

2015

For Dean of Engineering
and Dean of Faculty

CURRICULUM VITAE

1. NAME: LIU, Joseph T. C.
POSITION: Professor of Engineering
ACADEMIC DEPARTMENT: School of Engineering, Brown University

3. EDUCATION:

B.S.E. (Aeron. Engrg.), The University of Michigan 1957
B.S.E. (Mathematics), The University of Michigan 1957
M.S.E. (Aeron. Engrg.), The University of Michigan 1958
Ph.D. (Aeronautics), California Institute of Technology 1964
Ph.D. dissertation topic: Problems in Particle Fluid Mechanics

4. PROFESSIONAL APPOINTMENTS:

a. Pre-PhD. Appointments

1956-1958: Teaching Assistant, Department of Aeronautical Engineering, University of Michigan
Summer 1956: Assistant Engineer, Gas Turbine Division, Clark Bros. Co., Olean, New York
Summer 1957: Research Assistant, Department of Aeronautical Engineering, University of Michigan
1958-1959, & summer 1960: Propulsion Engineer, Advanced Heat Transfer and Thermodynamics Group, Convair - General Dynamics Corporation, Fort Worth, Texas
1959-1964: Research Assistant, GALCIT, California Institute of Technology
Summer 1962: Technical Staff, Dynamic Science, Inc., S. Pasadena, California
1963: Teaching Assistant, GALCIT, California Institute of Technology
1964: Technical Staff, National Engineering and Science Co., Pasadena, California

b. Post-PhD. Appointments

1964-1966: Post Doctoral Research Associate, Gas Dynamics Laboratory, Department of Aerospace and Mechanical Sciences, Princeton University
Summer 1966: Staff Scientist, AVCO Space Systems Division, Wilmington, Massachusetts
1966-1967: Assistant Professor of Engineering (Research), Division of Engineering, Brown University
1967-1969: Assistant Professor of Engineering, Division of Engineering, Brown University
1969-1973: Associate Professor of Engineering, Division of Engineering, Brown University
1973-present Professor of Engineering, School of Engineering, Brown University

c. Sabbaticals and other visits:

1972-73: Imperial College, Department of Mathematics, London, Academic Visitor
1979-80: Imperial College, Department of Mathematics, London, U.K. Science Research Council Visiting Fellow
1987-88: Imperial College, Department of Mathematics, London, U.K. Science & Engineering Research Council Visiting Fellow
1993-94: Université de Nantes, ISITEM, Lab. de Thermocinétique, Nantes, professeur invité
2000-01: Universität Stuttgart, Institut für Aerodynamik und Gasdynamik, Stuttgart, Guest Professor
2007-08: École polytechnique de l'université de Nantes, Lab. de Thermocinétique, professeur invite
2011-12: Imperial College, Department of Mathematics, London, U.K. Sabbatical leave Semester II, 2011-12 (6 months)

2015-16: Polish Academy of Sciences, Institute of Fundamental Technological Research (IPPT-PAN), Warsaw, Poland. Sabbatical leave Semester I, 2015-16 (6 months)

other visits:

June-July 1968: Pratt and Whitney Aircraft, Summer Faculty Program,
Nov. 1976: Stanford University, Joint Institute of Aeronautics & Acoustics, Palo Alto, 1 week
May-July 1983: Tianjin University, Department of Mechanics, Tianjin
March 1987: Università degli Studi di Roma "La Sapienza", Dipart. di Idraulica, Transporte e Strade, Rome, 1 week
Jan. 1988: The Technion-Israel Institute of Technology, Department of Mechanical Engineering, Haifa, 1 week
Feb. 1988: Cairo University, Department of Mechanical Engineering, Cairo, 1 week
March 1988: Institute for Fundamental and Technological Research, Department of Fluid Mechanics, Polish Academy of Sciences, Warsaw, 1 week
April 1988: CNRS, Lab. d'Aerothermique, Meudon, 1 week
June 1988: École Centrale de Paris, Aerospace Studies/Combustion Lab., 1 week
Jan. 1989: National Cheng Kung University, Institute of Aeronautics & Astronautics, Tainan, 11/2 weeks
Sept. 1989: Institute for Fundamental and Technological Research, Department of Fluid Mechanics, Polish Academy of Sciences, Warsaw, 1 week
Oct. 1989: Institute of Hydromechanics, Ukrainian Academy of Sciences, Kiev, 1 1/2 weeks
Dec. 1990-Jan. 1991: CNRS, Lab. d'Aerothermique, Meudon
Jan. 1992: Polytechnika Warszawska, Institute of Aeronautics and Applied Mechanics, Warsaw, 1 week
May 1992: Università degli Studi di Roma "La Sapienza", Dipart. di Idraulica, Transporte e Strade, Rome, 1 week
Nov. 1996: Rhur University, Fluid Mechanics and Thermodynamics Institute, Bochum, 1 week
Dec. 1996 - Jan. 1997: Cairo University, Dept. Mechanical Engineering, Cairo, 1 1/2 weeks
Jan. 1997: Université de Nantes, ISITEM, Lab. de Thermocinétique, Nantes, 1 week
May-June 2001: Department of Mechanics, Tianjin University, Tianjin
June-July 2003: Laboratoire de Thermocinétique, École polytechnique de l'université de Nantes, professeur invité
May 2012: Department of Mechanics, Tianjin University, China, 2 weeks
Sept. 2015: Department of Mechanics, Tianjin University, China, 3 weeks

5. COMPLETED RESEARCH, SCHOLARSHIP:

c. REFEREED JOURNAL and other reviewed publications

(*indicates internally reviewed publications)

1. "The Laminar Boundary Layer Flow on an Axisymmetric Body with Transverse Curvature Effect" (J.T.C. Liu). *Minta Martin First Award Papers - 1958* (Institute of the Aeronautical Sciences, Inc., New York, 1958), pp. 10-22.
- 2.* "Heat Transfer to the Stagnation Line Region of a Highly Swept Wing with Cylindrical Leading Edge" (J.T.C. Liu). Convair-Fort Worth Report FZA-321 (September 1959).
3. "On Laminar Heat Transfer to the Stagnation Line Region of a Highly Yawed Cylinder" (J.T.C. Liu). *Proceedings of 6th Midwestern Fluid Mechanics Conference* (Univ. of Texas Press, Austin, 1959), pp. 34-46.
- 4.* "Heat Transfer in Hypersonic Viscous Interaction with Chemical Reactions" (J.T.C. Liu). Convair-Fort Worth Engineering Research Report ERR-FW-037 (1961).
5. "On the Role of High Temperature Effects on Heat Transfer in Hypersonic Viscous Interaction" (J.T.C. Liu). *Developments in Mechanics* (Plenum Press, New York, 1961), Vol. I, pp. 417-429.
- 6.* "*Problems in Particle-Fluid Mechanics*" (J.T.C. Liu). Ph.D. Thesis, California Institute of Technology (1964).

- 7.* "Some Physical Considerations of the Hydrodynamic Stability of Parallel Flows of a Dusty Gas" (J.T.C. Liu). Princeton University, Department of Aerospace and Mechanical Sciences Report 745 (July 1965).
8. "On the Hydrodynamic Stability of Parallel Dusty Gas Flows" (J.T.C. Liu). *Phys. Fluids* 8, 1939-1945 (1965).
- 9.* "The Effect of Wall Temperature on Stagnation Region Heat Transfer and Shock Detachment Distance in Hypersonic Incipient Merged Layer Flow" (J.T.C. Liu). Princeton University, Department of Aerospace and Mechanical Sciences Report 753 (August 1965).
- 10.* "On Shock Tube Side Wall Langmuir Probes" (J.T.C. Liu). Princeton University, Department of Aerospace and Mechanical Sciences Report 764 (January 1966).
11. "Flow Induced by an Oscillating Infinite Flat Plate in a Dusty Gas" (J.T.C. Liu). *Phys. Fluids* 9, 1716-1720 (1966).
12. "The Effect of Wall Temperature on the Low Reynolds Number Hypersonic Stagnation Region Shock Layer" (J.T.C. Liu). *International Journal of Heat and Mass Transfer* 10, 83-95 (1967).
- 13.* "Summary Report on Wake Stability Studies - Effect of Nonequilibrium Chemistry on Compressible Wake Instability (H. Gold and J.T.C. Liu), AVCO Space Systems Division Report AVSSD-0367-67RR (September 1967).
14. "Shock Tube Side Wall Electrostatic Probes" (J.T.C. Liu). *AIAA J.* 5, 891-898 (1967).
15. "Flow Induced by the Impulsive Motion of an Infinite Flat Plate in a Dusty Gas" (J.T.C. Liu). *Astronautica Acta* 13, 369-377 (1967).
16. "Differential Formulations in Radiative Transfer for Non-Gray Gases" (J. T. C. Liu and J. H. Clarke). *Phys. Fluids* 10, 2088-2091 (1967).
- 17.* "On Radiative Transfer in the Low Reynolds Number Blunt Body Stagnation Region at Hypersonic Speeds. Part I. Emission Dominated Case" (J.T.C. Liu). Brown University, Division of Engineering Report Nonr 562(35)/21 (March 1968).
18. "A General Theory of the Development of Finite Amplitude Disturbances in the Unstable Laminar Wake Behind Plane Bodies at Hypersonic Flight Speeds" (J.T.C. Liu). Paper No. 68-684, The AIAA Fluid and Plasma Dynamics Conference, Los Angeles, June 24-26, 1968.
19. "On Radiative Transfer in the Low Reynolds Number Blunt Body Stagnation Region at Hypersonic Speeds" (J. T. C. Liu and E. Sogame), *AIAA J.* 7, 1273-1279 (1969).
20. "The Finite Amplitude Instability of the Compressible Laminar Wake. Weakly Nonlinear Theory" (J.T.C. Liu). *Phys. Fluids* 12, 1763-1774 (1969).
21. "Some Comments on the Use of Additives (Small Particles) in the Jet Noise Problem" (J.T.C. Liu). In *Basic Aerodynamic Noise Research*, Conference held at NASA Headquarters, Washington, D.C., July 14-15, 1969, NASA SP-207, pp. 515-518.
- 22.* "Correlation of Transition Data" (J. T. C. Liu and N. Thyson), AVCO Systems Division Report (1969).
23. "Influence of Upstream Absorption on the Inviscid Stagnation Region Shock Layer Radiation" (J.T.C. Liu). *AIAA J.* 8, 1730-1737 (1970).
24. "Reply to Author to W. Schneider" (J.T.C. Liu). *AIAA J.* 8, 1181 (1970).
25. "Finite Amplitude Instability of the Compressible Laminar Wake. Strongly Amplified Disturbances" (J. T. C. Liu & Lester Lees), *Phys. Fluids* 13, 2932-2938 (1970).
26. "The Incipient Transition Region of Two-Dimensional Hypersonic Wakes" (P. M. Gururaj & J. T. C. Liu), The AIAA 9th Aerospace Sciences Meeting, New York, January 25-27, 1971. AIAA Paper No. 71-202.
27. "On Eddy-Mach Wave Radiation Source Mechanism in the Jet Noise Problem" (J.T.C. Liu). The AIAA 9th Aerospace Sciences Meeting, New York, January 25-27, 1971. AIAA Paper No. 71-150.
28. "Noise Radiation from Turbulent Shear Layer Instability Waves in Supersonic Jet Exhausts" (J.T.C. Liu). *Proceedings of Noise Control Conference* (Purdue University Press, West Lafayette, Indiana, 1971), pp. 450-456.
29. "Nonlinear Development of an Instability Wave in a Turbulent Wake" (J.T.C. Liu). *Phys. Fluids* 14, 2251-2257 (1971).
30. "Finite Amplitude Instability of the Compressible Laminar Wake. Comparisons with Experiments" (J. T. C. Liu & P. M. Gururaj), *Phys. Fluids* 17, 532-543 (1974).

