

A Decadal Assessment of Plasma Science

Committee

Mark J. Kushner

Co-Chair

MARK J. KUSHNER [NAE] is the George I. Haddad Collegiate Professor in the Electrical Engineering & Computer Science Department at the University of Michigan and also holds appointments as a professor in the Nuclear Engineering and Radiological Science Department, Chemical Engineering Department, and Applied Physics Program. He is also director of the Michigan Institute for Plasma Science and Engineering and the Department of Energy Center on Control of Plasma Kinetics. Prior to joining the faculty at the University of Michigan, Dr. Kushner was on faculty at Iowa State University (2005-2008), and the University of Illinois at Urbana-Champaign (1986-2004). He also has industrial and national laboratory experience, serving as a member of technical staff at Sandia National Laboratory and Lawrence Livermore National Laboratory (1980-1983), and as Principal Research Scientist at Spectra Technology (1983-1986). Dr. Kushner received his Ph.D in applied physics from the California Institute of Technology in 1979. Dr. Kushner's research interests are in low temperature plasmas, addressing the fundamental aspects of the generation and transport of charged and chemically reactive species in plasmas, their interactions with surfaces for materials modification, and the development of plasma-based equipment and devices. Much of the impact of such research is in a wide range of society-benefiting technologies. Dr. Kushner has received numerous awards and honors and has served on several National Academies' studies, including the last plasma science decadal survey.

Gary P. Zank

Co-Chair

GARY ZANK [NAS] is the director of the Center for Space Plasma and Aeronomic Research (CSPAR), University of Alabama Board of Trustees Trustee Professor and Aerojet/Rocketdyne Chair in Space Science, an Eminent Scholar and distinguished professor, and chair of the Department of Space Science (SPA) at the University of Alabama in Huntsville. Dr. Zank's research interests extend across space physics, plasma astrophysics, and plasma physics. Although his research is related primarily to theory, modeling, and simulations, Dr. Zank is involved in numerous experimental and observational programs. Some areas of research include the interaction of the solar wind with the partially ionized interstellar medium. He and colleagues introduced models that include the coupling of the partially ionized interstellar gas with heliospheric plasma, which led to the prediction and subsequent observation of the so-called hydrogen-wall. Dr. Zank received his Ph.D in applied mathematics from the University of Natal in South Africa in 1987. He has been recognized in his field through the receipt of numerous honors and awards throughout his career. In 2017, he was named the University of Alabama Board Of Trustees Trustee Professor, the first and only University of Alabama System faculty member to achieve this position. This appointment was, in part, in recognition of Dr Zank being elected in 2016 as a member of the National Academies of Sciences, Engineering, and Medicine – the only person in the University of Alabama System to be elected a member of the National Academies of Sciences, Engineering, and Medicine. He was recognized internationally in 2015 with the AOGS Axford Medal, the highest honor given by the Asia Oceania Geosciences Society (AOGS). Other awards include his being a fellow of the American Geophysical Union, the American Physical Society, and the American Association for the Advancement of Science. In 2017, he was also elected an AOGS Honorary Member and was chosen by the International Space Science Institute (ISSI) to be the 2017 Johannes Geiss Fellow. One of his publications has been recognized as one of the twelve “classic papers” ever published in the Journal of Plasma Physics. Dr. Zank has served on a number of National Academies' ad hoc and standing committees.

Amitava Bhattacharjee

Member

AMITAVA BHATTACHARJEE is Professor of Astrophysical Sciences and Head of the Theory Department of the Princeton Plasma Physics Laboratory. He also serves as co-director of the Princeton Center for Heliophysics. He received his Ph.D. at Princeton University (1981) in theoretical plasma physics from the Department of Astrophysical Sciences. He has taught previously at Columbia University (1984-93) in the Department of Applied Physics, at the University of Iowa (1993-2003) in the Department of Physics and Astronomy, and the University of New Hampshire (2003-12), where he served as Paul Professor of Space Science. At the University of Iowa, he received the James Van Allen Natural Sciences Fellowship (1996), the Faculty Scholar Award (1997-2000), and the Michael J. Brody Award (2003). He has served as senior editor of the Journal of Geophysical Research-Space Physics, as chair of the Division of Plasma Physics of the American Physical Society, and as founding chair of the Topical Group in Plasma Astrophysics of the American Physical Society, and on various prize and fellowship committees. He is a fellow of the American Physical Society, the American Association of the Advancement of Science, and the American Geophysical Union. His research interests include: magnetic reconnection, turbulence and singularity formation, kinetic theory, free-electron lasers, and complex (or dusty) plasmas. He and his students and postdoctoral colleagues have authored about 250 papers with broad applications to laboratory (including fusion), space and astrophysical plasmas.

