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Portonovo S. Ayyaswamy

Asa Whitney Professor of Dynamical Engineering (Emeritus)
MEAM, SEAS, UPenn., Philadelphia 19104
&
Distinguished Adjunct Professor
Mechanical and Aerospace Engineering Department
School of Engineering and Applied Science
University of California
Los Angeles, CA 90024

PERSONAL

Citizenship:	U.S. Citizen
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EDUCATION

Ph.D. (1971) University of California, Los Angeles
Thesis Title: "Natural Convection Flows in Tilted Configurations"
Advisor: Professor Ivan Catton

M.E. (1967) Columbia University, New York
Thesis Title: "A Step by Step Design for Helical Tube Multi-Start Coil Heat Transfer Equipment: Entering Tube Side Fluid in the Super Critical Region or Otherwise"
Advisor: Professor Harold G. Elrod, Jr.

M.S. (1965) Columbia University, New York
B.E. (1962) University of Mysore

POSITIONS HELD

Mechanical and Aerospace Engineering Department, University of California, Los Angeles

2020- Present	Adjunct Professor, Above Scale
2019-2020	Visiting Professor

Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania

2019-Present	Asa Whitney Professor of Dynamical Engineering (Emeritus)
1996-2018	Asa Whitney Professor of Dynamical Engineering
1987-1996	Professor of Mechanical Engineering & Applied Mechanics
2004-2006	Chairman, Graduate Affairs
1990-1996	

1984-1986 Chairman, Undergraduate Affairs
1980-1987 Associate Professor
1974-1980 Assistant Professor

Energy and Kinetics Department, University of California, Los Angeles

1972-1974 Postdoctoral Scholar
1973-1974 Supervisors: Professors Ivan Catton and Donald K. Edwards:
Topic: **Capillary flows in grooved surfaces**.
1972-1973 Supervisor: Professor David Okrent:
Topic: **Large scale safety of nuclear reactors**.

Institute of Geophysics and Planetary Physics, University of California, Los Angeles
1971-1972 Postdoctoral Fellow
Supervisor: Professor Friedrich H. Busse
Topic: **Bounding theories in turbulence**.
Energy and Kinetics Department, University of California, Los Angeles
1969-1971 Post-Graduate Research Engineer
Supervisor: Professor Ivan Catton
Topic: **Natural Convection Flows in Tilted Configurations**
1968-1969 Teaching Associate
1967-1968 Research Assistant
Supervisor: Professor Richard Perrine
Topic: **Desalination**

The Lummus Company, Madison Avenue, New York
1966-1967 Heat Exchanger Engineer

School of Engineering and Applied Sciences, The City University of New York, New York
1964-1966 Instructor

Electronics Research Laboratories, Columbia University, New York, New York
1963-1964 Computer Assistant

Hydro-Electric Construction Project, Government of Mysore, Bangalore
1962-1963 Junior Engineer

HONORS/DISTINCTIONS

Special Issue: Honoring Dr. Portonovo Ayyaswamy's Retirement, ASME Journal of Heat Transfer, *Transactions of the ASME*, May 2019 2019

"Frontiers, Fundamentals, and Future Directions of Transport: From Theory to Applications"
A symposium to celebrate the distinguished career of Dr. Portonovo Ayyaswamy
University of Pennsylvania, Philadelphia, May 9, 2018 2018

Symposium Key Note Lectures by:
Profs. C. Thomas Avedisian (Cornell), James W. Baish (Bucknell), Michael Carchidi (UPenn), Ivan Catton (UCLA), Vijay Dhir, *NAE* (UCLA), David M.Eckmann (UPenn),Yogesh Jaluria (Rutgers), Joshua Lampe (Zoll Medical), Yaling Lu (Lehigh), Arun Majumdar, *NAE, NAS* (Stanford),

Raj Manglik (U.Cincinnati), K. Mukundakrishnan (Stone Ridge Tech), Ravi Radhakrishnan (UPenn), Satwindar S. Sadhal (USC), William A. Sirignano, *NAE* (UCI), Howard A. Stone, *NAE*, *NAS* (Princeton), Sheldon Weinbaum, *NAE*, *NAS, NAM* (CUNY)

Elected Honorary Member, Am. Soc. Mech. Engrs. Awarded for a "Life time of distinguished service to Engineering" 2018

UCLA Engineering Alumni Professional Achievement Award: 2017
One of the school's highest honors

Appointed: Editor-in-Chief, Am.Soc.Mech.Engrs. Journal of Heat Transfer 2015-

The Max Jakob Memorial Award "recognizes an eminent scholarly achievement and distinguished leadership in the field of heat transfer. Jointly awarded by the Am.Inst.Chem.Engrs and the Am.Soc.Mech.Engrs. It is the highest honor in the field of heat transfer these professional organizations bestow." 2014

"P. Ayyaswamy 70th Birthday Tribute" Special Sessions I & II 2014
on (I) Interfacial Fluid Dynamics and (II) Devices & Modeling Nanoparticles
7th World Congress of Biomechanics, Boston, MA

Member, Board of Governors 2014-2017
American Society for Gravitational and Space Research

75 th Anniversary Medal of the ASME Heat Transfer Division for service to the heat transfer community and contributions to the field 2013

ASME 2007 Worcester Reed Warner Medal for "outstanding contributions to the permanent literature of engineering" 2007

Expert Consultant, Workshop on "Meeting the workforce needs for the National Vision for Space Exploration," **National Research Council of the National Academies Committee, Washington, DC** 2006

Invited Participant, NAE Benchmarking **"**Virtual Congress Exercise" to determine the "best of the best" researchers in subfields and sub-subfields of Mechanical Engineering (Areas: Fluid Mechanics and Heat Transfer). **National Research Council of the National Academies Committee, Washington, DC** 2006

