryggvason. “Direct Numerical Simulations of Multiphase Flow.” Invited Talk. “10th International Conference on Discrete Simulation of Fluid Dynamics,” August 21-25, 2000, Santa Fe, New Mexico.

G. Tryggvason & B. Bunner. “Direct Numerical Simulations of Multiphase Flows.” First SIAM Conference on Computational Science and Engineering, Washington, D.C. Sept. 21-23, 2000,

The 53rd Annual Meeting of the American Physical Society's Division of Fluid Dynamics, November 19-21, 2000 in Washington, D.C. Four talks:

Mark Stock, Werner J.A. Dahm, and Gretar Tryggvason. “A Three-Dimensional Vortex Sheet Method for Inviscid Flows.”

Gretar Tryggvason and Warren Tauber. “Atomization due to Kelvin-Helmholtz Instability.”

Nabeel Al-Rawah and Gretar Tryggvason. “Effect of Melt Flow on Dendritic Solidification.”

Jie Zhang, S. George Bankoff, Michael Miksis, and Gretar Tryggvason. “Dynamics of an interface in an inclined channel.”

G. Tryggvason. “Direct Numerical Simulations of Multiphase Flow.” Invited Talk. Multiphase Flow 2001. Orlando, FL March 14-16, 2001

G. Tryggvason. “Direct numerical simulations of multiphase flow.” Plenary Lecture. International Workshop on Computational Methods for Continuum Physics and Their

Applications. Nanjing, China, May 21-24, 2001.

G. Tryggvason. “Direct numerical simulations of multiphase flow.” Keynote Lecture. ICMF—2001 Fourth International Conference on Multiphase Flow. New Orleans, LA, May 27-June 1, 2001.

ICMF—2001 Fourth International Conference on Multiphase Flow. New Orleans, LA, May 27-June 1, 2001. Five contributed talks:

G. Tryggvason and W. Tauber. “Numerical studies of atomization.”

M.F.G. Goz, B. Bunner, M. Sommerfeld and G. Tryggvason, “Direct numerical simulation of bidisperse bubble swarms.”

S. Homma, J. Koga, S. Matsumoto and G. Tryggvason. “Dynamics of mass transfer for an axisymmetric drop”

A. Esmaeeli and G. Tryggvason, “Direct numerical simulations of boiling flows.”

N. Z. Al-Rawahi and G. Tryggvason, “The effect of fluid flow on dendritic solidification.”

A. Fernandez and G. Tryggvason. “Effect of Electrostatic Forces on the Phase Distribution in Droplet Suspension.” ASME Fluids Engineering Division Summer Meeting, New Orleans, LA, May 29-June 1, 2001.

G. Tryggvason. “Direct numerical simulations of multiphase flow.” Invited Lecture. Direct and Large-Eddy Simulations IV. University of Twente, The Netherlands, July 18-20, 2001. (See also book chapters)

Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Abstracts in Bull. Amer. Phys. Soc. San Diego, CA, Nov. 18-20, 2001. Two talks:

M. Stock, W.J.A. Dahm and G. Tryggvason. “A Three-Dimensional Vortex Sheet Method for Large Eddy Simulations.”

A. Fernandez and G. Tryggvason “Direct numerical simulation of the electrostatic forces effect on the droplets distribution in a channel flow.”

A. Prosperetti and G. Tryggvason. “Task group on computational physics: Summary and Conclusions.” Workshop on Scientific Issues in Multiphase Flows: A Roadmap to the Future. University of Illinois, May 7-9. 2002.

G. Tryggvason. “Microbubble turbulent drag reduction: Effect of bubble size and deformation.” Friction Drag Reduction Program. DARPA Principal Investigators’ Meeting May 30-31, 2002. Denver, CO.

G. Tryggvason. A. Fernandez, J. Lu, and A. Esmaeeli. “Electrohydrodynamics of Droplet Suspensions by Front Tracking Simulations.” SIAM Annual Meeting, July 8-12, 2002, Philadelphia, PA.

