

A Thirteenth Successful Year for *JTHT*

SUPPORT from the thermophysics and heat transfer community for the *Journal of Thermophysics and Heat Transfer (JTHT)* continues to be good. The number of submissions for this year has increased over that of last year. Between 31 October 1998 and 1 November 1999, 144 papers were submitted to *JTHT*, with 50% originating from technical meetings. During this same time period, over 310 reviews were completed by volunteers to ensure the quality of *JTHT*. The average time between the receipt of a manuscript and the Associate Editor's decision to accept or revise was 3.5 months for the papers appearing in 1999. The average time between final acceptance and publication was 4.9 months. The total number of pages was 564, and all four issues of volume 13 were on schedule.

A Full-Spectrum Publication

It should be reemphasized that *JTHT* is a full-spectrum publication in the field of thermophysics and heat transfer, a breadth illustrated by the following list of pertinent topics:

Aerothermodynamics

Reentry
Thermal protection
Low density
Laser interaction
Ablation
Plumes
Computational

Radiative Heat Transfer

Surface interchange
Absorbing-emitting media
Multiple scattering
Nongray analysis
Multidimensional
Coupled with conduction
Coupled with convection

Thermal Control

Heat pipes
Thermal modeling
Electronics cooling
Large space structures
Contamination
Cryogenics
Insulation

Conduction/Phase Change

Contact conductance
Composite materials
Inverse problems
Conjugate problems
Nonlinear problems
Analytical techniques
Melting/solidification

Nonintrusive Diagnostics

IR signatures
Remote sensing
Laser techniques
Particle sizing
Scattering techniques

Convective Heat Transfer

Forced convection
Natural convection
Mixed convection
Internal/external flows
Boiling/condensation

Thermophysical Properties

Thermodynamic
Transport
Optical/radiative

Numerical Heat Transfer

Finite difference
Finite element
Parallel processing

A discipline-oriented publication, *JTHT* presents both original contributions of a fundamental nature and application-type papers. Analytical, numerical, and experimental approaches are all encouraged. Papers on the topics of aerothermodynamics, thermal control, and numerical heat transfer are especially encouraged. Although *JTHT* is published by AIAA, papers are not restricted to aerospace topics. Authors from the international thermophysics and heat transfer community are invited to submit papers.

Accuracy and Ethics

The AIAA Publications Committee approved the following: "The AIAA journals will not accept for publication any paper reporting (1) numerical solutions of an engineering problem that fails to adequately address accuracy of the computed results or (2) experimental

results unless the accuracy of the data is adequately presented." The purpose of this statement is to reiterate the desire to have high-quality investigations with properly documented results published in the AIAA journals and to clarify acceptable standards for presentation of numerical and experimental results. The editors and reviewers will remain the final judges. An ethical standards document was also approved by the Publications Committee and is reproduced in its entirety elsewhere in this issue. Prospective authors and reviewers are encouraged to study it carefully.

Manuscript Disks

Authors are requested to prepare their manuscripts electronically to reduce publication delays. Conversion of disks directly to type helps to avoid rekeyboarding and subsequent introduction of errors. Examples of easily converted software programs include TeX and LaTeX. Please retain the disk until the review process has been completed and final revisions have been incorporated into your paper.

1999 AIAA Thermophysics Award Recipient

Dr. Hassan A. Hassan, Professor of Mechanical and Aerospace



Engineering at North Carolina State University, was selected as the 1999 recipient of the AIAA Thermophysics Award. Dr. Hassan was chosen for his contributions to improving physical models in direct simulation Monte Carlo methods and hybrid Monte Carlo/Navier-Stokes solvers and for the development of a transition/turbulence model for the prediction of the onset and extent of transition on flight vehicles. The AIAA

Thermophysics Award is presented for an outstanding singular or sustained technical or scientific contribution by an individual in thermophysics, specifically as related to the properties and mechanisms involved in thermal energy transfer and the study of environmental effects on such properties and mechanisms. This award was presented to him at the AIAA Thermophysics Conference in June at Norfolk, Virginia.