Invited Member, Review of NASA Strategic Roadmaps: Space Station Panel, **National Research Council of the National Academies Committee, Washington, DC** 2005

ASME Heat Transfer Memorial Award in the Science Category for "seminal contributions to such diverse fields of heat transfer as phase change, plasma, bio, and natural convection, in particular to transport processes with moving droplets and thermal design of advanced industrial equipment." 2001

Visiting Professor, Department of Mechanical Engineering, University of California, Berkeley, CA 2000

Council of Indian Organizations Award for Distinguished Contributions to Engineering Science 1999

"**Aerospace Professional of the Year**" award, Am. Inst. Aeronautics and Astronautics for "Outstanding contributions to the advancement of the arts and sciences of aeronautics and astronautics." 1997

Appointed Asa Whitney Professor of Dynamical Engineering: "In recognition of his outstanding achievements in heat transfer research, excellence in teaching, and distinguished service to the University and his profession." 1996

Appointed United Nations Expert and Consultant for Engineering and Technology, UNIDO, Vienna, Austria 1991

Elected Fellow, American Society of Mechanical Engineers for "significant contributions to Heat Transfer;" "His studies on droplet dynamics in the presence of phase change (condensation, evaporation, and combustion) have yielded new and important insights into mechanisms of drag and heat transfer." 1990

Outstanding Faculty Advisor Award: "For dedication to quality education and development of professional awareness through student participation." American Society of Mechanical Engineers 1979

Lindback Award for Distinguished Teaching: "For distinguished teaching, in recognition of outstanding service in stimulating and guiding the intellectual development of students at the University of Pennsylvania." 1979

Reid Warren Award for Distinguished Teaching: "In recognition of outstanding service in stimulating and guiding the intellectual development of undergraduate students at the College of Engineering and Applied Science." University of Pennsylvania, Philadelphia 1978

PATENTS

1. Bioactive, degradable composite for tissue engineering, U.S. Patent #6328990.
2. Hollow bone mineral-like calcium phosphate particles, U.S. Patent #6416774.

IMPORTANT KEYNOTE, INVITED LECTURES

"The linear and non-linear stabilities of a Plasma-arc" University of Zurich, Zurich, Switzerland 1979

Keynote address to Chinese Nuclear Society on "Heat and Mass Removal from Nuclear Reactor Containment by Spray Droplets," China International Conference Center for Science and Technology, Beijing, People's Republic of China 1985

Invited Distinguished Participant and Keynote Speaker, Eighth National Heat and Mass Transfer Conference, Visakha Patnam, India. Invited by the Indian Society for Heat/Mass Transfer and the Ministry of Education, India. Address on "Heat and mass transfer with condensation"	1985
"The theory of condensation on moving droplets" Cavendish Laboratory, University of Cambridge, England	1986
"Hydrodynamics of condensation on a moving drop" The Royal Institute of Technology, Stockholm, Sweden	1986
"Mathematics of direct-contact condensation on a moving drop" The Danish Center for Applied Mathematics & Mechanics, The Technical University of Denmark, Lyngby, Denmark	1986
"Direct-Contact Phase Change Processes with Moving Liquid Droplets," International Symposium/Workshop on Boiling, Condensation and Two-Phase Flow Heat Transfer, Visakha Patnam, India	1994
Bio-Heat Transfer: "Effects of Micro-Wave Radiation on Biological Tissue Heating," Bhabha Atomic Research Center, Bombay, India	1994
Am. Inst. Aeronautics and Astronautics award lecture: "Bone-cell growth in microgravity," Philadelphia, PA	1997
Bio-Mass Transfer: "Bone-cell growth in microgravity--cell biology, fluid mechanics and mass transfer," 14th National Heat and Mass Transfer Conference and the 3rd ISHMT/ASME Joint Heat and Mass Transfer Conference, Kanpur, India	1997
"Interfacial motion of a molten layer subject to plasma heating" Chia-Shun Yih Memorial Symposium, 13th U.S. National Congress of Applied Mechanics, Gainesville, FL	1998
"The culture of three-dimensional bone-like tissue under simulated microgravity conditions in NASA's rotating-wall vessels: experimental and numerical studies." Engineering foundation conference on microgravity fluid physics and heat transfer (Microgravity and fluid physics program of NASA), Oahu, Hawaii	1999
Bio-Mass Transfer Processes: "Composite microsphere: Effects of different filler materials on polymeric surface bioactivity." Engineering Foundation Conference on microgravity transport processes in fluid, thermal, biological and materials sciences II, Banff, Alberta, Canada	2001
"Electric field effects on flames." Fifth ISHMT ASME Heat and Mass Transfer Conference, Science City, Kolkata, India	2002
"Low energy plasma heat transfer as applied to microelectronic manufacturing." International Symposium on Recent Trends in Heat and Mass Transfer, Indian Institute of Technology, Guwahati, India	2002

"Three-dimensional bone-like tissue generation in rotating-wall bioreactors" 2003
The 6th Am. Soc. Mech. Engrs/Japanese Soc. Mech. Engrs. Thermal Engineering Joint Conference, Hawaii Island, Hawaii

"Oscillating Flow and Heat Transfer in Porous Media" 2004
NASA Glenn Research Center, Cleveland, Ohio

"Loop Heat Pipe (LHP) for Spacecraft Thermal Control" 2004
NASA Glenn Research Center, Cleveland, Ohio

Plenary Speaker, 2004 ASME Heat Transfer/Fluids Engineering Summer Conference, Charlotte, NC. "Surfactant Transport to an Intravascular Bubble" 2004

