Invited Speakers

50th Anniversary Plenary Speaker — Commission A

USNC-URSI Commission A – History and Mission

Steve Weiss
Johns Hopkins University

Abstract: This Plenary Presentation will discuss both the history and mission of Commission A. The discussion will include historical background as well as the evolution of the topics addressed by the Commission.

In general, the mission of Commission A is to promote research and development in the field of measurement standards and physical constants, calibration and measurement methodologies, improved quantification of uncertainty, continued achievement of accuracy and traceability of measurements. Areas of emphasis pertain to Electromagnetic measurements and standards.

Accordingly, the Commission specifically addresses: (a) Measurements and standards in time and frequency, including infrared and optical frequencies; (b) Measurements in the time domain; (c) Measurements in the frequency domain; (d) Measurements in telecommunications; (e) Measurements using lasers; (f) Quantum metrology and electrical methods in fundamental constants; (g) Measurements and standards from dc to optical frequencies.

As such, the commission fosters accurate and consistent measurements needed to support research, development, and exploitation of electromagnetic technologies across the spectrum and for all commissions.

Additionally, the presentation will discuss the relationship between the USNC-URSI and URSI as well as the association with the IEEE APS conference.

Biographical Sketch: Dr. Steven Weiss obtained his bachelor's degree in Electrical Engineering from the Rochester Institute of Technology in 1985 (BSEE) and graduate degrees from George Washington University in 1989 (MS) and 1995 (DSc), both with concentrations in Electrophysics.

Dr. Weiss worked with the Army Research Lab from 1988 until retirement in 2023. As he was the team leader for the Antenna Team, he was instrumental in the development of numerous specialized antennas for military applications. The work ranged from antennas for communications in the VHF band, radar antennas, and antennas for Satellite on the Move (SOTM,) as well as antennas for collision avoidance. His interests included the associated beamformers and beamforming networks.

He is a fellow of the Washington Academy of Science and is on the board of directors of the Applied Computational Electromagnetics Society (ACES). He is a Senior Member of IEEE and has served in all officer positions for the Washington Section of the IEEE. He is a member of URSI Commissions A and B and served as the vice-chair and chair of Commission A. Additionally, he is an international member of URSI.

Dr. Weiss has taught at Johns Hopkins University since 2002 teaching courses in Antenna Systems, Advanced Antenna Systems, and Intermediate Electromagnetics. He has published numerous papers in the IEEE Antennas and Propagation society's transactions, letters, and conferences. He is a registered professional engineer in the states of Maryland and Delaware and maintains an active status in both states.

50th Anniversary Plenary Speaker — Commission B

Contributions and Accomplishments of USNC-URSI Commission B

Branislav M. Notaros
Colorado State University, Fort Collins, CO

Abstract: The 2024 National Radio Science Meeting (NRSM) to be held from January 9-13, 2024 at the University of Colorado at Boulder is the 50th Anniversary Event of NRSMs Boulder. Namely, at the 2024 NRSM, we will be celebrating the 50th anniversary of holding this meeting in Boulder, Colorado. This talk presents contributions of the Commission B of the U.S. National Committee (USNC) for the International Union of Radio Science (URSI) to the very

rich 50-year history and legacy of USNC-URSI and NRSM achievements with discussions of the present activities and an outlook for the future.

USNC-URSI Commission B covers all technical and scientific aspects of Fields and Waves. Commission B topics for NRSM Boulder meetings are clustered around Antennas; Propagation, Scattering, and Sensing; Numerical Methods of Electromagnetics; Electromagnetic Theory, Materials, and Education; and Devices, Systems, and Applications. We have organized, in every year, a great number of NRSM Special Sessions on established and emerging theories, techniques, technologies, and applications of Fields and Waves, with prominent invited authors and speakers within Commission B as well as leaders of interdisciplinary research and practice within the radio science community. USNC-URSI Commission B has also been a very active participant in our joint summer meetings with the IEEE Antennas and Propagation Society (AP-S), IEEE International Symposia on Antennas and Propagation and USNC-URSI Radio Science Meetings – APS/URSI Joint Meetings.