2000 Editorial Team

The editorial team includes Associate Editors and members of the Editorial Advisory Board. The Associate Editors are responsible for the technical evaluation of manuscripts, and the burden of maintaining quality rests predominantly with them. Photographs and biographies of the 2000 team are included in this issue. I encourage you to discuss your views of *JTHT* with members of the editorial team.

Appreciation

I would like to express my personal thanks to the authors who have chosen *JTHT* as the vehicle for their research work. I also want to thank the reviewers who have contributed their time to ensure the success of *JTHT*. Their names are listed in this issue. Finally, I would like to express my appreciation to Deanna Miller (Managing Editor), Carol Neff (TechBooks), and Norma Brennan (Director of Publications) for their help in keeping *JTHT* on schedule.

Alfred L. Crosbie
Editor-in-Chief

Editor-in-Chief



ALFRED L. CROSBIE, Curators' Professor of Mechanical Engineering at the University of Missouri-Rolla, received his B.S. from the University of Oklahoma in 1964, his M.S. in 1966, and his Ph.D. in 1969 from Purdue University, all in mechanical engineering. He joined the faculty of the University of Missouri-Rolla in 1968, where he was promoted to Professor in 1975. He has been an active researcher in the field of radiative heat transfer since 1964. His current research interests include multidimensional radiative heat transfer, multiple scattering, numerical heat transfer, and laser interaction. Dr. Crosbie has served as a member of the AIAA Thermophysics Technical Committee (1976–78), Technical Program Chairman for the AIAA 15th Thermophysics Conference (1980), Editor of two thermophysics volumes in the AIAA Progress in Astronautics and Aeronautics book series (1981), Associate Editor for the *AIAA Journal* (1981–83), and Chairman of the AIAA Thermophysics Technical Committee (1984–86). He is a Fellow of AIAA, AAAS, and ASME, a recipient of the AIAA Thermophysics Award (1987) and the ASME Heat Transfer Memorial Award (1990), and an Associate Editor for the *Journal of Quantitative Spectroscopy and Radiative Transfer* (1979–99). He is a member of the Editorial Advisory Board for *Heat Transfer—Recent Contents*. Dr. Crosbie is the author or coauthor of over 75 papers in archival journals.

Associate Editors



RICHARD O. BUCKIUS, Professor of Mechanical Engineering and Head of the Department of Mechanical and Industrial Engineering at the University of Illinois at Urbana-Champaign (UIUC), received his B.S. in 1972, M.S. in 1973, and Ph.D. in 1975 from the University of California, Berkeley, all in mechanical engineering. He joined the faculty of UIUC in 1975, where he was promoted to Professor in 1984. He served as Program Director of the Thermal Systems and Engineering Program at the National Science Foundation (1987–88). His research interests include radiative heat transfer, Monte Carlo methods in scattering media, and scattering from rough interfaces. Dr. Buckius was a member of the AIAA Thermophysics Technical Committee (1984–87), Technical Program Chair of the AIAA 22nd Thermophysics Conference (1987), and an Associate Technical Editor of the ASME *Journal of Heat Transfer* (1987–92). He is a Fellow of ASME and an Associate Fellow of AIAA. He is a member of the Editorial Advisory Board of *Microscale Thermophysical Engineering*, *Heat Transfer Research*, and *Heat Transfer—Japanese Research*. He is author or coauthor of over 80 papers in archival journals and a textbook on thermodynamics.



TA-SHEN CHEN, Curators' Professor of Mechanical Engineering at the University of Missouri-Rolla, received his B.S. from National Taiwan University in 1954, his M.S. from Kansas State University in 1961, and his Ph.D. from the University of Minnesota in 1966, all in mechanical engineering. He joined the faculty of the University of Missouri-Rolla in 1967, where he was promoted to Professor in 1973 and to Curators' Professor in 1991. His recent research centers on natural convection, mixed convection, heat transfer in separated flows, heat transfer in filmwise condensation, heat transfer in porous media, and wave and thermal instability of convective flows. Dr. Chen was a member of the AIAA Thermophysics Technical Committee (1986–88) and is a Fellow of ASME and an Associate Fellow of AIAA. He is the author or coauthor of over 120 journal articles and 60 technical papers. He has also contributed a chapter each to the *Handbook of Single-Phase Convective Heat Transfer* and the *Handbook of Numerical Heat Transfer*.