Sir G.I. Taylor Memorial lecture in Fluid Mechanics, 53rd Congress of the Indian Society for Theoretical and Applied Mechanics, Hyderabad, India. "Motion Of A Finite-Sized Gas Bubble In A Blood Vessel: Non-Newtonian Effects." 2008

Keynote address in Am. Soc. Mech. Engrs./Indian Soc. Heat & Mass Transfer Conference, Mumbai, India. "Effect of a soluble surfactant on a finite-sized bubble motion in a blood vessel" 2010

Keynote address in Am. Soc. Mech. Engrs/Indian Soc. Heat & Mass Transfer Conference, IIT, Kharagpur, India. "Modeling the Effects of Multibody Interactions on Nanoparticle Hydrodynamics in an Incompressible Newtonian Fluid." 2013

Keynote address in 7th World Congress of Biomechanics, Boston, MA, "Functionalized Nanocarrier Binding to Cell Surface in Targeted Drug Delivery: Hydrodynamic and Adhesive Interactions." 2014

Max Jakob Memorial Award lecture, Int. Mech.Eng. Congress & Exposition, Houston, Texas, "Modeling of a nanoparticle in a cylindrical vessel flow: Particle shape and wall effects" 2015

Stuart W. Churchill Memorial Keynote lecture, ASME 2017 SHT, Bellevue, Washington: "Transport phenomena associated with a nano-sized carrier in targeted drug delivery" 2017

AIChE Symposium in Honor of Professor Peter C.Wayner, Jr., Invited Lecture, ASME 2019 SHT, Bellevue, Washington: "Effect of a Soluble Surfactant on a Finite-Sized Bubble in Motion in a Blood Vessel" 2019

JOURNAL EDITORSHIP

Editor-in-Chief, ASME Journal of Heat Transfer 2016-2023

Editorial Panel Member, Expert Review of Medical Devices, London, UK 2013-Present

Associate Technical Editor, Journal of Heat Transfer, Trans. ASME 1997-2000, 2001-2004

MEMBERSHIP IN IMPORTANT PANELS, DELEGATION

Member, Review Panel, Division of CBET Systems, U.S. National Science Foundation	2012, 2013
Member, Review Panel, National Space Biomedical Research Institute, NASA, Washington, D.C.	2007, 2008, 2009, 2010,2011,2012
Invited Participant, NASA Workshop on Porous Media, NASA Glenn Research Center, Ohio	2004
Member, Requirements Definition Review Panel for Micro-Gravity Studies in Nucleate Boiling Heat Transfer, NASA Glenn, Ohio	2002
Member, NASA Bioreactor/Biosensor Research Review Panel, Washington D.C.	2002
Invited Participant, Workshop on research needs in space thermal systems and processes for human exploration of space, NASA Glenn, Ohio	2000
Member, Science Concept Review Panel for Micro-Gravity Experiments in Space, NASA, Lewis Research Center, Cleveland, Ohio	1998, 1990
Member, Review Panel for Micro-Gravity Studies in Heat Transfer and Fluid Mechanics, NASA, Washington, D.C.	1997, 1993
Invited Panelist, NSF/DOE Workshop on Advanced Thermal Manufacturing and Materials Processing: Future Needs for Research, Leesburg, Virginia	1995
United Nations Expert on Micro-Electronics: Lectured and Conducted a workshop on "Thermal Design/Analysis/Optimization in Microelectronics", Society for Applied Microwave Electronics Engineering and Research - Center for Electromagnetics, Madras, India	1992
Invited Panelist, NSF Workshop on "Thermal Engineering: Emerging Technologies and Critical Phenomena: Future needs for thermal engineering research," Chicago, Illinois	1991
Invited Panelist, National Workshop on Mass, Momentum, and Energy Exchange in Combusting Sprays: Droplet Studies, Sandia National Laboratories, Livermore, California	1988
Member, Evaluation Panel for Engineering Initiation Awards, U.S. NSF	1987
Member, Delegation on Nuclear Reactor Safety to the People's Republic of China at the invitation of the Chinese Nuclear Society and the Chinese Association for Science and Technology (Delegation leader: Professor Richard T. Lahey, Jr.)	1985

CONSULTING ACTIVITIES

Battelle, NC;
Boeing Satellite Systems, CA;
Combustion Unlimited Incorporated, PA;
General Electric Co, Valley Forge, PA;
General Motors Corporation MI;
Hughes Space and Communications, CA;
IBM Corporation, NY;
National Air Oil Burner Co., Inc., PA;
NASA, Glenn Research Center, OH;
Pathway Technology, Inc., PA;
Thermacore, Inc., PA;
United Nations Industrial Development Organization, Vienna, Austria

MASTER'S, DOCTORAL AND POST-DOCTORAL RESEARCH SUPERVISION

1. L.J. Huang, Laminar Condensation on a Moving Drop: Effects of Transients, M.S. Thesis (1986).

2. S.G. Klemick, Heat Transfer in Tissue Subject to Microwave Heating, M. S. Thesis (1988).

3. T.R. Stauffer, Multi Foil Insulation Systems for Hypersonic Vehicles, M.S. Thesis (1992).

4. J. Weiner, Thermal Stress Analysis of Multilayered Materials of Finite Thickness, M.S. Thesis (1994).

5. A. Chau, Bubble motion in a Casson fluid flowing through a vessel, M.S. Thesis (1996).

6. J.N. Chung, Laminar Condensation Phenomenon Associated with a Moving Droplet, Ph.D. Thesis (1979).
   (At present: Andrew H. Hines Jr./Florida Progress Eminent Scholar Chair Professor, U. of Florida, Gainesville.)