G. Tryggvason. “Direct Numerical Simulations of Multiphase Flows.” Invited Plenary Lecture: ASME Fluids Engineering Division Summer Meeting July 14-18, 2002, Montreal, Quebec, Canada

FEDSM'02 2002 ASME Fluids Engineering Division Summer Meeting July 14-18, 2002, Montreal, Quebec, Canada. Four papers:

G. Tryggvason FEDSM2002-31384: "Challenges in direct numerical simulations of multiphase flows."

J. Lu, A. Fernández, and G. Tryggvason FEDSM2002-31217 "Bubbles in Vortical Flows"

A. Fernández, J. Lu, A. Esmaeeli, and G. Tryggvason. FEDSM2002-31237: "The effect of electrostatic forces on the distribution of drops in a channel."

M. F. Gös, B. Bunner, M. Sommerfeld, and G. Tryggvason. FEDSM2002-31395: "Microstructure of a bidisperse swarm of spherical bubbles."

Sixth Microgravity Fluid Physics and Transport Phenomena Conference August 14-16, 2002 Cleveland OH. Two posters:

G. Tryggvason, A. Fernandez, and A Esmaeeli. "Electrostatic effects on droplet suspensions" (Poster presentation)

R. L. Vander Wal, J. P. Kizito, G. M. Berger, J. I. D. Alexander, and G. Tryggvason. "Splashing droplets" (Poster presentation)

Division of Fluid Dynamics 55th Annual Meeting November 24-26, 2002; Austin, Texas. Three talks:

J. Lu, A. Fernandez, and G. Tryggvason. "Effect of Microbubbles on Vortical Flows"

G. Tryggvason and A. Fernandez. "Electrohydrodynamic Effects on Droplet Suspensions"

M. Stock, W.J.A. Dahm and G. Tryggvason. "A Three-Dimensional Vortex Sheet Method for Multiphase Flows"

SIAM Conference on Computational Science and Engineering (CSE03) February 10-13, 2003, San Diego, CA. Two talks:

G. Tryggvason, A. Esmaeeli, and N. Al-Rawahi. "Direct Numerical Simulations of Complex Multiphase Flows"

A. Fernandez and G. Tryggvason. "Effects of Electrostatic Forces on the Phase Distribution in Droplet Suspension. Three-Dimensional Numerical Simulations"

G. Tryggvason. Presentation at a DARPA Contractors meeting March 21-22, 2003, San Diego.

Second M.I.T. Conference on Computational Fluid and Solid Mechanics. Boston, June 17-20, 2003. Two talks:

G. Tryggvason, A. Fernández, and J. Lu. "The effect of electrostatic forces on droplet suspensions"

G. Tryggvason, A. Esmaeeli, and N. Al-Rawahi. "Direct numerical simulations of flows with phase change"

FEDSM'03 4<sup>th</sup> ASME/JSME Joint Fluids Engineering Conference July 6-11, 2003, Honolulu, Hawaii, Two talks:

A. Fernández, J. Lu, and G. Tryggvason. FEDSM2003-45641: "Bubble effects on wall shear in vortical flows"

A. Esmaeeli and G. Tryggvason. FEDSM2003-45174: “Boiling Flows”

G. Tryggvason. Invited Lecturer. “Computational Techniques for Moving Interfaces.” August 23 - 28, 2003, Banff International Research Station. Banff, Canada

G. Tryggvason. Invited Talk. Perspectives on Nonlinear Equations and Optimization—Conference in honor of Homer Walker. WPI. Sept 20, 2003

G. Tryggvason. Invited Lectures. Woudschoten Conference of the Dutch-Flemish Numerical Analysis Communities 1 - 3 October 2003, Zeist. The Netherlands (two lectures).

G. Tryggvason. “ABET’s Path to Outcome Assessment.” Assessment Conference at the College of the Holy Cross. Nov. 7, 2003. Invited talk originally to be given by President E. A. Parrish of WPI who could not be there.