Peter J. Bruggeman

Member

PETER J. BRUGGEMAN is a Professor of Mechanical Engineering and the director of the High Temperature and Plasma Laboratory at the University of Minnesota. His primary research interests are in low temperature plasmas including plasma-liquid interactions and non-equilibrium plasma kinetics and chemistry applied to plasma processes for environmental, biomedical and renewable energy technologies. Previously, Dr. Bruggeman was on the faculty of Eindhoven University of Technology (the Netherlands) in the department of Applied Physics. He is a recipient of several awards including the 2012 Hershkowitz Early Career Award, the 2013 International Union of Pure and Applied Physics Young Scientist Medal and Prize in Plasma Physics, the 2016 US Department of Energy Early Career Award and the 2018 Peter Mark Memorial Award of the American Vacuum Society. He earned his PhD from the University of Ghent, Belgium. He serves as section editor for plasmas and plasma-surface interactions of the Journal of Physics D: Applied Physics (Institute of Physics Publishing) and as elected member of the board of directors of the International Plasma Chemistry Society.

Troy Carter

Member

TROY CARTER is a Professor of Physics at the University of California, Los Angeles. Prof. Carter is the director of the Basic Plasma Science Facility (BaPSF), a national user facility for plasma science supported by DOE and NSF. He is also the director of the Plasma Science and Technology Institute (PSTI), and organized research unit at UCLA. His research focuses on experimental studies of fundamental processes in magnetized plasmas and is motivated by current issues in magnetic confinement fusion energy research and in space and astrophysical plasmas including magnetic reconnection, turbulence and transport in magnetized plasmas, and the nonlinear physics of Alfvén waves. He was a co-recipient of the 2002 APS Division of Plasma Physics Excellence in Plasma Physics Research Award and is a fellow of the American Physical Society. Prof. Carter received B.S. degrees in physics and nuclear engineering from North Carolina State University in 1995 and a Ph.D. in astrophysical sciences from Princeton University in 2001.

John Cary

Member

JOHN CARY is a professor of physics at the University of Colorado Boulder. Dr. Cary's research focuses on the discovery of new methods for accelerating charged particles, heating and transport of magnetically confined plasma, dense plasma focus, and advanced computation on new computer architectures. His interests are concentrated in beam/accelerator physics, plasma physics, nonlinear dynamics, and computational physics. Dr. Cary's accelerator/beam physics interests are currently in advanced accelerator concepts: the generation and use of large (10-100 GV/m) fields through laser-plasma interactions. His plasma physics interests are currently in the simulation of the nonlinear interactions of radio frequency electromagnetic fields with plasma as occurring in plasma heating. In recent years, he has devoted extensive effort to computational methods, including developing a new arbitrary-dimensional, parallel, hybrid, plasma simulation code, VORPAL. He received a Ph.D. and M.S. in physics at University of California Berkeley in 1978 and 1975 respectively, as well as a bachelors in physics at University of California Irvine in 1973.

Christine Coverdale

Member

CHRISTINE A. COVERDALE is a plasma physicist at Sandia National Laboratories. Dr. Coverdale joined Sandia in 1997 and in 2011 was named a distinguished member of the technical staff. She has been involved in a broad range of experiments at the Saturn and Z pulsed power facilities centered around nuclear weapons certification and other national security projects. She most recently worked on radiation detection systems and diagnostics to assess warm and hard X-rays from Z-pinch plasmas. Dr. Coverdale has a doctorate in plasma physics from the University of California, Davis, has authored or co-authored more than 120 papers, and regularly presents at conferences. She served three terms on the executive committee of the IEEE Plasma Science and Applications Committee and was technical program chair for the IEEE International Conference on Plasma Science in 2009, 2010, 2012, and 2015. She also served a four-year term on the IEEE Nuclear Plasma Sciences Society Administrative Committee. Dr. Coverdale was on the Executive Committee of the American Physical Society (APS) Division of Plasma Physics and is senior editor for High Energy Density Physics for IEEE Transactions on Plasma Science. She is a fellow of both the IEEE and APS.