7. T. Sundararajan, Laminar Condensation Heat and Mass Transfer to a Drop Moving at Intermediate or High Reynolds Number, Ph.D Thesis (1983).
   (At present: Professor, Dept. of Mech. Eng., IIT, Madras, India)

8. J.M. Hogan, Wave Phenomena on the Interface Separating Fluids of Different Viscosities, Ph.D. Thesis (1984).
   (At present: Manager of Engineering, GE, Seton Center, PA)

9. G. Gogos, Evaporation and Combustion of a Moving Liquid Drop, Ph.D Thesis (1986).
   (At present: Associate Professor, Dept. of Mech. Eng., Univ. of Nebraska, Lincoln, Nebraska)

10. J.W. Baish, Convective Heat Transport Due to Blood Perfusion in Volumetrically Heated Biological Tissue, Ph.D. Thesis (1986). (Presidential Young Investigator Award Recipient)
    (At present: Professor, Dept. of Mech. Eng., Bucknell Univ., PA)

11. L.J. Huang, Fundamental Problems in Heat Transfer and Fluid Mechanics of Phase-Change Processes with Liquid Drops, Ph.D. Thesis (1989).
    (At present: Senior Engineer, R&D, GM, Lockport, NY)

12. M. Jog, Asymptotic and Numerical Studies of Plasma Arc Heat Transfer and Phase-Change Heat Transfer, Ph.D. Thesis (1993). (Engineering Initiation Award Recipient; NSF Career Award Recipient)
    (At present: Associate Professor, Dept. of Mech., Ind., and Nucl. Eng., University of Cincinnati, OH)

13. K. Zwick, The Fluid Mechanics of Bonding With Yield Stress Epoxies, Ph.D. Thesis (1996).
    (At Present: Research Engineer, Kimberly-Clark, Inc., WI)

14. W. Qin, Numerical and Experimental Studies of Heat Transfer Phenomena in Microelectronic Packaging, Ph.D. Thesis (1997).
    (At Present: Supervisor Engineer, Kulicke & Soffa Industries, PA)

15. S. Sripada, Fundamental Studies in Plasma-Arc and Phase-Change Heat Transfer, Ph.D. Thesis (1999).
    (At Present: Applications Engineer, i2 Technologies, Irving, TX)

16. H. Gao. Numerical studies of microcarrier particle dynamics and associated mass transfer in rotating wall vessels, Ph.D. Thesis (2000).
    (At Present: Engineering Specialist, Kimberly-Clark, Inc., WI)

17. M. Parker, Modeling of Looped heat pipes with applications to spacecraft thermal control (2000)
    (At Present: Thermal Engineering Specialist, Boeing Satellite Division, CA)

18. K. Mukundakrishnan, Fluid mechanics and mass transfer in rotating cylindrical vessels: A numerical and experimental study, Ph.D. Thesis (2005).
    (At Present: Engineer, Dassault Systemes Simulia, RI)

19. Josh Lampe, Interfacial characteristics of a gas bubble immersed in a surfactant and protein laden fluid: Experiments and Modeling, Ph.D. Thesis (2007) (Joint advisor: Prof. David Eckmann)
    (At Present: Research Associate, Dept. of Emergency Medicine, Univ.of Pennsylvania)

20. Dr. G.C. Das, Indian Institute of Plasma Physics, Bangalore, India, Research on the Thermal and Electrical Characteristics of Plasma Arcs (1976-77).

21. Dr. T. Sundararajan, University of Pennsylvania, Research in Hydrodynamics and Heat/Mass Transfer Associated with Condensation on Moving Spray Drops (1983-1985).

22. Dr. L.J. Huang, University of Pennsylvania, Research in Thermal and Resultant Stresses in Microelectronic Packaging (1989-1990).

23. Dr. M. Lavy, University of Cambridge, England, Research on Non-Equilibrium Wet Steam Flow in Turbine Cascades (1990-1991).

24. Dr. Q.Q. Qiu, University of Toronto, Canada, Research on the Use of Bioactive Glass Particles as Microcarriers in Microgravity Environment (supervision jointly with Professor P. Ducheyne), (1995-1999).

25. Dr. S. Radin, All-National Research Institute for Aircraft Materials, Russia, Research on Surface transformation of reactive glass in a microgravity environment (supervision jointly with Professor P. Ducheyne, 1998-2002)

26. Dr. J. Zhang, Northwestern University, Research in Fluid Mechanics/Mass Transfer associated with gas embolism, (2002-2005).

27. Dr. S. Quan, University of Massachusetts, Macromolecule Adsorption and Bubble Adhesion to Model Endothelial Surface, (2005-2007).

28. Dr. K. Mukundakrishnan, University of Pennsylvania, Numerical Studies of Intravascular Bubble Motion, (2005-2008).

29. Dr. A.J. Calderon, University of Michigan, Ann Arbor, MI, Fluid Mechanics and Mass transfer of Targeted Drug delivery, (2006-2009).

30. Dr. T.N. Swaminathan, University of Pennsylvania, Numerical Studies of Intravascular Bubble Motion, (2008-2011).

31. Dr. S. Dasgupta, Washington State University, Pullman, WA, Experimental and modeling studies of gas embolism, (2008-2009).

32. Dr. U. Balakrishnan, Indian Institute of Technology, Madras, India, Numerical modeling of gas bubble/targeted drug delivery microcarrier motion in a blood vessel, (2009-present)

33. Dr. J. Liu, Johns Hopkins University, Baltimore, MD, Numerical modeling of targeted drug delivery microcarriers, (2009-2011).

34. Dr. P. Sobolewski, University of California, San Diego, La Jolla, CA, Cellular Mechanotransduction in Gas Embolism, (2009-2012).