Division of Fluid Dynamics 56th Annual Meeting November 23-25, 2003; East Rutherford, New Jersey. Three talks:

J. Lu, A. Fernandez, and G. Tryggvason. “Direct Numerical Simulations of Microbubbles-Induced Drag Reduction”

G. Tryggvason and A. Esmaeeli. “Direct Numerical Simulations of Boiling”

A. Fernandez and G. Tryggvason. “Effects of an electrostatic field on a suspension of drops”

G. Tryggvason. “Educating Mechanical Engineers for the 21<sup>st</sup> Century.” WPI-ASME student section, WPI, February 17, 2004.

G. Tryggvason. Invited Talk. “The Effect of Bubbles on Near-Wall Vortical Flow at a conference on ‘Smart Control of Turbulence,’” at the University of Tokyo, Tokyo, Japan, February 28 - March 4, 2004.

G. Tryggvason. “The WPI Global Program,” Invited presentation at a symposium on globalization of engineering education at the ASME International Mechanical Engineering Education Conference, Sheraton Sand Key Resort, Clearwater Beach, FL, March 5-9, 2004:

G. Tryggvason. “Computations of atomization.” Invited presentation at a Topical Workshop: Investigating Primary Breakup at the 17th Annual Conference, ILASS - Americas: Institute for Liquid Atomization and Spray Systems, May 16-19, Arlington, VA

G. Tryggvason. Presentation at the DARPA FDR Program Principal Investigator (PI) Meeting . The Beach Resort, 2600 Sand Dunes Drive, Monterey, CA. May 18-19, 2004.

G. Tryggvason. “Numerical Methods for Multiphase Flows.” Invited presentation at a Workshop on “Novel methods for modeling the surface evolution of geomorphic interfaces.” MIT, Cambridge MA, May 23-25, 2004.

G. Tryggvason and A. Esmaeeli. “Computations of Boiling Flows.” May 31 - June 3, 2004: ICMF-2004: International Conference on Multiphase Flow, Yokohama Pacifico Conference Center, JAPAN.

G. Tryggvason and A. Esmaeeli. HT-FED2004-56268: “Computations of Boiling Flows.” July 11 - 15, 2004: ASME Heat Transfer/Fluids Engineering Summer Conference, Charlotte, North Carolina, USA, July 11 - 15, 2004

G. Tryggvason. “Direct Numerical Simulations of Complex Flows.” Conference on Analysis, Modeling, and Computations of PDE and Multiphase Flows. SUNY Stony Brook. August 3-5, 2004

G. Tryggvason. “Direct Numerical Simulations of Flows with Phase Change.” 6th WCCM (World Congress of Computational Mechanics), Beijing, China September 4 - 10 2004.

G. Tryggvason, J. Lu, S. Biswas, and A. Esmaeeli. “Direct Numerical Simulations of Bubbly Flows.” IUTAM Symposium on Computational Approaches to Disperse Multiphase Flow. Chicago, IL, October 4-7, 2004.

DFD 57th Annual Meeting 2004, November 21-23, Seattle, WA. Two talks:  
G. Tryggvason, A. Esmaeeli, S. Biswas. “DNS studies of bubbly flows”  
J. Lu, G. Tryggvason. “Direct numerical simulations of drag reduction due to bubble injection into a turbulent channel flow”

G. Tryggvason, A. Esmaeeli, J. Lu, S. Biswas, and S. Homma. Keynote Lecture “Recent Progress in Computational Studies of Disperse Bubbly Flows.” Japan-US Seminar on Two-Phase Flow Dynamics. December 6-11, 2004, Nagahama, Japan

B. Savelonis, H. Johari, G. Tryggvason, D. Olinger, and J. Blandino. “Development of a Unified Thermofluid Curriculum,” Proceedings of the 2005 ASEE New England Section Conference, 725-729, April 8-9, 2005.

G. Tryggvason. “Bubble interactions.” Keynote Lecture. 43rd European Two-Phase Flow Group Meeting. May 11-13, 2005, Prague, Czech Republic

J. Lu and G. Tryggvason. “DNS of Drag Reduction due to Bubble Injection into Turbulent Flow.” 2<sup>nd</sup> International Symposium on Seawater Drag Reduction. 23-26 May 2005, Busan, Korea.