The talk outlines USNC-URSI Commission B achievements and activities within half of a century, both technical/scientific and professional, in a celebratory spirit, but also addresses an outlook for the future of the commission and the organization, as well as encountered or anticipated challenges of the present time and the future. It emphasizes the accomplishments directly related to NRSM Boulder Meetings but also discusses the activities of the commission overall including APS/URSI Joint Meetings and our technical and professional activities outside of the meetings and conferences. The overview is greatly facilitated by the USNC-URSI Radio Science Meeting Archive, which includes copies of most of the proceedings of the National Radio Science Meetings in Boulder and USNC-URSI Radio Science Meetings, held jointly with IEEE AP-S, spanning the period from 1963 to the present, as well as other useful information.

Biographical Sketch: Branislav M. Notaros is a Professor of Electrical and Computer Engineering, Director of Electromagnetics Laboratory, and University Distinguished Teaching Scholar at Colorado State University. Previously, he held assistant/associate-professor positions at the University of Massachusetts Dartmouth and University of Belgrade. His research contributions are in computational and applied electromagnetics. His publications include more than 300 journal and conference papers, and textbooks "Electromagnetics" (2010) and "MATLAB-Based Electromagnetics" (2013) with Pearson Prentice Hall and "Conceptual Electromagnetics" (2017) with CRC Press.

Prof. Notaroš serves as President Elect of the IEEE Antennas and Propagation Society (AP-S), Chair of the USNC-URSI Commission B, Immediate Past President of the Applied Computational Electromagnetics Society (ACES), and Track Editor of the IEEE Transactions on Antennas and Propagation. He served as General Chair of the IEEE APS/URSI 2022 Denver Conference, Chair of the IEEE AP-S Meetings Committee, Chair of the Joint Meetings Committee, and AP-S AdCom member. He was the recipient of the 1999 IEE Marconi Premium, 2005 IEEE MTT-S Microwave Prize, 2022 IEEE Antennas and Propagation Edward E. Altshuler Prize Paper Award, 2019 ACES Technical Achievement Award, 2014 Carnegie Foundation Colorado Professor of the Year Award, 2015 ASEE ECE Distinguished Educator Award, 2015 IEEE Undergraduate Teaching Award, and many other research and teaching awards. He is Fellow of IEEE and ACES.

50th Anniversary Plenary Speaker — Commission C

The Future of Signals and Systems

Dev Palmer
DARPA Microsystems Technology Office

Abstract: The information- and intelligence-based economy continues to drive an explosion of data that must be moved, stored, processed, communicated, and converted to end-user information. This phenomenon raises an important question: Can the current trends in communications signals and systems keep up? Breakthroughs are needed in a wide range of key technologies. Among those critical capabilities are the development of new materials and device structures that maximize performance and efficiency, as well as new algorithms and hardware for signal processing that can handle the speed, scale, and complexity of the modern electromagnetic spectrum environment.

This talk will cover some of the national-level challenges facing communications signals and systems, highlight recent government programs addressing these challenges, and discuss relevant research results at DARPA.

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Biographical Sketch: Dev Palmer is Managing Director, Next-Generation Microelectronics Manufacturing at the DARPA Microsystems Technology Office. Previously he served as MTO Deputy Director. Prior to joining DARPA, he was Chief Technologist at Lockheed Martin Advanced Technology Laboratories where he directed the independent research and development program and implemented technology strategy. Earlier in his career he directed a portfolio of programs ranging from basic research to advanced technology transition in Program Manager roles at DARPA and the Army Research Office. Dr. Palmer is a Life Fellow of the IEEE, author on over 100 publications in print and electronic media, and inventor on four US patents.

50th Anniversary Plenary Speaker — Commission D

A History of Technical Contributions

Jonathan D. Chisum† and Zoya Popovic‡
†The University of Notre Dame, Notre Dame, IN
‡University of Colorado at Boulder, Boulder, CO

Abstract: Commission D: Electronics and Photonics, promotes research and reviews new development in: (a) Electronic devices and applications; (b) Photonic devices and applications; (c) Physics, materials, CAD, technology and reliability of electronic and photonic devices, with particular reference to radio science and telecommunications. The Commission deals with devices for generation, detection, storage and processing of electromagnetic signals together with their applications, covering all frequencies, including those in the microwave and optical domains.