35. Dr. A.L. Klinger, University of Virginia, Charlottesville, Virginia, Cellular Mechanotransduction in Gas Embolism, (2009-2012).

36. Dr. Hsiu-Yu Yu, Cornell University, Ithaca, New York, Muti-scale modeling of nanocarrier thermal motion and attachment., (2012-2018).

37. Dr. N. Ramakrishnan, IIT, Madras, India, Muti-scale modeling of the nanocarrier-cell adhesion interface in targeted drug delivery, (2012-2020).

38. Dr. A. Sarkar, IIT, Bombay, India, Muti-scale modeling of mass transfer by nanocarriers in targeted drug delivery, (2013-2015).

39. Dr. H. Vitoshkin, Tel-Aviv University, Tel-Aviv, Israel, Muti-scale modeling of the motion and mass transport associated with nanocarriers in targeted drug delivery, (2013-2015).

40. Dr. Y. Wang, Florida State University, Tallahassee, FL, Multi-scale modeling of the motion and mass transport associated with nanocarriers in targeted drug delivery, (2014-2016).

41. Dr. Z. Jabeen, IIT, Madras, India, Bridging Multiple Scales in Modeling Targeted Drug Nanocarrier Delivery, (2016-2019).

42. Dr. S. Farokhirad, CCNY, New York, Multiscale model development and application in targeted drug delivery using Hydrodynamics and Statistical Mechanical models, (2016-2021).

FUNDED RESEARCH ACTIVITIES

(Only grants where Ayyaswamy is the PI or a Co-PI are listed)

1. Grant Number: UO1 EB016027-01A1
   Sponsor: NIH
   Title: Bridging Multiple Scales in Modeling Targeted Drug Nanocarrier Delivery
   Award Amount: $2,702,120
   Period of Award: 6/1/2013 - 5/30/2018

2. Grant Number: 2RO1 EB006818-05A1
   Sponsor: NIH
   Title: Targeted Microcarrier Design and Optimization
   Award Amount: $1,955,247
   Period of Award: 6/1/2013 - 5/30/2017

3. Grant Number: CBET-1236514
   Sponsor: NSF
   Title: Multiscale Modeling of the Nanocarrier-Cell Adhesion Interface in Targeted Drug Delivery
   Award Amount: $360,000
   Period of Award: 9/1/2012 - 8/31/2015

4. Grant Number: RO1 HL067986
   Sponsor: NIH
   Title: Activation of Clotting and Cell Adhesion in Response to Gas embolism
   Award Amount: $910,587
   Period of Award: 7/01/2009 - 12/31/2011

5. Grant Number: RO1 EB06818
   Sponsor: NIH/NIBIB and NIGMS
   Title: Targeted microcarrier design and optimization
   Award Amount: $1,575,000
   Period of Award: 7/1/2008 - 9/30/2012

6. Grant Number: N00014-08-1-0436
   Sponsor: ONR
   Title: Molecular Basis of Injury and Treatment of Arterial Gas Embolism
   Award Amount: $1,006,274
   Period of Award: 3/01/2008 - 8/24/2011

7. Grant Number: RO1 HL60230-S1
   Sponsor: NIH

Title: Interfacial Mechanics in Intravascular Gas Embolism (Supplemental to support a minority Post Doc)
Award Amount:
Period of Award: 7/1/2008 - 1/8/2010

8. Grant Number: NNC05GA30G
Sponsor: NASA
Title: Macromolecule Adsorption and Bubble Adhesion to Model Endothelial Surface
Award Amount: $602,245
Period of Award: 2004-2006

9. Grant Number: RO1 HL67986-01A1
Sponsor: NIH
Title: Activation of clotting and cell adhesion in Response to gas embolism
Award Amount: $1,460,000
Period of Award: 2002-2007

10. Grant Number: NAG 9-1357
Sponsor: NASA
Title: Impact of microgravity on human osteoblast life history: Experimental investigation and Numerical study
Award Amount: $745,000
Period of Award: 2001-2004

11. Grant Number: 536689
Sponsor: Kulicke & Soffa Co., PA
Title: Design Improvements on wire bonding machinery
Award Amount: $101,912
Period of Award: 9/1/00 - 8/31/01

12. Grant Number: 5-35816
Sponsor: NSF & Pathway Technologies, Inc.
Title: A feasibility study on Electro-thermal compliant wheel and a micro accelerometer
Award Amount: $106,000
Period of Award: 6/1/00 - 5/31/01

13. Grant Number: 5-08727
Sponsor: Thermacore, Inc., PA
Title: Transport Phenomena in wick structures
Award Amount: $24,303
Period of Award: 6/1/00 - 5/31/01

14. Grant Number: NAG8-1483
Sponsor: NASA
Title: Surface Transformation of Reactive Glass in a Microgravity Environment
Award Amount: $403,300
Period of Award: 2/1/98 - 1/31/02

15. Grant Number: 5-01963
Sponsor: Delaware River Port Authority
Title: Recirculating Aquaculture System
Award Amount: $450,000 + $350,000
Period of Award: 7/1/97 - 6/30/99, renewal to 6/30/01

16. Grant Number: KS-95
Sponsor: Kulicke and Soffa Industries, Inc.
Title: Die Attach Adhesive Characterization Study
Award Amount: $35,263
Period of Award: 7/1/95-9/1/96

17. Grant Number: CTS-9421598 & REU
Sponsor: National Science Foundation
Title: Low energy arc heat transfer with applications in microelectronic packaging technology
Award Amount: $259,931
Period of Award: 5/95 -4/97