31. "Developing Large-Scale Wavelike Eddies and the Near Jet Noise Field" (J.T.C. Liu). *J. Fluid Mech.* 62, 437-543 (1974).
32. "On the Development of Large-Scale Wavelike Eddies in a Plane Turbulent Jet" (L. Merkin & J. T. C. Liu), *J. Fluid Mech.* 70, 353-368 (1975).
33. "The Large-Scale Wavelike Eddies and Their Near and Far Jet Noise Field" (J.T.C. Liu). *Proceedings of the 3rd Interagency Symposium on University Research in Transportation Noise* (University of Utah Press, Salt Lake City, Utah, 1975), pp. 460-466.
34. "Energy Integral Description of the Development of Kelvin-Helmholtz Billows" (J. T. C. Liu & L. Merkin), *Tellus* 28, 197-214 (1976).
35. "On the Interaction between Large-Scale Structure and Fine-Grained Turbulence in a Free Shear Flow. I. The Development of Temporal Interactions in the Mean" (J. T. C. Liu & L. Merkin), *Proc. Royal Soc. Lond. Ser. A*, 352, 213-237 (1976).
36. "On the Large-Scale Structure in Turbulent Free Shear Flows" (J. T. C. Liu & A. Alper), *Proceedings of Symposium on Turbulent Shear Flows*, pp. 11.1-11.11 (Pennsylvania State University, University Park, Pennsylvania, (1977).
37. "The Generation of Sound by Vorticity Waves in Swirling Duct-Flows" (M. S. Howe & J. T. C. Liu), *J. Fluid Mech.* 81, 369-383 (1977).
38. "Aerodynamic Sound in a Relaxing Medium" (J.T.C. Liu). *J. Fluid Mech.* 83, 775-778 (1977).
39. "The Large-Scale Organized Structure in Free Turbulent Shear Flow and its Radiation Properties" (J. T. C. Liu, A. Alper & R. Mankbadi), in *Structure and Mechanism of Turbulence*, II. (H. Fiedler, ed.), Berlin: Springer-Verlag (1978).
40. "On the Interaction between Large-Scale Structure and Fine-Grained Turbulence in a Free Shear Flow, II. The Development of Spatial Interactions in the Mean" (A. Alper & J. T. C. Liu), *Proc. Royal Soc. Lond. Ser. A* 359, 497-523 (1978).
41. "Generation of Interfacial Gravity Waves by Submerged Regions of Turbulence" (J.T.C. Liu). *Phy. Fluids* 22, 814-818 (1979).
42. "On the Interactions between Large-Scale Structure and Fine-Grained Turbulence in a Free Shear Flow, III. A Numerical Solution" (T.B. Gatski & J.T.C. Liu). *Phil. Trans. Royal Soc. Lond. Ser. A* 293, 473-509 (1980).
43. "A Study of the Interactions between Large-Scale Coherent Structures and Fine-Grained Turbulence in a Round Jet" (R. Mankbadi & J. T. C. Liu) , *Phil. Trans. Royal Soc. Lond. Ser. A* 298, 541-602 (1981).
44. "Interactions between Large-Scale Coherent Structures and Fine-Grained Turbulence in Free Shear Flows" (J.T.C. Liu). In *Transition and Turbulence* (R. E. Meyer, ed.), pp. 167-213, New York: Academic Press (1981).
45. "Note on a Wave-Hierarchy Interpretation of Fluidized Bed Instabilities" (J.T.C. Liu). *Proc. Roy. Soc. Lond. Ser. A* 380, 229-239 (1982).
46. "Nonlinear Instabilities in Fluidized Beds" (J.T.C. Liu). In *Proceedings Second Symposium Constitutive Relations in the Mechanics of Granular Materials* (J. T. Jenkins and M. Satake, eds.), pp. 357-364. Amsterdam: Elsevier Sci. Pub. Co. (1983).
47. "The Response of Finite-Amplitude Wave Motions to Seasonal Heating of a Baroclinic Shear Flow" (T. F. Hogan & J. T. C. Liu), *Proc. Roy. Soc. Lond. Ser. A* 387, 257-287 (1983).
48. "Nonlinear Unstable Wave Disturbances in Fluidized Beds", *Proc. Roy. Soc. Lond. Ser. A* 389, 331-347 (1983).
49. "Sound Generated Aerodynamically Revisited: Large-Scale Structures in a Turbulent Jet as a Source of Sound" (R. Mankbadi & J. T. C. Liu), *Phil. Trans. Roy. Soc. Lond. Ser. A* 311, 183-217 (1984).
50. "Large-Scale Coherent Structures in Free Turbulent Flows and Their Aerodynamic Sound" (J.T.C. Liu). In *Recent Advances in Aeronautics and Aeroacoustics* (A. Krothapali and C. A. Smith, eds.) pp. 297-334. Springer-Verlag, Berlin (1986).
51. "Nonlinear Binary-Mode Interactions in a Developing Mixing Layer", (D. E. Nikitopoulos & J. T. C. Liu), *J. Fluid Mech.* 179, 345-370 (1987).
52. "Control of Free Shear Layers" (J. T. C. Liu & H. T. Kaptanoglu), AIAA Paper No. 87-2689.
53. "Coherent Mode Interactions in Developing Free Shear Flows" (J.T.C. Liu). In *Proc. International Conf. Fluid Mechanics* (S. Qiu, ed.), pp. 1253-1258. Peking Univ. Press (1987).

54. "Contributions to the Understanding of Large-Scale Coherent Structures in Developing Free Turbulent Shear Flows" (J.T.C. Liu). In *Advances in Applied Mechanics* 26 (J. W. Hutchinson and T. Y. Wu, eds.), pp. 183-309. Academic Press, New York (1988).
55. "Nonlinear Development of Görtler Vortices and the Generation of High Shear Layers in the Boundary Layer" (A. S. Sabry & J. T. C. Liu). In *Proc. Symp. in Honor of C. C. Lin* (D. J. Benney, F. H. Shu & C. Yuan, eds.), pp. 175-183. Singapore: World Scientific (1988).
56. "Near-Wall Response of Unsteady Turbulent Shear Flow. I. Fluid Dynamics" (R. R. Mankbadi & J. T. C. Liu), *Proc. Inst. Acoustics* 10, 825-834 (1988).
57. "Coherent Mode Interactions in Developing Free Shear Flows with Application to Coherent Flames" (J.T.C. Liu). In *Proc. Symp. in Honor of F. E. Marble*, pp. 113-127, Calif. Inst. Tech., Pasadena (1988).
58. "Coherent Structures in Transitional and Turbulent Free Shear Flows" (J.T.C. Liu). In *Annual Reviews of Fluid Mechanics* 21, 285-315 (1989).
59. "Multiple Large-Scale Coherent Structures in Free Turbulent Shear Flows" (J. T. C. Liu & H. T. Kaptanoglu). In *Advances in Turbulence 2, Proc. 2nd European Turbulence Conf.*, Berlin, August 30 - September 2, 1988. (H.H. Fernholz and H. E. Fiedler, eds.), pp. 57-61. Berlin: Springer-Verlag (1989).
60. "Multiple Coherent Mode Interactions in a Developing Round Jet" (S. S. Lee & J. T. C. Liu). AIAA Paper No. 89-0967.
61. "Nonlinear Coherent Mode Interactions and the Control of Shear Layers" (D. E. Nikitopoulos & J. T. C. Liu., In. *Structure of Turbulence and Drag Reduction*. IUTAM Symp., Zurich, July 25-28, 1989 (A. Gyr, ed.), pp. 119-127. Berlin: Springer-Verlag (1989).
62. "Secondary Instabilities of Three-Dimensional Inflectional Velocity Profiles Resulting from Longitudinal Vorticity Elements in Boundary Layers" (A. S. Sabry, X. Yu & J. T. C. Liu). In *Proc. Third IUTAM Symp. Laminar-Turbulent Transition*, Toulouse, September 11-15, 1989 (D. Arnal & R. Michel, eds.), pp. 441-451. Berlin: Springer-Verlag (1990).
63. "Phase-Volume Representations of Two-Coherent Mode Transition to Turbulence in a Developing Mixing Layer" (J. T. C. Liu & H. T. Kaptanoglu). In *Proc. Fourth Intern. Workshop Nonlinear Processes and Turbulence in Physics*. Kiev: Inst. Theo. Physics, Acad. Sci Ukrainian SSR (1989).
64. "Possibilities of Incorporating Coherent Structure Models in Turbulent Shear Flow Calculations" (J.T.C. Liu). *Applied Mechanics Review* 43, S210-S213 (1990).
65. "Numerical Simulation of the Nonlinear Evolution of Görtler Vortices" (A.S. Sabry & J.T.C. Liu). In *Proc. Third Int. Congr. Fluid Mech.*, pp. 665-676. Cairo: Cairo University (1990).
66. "Concentration and Heat Transfer in Nonlinear Görtler Vortex Flow and the Analogy with Longitudinal Momentum Transfer" (J.T.C. Liu & A.S. Sabry). *Proc. Royal Soc. A* 432, 1-12 (1991).
67. "Scalar Transport in a Longitudinal Vorticity System in Boundary Layers" (J.T.C. Liu). In *Studies in Turbulence, Proc. Symp. in Honor of John L. Lumley*, ICASE/NASA Langley 1990. (T.B. Gatski, S. Sarkar & C.G. Speziale, eds.), pp. 436-446. Berlin: Springer-Verlag (1991).
68. "On Scalar Transport in Nonlinearly Developing Görtler Vortex Flow" (J.T.C. Liu). *Geophys. Astrophys. Fluid Dyn.* 58, 133-145 (1991).
69. "Longitudinal Vorticity Elements in Boundary Layers: Their Nonlinear Development from Initial Görtler Vortices as a Prototype Problem" (A.S. Sabry & J.T.C. Liu). *J. Fluid Mech.* 231, 615-665 (1991).
70. "On the Secondary Instability in Görtler Flow" (X. Yu & J.T.C. Liu). *Phys. Fluids* A3, 1845-1847 (1991).
71. "Wall-layer Response in an Unsteady Turbulent Flow" (J.T.C. Liu & R.R. Mankbadi). In *Proc. Response of Shear Flows to Imposed Unsteadiness - Assois* (G. Binder & D. Ronneberger, eds.). CNRS, Assois (1991).
72. "On the Growth of Mushroomlike Structures in Nonlinear Spatially Developing Görtler Vortex Flow" (K. Lee & J.T.C. Liu). *Phys. Fluids* A4, 95-103 (1992).
73. "Near-wall Response in Turbulent Shear Flows Subjected to Imposed Unsteadiness" (R.R. Mankbadi & J.T.C. Liu). *J. Fluid Mech.* 238, 55-71 (1992).
74. "Multiple-coherent Mode Interactions in a Developing Round Jet" (S.S. Lee & J.T.C. Liu). *J. Fluid Mech.* 248, 383-401 (1993).