In this talk we will review the community of and technical contributions from Commission D throughout the decades. Major thrusts include the maturation of electronic and photonic devices in Si/SiGe and III-V devices for signal generation and processing, metamaterial and plasmonic structures and optical fiber for the guiding of signals, and system applications including wireless and imaging for commercial and defense, THz and millimeter-wave instrumentation for security and planetary and earth sciences, and reconfigurable RF for cognitive radios in spectrum sensing/sharing. In addition, metrology and computer automated design tools will be discussed as supporting the major device, component, and system themes.

Biographical Sketch: Jonathan Chisum received the Ph.D. in Electrical Engineering from the University of Colorado at Boulder in Boulder, Colorado USA, in 2011. From 2012 to 2015 he was a Member of Technical Staff at the Massachusetts Institute of Technology Lincoln Laboratory in the Wideband Communications and Spectrum Operations groups. His work at Lincoln Laboratory focused on millimeter-wave phased arrays, antennas, and transceiver design for electronic warfare applications. In 2015 he joined the faculty of the University of Notre Dame where he is currently as Associate Professor in the Department of Electrical Engineering. He is the current and immediate past chair for USNC-URSI Commission D. His research interests include millimeter-wave communications and spectrum sensing using novel and engineered materials and devices to dramatically lower the power and cost and enable pervasive deployments. His group focuses on gradient index (GRIN) lenses for low-power millimeter-wave beam-steering antennas, nonlinear low-energy radio architectures for highly efficient communications and sensing up through millimeter-waves, phase-change materials for reconfigurable RF circuits for wideband distributed circuits and antennas, and microwave/spin-wave structures for low-power and chip-scale analog signal processing for spectrum sensing and protection.

Biographical Sketch: Distinguished Professor Zoya Popovic received the Dipl.Ing. degree from the University of Belgrade, Serbia, Yugoslavia, in 1985, and the PhD degree from the California Institute of Technology, Pasadena, in 1990. Since 1990, she has been with the University of Colorado Boulder, where she is currently a Distinguished Professor and holds the Lockheed Martin Endowed Chair in RF Engineering in the Department of Electrical, Computer and Energy Engineering. In

2001, she was a visiting professor with the Technical University of Munich, Munich, Germany. Since 1991, she has graduated more than 50 PhD students. She has served as the past USNC-URSI Commission D Chair and she is the current Chair of the USNC-URSI Women in Radio Science Chapter. Her research interests include high-efficiency, low-noise, and broadband microwave and millimeter-wave circuits, quasi-optical millimeter-wave techniques for imaging, smart and multibeam antenna arrays, intelligent RF front ends, and wireless powering for batteryless sensors. Popovic was the recipient of the 1993 and 2006 Microwave Prizes presented by the IEEE Microwave Theory and Techniques Society (IEEE MTT-S) for the best journal papers, and received the 1996 URSI IssacKoga Gold Medal. In 1997, Eta Kappa Nu students chose her as a Professor of the Year. She was the recipient of a 2000 Humboldt Research Award for Senior U.S. Scientists from the German Alexander von Humboldt Stiftung. She was elected a Foreign Member of the Serbian Academy of Sciences and Arts in 2006. She was also the recipient of the 2001 Hewlett-Packard(HP)/ American Society for Engineering Education(ASEE) Terman Medal for combined teaching and research excellence.

50th Anniversary Plenary Speaker — Commission E

Some Highlights in Commission E in National Radio Science Meetings

Robert L. Gardner
Consultant, Marietta, GA

Abstract: This Commission emphasizes (1) the scientific theory and engineering aspects of effects associated with naturally occurring and artificially induced electromagnetic-interference phenomena and (2) electromagnetic compatibility theory and practice for applications. Its activities provide venues for exchanging theoretical and technological knowledge and economic considerations for achieving electromagnetic spectral harmony. In particular, research presented in Commission E meetings has included:

1. Radiofrequency spectrum management
2. Scientific basis and effects of natural and intentional emissions on system performance
3. Electromagnetic compatibility in computational electromagnetics, education, measurement technologies, standards and radiation hazards
4. Electromagnetic modeling of systems and environments
5. High-power electromagnetic effects of transients on electronic systems

There has been a large variation in numbers and in topics over the last 50 years of Boulder meetings. Particular leaders, and, sometimes, lack of leadership have driven those changes. About 35 of the conference proceedings were available to us showing the rising and falling of topics like Electromagnetic Pulse and Spectrum Management.