PING CHENG, Professor and Head of Mechanical Engineering at the Hong Kong University of Science and Technology (HKUST), received his B.S. in mechanical engineering from Oklahoma State University in 1958, his M.S. in mechanical engineering from the Massachusetts Institute of Technology in 1960, and his Ph.D. in aeronautics and astronautics from Stanford University in 1965. Before joining HKUST in 1995, he held positions at New York University (1965–67), NASA Ames Research Center (1967–68), National Taiwan University (1968–70), and the University of Hawaii (1970–94). His recent research centers on convection, boiling and condensation in porous media, and reciprocating flow and oscillatory heat transfer. Dr. Cheng was a member of the AIAA Thermophysics Technical Committee (1988–89) and is a Fellow of ASME and Associate Fellow of AIAA. He is the author or coauthor of over 135 publications. He has also contributed chapters on heat transfer in geothermal systems and porous media to *Advances in Heat Transfer* and the *Handbook of Heat Transfer Applications*. He is a member of the editorial board of the *International Journal of Heat and Mass Transfer*, *Numerical Heat Transfer*, *Experimental Heat Transfer*, *Journal of Porous Media*, and *Revue Générale de Thermique*. He is a recipient of the ASME Heat Transfer Memorial Award (1996).



RONALD L. DOUGHERTY, Professor and Chair of Mechanical Engineering at the University of Kansas (KU), received his B.S. in 1972, M.S. in 1974, and Ph.D. in 1978 from the University of Missouri-Rolla, all in mechanical engineering. Before joining KU in 1999, he held positions at Pratt-Whitney Aircraft (1978–83), Terra Tek, Inc. (1983–85), and Oklahoma State University (1985–99). His recent research centers on radiative transfer in participating media, dynamic light scattering/photon spectroscopy, and particle characterization by nonintrusive laser diagnostics. Dr. Dougherty was a member of the AIAA Thermophysics Technical Committee (1986–89), Thermophysics Technical Program Chair at the AIAA 30th Aerospace Sciences Meeting (1992), and Chair of the Oklahoma Section of AIAA (1995–96). He has been a member of the ASME Heat Transfer Division's committee on Theory and Fundamental Research since 1993. He has chaired 10 thermophysics sessions at AIAA meetings. He is the author or coauthor of over 40 publications.



GEORGE P. "BUD" PETERSON, Associate Vice Chancellor and Executive Associate Dean of Engineering at Texas A&M University, received his B.S. in mechanical engineering in 1975, his B.S. in mathematics in 1977, and his M.S. in engineering in 1980, all from Kansas State University, and his Ph.D. in mechanical engineering from Texas A&M University in 1981. He joined the faculty of Texas A&M University in 1981, where he was promoted to Professor in 1990, Tenneco Professor in 1991, and Head of Mechanical Engineering in 1993. He served as Program Director of Thermal Transport and Thermal Processing at the National Science Foundation (1993–94). His research interests include phase change heat transfer, thermal control, conduction, and thermal contact resistance. He was a member of the AIAA Thermophysics Technical Committee (1986–89) and AIAA representative to the National Heat Transfer Conference (1990–93). He was an Associate Editor of the *Journal of Energy Resources Technology* (1986–92) and Editor of *Heat Transfer—Recent Contents* (1992–95). He is an Editor for *Experimental and Fluid Sciences* and *Microscale Thermophysical Engineering* and an Associate Editor for the *Journal of Heat Transfer* and the *Journal of Heat and Fluid Flow*. Dr. Peterson is a Fellow of ASME and AIAA and a recipient of the AIAA Award for Best Technical Paper in Thermophysics (1991) and of the AIAA Thermophysics Award (1996). He is the author or coauthor of over 125 papers in archival journals, seven book chapters, and a textbook on heat pipes.