75. "Heat transfer under Longitudinal Vortices Arising from Concave Surface" (J.T.C. Liu & K. Lee) in *Zagadnienia Maszyn Przeplywowych - Problems of Fluid-Flow Machines* (Z. Bilicki, E.S. Burka, Z. Domachowski, M. Dzida, B. Grochal, J. Krzyzanowski, J. Mikielwicz & E. Sliwicki, eds.), pp. 467-484. Gdansk: Wydawnictwo Inst. Maszyn Przeplywowych - PAN (1993).
76. "On the Mechanism of Sinuous and Varicose Modes in Three-dimensional Viscous Secondary Instability of Nonlinear Görtler Rolls" (X. Yu & J.T.C.Liu). *Phys. Fluids* 6, 736-750 (1994).
77. "Heat Transfer in Strongly-Nonlinear Spatially Developing Longitudinal Vorticity System" (J.T.C. Liu & K. Lee). *Phys. Fluids* 7, 559-599 (1995).
78. "Mixing Enhancement in the Initial Region of High Speed Jet Exhaust Flows" (K. Lee and J. T. C. Liu). AIAA Paper No, 96-0547, 34th Aerospace Sciences Meeting and Exhibit, 15-18 January 1996, Reno.
79. "Longitudinal Vortices in Boundary Layer Heat Transfer Augmentation" (J.T.C. Liu). In *Vortices and Heat Transfer* (M. Fiebig & N. Mitra, eds.) *Notes on Numerical Fluid Mechanics* Vol. 63, Vieweg Verlag & Sohn, Braunschweig/Wiesbaden (1998), pp. 328-337.
80. "Mixing Enhancement in a High Speed Turbulent Shear Layer Using Excited Coherent Modes" (K. Lee and J. T. C. Liu). *AIAA J.* 36, 2027-2035 (1998).
81. "The Role of Controlled Longitudinal Vortices on Transport." (J.T.C. Liu). In *Proc 7th International Symp. Flow Modeling and Turbulence Measurements*, Chenkung Univ., Tainan, October 5-6, 1998, pp. 589-607.
82. "Taylor-Görtler Vortices in Mixing Enhancement." (I.G. Girgis & J.T.C. Liu). In *Proc. 11th Int. Couette-Taylor Workshop: Centrifugal Flows in Science and Industry*, ZARM, Bremen, July 20-23, 1999, pp.85-86.
83. "Linear Stability of the Supersonic Turbulent Boundary Layer to Görtler Vortices on a Concave Wall." (I.G. Girgis & J.T.C. Liu). In *5th IUTAM Symp.-Transition to Turbulence* (W. Saric and H. Fasel, eds.) Springer-Verlag, Berlin (2000).
84. "Nonlinear Three-Mode Interactions in a Developing Mixing Layer" (D.E. Nikitopoulos & J.T.C. Liu). *Phys. Fluids* 13, 966-982 (2001).
85. "Mixing Enhancement via Release of Strongly Nonlinear Longitudinal Görtler Vortices and their Secondary Instabilities into the Mixing Region" (I.G. Girgis & J.T.C. Liu). *J. Fluid Mech.* 468, 29-75 (2002).
86. "Heat Transfer Enhancement by Nonlinear Wavy Instabilities of Steady Longitudinal vortices in Boundary Layer Flow" (J.T.C. Liu). In *Progress in Computational Heat and Mass Transfer*, Vol. 1 (R. Bennacer, ed.), Lavoisier, Paris (2005), pp. 190-195.
87. "Nonlinear Mechanics of Wavy Instability of Steady Longitudinal Vortices and its Effect on Skin Friction Rise in Boundary Layer Flow" (I.G. Girgis & J.T.C. Liu). *Phys. Fluids* 18, 024102 (2006).
88. "Some recent applications of Görtler vortices to scalar transport" (J.T.C. Liu). In *Proc. 15th Int. Couette-Taylor Workshop*, Le Havre Univ. (2007), pp. 60-63.
89. "An extended Reynolds analogy for excited wavy instabilities of developing streamwise vortices with applications to scalar mixing intensification" (J.T.C. Liu). *Proc. R. Soc. A* 463, 1791-1813 (2007). (doi:10.1098/rspa.2007.1848).
90. "Nonlinear instability of developing streamwise vortices with applications to boundary layer heat transfer intensification through an extended Reynolds analogy" (J.T.C. Liu). *Phil. Trans. R. Soc. A* 366, 2699-2716 (2008). (doi:10.1098/rsta.2008.0057). Published online 21 May 2008.
91. "An Explanation of Higher Heat Transfer Efficiency in Laminar Structured Boundary Layers Than in Turbulent Boundary Layers" (L. Momayez, G. Delacourt, P. Dupont, H. Peerhossaini, J. T. C. Liu), In *Proc. SFT 2008 – Congrès de la Société française de thermique, 3-6 juin 2008*. pp. 217-223. SFT, Toulouse, France.
92. "Numerical Heat Transfer Studies of Flows Over Concave Surfaces" (L.F. Sousa & J.T.C. Liu). In *ASME 14th Int. Heat Transfer Conference*, August 8-13, 2010, Washington D.C. Paper No. IHTC14-22390.
93. "Three-dimensional secondary instability of a spatially developing von Kármán vortex street in a far wake" (J.T.C. Liu & X. Yu). *Proc. R. Soc. A* 467, 675-694 (2011)

94. "On the generation of three-dimensional disturbances from two-dimensional nonlinear instabilities in shear flows" (J. T. C. Liu & X. Yu). 13th Euromech European Turbulence Conference (ETC13), *J. Phys.: Conference Series*, 318 (2011) 032013, IOP Publishing (doi:10.1088/1742-6596/318/3/032013).
95. "On the anomalous laminar heat transfer intensification in developing region of nanofluid flow in channels or tubes" (J.T.C. Liu). *Proc. R. Soc. A* **468**, 2383-2398 (2012) Z(doi:10.1098/rspa.06712011.0671).
96. "Nonlinear instability and forcing of coherent modes in the axisymmetric wake of very slender bodies of revolution" (J.T.C. Liu & K. Lee). *9th European Fluid Mechanics Conference EFM9 Proceedings* (2012).
97. "The influence of spanwise wavelength of Gortler vortices in heat transfer" (V. Malatesta, L.F. de Sousa & J.T.C. Liu), *Computational Thermal Sci.* **5**, 389-400, (2013).
98. "Modification of mean wake flow behind very slender axisymmetric body of revolution by imposed nonlinear unstable helical modes." (K. Lee & J.T.C. Liu), *Proc. R. Soc. A* **470**, 2013056 (2014).
99. "Nanofluid flow and heat transfer in channel entrance region" (J.T.C. Liu & G. Puliti), *4th Micro Nano Fluid Conference MNF2014 Proceedings* (2014).
100. "Heat transfer analysis in flow over concave wall with primary and secondary instabilities" (V. Malatesta, L.F. de Sousa, J.T.C. Liu & M. J. Kloker). *Procedia IUTAM, Volume 14*, 487–495 (2015). IUTAM_ABCM Symposium on Laminar Turbulent Transition. (doi:10.1016/j.piutam.2015.03.077)
101. "Some fundamental considerations of streamwise vortices found useful in mixing enhancement and jet noise suppression" (J.T.C. Liu). *Int. J. Aeroacoustics* (accepted for publication.2015).
102. "Nanofluid flow and heat transfer in boundary layers at small nanoparticle volume fraction" (J. T. C. Liu, Mark E. Fuller, Ling Ka Wu, Alexander Czulak, Alexander G. Kithes, Collin J. Felten). Accepted (2015) for presentation at 5th Micro Nano Flows Conf. 11-14 Sept. 2016, Milano, Italy (www.MNF2016.com). Manuscript on progress.

e. Book Reviews

1. Review of *Whither Turbulence? Turbulence at the Crossroads*, (J. L. Lumley, ed.), Lecture Notes in Physics 357. Berlin: Springer-Verlag (1990). *A.I.A.A. J.* 30, 2999 (1992).

f. ABSTRACTS (only recent abstract listings are cited, under h. PAPERS READ)

g. INVITED LECTURES:

INVITED SEMINAR LECTURES, *International* (since 1987)

1,2 Universita degli Studi di Roma "La Sapienza", Rome, Dipartimento di Idraulica, Trasporti e Strade Seminari, 23-27 March 1987: "Large-Scale Coherent Structures in Free Turbulent Shear Flows. I. Fundamental Basis. II. Applications"