G. Tryggvason. “Direct Numerical Simulations of Bubbly Flows.” Keynote Lecture. Hydrodynamics of Bubbly Flows. Euromech Colloquium and Workshop. June 6-16, Leiden University, Netherlands.

A. Esmaeeli and G. Tryggvason. Invited talk. Workshop on Multiphase and Reacting Flow Simulations, June 27-28, 2005. Purdue University.

ASME International Mechanical Engineering Congress & Exposition - Orlando, FL, November 15-11, 2005. Two talks:

Tryggvason and A. Fernandez. “Computations of the effect of electric fields on the Motion of Droplets”

G. Tryggvason. “Direct Numerical Simulations of Boiling”

American Physical Society, Division of Fluid Dynamics 58th Annual Meeting (DFD05), Chicago, IL, November 20-22, 2005: Three talks:

J. Lu, S. Biswas, and G. Tryggvason. “Laminar bubbly flow in a vertical channel”

S. Biswas, J. Lu, and G. Tryggvason. “Bubbly wall-layers in a vertical channel”

D. Juric and G. Tryggvason. “Three-dimensional simulation of vapor bubble dynamics in nucleate boiling”

G. Tryggvason. “Computations of the Dynamics of Heterogeneous Continuum Systems,” Invited talk at the 18th JSME Computational Mechanics Conference in Tsukuba, Japan. November 20, 2005.

G. Tryggvason. “Educating Engineers for the Challenges of the 21<sup>st</sup> Century.” Invited talk at a joint ASME, EEE and SME meeting at WPI on Feb. 21, 2006

G. Tryggvason. “Direct Numerical Simulations of Multiphase Flows.” Invited talk at the Workshop on High end computing for nuclear fission science and engineering. Salt Lake City February 22-23, 2006

P. Quinn, L. Schachterle, G. Tryggvason and R. Vaz. “The WPI Bachelor of Arts degree in ‘Liberal and Engineering Studies.’” In *Proceedings of the ASEE New England Section 2006 Annual Conference*. Worcester, MA, March 17-18, 2006

G. Tryggvason, R. Vaz, P. Davis and N. A. Mello. “Preparing Engineers to Work in a Flat World—The WPI Global Perspective Program.” 2006 International Mechanical Engineering Education Conference: Mechanical Engineering Education and Global Industry. Beijing, China, March 31 - April 4, 2006

G. Tryggvason, J. Lu, S. Biswas and A. Esmaeeli. “Studies of Bubbly Channel Flows by Direct Numerical Simulations.” Keynote lecture at the Conference on Turbulence and Interactions TI2006, May 29 – June 2, 2006, Porquerolles, France

G. Tryggvason, J. Lu, and S. Biswas, FEDSM2006-98102: “Direct Numerical Simulations of Bubbles in Vertical Channels.” 2006 ASME Fluids Engineering Conference. July 17-20, 2006. Miami, Florida

G. Tryggvason. “Studying the dynamics of heterogeneous continuum systems using a Front-Tracking method.” Invited talk at Euromech Colloquium 479 Numerical Simulation of Multiphase Flow with Deformable Interfaces. August 14-16th, 2006, The Pier, Scheveningen, The Netherlands

American Physical Society, Division of Fluid Dynamics 59th Annual Meeting

(DFD06), Tampa, FL, November 19-21, 2006: Three talks:

J. Lu and G. Tryggvason. “DNS of turbulent bubbly flows in vertical channels”

S. Biswas and G. Tryggvason. “Studies of bubble dispersion”

G. Tryggvason and D. Juric. “Multiscale simulations of nucleate boiling”

G. Tryggvason. A series of four “Tutorial Lectures” on “Moving Interface Problems: Methods & Applications.” Workshop on Moving Interface Problems and Applications in Fluid Dynamics. Singapore National University. March 12, 2007

G. Tryggvason, J. Lu, and S. Biswas. DNS of Bubbly Channel Flows. Workshop on Moving Interface Problems and Applications in Fluid Dynamics. Singapore National University, March 13, 2007

G. Tryggvason. “Using DNS to Explore the Dynamics of Heterogeneous Continuum Systems.” Invited Talk. Farewell Symposium for Prof.dr.ir. Pieter Wesseling. Delft University of Technology, June 6, 2007

G. Tryggvason. “Direct Numerical Simulations of Bubbly Channel Flows.” Keynote Lecture. IUTAM Symposium on Recent Advances in Multiphase Flows: Numerical and Experimental. Istanbul, Turkey on June 11-14, 2007.