ALLIE M. SMITH, Dean of Engineering and Professor of Mechanical Engineering at the University of Mississippi, received his B.S. in mechanical engineering from North Carolina State University in 1956 and his M.S. in 1961 and his Ph.D. in 1966 from North Carolina State University in mechanical and aerospace engineering. Before joining the University of Mississippi in 1979, he worked for ARO for 14 years as a thermal physics supervisor and as a research manager. His research work has been in the area of radiative heat transfer, particularly the experimental and theoretical understanding of cryodeposits. Dr. Smith has been active in the AIAA thermophysics community: member of the AIAA Thermophysics Technical Committee (1973–75, 1985–88), Chairman of the AIAA Thermophysics Technical Committee (1976–77), and General Chairman of the 10th AIAA Thermophysics Conference (1975). He served as an Associate Editor of the *AIAA Journal* (1975–77), Editor for two thermophysics volumes in the AIAA Progress in Astronautics and Aeronautics book series (1976, 1977), General Chairman of the 17th Aerospace Sciences Meeting (1979), and Chairman of the AIAA Terrestrial Energy Systems Committee (1981–82). Dr. Smith is a Fellow of AIAA and ASME and recipient of the AIAA Thermophysics Award (1978) and the AIAA Hermann Oberth Award (1985). He is the author or coauthor of over 75 publications.

Editorial Advisory Board



DONALD K. EDWARDS, Professor Emeritus of Mechanical Engineering at the University of California, Irvine (UCI), received his B.S. in 1954, M.S. in 1956, and Ph.D. in 1959 from the University of California, Berkeley, all in mechanical engineering. In 1959 he joined the faculty of the University of California, Los Angeles, where he was promoted to Professor in 1968 and served as Chairman of Chemical, Nuclear, and Thermal Engineering (1975–78). At UCI he served as chairman of Mechanical Engineering and Associate Dean of Engineering before retiring in 1991. He received the ASME Heat Transfer Division's Memorial Award (1973) and was the first recipient of the AIAA Thermophysics Award (1976). He was a Technical Editor for the *Journal of Heat Transfer* (1975–81) and an Associate Editor for the *International Journal of Solar Energy* (1983–85). He is a Fellow of AIAA and ASME and a member of the Editorial Advisory Board for the *International Journal of Heat and Mass Transfer*.



JOHN T. HOWE, Consultant at ELORET Thermal Sciences, received his B.S. from the University of Michigan in 1950 and his M.S. in 1956 and the degree of Engineer in 1958 from Stanford University, all in engineering mechanics. He has been visiting scholar, text author, and lecturer for "Hypervelocity Atmospheric Flight and Real Gas Phenomena" at Stanford University. During his 41 years with NASA, he has held numerous technical managerial positions at Ames Research Center and NASA Headquarters, including Chief Scientist and member of the Management Council at NASA Ames Research Center (1991–1998). He is known for his pioneering research contributions to the aerothermodynamics of planetary atmospheric entry, including radiative energy transfer, reactive gas flows, and innovative thermal protection systems. He led the supporting research effort for the Galileo Probe Entry into the Jupiter Atmosphere in 1995—100-fold more severe than the Apollo Entry—for which he received the NASA Outstanding Leadership Medal (1996). He is active in analysis and experimental research on ocean upwelling along the west coast of North America. He was a member of the AIAA Thermophysics Technical Committee (1982–84) and an Associate Editor of the *Journal of Spacecraft and Rockets* (1982–84). He is a recipient of the AIAA Thermophysics Award (1986) and is a Fellow of AIAA.