3-8 Lectures on "Nonlinear Development of Görtler Vortices":
 University College-London, Applied Mathematics Seminar, 2 Nov. 1987
 University of Bristol, Applied Mathematics Seminar, 5 Nov. 1987
 The Technion-Israel Institute of Technology, Haifa, Mechanical Engineering Seminar, 4 Jan. 1988
 University of Cambridge, Fluid Mechanics Seminar, 22 Jan. 1988
 University of Exeter, Joint Applied Mathematics-Engineering Seminar, 29 Jan. 1988
 Cairo University, Dept. of Mechanical Engineering Seminar, 10 Feb. 1988
 University of Manchester, Joint Applied Mathematics-Aeronautics Seminar, 2 March 1988
 University of Newcastle, Mathematics Colloquium, 4 March 1988

9 Imperial College, London, Applied Mathematics Friday Seminar Series, 29 Jan. 1988: "Control of Free Turbulent Shear Layers"

- 10, 11 Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Fluid Mechanics Seminar:
 24 March 1988: "Coherent Structures in Free Turbulent Shear Flows"
 30 March 1988: "Nonlinear Development of Görtler Vortices and the Generation of High Shear Layers in the Boundary Layer"
- 12 Université Pierre et Marie Curie (Paris-VI), Paris, Formation Doctorale de Transferts Thermiques Séminaires, 20 April 1988: "Nonlinear Development of Heat Transfer-Enhancing Görtler Vortices in Boundary Layers"
- 13 University of St. Andrews, Department of Mathematics Seminar, 29 April 1988: "Mode Interactions in Turbulent Free Shear Flows"
- 14 University of Oxford, Mathematical Institute Seminar, 16 May 1988: "The Turbulent Stokes Layer"
- 15 Eidgenössische Technische Hochschule (ETH), Zurich-Zentrum, Institut für Fluidodynamik Seminar, 21 June 1988: "Nonlinear Development of Görtler Vortices and the Generation of High Instnse Shear Layers"
- 16 Ruhr-Universität, Bochum, Institut für Thermo- und Fluidodynamik Seminar, 4 July 1988: "Longitudinal Vorticity Elements in Boundary Layers"
- 17, 18 Institute of Aeronautics & Astronautics, National Cheng Kung University, Tainan, 9-12 January 1989: eight 2-hour lectures at Workshop on Advances in Fluid Dynamics and Combustion Instabilities on "Coherent structures in free turbulent shear flows" and "Longitudinal vorticity elements in wall bounded shear flows"
- 19 Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Fluid Mechanics Seminar, 9 September 1989: "Secondary Instabilities of Longitudinal Vorticity Systems in Transitional Boundary Layers"
- 20 Institute of Hydromechanics, Academy of Sciences of the Ukrainian SSR, Kiev, Hydromechanics Seminar, 17 October 1989: "Longitudinal Vorticity Elements in Boundary Layers"
- 21 Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Fluid Mechanics Seminar, 25 July 1990: "Heat and Mass Transfer in Nonlinearly Developing Görtler Vortices"
- 22 Laboratoire d'aérothermique, C.N.R.S., Meudon, Seminar, 9 January 1991: "Nonlinear Consequences in Longitudinal Vorticity Elements in Boundary Layers"
- 23 Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Fluid Mechanics Seminar, 19 February 1991: "Wall Bounded Turbulent Shear Flows with Imposed Unsteadiness"
- 24,25 Polytechnika Warszawska, Institute of Aeronautics & Applied Mechanics, Warsaw, Fluid Mechanics Seminar:
 6 January 1992: "Longitudinal Vorticity Elements in Boundary Layers":
 8 January 1992: "Scalar Transport in Longitudinal Vorticity Elements in Boundary Layers"
- 26,27 Università degli Studi di Roma "La Sapienza", Rome, Dipartimento di Idraulica, Trasporti e Strade Seminari:
 5 May 1992: "Longitudinal Vorticity Elements in Boundary Layer Flow"
 8 May 1992: "Two- and Three-Dimensional Mode Interactions in Free Shear Flows"
- 28 Polytechnika Warszawska, Institute of Aeronautics & Applied Mechanics, Warsaw, Fluid Mechanics Seminar, 6 April 1993: "The mechanism of varicose and sinuous modes in secondary instability of nonlinear longitudinal vortices"
- 29 Laboratoire d'aérothermique, CNRS/Meudon, Seminar, 13 December 1993: "Heat Transfer under Longitudinal Vortices Arising from Concave Surface Curvature."

- 30 Laboratoire de Thermocinétique, ISITEM, Univ. de Nantes, 16 December 1993: "Momentum and Heat Transfer in Longitudinal Vortices on Concave Wall Surfaces."
- 31 Laboratoire de mecanique de fluides, Poiter, 25 February 1994: "Momentum and Heat Transfer in Longitudinal Vortices on Concave Walls."
- 32-36 Laboratoire de Thermocinétique, ISITEM, Univ. de Nantes:
 8 April 1994: "Physical Mechanisms in Hydrodynamic Stability of Free and Wall Bounded Shear Flows.
 15 April 1994: "The Interaction of Various Scales of Motion."
 22 April 1994: "Finite amplitude instability of laminar free shear flows. Coherent Structures in Turbulent Free Shear Flows."
 29 April 1994: "Finite Amplitude Instabilities in Flow over Concave Surface:
 i) Steady Görtler rolls; ii) Secondary instability of Görtler rolls."
 9 May 1994: "Heat and Mass Transfer in Görtler rolls."
- 37 Polytechnika Warszawska, Institute of Aeronautics & Applied Mechanics, Warsaw, Fluid Mechanics Seminar, 27 March 1996: "Boundary Layer Heat Transfer under Longitudinal Vorticity Elements."
- 38 CNRS/Orsay and University of Orsay, Laboratory for Turbomachines and Fluid Mechanics Seminar, 17 January 1997: "Heat Transfer under Longitudinal Vortices and its Control."
- 39 Institute for Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Mechanics Seminar, 17 January 1998: "Mixing Enhancement by Longitudinal Vortices"
- 40 Institut für Aerodynamik und Gasdynamik, Universität Stuttgart, Transition Seminar, 11 October 2000: "Secondary Instabilities of Görtler Vortices."
- 41 Department of Mechanics, Tianjin University, Fluid Mechanics Seminar, 20 May 2001: "Recent Developments in Nonlinear Aspects of Secondary Instability of Longitudinal Vortex Flows"
- 42 Laboratoire de Thermocinétique, École polytechnique de l'universite de Nantes, Fluid Mechanics Seminar, 12 June 2003: "Nonlinear Developemt of Gortler Vortices and their Secondary Instabilities and Scalar Transport Effects"
- 43 Department of Mathematics, Fluid Mechanics Seminar, Imperial College, 23 March 2012: "Anomalous heat transfer of nanofluid flow in the developing region of channels or tubes"
- 43, 45 Department of Mechanics, Fluid Mechanics Seminar, Tianjin University, 16 May 2012:
 Part I: "Three-dimensional instability of nonlinear two-dimensional wake behind a flat plate"
 Part II: "instability of far wake behind a slender body of revolution and modification of the round wake by nonlinear helical modes"
- 46 Department of Mechanics Fluid Mechanics Seminar, Tianjin University, 22 May 2012: "The anomalous laminar heat transfer intensification in developing region of nanofluid flow in channels or tubes"
- 47, 48 Department of Mechanics Seminar, Tianjin University, 17 Sept. 2015:
 "Contributions to the Understanding of Large-Scale Coherent Structures in Free Turbulent Shear Flows-Revisited"
 and
 "Nanofluid flow and heat transfer in boundary layers at small nanoparticle volume fraction"
- 49 Instytutowe Seminarium Mechaniki, Institute of Fundamental Technological Research, Polish Academy of Sciences (IPPT-PAN), Warsaw, 9 November 2015: "Nanofluid flow and heat transfer in boundary layers at small nanoparticle volume fraction"

INVITED SEMINAR LECTURES, U.S. (since 1987)

- 1 Bolt, Baranek & Newman, Cambridge, Applied and Computational Mathematics Seminar, 28 January 1987: "Coherent Eddy Structures in Free Turbulent Shear Flows"
- 2 NASA, Lewis Research Center, Cleveland, Turbulent Flow Seminar, 6 August 1987: "Multiple Mode Interactions in Free Turbulent Shear Flows"
- 3 Georgia Institute of Technology, Atlanta, Mechanical Engineering Seminar, 21 October 1988: "Longitudinal Vorticity Elements in Boundary Layers"
- 4 NASA, Lewis Research Center, Cleveland, Internal Fluid Mechanics Division Seminar Series, 17 November 1988: "Three-frequency Mode Interactions in a Developing Free Shear Flow"
- 5 University of Rhode Island, S. Kingston, Mechanical Engineering & Applied Mechanics Seminar, 21 March 1989: "Longitudinal Vorticity Elements in Boundary Layers"
- 6 NASA, Lewis Research Center, Cleveland, Internal Fluid Mechanics Division Seminar Series, 17 April 1989: "Applications of Coherent Structure Ideas to Heat Transfer, Transition and Coherent Flames"
- 7 Arizona State University, Tempe, Department of Aerospace & Mechanical Engineering Seminar, 26 October 1990: "Nonlinear Aspects of Görtler Vortex Flows"
- 8 NASA, Lewis Research Center, Cleveland, Internal Fluid Mechanics Seminar, 29 May 1991: "Coherent Structure Theory Applications to Problems in Propulsion Systems"
- 9 University of Houston, Mechanical Engineering Seminar, 21 November 1991: "Nonlinear Görtler Vortices in Boundary Layers"
- 10 NASA, Lewis Research Center, Cleveland, Internal Fluid Mechanics Division Seminar Series, 24 February 1992: "Mode Interactions in Free Shear Flows"
- 11 M.I.T., Cambridge, Fluid Mechanics Seminar, 13 March 1992: "Longitudinal Vorticity Elements in Boundary Layers"
- 12 Princeton University, Seminars in Applied Physics, Fluid Mechanics, Combustion Dynamics and Control, 1 December 1992: "Momentum and Scalar Transport in Nonlinear Görtler Vortices"
- 13 NASA-Lewis Research Center; Inlet, Duct and Nozzle Flow Physics Branch, Internal Fluid Mechanics Division, 10 November 1993: "Progress on the research in high speed mixing enhancement via excitation of control-coherent modes"
- 14 Boston University, Department of Mechanical and Aerospace Engineering Seminar, 14 October 1994: "Heat transfer under nonlinearly developing Görtler vortices."
- 15 NASA-Lewis Research Center; Inlet, Duct and Nozzle Flow Physics Branch, Internal Fluid Mechanics Division, 7 November 1994: "Research progress in high speed mixing enhancement via excitation of coherent modes."
- 16 University of Arizona, Department of Aerospace and Mechanical Engineering Seminar, 26 January 1995: "Heat transfer in strongly nonlinear spatially developing longitudinal vorticity system."
- 17 Arizona State University, Department of Mechanical and Aerospace Engineering, 27 January 1995: "Heat transfer in strongly nonlinear spatially developing longitudinal vorticity system."
- 18 MIT, Department of Mechanical Engineering, Fluid Mechanics Laboratory Seminar, 6 May 1996: "Boundary layer heat transfer under strongly nonlinear longitudinal vorticity elements."