18. Grant Number: NAG 9-817
Sponsor: NASA
Title: The use of bioactive glass particles as microcarriers in microgravity environment
Award Amount: $730,000
Period of Award: 7/95- 6/99

19. Grant Number: DDM 90-005732 & REU
Sponsor: National Science Foundation
Title: Advances in Design of Automated Wire and Die Bonding Machinery in Microelectronic Manufacturing
Award Amount: $274,250
Period of Award: 6/1/90 - 8/31/94

20. Grant Number: BFP #90S.5055R-01 and #89S.5055R-01
Sponsor: Benjamin Franklin Partnership/State of Pennsylvania
Title: Design of Automated Packaging Machinery in Microelectronic Manufacturing
Award Amount: $60,000
Period of Award: 6/30/90- 8/31/93

21. Sponsor: Kulicke & Soffa Industries, Inc.
Title: Advances in Wire Bonding
Award Amount: $53,000
Period of Award: 6/30/90 -8/31/94

22. Grant Number: 3-71747
Sponsor: University of Pennsylvania Research Foundation
Title: Numerical Simulation of Process Problems in the Design of Automated Machinery for Assembly of Semiconductor Integrated Circuit Chip
Award Amount: $15,925
Period of Award: 1/7/92-12/31/92

23. Grant Number: 5-21201
    Sponsor: IBM Corporation
    Title: Analysis and Simulation of Thermal Transients and Resultant Stresses in Microelectronic Equipment
    Award Amount: $29,975
    Period of Award: 7/1/90 - 6/30/91

24. Grant Number: DMC 87-09537 & REU
    Sponsor: National Science Foundation
    Title: Ball Formation Processes in Wire Bonding Apparatus
    Award Amount: $261,654
    Period of Award: 6/1/88 - 5/31/90

25. Grant Number: BFP #07,510 RU
    Sponsor: Benjamin Franklin Partnership/State of Pennsylvania
    Title: Ball Formation Processes in Wire Bonding Apparatus
    Award Amount: $19,669
    Period of Award: 9/1/88 - 8/31/89

26. Grant Number: BFP #06,500 NU
    Sponsor: Benjamin Franklin Partnership/State of Pennsylvania
    Title: Ball Formation Processes in Wire Bonding Apparatus
    Award Amount: $23,000
    Period of Award: 9/1/87 - 8/31/88

27. Grant Number: DMC 85-13128 & REU
    Sponsor: National Science Foundation
    Title: Ball Formation Processes in Wire Bonding Apparatus
    Award Amount: $220,365
    Period of Award: 9/1/85 - 1/30/88

28. Grant Number: 5-R01-CA 36624-03 Sub 01
    Sponsor: National Institute of Health
    Title: Dynamic Phantom Models for Hyperthermia Research
    Award Amount: $40,008
    Period of Award: 6/1/85 - 5/31/86

29. Grant Number: 5-RO1-CA 36624-02 SUB01
    Sponsor: National Institute of Health
    Title: Dynamic Tissue Models for Hyperthermia Research
    Award Amount: $105,830
    Period of Award: 6/1/83 - 5/31/85

30. Grant Number: MEA82-17097
    Sponsor: National Science Foundation
    Title: Laminar Film Condensation on Drops Translating in Steam-Air Mixture
    Award Amount: $61,743
    Period of Award: 7/1/83 - 12/31/84

31. Grant Number: MEA80-23861
Sponsor: National Science Foundation
Title: Laminar Film Condensation on a Droplet Translating in Steam-Air Mixture
Award Amount: $60,770
Period of Award: 7/1/81 - 4/30/83

32. Grant Number: 5-RO1-CA-26046
Sponsor: National Institute of Health
Title: Microwave Dielectric Properties of Tumor and Normal Tissue
Award Amount: $53,516
Period of Award: 7/1/81 - 6/30/82

33. Grant Number: ENG78-25899
Sponsor: National Science Foundation
Title: Electrostatic Sheath Stability in Magnetohydrodynamic Flows
Award Amount: $93,033
Period of Award: 4/1/79 - 9/30/81

34. Grant Number: ENG77-23137
Sponsor: National Science Foundation
Title: Laminar Film Condensation on a Spherical Droplet Translating in a Steam-air Mixture
Award Amount: $80,147
Period of Award: 4/15/78 - 3/31/81

35. Grant Number: FAC. Grant & Award Project #0060
Sponsor: University of Pennsylvania Faculty Grants and Awards
Title: Turbulent Couette Motion
Award Amount: $1,000
Period of Award: 7/1/76 - 6/30/77

36. Grant Number: RP-378-1
Sponsor: Electric Power Research Institute
Title: Arc Discharges
Award Amount: $166,000
Period of Award: 12/1/74 - 6/30/77

FUNDED GRANTS FOR ACADEMIC ACTIVITIES

1. Grant Number: PO94B30032
Sponsor: U.S. Department of Education
Title: Patricia Roberts Harris Doctoral Fellowships
Co-Authors of Proposal: D. Graves, W. Shieh and M. Steedman
Award Amount: For MEAM Department: 2 Fellowships @ $28,000 per year, per student, for a total of three years.
Period of Award: 1993-1998

2. Sponsor: National Science Foundation and Advanced Research Project Agency (NSF-ARPA)

Title: A Program for Manufacturing Management in Support of the Technology Reinvestment Program
Principal Investigators: G. Anandalingam and J. Adler
Co-Faculty Contributors: I.M. Cohen, N. Dorny, V. Kumar and W. Seider
Award Amount: $600,000
Period of Award: 1994-1997