I can only tell the early part of the story from my point of view, but the Commission E documentation begins when I started attending USNC Boulder meetings in 1978. I started working for Dr. J. R. Wait on my PhD in 1978 and gave my first talk at NRSM that same year. Dr. David LeVine gave a talk on fields radiated from lightning in the combined session, which became central to my thesis work and the later high – power electromagnetics sessions. The HPE sessions continued until the BE joint session in 2021.

Dr. George Hagn was USNC Commission E chair in 1978. He was one of three of us that continued to become international Commission E Chairs. R. L. Gardner and D. V. Giri were the other two. While HPE was an important part of Commission E's work, primarily due to the encouragement of Dr. Carl Baum, noise characterization and frequency management were also central to that work for decades under such leaders as Dr. R. D. Parlow, G. Hagn, and Anthony Fraser – Smith.

Biographical Sketch: Dr. Robert L. Gardner received his PhD in Physics from the University of Colorado in Boulder in 1980 under the direction of Dr. A. V. Phelps and Dr. J. R. Wait. He began his association with the National Radio Science Meeting in 1978 and continued a 15-year

Commission E leadership role starting with USNC Commission E Vice-Chair in 1990, E Chair in 1993, International E Vice Chair in 1996, International E Chair in 1999 and Member at Large for USNC in 2002.

Dr. Gardner has served in a variety of technical positions as military officer, civil servant, contractor and consultant for the Air Force, Navy, and Under Secretary of Defense for Intelligence. He has won a number of awards including a Legion of Merit, 3 Best Paper Awards and several technical society fellowships. He is now a Principal Research Engineer for the Georgia Tech Research Institute.

Dr. Gardner received his PhD in Physics from the University of Colorado in Boulder in 1980 under the direction of Dr. A. V. Phelps and Dr. J. R. Wait. He began his association with the National Radio Science Meeting in 1978 and continued a 15-year Commission E leadership role starting with USNC Commission E Vice-Chair in 1990, E Chair in 1993, International E Vice Chair in 1996, International E Chair in 1999 and Member at Large for USNC in 2002.

Dr. Gardner has served in a variety of technical positions as military officer, civil servant, contractor and consultant for the Air Force, Navy, and Under Secretary of Defense for Intelligence. He has won a number of awards including a Legion of Merit, 3 Best Paper Awards and several technical society fellowships. He is now a Principal Research Engineer for the Georgia Tech Research Institute.

50th Anniversary Plenary Speaker — Commission F

50 Years of Wave Propagation and Remote Sensing Science at the National Radio Science Meeting in Boulder, CO

David Kunkee[†], Thomas Hanley[‡], Christopher Ruf[§], and Mehmet Ogut[*]

[†]The Aerospace Corporation, Los Angeles, CA; [‡]JHU-APL, Baltimore, MD; [§]University of Michigan, Ann Arbor, MI; [*]JPL, Pasadena, CA

Abstract: In 2024 we celebrate the 50th anniversary of the National Radio Science Meeting (NRSM) in Boulder, CO. The roots of Commission F can be traced back to the earlier commissions of the national committee, specifically Commission II involving 'Radio and Non-Ionized Media.' The change to Commission F was part of a reorganization of USNC-URSI that occurred shortly after the meeting series began in Boulder in 1974. This was the beginning of present-day Commission F involving Wave Propagation and Remote Sensing.

Since 1978 the Commission F series of presentations at the Boulder NRSM has offered many opportunities for inquiry on important topics in radio science including atmospheric attenuation and ducting, propagation in complex media, Earth surface modelling, and application of new sensors and technology. Recently, modern approaches to remote sensing involving CubeSats and signals of opportunity, for example, are treated while leveraging the wealth of knowledge held by the Commission members and their close ties related to the various radio science disciplines represented within the USNC. One topic that has been featured routinely in Commission F sessions at Boulder involves the detailed characteristics of wave propagation through the Earth's atmosphere. The Hans Liebe Lecture Series has been held at the NRSM since 2014 to honor his contributions in this area.

This talk will commemorate 50 years of wave propagation and remote sensing science within the U.S. radio science community at the NRSM Boulder meetings. It will summarize the history and growth of Commission F membership and its scope while suggesting important topics for future inquiry by its members. Accordingly, some topics to consider for the future include the advancement of Radio Frequency Interference (RFI) detection and techniques to control its negative impact on observations of the Earth, modeling and measurement of millimeter-wave propagation in support of 5G and 6G networks, remote sensing of planets that may have sub-surface oceans, technology and techniques for the next generation of scientific instruments supporting remote sensing as well as other emerging topics.