19 Ohio Aerospace Institute Distinguished Lecture Series, Brook Park, Ohio, 25 July 1997: "Boundary layer heat transfer under longitudinal vortices."

20. Embry-Riddle Aeronautical University, Engineering Sciences Seminar, 27 January 2005: "Longitudinal Vorticity Elements in Boundary Layer Flows."

h. PAPERS READ

KEYNOTE and other INVITED CONFERENCE LECTURES (since 1987)

1 11th A.I.A.A. Aeroacoustics Conference, Palo Alto, 20-22 October 1987: "Control of free shear flows" (Keynote Lecture)

2 30th British Theoretical Mechanics Colloquium, London, 11-15 April 1988: "Longitudinal vorticity elements in boundary layers" (Keynote Lecture)

3 S.I.A.M. Conference on Dynamical Systems, Mini-Symposium on Aircraft Design Problems, Orlando, 7-10 May 1990: "Some problems in transition from laminar to turbulent flow" (Invited Lecture)

4 11th U. S. National Congress in Applied Mechanics, Symposium on Coherent Structures in Turbulent Flows, Tucson, 21-25 May 1990: "Possibilities of incorporating coherent structure models in calculation of turbulent shear flows" (Invited Lecture)

5 Annual-March Condensed Matter Meeting, Am. Phys. Soc., Symposium on Vortex Motion and Turbulence-2, Indianapolis, 16-29 March 1992: "Momentum, heat and mass transport in longitudinal vorticity system in boundary layer flows" (Invited Lecture)

6 International Symposium on Theoretical and Computational Fluid Mechanics, in Honour of Sir James Lighthill, Tallahassee, 6-8 November 1996: "The response of heat transfer to longitudinal vorticity elements in the boundary layer." (Invited Lecture)

7 Symposium on Vortices and Heat Transfer, Bochum, Germany, 28-29 November 1996: "Longitudinal vortices in boundary layer heat transfer augmentation" (Keynote Lecture)

8 International Conference on Fluid Mechanics and Propulsion, Cairo, Egypt, 29-31 December, 1996: "The effects of longitudinal vorticity elements in boundary layer heat and mass transfer" (Keynote Lecture)

9 Seventh International Symposium on Flow Modeling and Turbulence Measurements, Tainan, 5-6 October 1998: "The role of controlled longitudinal vortices on transport" (Keynote Lecture)

10 ASME Fluids Engineering Meeting, Boston, 12 -14 June 2000: "Mixing enhancement and control in high and low speed jet exhaust flows" (Keynote Lecture)

11 The Ffowcs Williams Acoustics Symposium 'Shonfest', Emmanuel College, University of Cambridge, 30 June-2 July 2002: "Mechanics of Wavy Coherent Structures of Streamwise Vorticity-Dominated Flow (as possible Source of Sound)"

12 Int. Symposium on Fluid Dynamics Research, Institut für Aerodynamik und Gasdynamik, Universität Stuttgart, May 7, 2004: "Aerodynamic Sound Generation Revisited" (Abstract in Proc., pp. 8-9)

13 EUROTHERM 79 Summer School, Mixing and Heat Transfer in Chemical Reaction Processes, Cargèse, 31 July-5 August 2006: Workshop on Heat and Mass Transfer Intensification: "Heat and Mass Transport Enhancement by Steady Streamwise Vortex Flow and its Wavy Instabilities"

14 Int. Conf. Theoretical Fluid Dynamics in the 21st Century – A Special Meeting in Honour of J. T. Stuart, FRS, Imperial College, 15 – 16 December 2006: “Nonlinear Instability of Developing Streamwise Vortices” (Invited Plenary Lecture, collective papers of Conf. published in Phil Trans. Royal Soc. A)

15 *Conference on Nonlinear stability theory, Royal Inst. Engineering*, 19-21 March 2014, London, UK: “Weakly nonlinear theory to nearly turbulence in hydrodynamic stability of compressible fluids and recent developments on the modification of mean wake flow behind a slender body of revolution”

CONTRIBUTED PAPERS READ, *International* (since 1987)

1 18th Biennial Fluid Dynamics Symposium, Mragowo, 6-11 September 1987: "Multiple mode interactions in developing free turbulent shear flows"

2 Euromech 228, Boundary Layer Stability and Transition, Exeter, 21-25 September 1987: The generation of high intense shear layers by the nonlinear development of Görtler vortices "

3 IUTAM 2nd European Turbulence Conference, Technical University of Berlin, 30 August-2 September 1988: "Multiple large scale coherent structures in free turbulent shear flows"

4 IUTAM 2nd Symposium on Structure of Turbulence and Drag Reduction, E.T.H., Zurich, 25-28 July 1989: "Nonlinear coherent mode interactions and the control of shear layers"

5 IUTAM 3rd Symposium on Laminar-Turbulent Transition, ONERA/CERT, Toulouse, 11-15 September 1989: "Secondary instabilities of three-dimensional inflectional velocity profiles resulting from longitudinal vorticity elements in boundary layers"

6 4th International Workshop on Nonlinear Processes and Turbulence in Physics, Institute for Theoretical Physics, Academy of Sciences of the Ukrainian SSR, Kiev, 9-22 October 1989: "Phase volume representation of two-coherent mode transition to turbulence in a mixing layer"

7 Euromech 261, 1st International Workshop on Görtler Vortices, Nantes, 11-14 June 1990: "Heat and mass transfer in spatially developing nonlinear Görtler vortex flow and the interpretation of flow visualization"

8 IUTAM Symposium on Nonlinear Hydrodynamic Stability and Transition, Valbone, 3-8 September 1990: "Phase volume representation of two-coherent mode transition to turbulence in a developing free shear layer"

9 Euromech 272, Response of Shear Flows to Imposed Unsteadiness, Assois, 14-18 January 1991: "Wall layer response in unsteady turbulent flows"

10 1st European Fluid Mechanics Conference, Cambridge University, 14-20 September 1991: "Multiple mode evolution and control in spatially developing turbulent wakes"

11 Symposium on Fluid Dynamics, in honour of the 80th Birthday of W. Fiszdon, Warsaw, 25-27 June 1992: "Scalar transport under longitudinal vortices in boundary layers"

12 8th NATO Advanced Workshop on Couette-Taylor Flow, Inst. Nonlinear Sci., Nice, 29-31 March 1993: "The mechanism of varicose and sinuous modes in secondary instability of Görtler vortex flow"

13 Eurotherm 31, Vortices and Heat Transfer Symp., Ruhr-Universität Bochum, 24-26 May 1993: "Heat transfer under nonlinearly developing longitudinal vortices in boundary layers"

14 10th International Couette-Taylor Workshop: Centrifugal Flows in Science and Industry, ESPCI, Paris, 15-18 July 1997: (abstract appear in Proceedings of 10th Int. Couette-Taylor Workshop): "Mixing Enhancement Properties of Persisting Nonlinear Taylor-Görtler Vortices Beyond the Trailing Edge of a Concave Wall."

15. 11th Int. Couette-Taylor Workshop: Centrifugal Flows in Science and Industry, ZARM, Bremen, July 20-23, 1999: "Taylor-Görtler Vortices in Mixing Enhancement."
16. 13th International Couette Taylor Workshop, Nonlinear Dynamics in Fluids, Univ. Politècnica de Catalunya, Barcelona, 3-5 July 2003: "Nonlinear Mechanics of Wavy Instability of Steady Longitudinal Vortices in Free Mixing and Wall Bounded Flows" (extended Abstract in *Nonlinear Dynamics in Fluids* (F. Marqués & A. Meseguer, Eds.), Chapter VII, 2 pp. CIMNE Int. Center for Numerical Methods in Engineering, Barcelona, (2003).
17. XXI Int. Congress of Theoretical and Applied Mechanics (ICTAM), Warsaw, Poland, August 15-21, 2004: "Nonlinear Mechanics of Wavy Instability of Steady Longitudinal Vortices and Drag Rise in Boundary Layer Flow" (abstract in *Proceedings*, p.126, Paper No.fM13S-10487, IPPT PAN, Warszawa 2004).
18. 4th Int. Conference on Computational Heat and Mass Transfer, Paris-Cachan, France, May 17-20, 2005: "Heat Transfer Enhancement by Nonlinear Wavy Instabilities of Steady Longitudinal Vortices in Boundary Layer Flow."
19. 15th Int. Couette-Taylor Workshop, Le Havre, France, 9-12 July 2007: "Some recent applications of Görtler vortices to scalar transport."
20. SFT 2008 – Congrès de la Société française de thermique, Toulouse, France, 3-6 juin 2008: "An Explanation of Higher Heat Transfer Efficiency in Laminar Structured Boundary Layers Than in Turbulent Boundary Layers" (L. Momayez, G. Delacourt, P. Dupont, H. Peerhossaini, J. T. C. Liu).
21. Nanofluids Fundamentals and Applications II, Montreal, Canada (Engrg. Conf. Internal.). August 15-19, 2010: "A theoretical consideration of nanofluid heat transfer enhancement in a developing laminar shear flow."
22. 13th European Turbulence Conference (Euromech), Warsaw, Poland, September 10-15, 2011 "On the generation of three-dimensional disturbances from two-dimensional nonlinear instabilities in shear flow" (J. T. C. Liu & X. Yu)
23. 12th ICHMT International Symposium on Advances in Computational Heat Transfer, Bath, England, July 1-6, 2012 (Paper No. CHT-12-FC05). "The influence of spanwise wavelength of Gortler vortices in heat transfer." (L.F. de Sousa, V. Malatesta & J.T.C. Liu),
24. 9th European Fluid Mechanics Conference (EFMC9), Rome, Italy, September 9-13, 2012 "[Nonlinear instability and forcing of coherent modes in the axisymmetric wake of very slender bodies of revolution](#)" (J. T. C. Liu & K. Lee).
25. 14th Pan-American Congress of Applied Mechanics, PACAM XIV, 3/24-28, 2014, Santiago, Chile "The secondary instability of varicose mode on heat transfer enhancement." (V. Malatesta, L.F. de Sousa, J.T.C. Liu).
26. IUTAM-ABCM Symposium on Laminar-Turbulent Transition, September 8-12, 2014, Rio de Janeiro, Brazil. "Heat transfer analysis in a flow over concave wall with primary and secondary instabilities." (V.Malatesta, L.F. de Sousa, J.T.C. Liu, M.J. Kloker).
27. 4th Micro and Nano Flows (MNF2014), September 7-10, 2014, University College, London, UK: "Nanofluid flow and heat transfer in channel entrance region." (J.T.C. Liu & G. Puliti).