Arati Dasgupta

Member

ARATI DASGUPTA is a senior research physicist at Naval Research Laboratory. Dr. Dasgupta is widely known for highly accurate calculations of the Dielectronic Recombination (DR) process. This is the dominant recombination mechanism for the determination of the ionization-recombination balance for non-hydrogenic ions in the important temperature region of laboratory and astrophysical plasmas. She is internationally recognized for her important contributions to the precise description of this intricate atomic process, together with applications to the improved understanding of atomic interactions in plasmas. She has also used this expertise in analyzing spectra from astrophysical phenomena such as shock waves, stellar winds, and accretions of iron rich knots in Super Novae Remnants. Dr. Dasgupta has made important contributions to the description of the interaction of intense, ultra-short-pulse laser radiation with clusters (a unique combination of gas and solid phase with small, multi-atom particles between 10 and 3×10^6) of noble gas atoms, particularly Xe. Dr. Dasgupta currently chairs the Committee of Women in Plasma Physics of the American Physical Society's (APS) Division of Plasma Physics. She has served on the APS Division of atomic and molecular physics (DAMOP) program and education committees. She also served on the Atomic Physics panel of DOE's HEDP basic research needs international workshop to participate in writing a report on the status and future goals of HED physics. Dr. Dasgupta received her bachelor's degree with honors in physics, master's degree and doctorate in atomic physics, all from the University of Maryland. She moved to NRL in 1986 and has become a sought after expert in several areas of theoretical atomic and plasma physics of international importance. Her awards and professional honors include induction to the Sigma Xi Sigma honors society, and an award for excellence in physics from the Women's Society of the University of Maryland. She was elected Fellow of the American Physical Society in 2010.

Daniel H. Dubin

Member

DANIEL DUBIN is a professor of physics at University of California San Diego. His principal area of research is theoretical plasma physics, and recently my investigations have centered on nonneutral plasmas (pure electron plasmas, pure ion plasmas, positron plasmas, etc.). These systems provide simple, theoretically tractable models for many of the phenomena associated with neutral plasmas, and also exhibit unique behavior in their own right. For example, there is international interest in the low-temperature behavior of these systems, in which liquid and even crystal states are predicted to occur. Dubin's studies of this interesting many-body system employ techniques which are drawn from a range of disciplines including plasma physics, statistical mechanics, nonlinear dynamics, computer simulation, and quantum mechanics. He was the recipient of the 2000 Award for Excellence in Plasma Physics Research. He received his Ph.D. in physics from Princeton in 1984.

Cameron G. Geddes

Member

CAMERON G.R. GEDDES is a senior scientist in the BELLA center of Lawrence Berkeley National Laboratory, focusing on study of laser driven plasma waves and their applications compact particle accelerators and photon sources. He leads a project developing plasma based accelerators as compact sources of near-monochromatic MeV photons for nuclear material detection and characterization. He is involved in related areas such as extending the future reach of high-energy physics as well as radiation sources in the x-ray to THz bands, and in both experiment and computation. Previous positions have spanned a variety of plasma physics disciplines including Thomson scattering measurement of driven waves in inertial confinement fusion laser-plasma interaction at LLNL, wave mixing in Omega laser experiments by Polymath Research, and small aspect Tokamak equilibria at the University of Wisconsin. He received the Ph.D. in 2005 at the University of California, Berkeley, supported by the Hertz Fellowship, where he received the Hertz and APS Rosenbluth dissertation awards for demonstration of a laser driven, plasma based electron accelerator producing mono-energetic beams. He received the B.A. degree from Swarthmore College in 1997, and received the APS Apker Award and Swarthmore Elmore Prize for work on Spheromak plasma magnetic equilibria. He is a fellow of the American Physical Society Division on Plasma Physics and a recipient of the Society's Dawson award, and of two LBNL Outstanding Performance awards. Previous community planning exercises have include Frontiers of Plasma Science (2015, FES), Snowmass (2013, HEP), and the HEDLP ReNeW panel (2009).