Biographical Sketch: David Kunkee received the Ph.D. degree in electrical engineering from the Georgia Institute of Technology, Atlanta, in 1995. He joined The Aerospace Corporation in 1995 and is currently a Principal Engineer/Scientist within the Sensor Systems Subdivision. From 2010 to 2014 he was a member of the Environmental Satellite Systems Division as part of the Defense Weather Satellite System (DWSS) and Weather System Follow-on (WSF) program offices. From 2006 to 2010 he was a member of the National Polar-orbiting Operational Environmental Satellite

System (NPOESS) Integrated Program Office (IPO), and led the Aerospace Microwave Sensors and Data Products Department within the NPOESS IPO. From 2002 to 2005 he was the Associate Director of the Radar and Signal Systems Department at Aerospace. Dr. Kunkee has served on several review boards supporting space-based sensors and technology for environmental monitoring and associated mission development.

Dr. Kunkee is currently Vice-Chair of USNC-URSI Commission F and Past-President of the IEEE Geoscience and Remote Sensing Society (GRSS). He was General Co-Chair of the 2017 International Geoscience and Remote Sensing Symposium (IGARSS) and served as Co-Chair of the Technical Program Committee for IGARSS 2010 and 2023. From 2007 to 2009 he was Editor-in-Chief of the GRSS Newsletter. Dr. Kunkee has also served on the U.S. National Academies' Committee on Radio Frequencies (CORF) including its Committee on Scientific Use of the Radio Spectrum.

50th Anniversary Plenary Speaker — Commission G

Progress in Understanding Our Ionosphere, Atmosphere, and Near-Earth Space through URSI Commission G: Selected 50 Year Highlights

Philip J. Erickson
MIT Haystack Observatory

Abstract: URSI Commission G - ionospheric radio and propagation - focuses on ionospheric communications and remote sensing of ionized media. The Commission deals with the study of Earth's ionosphere in both a basic and applied sense, in order to provide a broad understanding necessary for radio communications along with the physics, chemistry, and electrodynamics of ionized media in near-Earth space. Particular focus areas include (a) Global morphology and modeling of the ionosphere; (b) Ionospheric space-time variations; (c) Development of tools and networks needed to measure ionospheric properties and trends; (d) Theory and practice of radio propagation via the ionosphere; and (e) Application of ionospheric information to radio communications. To achieve these objectives, Commission G works closely with other URSI Commissions, corresponding bodies of the ICSU family (e.g. IUGG, IAU, COSPAR, SCOSTEP) and other relevant organizations (e.g. ITU, IEEE).

The history of US Commission G parallels the origins and history of URSI itself, as the earliest 20th century remote sensing tools for the charged upper atmosphere were radio wave based, occurring well before the advent of spacecraft direct sampling of these regions. We briefly review the 50 year history of Commission G in this light, with its participants and studies driving many significant firsts in global radio science. These include (1) continued innovations in HF ionosondes, considered the oldest active ionospheric remote sensing technique; (2) the extremely powerful collective Thomson/incoherent scatter radar technique for providing full altitude profiles of the thermal ionospheric plasma state; (3) the incisive development of global ionospheric total electron content observations and science using global navigation satellite signal (GNSS) scientific receivers and processing; (4) in conjunction with Commission H, active plasma experiments investigating fundamental physics using HF transmissions from ionospheric heaters; (5) ionospheric modeling advances and coupling to whole-atmosphere frontier models, including the important development of the IRI empirical ionospheric model; and (6) multi-wavelength radio scintillation investigations of ionospheric plasma irregularities and deep electron density depletions. Throughout, we will highlight common themes in these advances based on technology advances in radio wave capture, combined with increasing sophistication in first-principles understanding of ionospheric physics and space weather dynamics.