CONTRIBUTED PAPERS READ, U. S. (since 1987)

1. Symposium in Honor of C. C. Lin, M.I.T., Cambridge, 22-24 June 1987: "Nonlinear development of Görtler vortices and the generation of high shear layers in the boundary layer"
2. Turbulent Wall Layer Workshop in Honor of W. W. Willmarth, University of Michigan, Ann Arbor, 18-19 November 1988: "Longitudinal vorticity effects and the development of enstrophy in the boundary layer"

- 3-5 40th Annual Division of Fluid Dynamics Meeting, APS, University of Oregon, 22-24 November 1987:
 "Nonlinear interactions between three frequency wave modes in a developing mixing layer" (Abstract in *Bull. Am. Phys. Soc.* 32, 2048, (1987))
 "Helical and axisymmetric mode interactions in a round jet" (Abstract in *Bull. Am. Phys. Soc.* 32, 2044 (1987))
 "On the generation of high intense shear layers from nonlinear development of Görtler vortices" (Abstract in *Bull. Am. Phys. Soc.* 32, 2096 (1987))
- 6 2nd Newport Conference on Shear Flows, 13-15 June 1988: "Two- and three-dimensional mode interactions in transitional and turbulent free shear flows-prospects for control of mixing"
- 7-8 41st Annual Division of Fluid Dynamics Meeting, APS, SUNY-Buffalo, 20-22 November 1988:
 "Nonlinear mode interactions in a spatially developing mixing layer" (Abstract in *Bull. Am. Phys. Soc.* 33, 2236 (1988))
 "On the development of vorticity and enstrophy during the transition over slightly curved surfaces" (Abstract in *Bull. Am. Phys. Soc.* 33, 2260 (1988))
- 9 AIAA 2nd Shear Flow Conference, Tempe, 12-16 March 1989: "Multiple coherent mode interactions in a developing round jet"
- 10-11 42nd Annual Division of Fluid Dynamics Meeting, APS, Palo Alto, 19-21 November 1989:
 "On the secondary instability in the transition process in wall bounded shear flows" (Abstract in *Bull. Am. Phys. Soc.* 34, 2268 (1989))
 "Five coherent mode interactions in a spatially developing mixing layer" (Abstract in *Bull. Am. Phys. Soc.* 34, 2301 (1989))
- 12 Symposium in Honor of J. L. Lumley, Hampton, 12-13 November 1990: "Scalar transport in a longitudinal vorticity system in boundary layers"
- 13-16 43rd Annual Division of Fluid Dynamics Meeting, APS, Cornell University, 18-20 1990:
 "Nonlinear evolution of Görtler vortices in a spatially growing boundary layer" (Abstract in *Bull. Am. Phys. Soc.* 35, 2230 (1990))
 "Advected scalars in nonlinear spatially developing Görtler vortices" (Abstract in *Bull. Am. Phys. Soc.* 35, 2230 (1990))
 "On secondary instability in the transition process in wall bounded shear flows" (Abstract in *Bull. Am. Phys. Soc.* 35, 2280 (1990))
 "Two- and three-dimensional mode interactions in a spatially developing turbulent shear layer, II" (Abstract in *Bull. Am. Phys. Soc.* 35, 228 (1990))
- 17-18 44th Annual Division of Fluid Dynamics Meeting, APS, Arizona State University, 24-26 November 1991:
 "Control of multiple mode interactions in turbulent wakes" (Abstract in *Bull. Am. Phys. Soc.* 36 (1991))
 "Secondary instability of primary modes in far wakes" (Abstract in *Bull. Am. Phys. Soc.* 36 (1991))
 "Numerical computation of nonlinear unstable modes in axisymmetric wake flows" (Abstract in *Bull. Am. Phys. Soc.* 36 (1991))
- 19 Office of Naval Research Workshop on Nonequilibrium Turbulence, Tempe, 10-12 March 1993:
 "Nonequilibrium (dynamical) subgrid closure in large eddy simulation"
- 20 47th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, 20-22 November 1994, Atlanta: "Mixing enhancement via controlled coherent modes in high speed compressible jet flows" (Abstract in *Bull. Am. Phys. Soc.* 39, p. 1861 (1994)).
- 21 48th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, 19-21 November 1995, Irvine: "Streamwise Vorticity Generation, Mean Flow Modification and Mixing Enhancement by Nonlinear Wave Mode Interactions in an otherwise Axisymmetric mean Shear Flow" (Abstract in *Bull. Am. Phys. Soc.* 40, p.1966 (1995)).

- 22 34th Aerospace Sciences Meeting and Exhibit, American Institute of Aeronautics and Astronautics, Reno, 15-18 January 1996: "Mixing Enhancement in the Initial Region of Highspeed Jet Exhaust Flows via Excited Coherent Wave Modes"
- 23 50th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Francisco, 23-25 November 1997, : "Mixing Enhancement Properties of Persisting Nonlinear Görtler Vortices Beyond the Trailing Edge of a Concave Wall".(Abstract in *Bull. Am. Physical Soc.* 42, p. 2262, (1997) paper no. Ia 10).
- 24,25 51st Annual Division of Fluid Dynamics Meeting, American Physical Society, Philadelphia, 22-24 November 1998:
"Taylor-Görtler Vortices in a Supersonic Turbulent Boundary Layer" (Abstract in *Bull. Am. Phys. Soc.* 43, p. 2015, (1998) paper no. DH7).
"Mixing Properties of Strongly Nonlinear Taylor-Görtler Vortices Downstream from a Concave Wall" (Abstract in *Bull. Am. Phys. Soc.* 43, p. 2080, (1998) paper no. JL6).
- 26 IUTAM 5th Symposium on Laminar Transition to Turbulence, Sedona, September 13-17, 1999: "Linear Stability of the Supersonic Turbulent Boundary Layer to Görtler Vortices on a Concave Wall."
- 27 52nd Annual Division of Fluid Dynamics Meeting, American Physical Society, New Orleans, 21-23 November 1999: "The Role of Strongly Nonlinear Secondary Instabilities in Mixing Enhancement Process" (Abstract in *Bull. Am. Phys. Soc.* 44, p. 162, (1999) paper no. KL2).
- 28 53rd Annual Division of Fluid Dynamics Meeting, American Physical Society, Washington DC, 19-21 November 2000: "Numerical Simulation of Görtler Vortices Transition Process and its Effects on Mixing Enhancement" (Abstract in *Bull. Am. Phys. Soc.* 45, p.42, (2000) paper no. BG3).
- 29 54th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Diego, 23-25 November 2001: "Görtler Vortices and their Secondary Instabilities in Mixing Enhancement" (Abstract in *Bull. Am. Phys. Soc.* 46, (2001)).
- 30 56th Annual Division of Fluid Dynamics Meeting, American Physical Society, E. Rutherford, NJ, 23-25 November 2003: "Skin Friction Modification by Nonlinear Secondary Instabilities of Goetler Vortices" (Abstract in *Bull. Am. Phys. Soc.* 48, p.31, (2003) paper no. AH6)
- 31 58th Annual Division of Fluid Dynamics Meeting, American Physical Society, Chicago, IL, 20-22 November 2005: "Significant Surface Heat Transfer Rate Enhancement and Scalar Transport under Secondary Instabilities of Steady Longitudinal Vorticity Elements in Boundary Layers" (Abstract in *Bull. Am. Phys. Soc.* 50, p.192, (2005) paper no. LS.00001)
- 32 59th Annual Division of Fluid Dynamics Meeting, American Physical Society, Tampa Bay, FL, 19-21 November 2006: "Scalar Mixing Enhancement via Streamwise Vortices and their Excited Wavy Instabilities in a Free Shear Flow" (Abstract in *Bull. Am. Phys. Soc.* 51, No. 11 (2006) paper no. GP.00002)
- 33 63rd Annual Division of Fluid Dynamics Meeting, American Physical Society, Long Beach, CA 21-23 November 2010: "Nanofluid heat transfer enhancement in a developing laminar shear flow" (Abstract in *Bull. Am. Phys. Soc.* 55, No. 16. p. 93 (2010) Abstract ID: BAPS.2010.DFD.CP.7).
- 34 64th Annual Division of Fluid Dynamics Meeting, American Physical Society, Baltimore, Md 20-22 November 2011: "Nanofluid heat transfer anomaly: Theoretical explanation of observations in the development region of microchannels" (Abstract in *Bull. Am. Phys. Soc.* 56, No. 18. p. 93 (2011), Abstract ID: BAPS.2011.DFD.G2.2).
- 35 65th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Diego, CA 18-20 November 2012: "Modification of mean wake flow behind very slender axially symmetric bodies by nonlinear convectively unstable helical modes" (J.T.C. Liu & K. Lee), Abstract in *Bull. Am. Phys. Soc.* 57, No. 17. (2012), Abstract ID: BAPS.2012.DFD.D10.2). <http://meetings.aps.org/link/BAPS.2012.DFD.D10.2>

36 65th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Diego, CA 18-20 November 2012: “Analysis of Gortler Vortices Spanwise Wavelength Influence in Heat Transfer Rates” (L.F. Sousa, V. Malatesta & J.T.C. Liu), Abstract in *Bull. Am. Phys. Soc.* **57**, No. 17. (2012), Abstract ID: BAPS.2012.DFD.F1.82. Poster Session F1). <http://meetings.aps.org/link/BAPS.2012.DFD.F1.82>

37 66th Annual Division of Fluid Dynamics Meeting, American Physical Society, Pittsburgh, PA 23-26 November 2013: “The mechanisms of convective and standing wave mode generation in the wake behind very slender asisymmetric bodies by selective excitation of unstable helical modes” (J.T.C. Liu & K. Lee) Abstract in *Bull. Am. Phys. Soc.* **58**, No. 18. (2013), Abstract ID: BAPS 2013 DFD H10.2).