S. G. Glendinning

Member

S. GAIL GLENDINNING is a technical staff member at Lawrence Livermore National Laboratory. She received her B.A. in experimental physics from Middlebury College in 1973 and her Ph.D. in experimental nuclear physics from Duke University in 1980. Following post-doctoral work at Duke, she worked for the nuclear fuels division of General Electric in Wilmington, NC and San Jose, CA, designing monitoring systems for low-level radioactive waste. She joined Lawrence Livermore National Laboratory in the Inertial Confinement Fusion program in 1985. Her work on ICF has focused on the study of hydrodynamic instabilities in planar systems using both direct and hohlraum drive. She is currently continuing research in hydrodynamic instabilities and conducting a series of experiments examining hohlraum drive symmetry.

Dan M. Goebel

Member

DAN M. GOEBEL is a Jet Propulsion Laboratory Fellow and senior research scientist, an adjunct professor of Electrical Engineering at USC and an adjunct professor of Electrical Engineering and Aerospace Engineering at UCLA. At JPL he is responsible for the development of advanced electric propulsion systems and spacecraft technologies, and is the chief engineer of the NASA Psyche Mission that will launch in 2022. Previously he was a research scientist at HRL Laboratories in Malibu, CA, and Principal Scientist at Hughes/Boeing EDD in Torrance, CA where he was the supervisor of the Advanced Technology Group for microwave tube development and the lead scientist of the XIPS ion thruster program for commercial satellite station keeping. He received a NASA Engineering Achievement Medal in 2011 and a NASA Space Technology Award in 2015 and 2018. He earned his Ph.D. in applied plasma physics from the University of California, Los Angeles. Dr. Goebel is a member of the National Academy of Engineering, a fellow of the National Academy of Inventors, a fellow of the AIAA, fellow of the IEEE, and a fellow of the American Physical Society (APS). He is the author of over 130 technical journal papers, 150 conference papers, one book entitled Fundamentals of Electric Propulsion: Ion and Hall Thrusters, and holds 52 patents.

David B. Graves

Member

DAVID B. GRAVES is a professor of chemical engineering in the Department of Chemical and Biomolecular Engineering in the College of Chemistry at the University of California at Berkeley. At UCB, Dr. Graves has been a leading figure in research associated with semiconductor manufacturing applications of low temperature plasma. His research interests include plasma modeling and simulations, plasma-surface interactions dusty plasmas, and novel applications of plasma in biology, agriculture and medicine. He is a fellow of the American Vacuum Society and the Institute of Physics and was the recipient of the Electrochemical Society Young Author Award, the NSF Presidential Young Investigator Award, the Tegal Plasma Thinker Award, and the Plasma Prize of the Plasma Science and Technology Division of the AVS. He was named the Lam Research Distinguished Chair in Semiconductor Processing at UC Berkeley for 2011-16. He received the Allis Prize for the Study of Ionized Gases from the American Physical Society in 2014 and the 2017 International Symposium of Dry Processes Nishizawa Award. He earned his Ph.D. in chemical engineering from the University of Minnesota, USA. He acted as co-editor for the Report on Data Needs for Plasma Processing (1995-96). He was co-editor of the Low Temperature Plasma Science Challenges for the Next Decade. (2008) He is currently senior editor of the IEEE Transactions on Radiation and Plasma Medical Science.

Judith T. Karpen

Member

JUDY KARPEN has been a research astrophysicist in the Space Weather Laboratory, Heliophysics Science Division, NASA Goddard Space Flight Center, since July 2008. Her primary research interests include analytical and numerical modeling of dynamic solar and heliospheric phenomena, and applications of plasma physics and magnetohydrodynamics to solar and heliospheric activity. Her current research is focused on solar prominences, coronal mass ejections/eruptive flares, coronal/heliospheric jets, and magnetic reconnection. Dr. Karpen has been a Principal or Co-Investigator in research sponsored by NASA's Heliophysics Theory Program, Heliophysics SR program, Heliophysics Guest Investigator programs, LWS TR&T program, and High Performance Computing and Communications Program. In addition she has served as a Principal or Co-Investigator on numerous grants of computer time under the DoD High Performance Computing Modernization and the NASA High End Computing programs. She became the Chief of the Space Weather Laboratory in May 2012. From October 1980 until September 1982, Dr. Karpen was an NRL-NRC Postdoctoral Research Associate with the Solar Physics Branch, Space Science Division, Naval Research Laboratory (NRL). From October 1982 until September 1984, she was a staff scientist with Berkeley Research Associates, working at the Laboratory for Computational Physics and Fluid Dynamics, NRL. Dr. Karpen was a research physicist in the Solar-Terrestrial Relationships Branch, Space Science Division, NRL, from October 1984 until July 2008. Dr. Karpen is a member of the American Astronomical Society, Solar Physics Division; the International Astronomical Union; and the American Geophysical Union. She has served on numerous NASA, NSF, and NAS advisory/review committees; AAS and AAS/SPD committees and elected positions; and as a reviewer for journals including Astrophysics Journal, Astronomy and Astrophysics, Nature, and Solar Physics. She served on the NAS/NRC Committee on Solar and Space Physics (1997-2000) and the NAS/NRC Solar-Heliospheric Panel of the Solar and Space Physics Decadal Survey(2001-2002).