Biographical Sketch: Dr. Philip J. Erickson is a Principal Research Scientist and the director of Haystack Observatory, a multidisciplinary radio and radar remote sensing observatory operated by Massachusetts Institute of Technology for studies of near-Earth space, Earth dynamics, and the radio universe. He has been a Haystack scientist for 29 years and has led the observatory's Atmospheric and Geospace Sciences group since 2015 in its active and passive radio remote sensing programs, using a variety of techniques and RF signals at femtowatt to megawatt levels. Erickson is the principal investigator for the NSF funded Millstone Hill Geospace Facility, which encompasses the large aperture mid-latitude Millstone Hill UHF incoherent scatter radar system, global GNSS total electron content observations, and the Madrigal distributed database. He is also the principal investigator for a forthcoming NASA Heliophysics dual small satellite mission to study Earth's radio aurora in low Earth orbit using MF and HF frequency electromagnetic vector sensors. Erickson's research focuses on linear and nonlinear dynamics of Earth's ionosphere,

thermosphere, plasmasphere, and radiation belts, along with collective Thomson and fundamental plasma irregularity scattering mechanisms.

His association with URSI Commission G began in graduate school at Cornell University, where he received a PhD in space plasma physics in 1998 under the direction of radio remote sensing pioneers and Commission G members Donald Farley, Michael Kelley, and Wesley Swartz. Erickson is an associate editor for Frontiers in Astronomy and Space Science, advises on the board of the HamSCI citizen science initiative, and serves on a number of committees including the National Academy of Science, Engineering, and Mathematics (NASEM) Committee on Radio Frequencies. He is co-chair of the NASEM Panel on the Physics of Ionospheres, Thermospheres, and Mesospheres within the 2024-2033 Decadal Survey for Solar and Space Physics (Heliophysics).

50th Anniversary Plenary Speaker — Commission H

Waves in Plasmas: A 50-Year Quest for Resonance through Inhomogeneities, Anisotropies, and Induced Perturbations

Mark Golkowski
University of Colorado – Denver

Abstract: The past half-century has marked an era of remarkable achievement for USNC URSI Commission H. The primary focus of the commission members is the study of waves in plasmas in the broadest sense. As such our membership has tackled a vast spectrum of plasma physics and radio waves, encompassing scales ranging from the intricate orbits of individual electrons to the profound planetary ramifications of space weather. Major activities can be categorized into active geophysical experiments, observations on the ground and with spacecraft, laboratory plasma experiments, and theoretical and simulation efforts.

Commission H's enduring legacy is underscored by the creation of iconic ground facilities, including the legendary Arecibo Observatory, Siple Station, and the groundbreaking HAARP facility. These facilities have empowered us with the extraordinary ability to actively probe and manipulate natural plasmas using high-power radio waves. Taking advantage and studying nature's own powerful radio waves from thunderstorm lightning has also bestowed upon us a trove of knowledge.

Attempts to reproduce the complex physics of space-based wave-particle interactions continue to be pursued, chiefly at the Naval Research Laboratory and also at the University of California Los Angeles. Large plasma chambers with multi-meter dimensions and intense magnetic fields are used to recreate the space plasma environment and replicate nonlinear interactions and wave mode conversions. Numerous scientific orbital spacecraft were launched in the past decades that provided fresh insight into radio wave interactions with space plasmas. Worth highlighting are missions both young and old starting with the NASA Orbiting Geophysical Observatory (OGO) in the 1960's and the more recent missions of the Van Allen Probes (2012-2019), Magnetospheric Multiscale Mission (launched 2015) and the US Air Force DSX satellite (2019-2021).

The extraordinary increase in available computing power over the last three decades has touched all research fields and in Commission H at least two areas of focus are worth mentioning. The complex and three dimensional nature of wave-plasma interactions makes self-consistent simulation very computationally expensive. One powerful technique is the so-called particle-in-cell (PIC) algorithm in which individual charged particle trajectories are tracked under the influence of all electromagnetic forces. In the last 15 years a number of PIC and hybrid-PIC codes have been developed to reproduce key wave-particle interactions. Another area of focus has been leveraging machine learning algorithms for space weather prediction. Work in this area has accelerated and the coming years will no doubt bring new capabilities.

As we celebrate five decades of discovery, Commission H stands at the precipice of a bright future, poised to unlock new dimensions of plasma wave phenomena.