38 67th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Francisco, CA 22-25 November 2014: “Nanofluid flow and heat transfer in channel entrance region” (J.T.C. Liu & G. Puliti) Abstract in *Bull. Am. Phys. Soc.* **59** (2014), Abstract ID: BAPS 2014.DFD M36.2).

i. **OTHER** (EXHIBITIONS, PROFESSIONALLY PRODUCED ARCHIVAL VIDEOS):

Gallery of Fluid Motion Video Exhibition, 50th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Francisco, November 23-25, 1997:"Longitudinal Vortices in Mixing Enhancement" (RT-approx. 5 minutes).

Ohio Aerospace Institute Video Production, Brook Park, Ohio, 1997, OAI Distinguished Lecture Series Presents - Joseph T. C. Liu, Professor, Brown University, "Boundary Layer Heat Transfer Under Longitudinal Vortices" (RT-approx. 55 minutes).

Gallery of Fluid Motion Video Exhibition, 54th Annual Division of Fluid Dynamics Meeting, American Physical Society, San Diego, November 23-25, 2001:"Longitudinal Vortices in Mixing Enhancement" (RT-approx. 5 minutes).

6. RESEARCH IN PROGRESS

Nonlinear unstable streamwise vortex flow over concave surface, with applications to surface heat transfer rate intensification.

Nonlinear unstable disturbances in controlling far wake flows behind slender bodies of revolution..

Nanofluid flow in micro- and macro-channels and heat transfer intensification.

7. SERVICE

(i.) **service to the University**

- | | | |
|----|----------|--|
| 1 | 1966-69: | Engineering Faculty Advisor to Student Organizations |
| 2 | 1966-70: | Center for Fluid Dynamics Colloquium Chair |
| 3 | 1970-72: | Engineering Concentration Committee |
| 4 | 1973-77: | Committee on Graduate Studies in Engineering |
| 5 | 1975-76: | Engineering 3,4,17 Courses Committee |
| 6 | 1976-78: | Fluid Mechanics Seminar Chair |
| 7 | 1977-79: | Chemical Engineering Formation Committee |
| 8 | 1978-79: | Engineering Executive Committee |
| 9 | 1980-81: | Chemical Engineering Search Committee Chair |
| 10 | 1980-87: | Freshman, Sophmore, Pre-Freshman Counseling & followups |
| 11 | 1980-83: | Engineering–Science Library Lianson Committee Chair |
| 12 | 1981-84: | University Advisory Committee on Honorary Degrees |
| 13 | 1982-87: | Subcommittee on Graduate Studies in Engineering |
| 14 | 1983-87: | Concentration Advisor, A.B. in Engineering Program |
| 15 | 1984-87: | Engineering–Science Library Lianson Committee |
| 16 | 1984: | Faculty host to Sir James Lighthill, FRS and Lady Lighthill for Honorary Degree and other ceremonies, 17-19 November |
| 17 | 1985-86: | Solid Mechanics and Structures Search Committee |
| 18 | 1985-86: | Electrical Sciences Search Committee |

19. 1985-87: University Advisory Committee on Honorary Degrees (Chair during 1986-87).
20. 1986: Faculty host to J.T. Stuart, FRS and spouse for Honorary Degree and other ceremonies, 18-19 September.
21. 1986-87: Fluid and Thermal Science Search Committee Chair, for two vacancies.
22. 1986-89: Associate Director, Center for Fluid Mechanics, Turbulence and Computation
24. 1987: Faculty host to Ms Connie Chung and spouse for Honorary Degree and other Ceremonies, 28-30 May.
25. 1988-90: Engineering Executive Committee
26. 1988-91: Advisory Committee on Honorary Degrees
27. 1989- : Faculty Advisor, Brown student branch of American Institute of Aeronautics and Astronautics
28. 1990-92: Engineering-Science Library Liason Committee Chair
29. 1992-97: Faculty Capital Campaign Committee
30. 1995-99: Engineering Graduate Committee for Fluids, Thermal and Chemical Processes
31. 1994-95: Mechanical Engineering Committee
32. 1994-96: Freshman Engineering Counseling
33. 1994-2000: The Graduate School Citation Committee
33. 1995-97: Sophomore Engineering Counseling
34. 1996-97: Fluids and Thermal Undergraduate Engineering Laboratory Committee Chair
35. 1997: Faculty host to R.F. Probstein, NAE and spouse for Honorary Degree and other ceremonies 12-15 September 1997
36. 1996-98: Engineering Sesquicentennial Celebration Awards and Colloquium Subcommittee
37. 1997-98: Freshman Engineering Counseling (8 counselees)
38. 1998-99: Freshman Engineering Counseling (8 counselees)
Sophomore Engineering Counseling (7 counselees)
39. 1998-99: Fluid, Thermal and Chemical Processes Search Committee
40. 1999-00: Sophomore Counseling (6 counselees)
41. 1999-00: Fluids, Thermal and Chemical Processes Seminar chair
42. 2001-03: Fluids, Thermal and Chemical Processes Seminar chair
43. 2001-03: Freshman Counseling (7 counselees each year)
44. 2002-04: sophomore Counseling (4 and 3 counselees)
45. 2003-06: Faculty Committee on Honorary Degrees
46. 2004-05: Freshman advisor (7 counselees)
47. 2005-06: Freshman advisor (7 counselees)
48. 2006-07: Freshman advisor (7 counselees)
49. 2008-09: Freshman advisor (5 counselees)
Sophomore advisor (1 advisee)
50. 2009-10: Sophomore advisor (5 advisees)
Fluids, Thermal and Chemical Processes Seminar chair
51. 2010-11: Freshman advisor (7 advisees)
Engineering study-abroad liaison
52. 2011-12: Freshman advisor (7 advisees)
Sophomore advisor (1 advisee)
Engineering study-abroad liaison
53. 2012-15: School of Engineering study-abroad liaison
54. 2013-15: School of Engineering Library liaison
55. 2014-: Honorary Degrees Committee

(ii) service to the profession:

1. 1968: Chair, American Institute of Aeronautics and Astronautics Northeast Regional Student Paper Competition Conference, held at Brown University, 3-4 May
2. 1978: Panel member, National Science Foundation, Fluid Mechanics Research Initiation Grant Panel
3. 1978-83: The Theodore von Kármán Professorship Committee, California Institute of Technology
4. 1981: Panel Member, National Science Foundation, Fluid Mechanics Research Initiation Grant Panel

5. 1983: Panel member, National Science Foundation, Presidential Young Investigators Award Panel
6. 1981-83: Turbulence Committee, Society of Engineering Science
7. 1984: Chair, 37th Division of Fluid Dynamics Annual Meeting, American Physical Society, held at Brown University and at the Biltmore, 17-20 November
8. 1985-86: Otto Laporte Lectureship Committee (Chair in 1986), American Physical Society (Lectureship awarded to J.T. Stuart, FRS 1987)
9. 1986-89: DARPA/University Research Initiative-Naval Laboratories Liaison Committee
10. 1986: Co-Chair, DARPA/University Research Initiative 1st Meeting on Turbulent Flow in Fluid Dynamics, held at Brown University, 29-30 September
11. 1986-93: Associate Editor, ASME Journal of Applied Mechanics
12. 1987-90: Editorial Board, International Journal of Engineering Science
13. 1988-89: Fluid Dynamics Prize Committee, American Physical Society, Vice Chair in 1988, Chair in 1989 (Prize awarded to W. Wilmarth 1989, J.L. Lumley 1990).
14. 1990: Member, National Science Foundation, Computational Systems Research Grant Panel
15. 1994: Member, EUROMECH-327 Scientific Committee, Conference on Effects of Organized Vortex Motion on Heat and Mass Transfer, Institute of Hydromechanics, Ukrainian Academy of Sciences, Kiev, 24-26 August
16. 1994, 1997 invited Member of the Jury, Thèse de Doctorat: ESPCI, Paris in 1994 and ISITEM, Université de Nantes in 1997
17. 1996: Member, National Science Foundation, Division of Chemical and Transport Systems Career Proposal Review Panel
18. 1996-2000: Member, American Society of Mechanical Engineering, Heat Transfer Education Committee
19. 1996: Member, Scientific Committee, International Conference on Fluid Mechanics and Propulsion, Cairo, 29-31 December
20. 1998: International Scientific Committee, 7th International Symposium on Flow Modeling and Turbulence Measurements, Tainan, 5-8 October
21. 1999-2002: Division of Fluid Dynamics Nomination Committee, American Physical Society
22. 2000: Organizing Committee, International Conference on Organized Vortices as a Basis for Boundary Layer Control, Institute of Hydromechanics, Ukrainian Academy of Sciences, Kiev, 20-23 September
23. 2005: Member, Scientific Committee, 8th International Conference on Fluid Dynamics and Propulsion (ICFDP8), Sharm El-Sheikh, Sinai, Egypt, 14-17 December 2006
24. 2005- 2010: Editorial Board, UK Royal Society: Proc. Royal Soc. A
25. 2011-2013 : Editorial Board, UK Royal Society: Phil. Trans. Royal Soc. A
26. 2014-16: Editorial Board, UK Royal Society: Phil. Trans. Royal Soc. A
27. 2013-15: UK Royal Society Editorial Committee for 350th Anniversary issue of Phil. Trans. Royal Soc. A

Other services to the profession:

Journal Refereeing: Physics of Fluids, Journal of Fluid Mech., Journal of Applied Mechanics, American Institute of Aeronautics and Astronautics Journal, Chemical Engineering Communications, International Journal of Engineering Science, Experiment in Fluids

Proposals reviews: Army Research Office, U.S.-Israel Foundation, U.S.-former Soviet Union Research Cooperative support agencies, National Science Foundation

recent Conference Session Chairing: (15 since 1987):

Session on Convective Heat Transfer, 4th Int. Conference on Computational Heat and Mass Transfer, Paris-Cachan, France, May 17-20, 2005