G. Tryggvason. Invited talk. UTRC Workshop on primary atomization. East Hartford CT, June 18, 2007

6<sup>th</sup> International Conference on Multiphase Flow, ICMF 2007, Leipzig, Germany, July 9 – 13, 2007. Three talks:

D. Juric, S. Shin and G. Tryggvason. “Direct Numerical Simulations of Nucleate Boiling.”

J. Lu, S. Biswas and G. Tryggvason. “Direct Numerical Simulations of Bubbly Flows in Vertical Channels.”

S. Mortasavi, J. Lu, and G. Tryggvason. “Topology Changes in Front Tracking Simulations of Multiphase Flows.”

G. Tryggvason. “Studying the Dynamics of Heterogeneous Continuum Systems Using DNS.” Invited talk. NSF Workshop on Cyber-Fluid Dynamics: Frontiers in Research and Education, Arlington, VA, July 19-20, 2007

G. Tryggvason. “Direct Numerical Simulations of Bubbly Flows.” Two invited lectures. Sept 5-7, 2007. Invited speaker. Advanced School on Lagrangian Techniques in Multiphase Flow. Trieste, Italy

G. Tryggvason and J. Li. “Direct Numerical Simulations of Multiphase Flows.” Keynote lecture. 10th UK National Heat Transfer Conference, Edinburgh, 10-11 September 2007

G. Tryggvason. “Studying the Dynamics of Heterogeneous Continuum Systems using DNS.” Invited lecture. 2007-08 Program on Random Media Opening Workshop, Research Triangle Park, NC, September 23-26, 2007

G. Tryggvason. “Direct Numerical Simulations of Nucleate Boiling.” Sandia/NSF Workshop. Albuquerque, NM, October 25 – 26, 2007

### **Other writings**

G. Tryggvason, “Numerical Experiments on Slumping Gravity Currents.” Woods Hole Oceanographic Institution, Tech. Rep. WHOI-83-41, 207-228 (1983).

G. Tryggvason. “Imbedded Interface Methods.” Lecture notes for a short course on Modeling and Computation of Multiphase Flow, Zurich, March 8-12, 1999. 50 pages

G. Tryggvason and D. Apelian. “Re-Engineering Engineering Education for the Challenges of the 21<sup>st</sup> Century.” Commentary in JOM: The Member Journal of TMS, October 2006.

### **Invited Seminars**

Woods Hole Oceanographic Institute, 1983.

Brown University, Division of Engineering, 1983.

Los Alamos National Laboratory, 1984.

University of Wyoming, Department of Mathematics, 1984.

Yale University, Division of Mechanical Engineering, 1984.

Courant Institute of Mathematical Sciences, 1984.

Exxon Research and Engineering Company, Annandale, New Jersey, 1984.

University of Houston, Department of Mechanical Engineering, 1985.

Florida State University, Department of Mathematics, 1985.

University of Michigan, Department of Mech Eng & Appl Mech, 1985.

Lawrence Livermore National Laboratory, 1986

University of California, San Diego, Department of Mechanical Engineering, 1986

Caltech, GALCIT, 1986

University of Michigan, Department of Naval Architecture, 1986

Woods Hole Oceanographic Institute, 1986

Woods Hole Oceanographic Institute, 1988

University of Michigan, Program in Ship Hydrodynamics, 1988

Naval Research Laboratory, 1989

University of Michigan, Department of Aerospace Engineering

Minnesota Supercomputer Center, 4/03/91

NASA Lewis Research Center, ICOMP, 5/17/91

University of Iceland, Mathematics Department, 9/19/91

RPI, Department of Mechanical Engineering, 9/27/91

NASA Lewis Research Center 8/11/93.

University of Illinois 9/16/93.