TOM J. LOVE, George Lynn Cross Professor Emeritus of Aerospace, Mechanical, and Nuclear Engineering and Halliburton Professor of Engineering at the University of Oklahoma, received his B.S. from the University of Oklahoma in 1948, his M.S. from the University of Kansas in 1956, and his Ph.D. from Purdue University in 1963, all in mechanical engineering. In 1956 he joined the faculty of the University of Oklahoma, where he was promoted to Professor (1965) and served as Director of the School of Aerospace, Mechanical, and Nuclear Engineering (1963–72). He was a member of the AIAA Thermophysics Technical Committee (1970–72), an Associate Editor for the *AIAA Journal* (1972–75), and an Associate Editor for the *ASME Journal of Bioengineering* (1976–79). He is a Fellow of AIAA and ASME. Dr. Love is a recipient of the AIAA Thermophysics Award (1984) and of the ASME Memorial Heat Transfer Award (1989).



JAMES N. MOSS, Senior Research Engineer for Aerothermodynamics at the NASA Langley Research Center, received his B.S. in engineering science from the Tennessee Polytechnic Institute in 1962, his M.S. in aerospace engineering from the University of Virginia in 1968, and his Ph.D. in aerospace engineering from Virginia Polytechnic Institute and State University in 1972. He also received an M.S. in engineering administration in 1988 from George Washington University. Dr. Moss joined NASA in 1962, where his early research assignments dealt with ablating systems. His current research concerns transitional and rarefied flows. Dr. Moss has been active in the AIAA thermophysics community: member of the AIAA Thermophysics Technical Committee (1978–80), Technical Program Chairman of the 16th AIAA Thermophysics Conference (1981), General Program Chairman of the 20th AIAA Thermophysics Conference (1985), Co-Editor of a thermophysics volume in the AIAA Progress in Astronautics and Aeronautics book series (1986), Chairman of the AIAA Thermophysics Technical Committee (1986–88), and Associate Editor of the *Journal of Thermophysics and Heat Transfer* (1986–89). He is a Fellow of AIAA and a member of the International Advisory Committee on Rarefied Gas Dynamics. Dr. Moss is a recipient of the AIAA Thermophysics Award (1989) and the NASA Exceptional Engineering Achievement Medal (1990).



ROBERT SIEGEL, Heat Transfer Consultant, received his B.S. in 1950 and M.S. in 1951 from the Case Institute of Technology and his Sc.D. from the Massachusetts Institute of Technology in 1953, all in mechanical engineering. He worked at NASA John H. Glenn Research Center at Lewis Field from 1955 to 1999 and became a Senior Research Scientist. Before joining NASA, he worked for General Electric as a heat transfer engineer and analyst. He has been an active researcher in heat transfer since 1950. The majority of his research is in radiative heat transfer, reduced-gravity boiling, transient convection, and solidification. He invented the first drop tower. He served as an Associate Technical Editor for the *Journal of Heat Transfer* (1973–83) and an Associate Editor of the *Journal of Thermophysics and Heat Transfer* (1986–98). Dr. Siegel is a Fellow of AIAA and ASME and a member of the Honorary Advisory Boards of the *International Journal of Heat and Mass Transfer* and *International Communications in Heat and Mass Transfer*. He is the recipient of the ASME Heat Transfer Division's Memorial Award (1970), the NASA Exceptional Scientific Achievement Award (1986), a Space Act Award (1993), the AIAA Thermophysics Award (1993), and the ASME/AICHE Max Jakob Memorial Award (1996).



CHANG-LIN TIEN, NEC Distinguished Professor of Engineering at the University of California, Berkeley, received his B.S. from National Taiwan University in 1955, his M.M.E. from the University of Louisville in 1957, and his M.A. and Ph.D. in 1959 from Princeton University. He joined the University of California, Berkeley, in 1959, where he was promoted to Professor in 1968 and was appointed A. Martin Berlin Chair Professor in 1987. He served as Chairman of Mechanical Engineering (1974–81), as Vice Chancellor-Research (1983–85), and as Chancellor (1990–97). He also served as Executive Vice Chancellor and Distinguished Professor at the University of California, Irvine (1988–90). He was a member of the AIAA Thermophysics Technical Committee (1970–72), General Chairman of the 7th AIAA Thermophysics Conference (1972), General Chairman of the AIAA 12th Aerospace Sciences Meeting (1974), Editor of a volume in the AIAA Progress in Astronautics and Aeronautics book series (1973), and an Associate Editor for the *Journal of Quantitative Spectroscopy and Radiative Transfer* (1971–92). He is a recipient of the ASME Heat Transfer Division's Memorial Award (1974), the AIAA Thermophysics Award (1977), and the ASME/AlChE Max Jakob Memorial Award (1981). He is a recipient of many honorary doctoral degrees from universities in the United States and abroad. He is an AIAA Fellow, an ASME Honorary Member, and a member of the National Academy of Engineering. He is Editor of the *Annual Review of Heat Transfer*, Editor for the *International Journal of Heat and Mass Transfer*, and Editor-in-Chief of *Experimental Heat Transfer* and of *Microscale Thermophysical Engineering*.