Session on Boundary Layer Instabilities II, 58th Annual Division of Fluid Dynamics Meeting, American Physical Society, Chicago, IL, 20-22 November 2005

Session on Shear Layer Instabilities, 59th Annual Division of Fluid Dynamics Meeting, American Physical Society, Tampa Bay, FL, 19-21 November 2006

(iii) service to the community

Served a consultant to local and other industries, firms and laboratories, some involving environmental issues:

1. 1966-68, 1969-70: AVCO Space Systems Division, Wilmington, MA, on re-entry wake observable
2. 1976: Miller Electric Co., Woonsocket, RI, on abatement of noise from wire-bunching machines
3. 1982: Novogroski, Neal and Noel, Ltd., Providence, RI, on the noise emission from a roller skating rink and its abatement
4. 1984: Bostitch Division of Textron, East Greenwich, RI, on compressed-air nail gun response
5. 1989: Hinckley, Allen, Snyder and Comen, Providence, RI, on a toxic waste combustor residence time and response
6. 1990: Textron Defense Systems, Wilmington, MA, on transition from laminar to turbulent flow on the hypersonic aerospace-plane configuration
7. 1991-92: Institute for Computation in Mechanics and Propulsion, NASA Lewis Research Center, on fluid mechanics and thermodynamics of flow in propulsion systems
8. 1995-2003: informal participation, with spouse, in hosting international visitors and scholars and in other activities of the International House

8. ACADEMIC HONORS, RESEARCH GRANTS, FELLOWSHIPS, HONORARY SOCIETIES

- 1958: Institute of Aeronautical Sciences, Southwest Regional Student Paper Competition, Texas Section, Graduate Division 1st Prize
- 1958: Institute of Aeronautical Sciences, Minta Martin National Award, Graduate Division 1st Prize
- 1960: Society of the Sigma Xi, elected to membership
- 1979-80: United Kingdom Science Research Council Visiting Fellowship
- 1984: American Institute of Aeronautics and Astronautics, elected Associate Fellow
- 1984-85 & 1986-87: Executive Committee, Division of Fluid Dynamics, American Physical Society
- 1984: Fellow, American Physical Society
- 1987-88: United Kingdom Science and Engineering Research Council Visiting Fellowship
- 1997: Distinguished Lectureship, the Ohio Aerospace Institute and NASA Lewis Research Center
- 2005-10: Royal Society (U.K.) Editorial Board, A-side Proceedings (Mathematics, Physical and Engineering Sciences).
- 2011-16: Royal Society (U.K.), Editorial Board, A-side Philosophical Transactions (Mathematics, Physical and Engineering Sciences).
- 2014-15 U.K. Royal Society Editorial Committee, *350th Anniversary Issue of Philosophical Transactions A*.

RESEARCH GRANTS

1. "Wake instability, breakdown and transition", NSF Fluid Mechanics Program, Grant GK-10009, 1 June 1969-31 August 1974. \$100,200
2. "Internal wave development", ONR, Fluid Dynamics Program, Contract N00014-67-A-0191-0022, 1 September 1971-30 August 1975. \$96,375
3. "Investigations of the large-scale wavelike eddies and their near and far jet noise field", NASA Langley Research Center, Grant NSG-1076, 1 October 1973-30 September 1976. \$76,000
4. "Shear flow instability, breakdown and transition", NSF, Fluid Mechanics Program, Grant ENG73-04104, 1 September 1974-28 February 1977. \$62,500
5. "Internal Wave development", ONR, Fluid Dynamics Program, Contract N00014-76-C-0363, 1 September 1975-29 February 1980. \$121,500
6. "Shear flow instabilities", NSF, Fluid Mechanics Program, Grant ENG76-24585, 15 March 1977-15 March 1979. \$70,000
7. "Studies of shear flow instabilities", NSF, Fluid Mechanics Program, continuing Grant MEA78-22127, 15 March-31 May 1984. \$285,463
8. "Internal Wave development", ONR, Fluid Dynamics Program, Contract N00014-76-C-0363, 1 March 1980-31 May 1984. \$215,000

9. "Studies of turbulent eddy structures relevant to jet noise", NASA Langley Research Center, Grant NAG1-379, 1 July 1983-15 October 1985. \$106,500
10. "Studies of shear flow instabilities", NSF, Fluid Mechanics Program, continuing Grant MSM83-20307, 15 June 1985-30 September 1989. \$176,330
11. "Turbulent shear flows and their control", NASA Lewis Research Center, Grant NAG3-673, 15 December 1985-14 December 1988. \$130,000
12. "Linear and nonlinear problems in hydrodynamic stability", NSF U.S.-China Cooperative Research Program, Grant INT85-12196, 1 January 1986-31 August 1989. \$21,988
13. "Nonlinear hydrodynamic stability and applications", NATO Research Grant 343/85, joint with J. T. Stuart, administered at Imperial College, London, 1 July 1985-30 June 1991. \$9,670
14. "Analysis, prediction and control of turbulent flows", DARPA/University Research Initiative, Applied and Computational Mathematics Program, joint with Applied Mathematics and the Center for Fluid Mechanics, Turbulence and Computation, administered in the Division of Applied Mathematics, 15 September 1989-21 October 1991. \$7,000,000+
15. "Studies of turbulent shear flows and their control", NASA Lewis Research Center, Grant NAG3-1016, 23 February 1989-21 October 1992. \$120,000
16. "Studies of nonlinear instabilities of developing wake flows behind bluff bodies and their control", ONR, Fluid Dynamics Program, Grant N00014-90-J-1430, 15 December 1989-30 June 1993. \$294,432
17. "Mixing enhancement in high speed jet flows through nonlinear multiple-frequency mode interactions", NASA Lewis Research Center, continuing Grant NAG3-1484, 26 April 1993-30 June 1997. \$220,200
18. "Study of the instability to Görtler vortices of the supersonic turbulent boundary layer on a concave wall", NASA Lewis Research Center, Grant NAG3-2067, 1 June 1997-30 September 1997. \$40,000
19. "Effect of longitudinal vortices on heat transfer enhancement", NSF, Thermal Systems Program and U.S.-Egypt Cooperative Research Program, Grant INT96-02043, 15 July 1996-30 June 2000. \$29,231

9. TEACHING

- 1999-00: Semester I: Engineering 170. Applied Thermodynamics (9 students)
Engineering 195. Independent Studies in Engineering: Development of a heat exchanger laboratory experiment (1)
Semester II: Engineering 171. Heat and Mass Transfer (20)
Engineering 194X. Vehicle Design: a trans-Pacific hypersonic business jet (5)
Engineering 196. Independent Studies in Engineering: Development of a Heat Exchanger Laboratory Experiment (1)
- 2000-01: Sabbatical leave
- 2001-02: Semester I: Engineering 170. Applied Thermodynamics (3)
Semester II: Engineering 171. Heat and Mass Transfer (12)
Engineering 282 (Appl. Maths. 242): Fluid Mechanics II (3)
- 2002-03: Semester I: Engineering 170. Applied Thermodynamics (3)
Semester II: Engineering 171. Heat and Mass Transfer (11)
Engineering 282 (Appl. Maths. 242): Fluid Mechanics II (9)
- 2003-04: Semester I: Engineering 186 Advanced Fluid Mechanics (7)
Semester II: Engineering 171 Heat and Mass Transfer (7)
- 2004-05: Semester I: Engineering 186 Advanced Fluid Mechanics (1)
Engineering 170 Heat and Mass Transfer (4)
Semester II: Engineering 171 Heat and Mass Transfer (16)
- 2005-06: Semester I: Engineering 170 Applied Thermodynamics (12)
Semester II: Engineering 171 Heat and Mass Transfer (12)
Engineering 282 (Appl. Maths. 242): Fluid Mechanics II (5)
- 2006-07: Semester I: Engineering 81 Fluid Mechanics (50+)
Engineering 195 Independent Studies in Engineering: Design of a Hydraulic channel for Supersonic Flow Simulation (1)
Semester II: Engineering 04 , Dynamics, 2 recitation sections, full participation in course (50+ recitation sections, 120+ course)
Engineering 196 Independent Studies in Engineering: Fabrication of Hydraulic channel for Supersonic Flow Simulation (1)

Engineering 282 & Appl. Maths. 242: Fluid Mechanics II (2)

Engineering 196 Nitrous Oxide burner, ex-officio advisor, (about 5+)

- 2007-08: Sabbatical leave
- 2008-09: Semester I: Engineering 170 Applied Thermodynamics (12)
Semester II: Engineering 186 Advanced Fluid Mechanics (19)
- 2009-10 Semester I: Engineering 170 Applied Thermodynamics (10)
Semester II: Engineering 186 Advanced Fluid Mechanics (16)
- 2010-11: Semester I: Engineering 170 Applied Thermodynamics (13)
Semester II: Engineering 186 Advanced Fluid mechanics (22)
- 2011-12: Semester I: Engineering 170 Applied Thermodynamics (16)
Semester II: Sabbatical leave
- 2012-13: Semester I: Engineering 1700 Applied Thermodynamics (11)
Engineering 2010 Mathematical Methods in Engineering & Physics (43)
Semester II: Engineering 1860 Advanced Fluid Mechanics (18)
- 2013-14: Semester I: Engineering 1700 Jet Engines and Aerospace Propulsion (9)
Engineering 2010 Mathematical Methods in Engineering & Physics (27)
Semester II: Engineering 2760 Heat and Mass Transfer (12)
- 2014-15: Semester I: Engineering 1700 Jet Engines and Aerospace Propulsion (13)
Semester II: Engineering 1860 Advanced Fluid Mechanics (14)
Engineering 2760 Heat and Mass Transfer (5)
- 2015-16: Semester I: Sabbatical leave
Engineering 2760 Heat and Mass Transfer

Graduate Students: 2012-13 (visiting Ph.D. student, U. San Paulo at San Carlos, Brazil)

Honors theses directed: 1997: 1, 2000: 1

Postdoctoral fellow: 1974-76: 1, 1994-96: 1

ScM thesis directed, completed in: 1968: 1, 1975:2, 1980:1, 1982:1

Ph.D. theses directed, completed in: 1974: 2, 1979: 1, 1980: 1, 1987: 2, 1992: 1, 1994: 2, 2000: 1

Collaborated with Graduate (4), Undergrad (1) Students on joint paper, 2015 (accepted for presentation at www.mnf2016.com, manuscript under preparation)

9. date of preparation: 28 January 2016