PENDING GRANT APPLICATIONS

1. Title : None at Present
   Submitted to
   Funds requested:
   Period (expected):

PUBLICATIONS

a). REVIEW ARTICLES BY INVITATION

"Fluid Mechanics of Direct-Contact Transfer Processes with Moving Liquid Droplets**"** in **Encyclopedia of Fluid Mechanics,** Ed: N.P. Cheremisinoff, 8, 535-587 (1989)

"Combustion Dynamics of Moving Droplets" in
Encyclopedia of Environmental Control Technology, Ed: P.N. Cheremisinoff, 1, 479-532 (1989)

"Direct Contact Transfer Processes with Moving Liquid Droplets" in
Advances in Heat Transfer, Eds: Cho, Hartnett and Irvine, Jr., 26, 1-104 (1995)

"Mathematical Methods in Direct-Contact Transfer Studies with Droplets" in
Annual Review of Heat Transfer, Ed: Chang-Lin Tien, VII, 245-331 (1996)

"Low Energy Plasma Heat Transfer as Applied to Microelectronic Manufacturing" in
Annual Review of Heat Transfer, Ed: Chang-Lin Tien, V. Prasad
and F. Incropera, XII, 27-78 (2002)

"Numerical models of blood flow effects in biological tissues" (with J.W. Baish and K. Mukundakrishnan), in **Advances in Numerical Heat Transfer 3**, Eds: W.J.Minkowycz and E. M. Sparrow, III, 29-71 (2009)

"Nanoparticle transport phenomena in confined flows" (with R. Radhakrishnan, S. Farokhirad, and D.M. Eckmann), **Advances in Heat Transfer,** Eds: E.M. Sparrow, J.Abraham, and J. Gorman, 51, *In Press* (2019).

b). EDITED BOOKS AND BOOK PUBLICATIONS

Advances in Design and Analysis in Pressure Vessel Technology
Co-Editors: H. Chung, D.W. Nicholson, and W.S. Woodward, ASME Press, New York (1987).

Transport Phenomena with Drops and Bubbles
Co-Authors: S.S. Sadhal and J.N. Chung, Springer-Verlag Publishers (1997).
(Monograph contains significant new and unpublished work on Interfacial Fluid Mechanics).

Introduction to Biofluid Mechanics
Chapter 17 in *Fluid Mechanics*, P.K. Kundu and I.M. Cohen, Academic Press, MA, (2007).

c). PUBLICATIONS IN REFEREED JOURNALS (UNDER REVIEW)

None under review at present.

d). PUBLICATIONS IN REFEREED JOURNALS/BOOKS (* : INVITED PAPER / ARTICLE)

Archival Publications in : *Multi-Phase Flow &Transport, Bio Heat & Mass Transport, and Electric Arc Plasma Heat & Mass Transport*

142. "akshayb29/Shell-and-Tube-Heat Exchanger-STHX-Numerical Model: Shell-and-Tube Heat Exchanger Numerical Model" (with A.B. Krishna, K.Jin, I. Catton, and T.S. Fisher), doi.10.5281/ZENODO.5117859

141. "Thermohydraulic experiments on a supercritical carbon dioxide – air microtube heat exchanger" (with K. Jin, A.B. Krishna, Z.Wong, I. Catton, and T.S. Fisher), ***Int. J. Heat Mass Transfer***, 203(April 2023): 123840 doi.10.1016/j.ijheatmasstransfer.2022.123480

140. "Technoeconomic optimization of superalloy supercritical CO_2 microtube shell-and-tube heat exchangers" (with A.B. Krishna, K. Jin, I. Catton, and T.S. Fisher), ***Applied Thermal Engineering***, 220(Feb 2023): 119578 doi.10.1016/j.applthermaleng.2022.119578

139. "Modeling of Supercritical CO_2 Shell-and-Tube Heat Exchangers under extreme conditions. Part II: Heat Exchanger Model" (with A.B. Krishna, K. Jin, I. Catton, and T.S. Fisher), ***ASME J. Heat Transfer***, Vol. 144(5):051903 (13 pages), Paper No: HT-21-1502, https://doi.org/10.1115/1.4053511

138. "Modeling of Supercritical CO_2 Shell-and-Tube Heat Exchangers under extreme conditions. Part I: Correlation Development" (with A.B. Krishna, K. Jin, I. Catton, and T.S. Fisher), ***ASME J. Heat Transfer***, Vol. 144(5):051902 (11 pages), Paper No: HT-21-1501, https://doi.org/10.1115/1.4053510

137. "Biophysical considerations in the design and cellular targeting of flexible polymeric nanoparticles " (with S. Farokhirad, S. Kutti Kandy, A. Tsourkas, D.M. Eckmann, and R. Radhakrishnan), ***Advanced Materials Interfaces***, 2101290, (2021). PMCID: Pending DOI: 10.1002/admi.202101290

136. "Hydrodynamics and interfacial surfactant transport in vascular embolism" (with D.M. Eckmann, and J. Zhang), ***ASME J. Heat Transfer***, Vol. 143(10):100802 (2021). DOI:10.1115/1.4050923

135. "Stiffness can mediate balance between hydrodynamic forces and avidity to impact the targeting of flexible polymeric nanoparticles in flow" (with S. Farokhirad, A. Ranganathan, J. Myerson, V. Muzykantov, D.M. Eckmann, and R. Radhakrishnan), ***Nanoscale***, 11, 6916-6928 (2019). PMCID:PMC6528683 DOI:10.1115/1.4043014

134. "Nanofluid dynamics of flexible polymeric nanoparticles under wall confinement" (with S. Farokhirad, N. Ramakrishnan, D.M. Eckmann, and R. Radhakrishnan), ***ASME J. Heat Transfer***, Vol. 141(5):052401-052401-6 (2019). PMCID:PMC7376444 DOI:10.1039/c8nr09594a

*133. "Nanoparticle transport phenomena in confined flows" (with R. Radhakrishnan, S. Farokhirad, and D.M. Eckmann), ***Advances in Heat Transfer,*** Eds: E.M. Sparrow, J.Abraham, and J. Gorman, 51, In Press (2019).