Biographical Sketch: Mark Golkowski received his B.S. degree in electrical engineering from Cornell University in 2002 and his M.S. and Ph.D. degrees in electrical engineering from Stanford University in 2004 and 2009, respectively. He served as a Postdoctoral Fellow with the Space, Telecommunications, and Radio Science Laboratory at Stanford University from 2009-2010. His doctoral work and subsequent research heavily utilized the HAARP facility in Gakona, Alaska for

experiments on active ELF/VLF wave injection into space. Dr. Golkowski is currently Professor and Chair of Electrical Engineering at the University of Colorado Denver. He actively conducts research on electromagnetic waves in plasmas, ionospheric physics, near-Earth space physics, and biomedical applications of gas discharge plasmas. Dr. Golkowski has served as associate editor of the journal Earth, Moon, Planets. Dr. Golkowski was recipient of International Association of Geomagnetism and Aeronomy (IAGA) Young Scientist Award for Excellence in 2008, IEEE Electromagnetic Compatibility Society Best Symposium Paper Award in 2011 and National Science Foundation CAREER Award in 2013. He served as Associate Dean of Education and Student Success in 2020-2022 and has received campus level recognition in teaching, research, and student mentoring at the University of Colorado Denver. Dr. Golkowski served as Chair of USNC Commission H Waves in Plasmas from 2020-2023.

50th Anniversary Plenary Speaker — Commission J

Discovering the Radio Universe

Ken I. Kellermann[1] and Alyson Ford[2]

[1]National Radio Astronomy Observatory, Charlottesvile, VA

[2]Steward Observatory, University of Arizona

Abstract: Until Karl Jansky's 1933 discovery of non-thermal cosmic radio emission at Bell Laboratories, astronomy was limited to observations in the narrow visible slice of the electromagnetic spectrum. Jansky and later Grote Reber opened the radio window to studying the Universe. Using instruments of ever increasing sensitivity and resolution, radio astronomers discovered bursts of radio noise from the Sun, electrical storms on Jupiter, radio galaxies, quasars, apparent faster-than-light motion, the cosmic microwave background, the first observational evidence for the big-bang and cosmic evolution, pulsars, gravitational lensing, cosmic masers, giant molecular clouds, evidence for dark matter, fast radio bursts, and the first known planets beyond our Solar System.

Most of these radio astronomy discoveries were serendipitous: they were unanticipated and unexpected, often involving some degree of luck. Theory generally played no role, or, in some cases, even led in the wrong direction and delayed discoveries which might have otherwise occurred earlier. Some discoveries came as a result of military activities, others from industrial research, some from academic research intended for other purposes, and some from even just looking with a new instrument or new technique. Often it was the right person in the right place doing the right thing – or sometimes the wrong thing. The scientists responsible for these discoveries were mostly young - under 40 years of age, and had little or no formal training in astronomy. Although there is no Nobel Prize in astronomy, the first three Nobel Prizes awarded for work in observational astronomy went to six radio astronomers.

Following a surge in the rate of new discoveries by radio astronomers in the decades following World War II, since the 1980s the rate of discovery has declined. Similarly, following the initial awards of Nobel Prizes to six radio astronomers, for the past thirty years there have been no new discoveries in radio astronomy that have led to a Nobel Prize. We conclude with speculations about why the rate of new discoveries has decreased and how the changing culture of scientific research may constrain the rate of future new discoveries.

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities Inc.

Biographical Sketch: Ken Kellermann is a Senior Scientist Emeritus at the National Radio Astronomy Observatory where he works on the study of radio galaxies, quasars and cosmology, on the development of new instrumentation for radio astronomy, and on the history of radio astronomy. He is a Member of the National Academy of Sciences, a Foreign Member of the Russian Academy of Sciences, the German Max Planck Society and a Fellow of American Philosophical Society. He has received the Warner Prize of the American Astronomical Society, the Gould Prize of the National Academy of Sciences, the 2014 Bruce Medal of the Astronomical Society of the Pacific, and was co-recipient the 1971 Rumford Medal of the American Academy of Arts and Sciences for his role in the development of VLBI. He has

served as the Chairs of the USNC-URSI (CJ) and USNC-IAU as well as the President of IAU Commission 40 (Radio Astronomy).