Maxim Y. Lyutikov

Member

MAXIM Y. LYUTIKOV is a professor of physics and astronomy at Purdue University. He was an editor of the topical issue "Dynamics and dissipation in electromagnetically dominated media" for Advances in Plasma Physics Research. His research interests include high-energy astrophysics, compact objects, extragalactic astrophysics, cosmic rays, and plasma astrophysics. He earned his M.S. in theoretical physics from Moscow Engineering Physics Institute and his Ph.D in theoretical astrophysics from California Institute of Technology in 1998. He has been awarded as a Simons Fellow in Theoretical Physics, and received the CITA National Fellowship, the Allan T. Moffett Fellowship, and the Van Maanen Fellowship throughout his career.

John S. Sarff

Member

JOHN S. SARFF is a professor of physics at the University of Wisconsin-Madison. He served as the Director of the Madison Symmetric Torus (MST) facility, which is used for studies of magnetic fusion and basic plasma science based on the reversed field pinch (RFP) and tokamak magnetic confinement configurations. His research interests include toroidal magnetically confined plasmas, especially the self-organizing dynamics in RFP plasmas and their connections to astrophysical plasmas through processes such as magnetic reconnection, particle heating and energization, and turbulence and transport. He earned his Ph.D. in physics from the University of Wisconsin-Madison. He has served on a number of committees and panels for the APS Division of Plasma Physics and FESAC. He has also served on the advisory committees for the U.S.'s major user facilities for magnetic fusion research. He is the current President of the University Fusion Association and has been an active participant in community planning exercises for fusion and plasma science. He is a fellow of the American Physical Society.

Adam Sefkow

Member

ADAM SEFKOW is an assistant professor of mechanical engineering at the University of Rochester and senior scientist at the Laboratory of Laser Energetics. Sefkow earned his Ph.D. from Princeton University in 2007 and was a principal member of the technical staff in the Pulsed Power Sciences Center at Sandia National Laboratories before joining the University of Rochester in 2016. He has received the Early Career Research Program award from the US Department of Energy to develop a hybrid fluid-kinetic multi-physics simulation code to help interpret data acquired from high-energy-density physics and inertial confinement fusion experiments. Sefkow also received the Fusion Power Associates 2017 Excellence in Fusion Engineering Award in recognition of his scientific contributions on a range of topics, including magneto-inertial fusion, short-pulse and long-pulse laser-plasma interaction physics, and intense charged-particle beam transport.

Edward E. Thomas, Jr.

Member

EDWARD THOMAS JR. is the Charles W. Barkley Endowed Professor of Physics and the Associate Dean for Research and Graduate Studies in the College of Sciences and Mathematics at Auburn University. Prof. Thomas began his research career studying edge particle transport in fusion plasmas. Over the years, his work has become centered in basic plasma physics where his group conducts experimental plasma physics research on dusty (complex) plasmas, magnetized plasmas and plasma diagnostic development – with an emphasis on the particle, wave, and energy transport in low temperature plasmas. Most recently, he has led the development of the Magnetized Dusty Plasma Experiment (MDPX) device, a superconducting, 4-Tesla, multi-configuration, multi-user research platform for studying plasmas in which the electron, ion, and charged microparticle components are dominated by the presence of the magnetic field. Previously, Prof. Thomas was a faculty member at Fisk University in the Department of Physics. He is an elected member of the International Union of Radio Science (URSI) – Commission H and is a fellow of the American Physical Society and the National Society of Black Physicists. He earned his Ph.D. in physics from the Auburn University. He has served as a member of numerous advisory committees for the American Physical Society, National Science Foundation, Department of Energy, National Research Council, European Space Agency, and several research centers in the US, Europe and India – including the National Research Council Plasma Science Committee and the Dept. of Energy - Fusion Energy Sciences Advisory Committee.