132. "Rheology of colloidal suspensions in confined flow: Treatment of hydrodynamic interactions in

particle-based simulations inspired by dynamical density functional theory" (with Z. Jabeen, H.-Y. Yu, D.M. Eckmann, and R. Radhakrishnan), ***Phys. Rev. E***, 98:042602-1-13(2018).

*131. "Nanoscale Fluid Dynamics" (with R. Radhakrishnan, D.M. Eckmann, and N. Ramakrishnan) **, 21 st Century - Nanoscience - - A Handbook,** Ed: K.D. Sattler, Taylor & Francis (CRC Press), In Press (2018).

130. "Excess area dependent scaling behavior of nano-sized membrane tethers" (with N. Ramakrishnan, K.K. Sreeja, A.Roychoudhury, D. M. Eckmann, T. Baumgart, T. Pucadyil, S.Patil, V. M. Weaver and R. Radhakrishnan), **, *Physical Biology,*** 15, 026002, (2018), (https://doi.org/10.1088/1478-3975/aa9905).

129. "Microstructure of flow-driven suspension of hardspheres in cylindrical confinement: a Dynamical Density Functional theory and Monte Carlo study" (with H.-Y. Yu, Z. Jabeen, D. M. Eckmann, and R. Radhakrishnan), ***Langmuir***, 33 (42):11332-11344, (2017).

*128. "Computational methods related to molecular structure and reaction chemistry of Biomaterials" (with S. Farokhirad, R.P. Bradley, A.Sarkar, A.Shih, S. Telesco, Y. Liu, R. Venkataramani, D.M. Eckmann, and R.Radhakrishnan), **Comprehensive Biomaterials II**, Ed: P. Ducheyne, Vol.3, 245-267, Oxford: Elsevier Publishers, (2017)

127. "Motion of a nano-spheroid in a cylindrical vessel flow: Brownian and hydrodynamic interactions" (with N. Ramakrishnan, Y. Wang, D.M. Eckmann and R. Radhakrishnan), ***J. Fluid Mech.***, Vol. 821, 117-152, (2017), (supp info: https://doi.org/10.1017/jfm.2017.182)

126. "Computational models for nanoscale fluid dynamics and transport inspired by non-equilibrium thermodynamics" (with R. Radhakrishnan, H.-Y.Yu, and D.M. Eckmann), ***ASME J. Heat Transfer***, Vol. 139, 033001- 033009, (2017)

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121. "Composite Generalized Langevin Equation for Brownian Motion in Different Hydrodynamic and Adhesion Regimes" (with H.Yu, D.M.Eckmann, and R. Radhakrishnan), ***Phys. Rev. E***, 91:052303-1 – 052303-11 (2015).

120. "Modeling of Binding Free Energy of Targeted Nanocarriers to Cell Surface" (with J. Liu, D.M. Eckmann, and R. Radhakrishnan), ***Heat and Mass Transfer, (Springer)***, 50 (3), 315-321 (2014), (doi: 10.1007/s 00231-013-1274-0).

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117. “Nanocarrier hydrodynamics and binding in targeted drug delivery : Challenges in numerical modeling and experimental validation ” (with V.R. Muzykantov, D.M.Eckmann, and R.Radhakrishnan) **,** ***ASME J. Nanotechnology in Engineering and Medicine*** , Vol.4, No.1, 011001-1-10, (2013).

116. “Understanding the Role of Exogenous and Endogenous Surfactants in Gas Embolism,” (with J. Lampe and D.M. Eckmann) , **Proteins at Interfaces III State of the Art**, Eds: T. Horbett, J.L. Brash, and W.Norde, Publisher : ACS Symposium Series 1120**,** Am. Chemical Soc., Washington, DC , Distributed in print by Oxford University Press, Chapter 18, 395 - 418 (2013).

115. “A hybrid approach for the simulation of the thermal motion of a nearly neutrally buoyant nanoparticle in an incompressible Newtonian fluid medium”(with B.Uma, R.Radhakrishnan and D.M.Eckmann) , HT-12-1135, *Special Issue **:** Computational Fluid Dynamics,* ***ASME J.Heat Transfer,*** 135**,** No.1, 011011-1 - 011011-9 (2013).

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109. “Generalized Langevin dynamics of a nanoparticle using a finite element approach: Thermostating with correlated noise” (with B. Uma, T.N. Swaminathan, D.M. Eckmann and R. Radhakrishnan), ***J. Chem. Phys.***, 135, 114104-1-13 (2011). (DOI: 10.1063/1.3635776) [PMCID: PMC 3189970]. Erratum, ***J. Chem. Phys.***, 136, 019901-1 (2012).[PMCID:PMC 3266821]

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*102."Rotating wall vessels for cell culture" (with Qing-Qing Qiu and P. Ducheyne), **Comprehensive Biomaterials**, Eds: P. Ducheyne, K. Healy, D. Hutmacher, D.W. Grainger, and J. Kirkpatrick, Vol.5, 147-167,Elsevier Publishers, (2011).

101."Computational model for nanocarrier binding to endothelium validated using in vivo, in vitro, and atomic force microscopy experiments" (with J. Liu, G.E.R. Weller, B.Zern, D.M. Eckmann, V.R. Muzykanotv and R. Radhakrishnan), ***Proc. Natl. Acad. Sci. USA***,107(38), 16530-16535 (2010). [PMCID: PMC 2944711]

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