University of California, Davis 2/17/94

Livermore National Laboratory 2/18/94

University of California, Irvine 3/11/94

University of California, San Diego 4/14/94

California Institute of Technology 4/08/94

University of California, Berkeley 5/05/94

Los Alamos National Laboratory 7/28/94

Univ. of Michigan, LaSC Seminar 10/20/95  
University of Minnesota 1/13/95  
John Hopkins 12/14/95  
University of Michigan, Nuclear Engineering 2/16/96  
Tokyo University 8/21/96  
Georgia Tech. (new ME curriculum) 12/16/96  
Reactor Thermal Hydraulics section, CAE, Grenoble, France.  
Series of three lectures, Jan. 21-23, 1997.  
IUSTI, University of Provence, Marseille, France, 1/27/97  
UCSB, Chemical Engineering. 11/21/97  
University of Arizona, 1/29/98  
NASA Lewis Research Center, 3/10/98  
University of Massachusetts, Amherst (ABET Preparation) 1/21/99  
Rutgers University, 2/12/99  
UCSD, 1/14/00  
John Hopkins, 2/17/00  
WPI (Mechanical Engineering) 5/31/00  
WPI (Mathematics) 9/15/00  
Los Alamos 10/5/00  
Brown University (Applied Math) 02/27/01  
Princeton University (Chemical Engineering) 02/06/02  
Clark University (Physics) 09/26/02  
Yale University (Mechanical Engineering) 11/13/02  
University of Alberta (Chemical Engineering) 3/01/03  
University of Florida (Mechanical and Aerospace Engineering) 3/11/03  
RPI (Mathematics) 3/18/03  
ETH Zurich, 3/28/03  
Knolls Atomic Power Laboratory/GE 8/12/03  
University of Delaware (Mechanical Engineering) 10/31/03  
SUNY, Stony Brook (Applied Mathematics) 12/3/03  
Ritsumeikan University (Civil Engineering), Japan, 12/10/04  
Louisiana State University (Mechanical Engineering) 3/4/05  
University of Notre Dame (Aerospace and Mechanical Engineering) 11/20/05  
University of Maryland, College Park (Mechanical Engineering) 2/10/06  
University of Illinois, Urbana-Champaign (Mechanical Engineering) 5/15/06  
University of Massachusetts (Mathematics) 9/26/06  
University of Massachusetts (Chemical Engineering) 10/24/06  
RPI (Mechanical Engineering) 12/6/06  
Institute for High Performance Computing, Singapore 3/15/07  
Stanford University, Fluid Mechanics Seminar 4/10/07  
Centrum voor Wiskunde en Informatica, Amsterdam. 6/7/07  
Brookhaven National Laboratory 10/31/07  
SUNY, Stony Brook (Applied Mathematics) 11/1/07

### Articles About my Work

Paul Tooby. "Dancing Bubbles, Simulating Multiphase Flow." *Envision* (the NPACI magazine) Vol. 16 (4), Oct.-Dec. 2000.

**Research Grants and Contracts****Institutional Funds:**

Numerical Simulations of Instabilities of Fluid Interfaces. Rackham Faculty Grant from the University of Michigan, 1986. \$10,000. Duration 1 year.

Computations of Multi-Phase Flows. Phoenix Memorial Foundation at the University of Michigan. \$5,000 for summer 1990.

Research maintenance funds from the University of Michigan. \$10,000 for summer 1990 and \$5,000 for fall 1993.

**External Funds:**

Numerical Simulations of Instabilities of Fluid Interfaces. National Science Foundation Engineering Initiation Award, MSM-8707646. \$60,000. Duration 9/1/87 - 2/28/89.

Program in Ship Hydrodynamics. Office of Naval Research (under the URI program, contract N000184-86-K-0684. P.I.: R. Beck). My part was \$263,908. Duration: 9/1/86 - 8/31/91.

A Basic Research Model of Gas Combustion in Turbulent Flow, Phase I. Gas Research Institute Contract No. 5088-260-1692. \$246,000. Duration: 6/1/88 - 7/31/90. Co-Principal Investigator with W.J.A. Dahm and R. Krasny.