RAYMOND VISKANTA, W.F.M. Goss Distinguished Professor of Engineering at Purdue University, received his B.S. from the University of Illinois in 1955, and his M.S. in 1956 and Ph.D. in 1960 from Purdue University, all in mechanical engineering. After a brief period with Argonne National Laboratory, he joined the faculty of Purdue University, where he was promoted to Professor in 1966. He was a member of the AIAA Thermophysics Technical Committee (1972–75), General Chairman of the 2nd AIAA/ASME Thermophysics and Heat Transfer Conference (1978), and Editor of two volumes in the AIAA Progress in Astronautics and Aeronautics book series (1979). He is a recipient of the ASME Heat Transfer Division's Memorial Award (1976), the AIAA Thermophysics Award (1979), the ASEE Senior Research Award (1984), the ASME/AlChE Max Jakob Memorial Award (1986), the ASME Melville Medal (1988), and the 1991 Nusselt-Reynolds Prize of the Assembly of World Conferences on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics. Dr. Viskanta is a Fellow of ASME and AIAA, a member of the National Academy of Engineering, a foreign member of the Academy of Engineering Sciences of the Russian Federation, and a Dr.-Ing. E.h. (Honorary Doctor of Engineering Degree) from Technical University of Munich. He was an Associate Editor for the *Journal of Quantitative Spectroscopy and Radiative Transfer* (1969–72), an Associate Technical Editor for the *Journal of Heat Transfer* (1981–87) and *Experimental Heat Transfer* (1987–90), and the Technical Editor of the ASME *Journal of Heat Transfer* (1990–95). He is a member of the Editorial Advisory Boards of the *International Journal of Heat and Mass Transfer*, *International Journal of Heat and Fluid Flow*, *Numerical Heat Transfer*, and *KSME International Journal* and is Chair of the Committee on Microgravity Research and member of the Space Studies Board of the National Research Council.



M. MICHAEL YOVANOVICH, Professor of Mechanical Engineering at the University of Waterloo, Ontario, Canada, received his B.S. from Queen's University in 1957, his M.S. from the State University of New York at Buffalo in 1963, and his M.E. and Sc.D. from the Massachusetts Institute of Technology in 1965 and 1967, respectively. After a brief period with the University of Poitiers in France, he joined the faculty of the University of Waterloo, where he was promoted to Professor in 1972. He was a member of the AIAA Thermophysics Technical Committee (1971–74, 85–88, 91–94), General Chairman of the first AIAA/ASME Thermophysics and Heat Transfer Conference (1974), and Editor of a thermophysics volume in the AIAA Progress in Astronautics and Aeronautics book series (1975). He is a recipient of the AIAA Thermophysics Award (1984) and the AIAA Award for Best Technical Paper in Thermophysics (1983 and 1994). Dr. Yovanovich is a fellow of AAAS, AIAA, and ASME. He was an Associate Technical Editor of the ASME *Journal of Heat Transfer* (1984–86) and Associate Senior Editor of the ASME *Journal of Electronic Packaging* (1988–93). He was a member of the Editorial Advisory Boards of the *Transactions of the Canadian Society of Mechanical Engineers* and the *International Journal of Heat and Fluid Flow*.