A Basic Research Model of Gas Combustion in Turbulent Flow, Phase II. Gas Research Institute. \$392,112. Duration: 8/1/90 - 7/31/93. (Renewal of Phase I). Co-Principal Investigator with W.J.A. Dahm and R. Krasny.

Studies of Bubbly Flows. Office of Naval Research, contract N00014-91-J-1084. \$255,960. Duration: 10/1/90 - 9/30/93.

Numerical Studies of Multi-fluid Systems. National Science Foundation, grant CTS-913214. \$193,166. Duration: 5/1/91 - 4/30/94.

A Basic Research Model of Gas Combustion in Turbulent Flow, Phase IIb. Gas Research Institute. \$68,816. Duration: 9/1/93 - 8/41/95. (Continuation of Phase II). Co-Principal Investigator with W.J.A. Dahm.

Computational Studies of Drop Collision and Coalescence. National Aeronautics and Space Administration, contract NAG3-1317. \$253,090. Duration: 1/1/92 - 6/1/96. (With D. Jacqmin at NASA Lewis Research Center).

Fellowship for Damir Juric. National Aeronautics and Space Administration, contract NGT-51070. \$66,000. Duration: 7/1/93 - 6/30/96

Fundamentals of Mold-Free Casting: Experimental and Computational Studies. National Aeronautics and Space Administration, \$100,000 for 7/11/94-1/10/96. (Co-PI with S. Ceccio).

A Hierarchy of Reduced Models for Underhood Flows. Ford Motor Company. \$51,514. Duration: 6/1/95-5/31/96. (Co-PI with K. Powell).

Ocean Surface Processes. Office of Naval Research (under the URI program. P.I.:J. Vaseki and G. Medows). My part was about \$220,000. Duration: 1/5/92 - 6/30/97.

Direct Numerical Studies of Multi-Phase Flows. National Science Foundation. CTC-9503208: \$240,000. Duration: 8/1/95-7/31/98.

Computational Investigations of Atomization. Air Force Office of Scientific Research. FA9620-96-1-0356: \$257,061. Duration: 7/1/96-6/31/99.

Liquid Droplet Deposition Manufacturing. Graduate student support grant for Hwei N. Che. National Aeronautics and Space Administration, contract NGT3-52319. \$66,000. Duration: 8/15/96 - 8/14/99. (Co-PI with S.L. Ceccio.)

Flame Structure Measurements and Modeling: Developing Tools from Basic Research to Meet Gas Industry Needs. Gas Research Institute. \$780,138 (most of which went to Dahm and Driscoll for experimental work). Duration: 1/1/97 - 12/31/99. Co-Principal Investigator with W.J.A. Dahm and J. Driscoll.

Advanced Modeling of Multiphase Flow Problems. Chevron Petroleum and Technology Company. Phase 1. \$99,814.00. Duration: 12/14/98-1/31/2000. Co-PI with W.J.A. Dahm.

Computational Investigations of Atomization. Air Force Office of Scientific Research. F49620-99-1-0314. \$50,000

Computations of Droplet/Flow Interactions in Sprays. Air Force Office of Scientific Research -AASERT grant. \$124,216. Duration: 9/1/97-8/31/00.

U.S. Germany Cooperative Research: Analysis and Modeling of Turbulence Phenomena in Bubble Columns. National Science Foundation Grant INT-9726759. \$24,460. Duration 3/15/98-2/29/00

Advanced Modeling of Multiphase Flow Problems. Chevron Petroleum and Technology Company. Phase 2. \$49,791. Duration: 2/1/2000-7/31/2000. (Co-PI with W.J.A. Dahm.)

Advanced Modeling of Multiphase Flow Problems Phase III. Chevron. \$65,004. Duration: 01/01/01 - 12/31/01. (Co-PI with W.J.A. Dahm.)

NAG3-2162 and NAG3-2583: Computations of Boiling in Microgravity. National Aeronautics and Space Administration. \$356,000. Duration: 2/10/98-2/9/02.

NAG3-2332 and NAG3-2545: Computational modeling of the effect of secondary forces on the phase distribution in dispersed multiphase channel flow. National

Aeronautics and Space Administration. Originally awarded to University of Michigan at \$360,000 for 5/1/00-11/30/03 (NAG3-2332). When I moved to WPI the remaining funds were awarded to WPI at \$290,000 for 2/7/01-2/6/04 (NAG3-2545).

Micro-bubble and Micro-bubble/Polymer Turbulent Drag Reduction. DARPA BAA 00-38. P.I. M. Maxey, Brown University. Tryggvason is Co-Investigator. The WPI part was \$157,337 for 15 months.

Micro-bubble and Micro-bubble/Polymer Turbulent Drag Reduction Phase II. DARPA BAA 00-38. P.I. M. Maxey, Brown University. Tryggvason is Co-Investigator. The WPI part was \$100,000 for 7/1/02-9/1/03.

Computations of Spray Cooling. Parker Hannifin Corporation, Co-PI (PI.: A. Esmaeeli). \$15,000.

Advanced Modeling of Multiphase Flow Problems Phase IIIb. Chevron. \$71,235. Duration: 01/01/02 - 12/31/02. (Co-PI with W.J.A. Dahm.)

NAG3-2535: Splating drops. NASA. PI.: R. Vander Wal, NASA Glen Research Center. Tryggvason is Co-Investigator. The WPI part is \$44,000 for 3/1/00-11/30/03.

DE-FG02-03ER46083: Investigations of Bubbly Flows using Direct Numerical Simulations. Department of Energy. \$380,756 for 9/1/03-2/28/07 (no cost extension to 12/31/07).

Multiscale Physical Modeling for Microbubble Drag Reduction at High Reynolds Numbers DARPA Subcontract to the Pennsylvania State University, PI.: R. Kunz). The WPI part was \$158,246 for 11/03/03-12/31/04.

Droplets Impacting Liquid Films: Coalescence or Splash. NASA. Co-Investigator (PI.: R. Vander Wal at NASA). The WPI part is \$180,951 for four years.

NNC05GA26G: Studies of Forced Convection Boiling by Direct Numerical Simulations. NASA. \$241,992 for 03/22/05-9/30/06 (no cost extension to 6/30/07).

CTS-0522581: Multiscale simulations of multiphase systems. National Science Foundation. \$40,000 for 09/01/05-08/31/06.

Development of 1<sup>st</sup> generation subscale models/correlations for the adapted S-gamma model. AREVA, Inc. \$52,942. 07/01/06-12/31/06.

Direct Numerical Simulations of Nucleate Flow Boiling. Contract 619042, Sandia National Laboratory (NSF-Sandia collaborative program). \$320,000. 10/1/06-09/31/09.

Direct grant of large amount of computer time from various sources, including the San Diego Supercomputer Center, NPACI (at SDSC, Maui, and U of M.), NASA, and others. Continuous support since 4/1/86.

**Fundraising for educational activities and departmental infrastructure at WPI**

WPI Manufacturing Engineering Program — Haas Technical Education Center. \$400,000. Lufkin Foundation, 2001. With D. R. Rodino, W.W. Durgin, C. Brown and others.

Planning Revisions in the Mechanical Engineering Program at WPI. National Science Foundation. \$99,960 for 09/01/03-08/31/04. PI.: Tryggvason. Co-PIs: C. Brown; A. Hoffman; Z. Hou; D. Olinger.

MEMS Laboratory and graduate fellowship. \$400,000. Lufkin Foundation, 2004. With D. R. Rodino, R. J. Pryputniewicz, W.W. Durgin and others.

Social Networking in the FIRST Robotics Competition Community. National Science Foundation. \$189,500.00 for 10/01/07-9/30/08. PI.: G. Tryggvason. Co-PIs.: C. Randall, J. Doyle, and M. Genner.

CPATH CB: Building Community via Robotics Innovations Competition and Conference. National Science Foundation. \$359,761.00 for 07/15/07-06/14/10. PI. M. Gennert. Co-PIs.: G. Tryggvason and D. Cyganski.

Updated 11/03/07