Biographical Sketch: Dr. Alyson Ford is the Associate Director of Steward Observatory at the University of Arizona, where she oversees the Arizona Radio Observatory (ARO) and Mountain Operations (Mtn Ops) groups. These groups are responsible for the maintenance, operations, and development projects of Steward Observatory's radio, optical, and infrared facilities located on Kitt Peak, Mount Lemmon, Mount Bigelow, and Mt. Graham. Dr. Ford's research focuses primarily on the gaseous content of galaxies and the processes that shape this gas, with an emphasis on extremely faint emissions that can only be detected using Earth's most sensitive radio telescopes. With a strong interest in operations, instrumentation, and image and signal processing, she also applies her expertise to space domain awareness (SDA) activities. Dr. Ford served as Lead Scientist for the RadioAstron Green Bank Earth Station, and has led several proof-of-concept tests for satellite tracking in MEO and GEO belts, performed bistatic radar observations of near-Earth asteroids, infrared observations of high area-to-mass ratio (HAMR) objects, space debris, and satellites, and is particularly interested in passive radar. She is a member of the Event Horizon Telescope Collaboration and currently serves as Chair of Commission J (Radio Astronomy) for the United States National Committee (USNC) for the Union Radio-Scientifique Internationale (URSI). Dr. Ford received her PhD in Astrophysics from Swinburne University of Technology in Melbourne, Australia.

50th Anniversary Plenary Speaker — Commission K

The Intersection of Radio Science and Biology and Medicine:

A Celebration of the Past and Future of Commission K

Susan C. Hagness
University of Wisconsin – Madison, Madison, WI

Abstract: Radio scientists and electromagnetic engineers have long been inspired by the prospects of contributing to the advancement of human health and quality of life. Commission K sessions at the National Radio Science Meeting (NRSM) have provided an invaluable venue for disseminating research advances at the intersection of radio science with biology and medicine. At the foundation of Commission K is a focus on the physical interaction mechanisms of electromagnetic fields and waves – from DC to daylight – with biological systems, whether at the cellular or whole human body level. Two primary pillars build upon that foundation: 1) basic research on biological effects, the underlying mechanisms responsible for the effects, and techniques for quantifying and assessing exposure to electromagnetic fields and waves, and 2) applied research involving the development of diagnostic and therapeutic technologies for a host of medical applications. Commission K has also embraced research on communications and sensing technologies for non-medical applications that nevertheless involve interactions with the human body.

As we celebrate the 50th anniversary of the NRSM in Boulder, CO, it is exciting to reflect on a 50-year span that straddles both the past and the future. Accordingly, this talk will provide a brief 25-year retrospective, highlighting representative research advances across the foundation and pillars of Commission K, and a forward-looking vision for the next 25 years. A timely societal challenge for Commission K to tackle is healthy aging. There are currently more than 55 million people in the U.S. above age 65, according to U.S. census data from 2020, and by 2030 an estimated 1.4 billion people will be over 60 years of age, according to the World Health Organization. Electromagnetics engineering in biology and medicine includes countless research directions that will yield future technologies in support of healthy aging, including supporting aging in place (e.g. health status monitoring and screening, detecting falls, etc.), energy harvesting for powering smartphones and other devices for monitoring and rehabilitation, and advancing point-of-care diagnostics and novel therapies.

Biographical Sketch: Susan C. Hagness received the B.S. and Ph.D. degrees in electrical engineering from Northwestern University in 1993 and 1998, respectively. She is currently the Philip D. Reed Professor of the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison, where she has served as Department Chair since 2018. She previously served as the College of Engineering Associate Dean for Research (2014-2017) and has held

a variety of professional society and advisory board appointments and leadership roles within the IEEE, the U.S. National Committee of URSI, the ASEE Engineering Research Council, and ECEDHA. She has co-authored more than 100 journal papers, eight book chapters, and two editions (with Allen Taflove) of Computational Electrodynamics: The Finite-Difference Time-Domain Method (Artech House, 2000 and 2005).

She has received numerous recognitions for her holistic approach to teaching and mentoring and for her research in computational and experimental applied electromagnetics, which has emphasized medical applications over the past 25 years. Highlights include the Presidential Early Career Award for Scientists and Engineers (2000), the IEEE Engineering in Medicine and Biology Society Early Career Achievement Award (2004), the URSI Issac Koga Gold Medal (2005), the IEEE Trans. Biomedical Engineering Outstanding Paper Award (2007), the IEEE Education Society Van Valkenburg Early Career Teaching Award (2007), the Physics in Medicine and Biology Citations Prize (2011), the UW-Madison Women Faculty Mentoring Program Slesinger Award for Excellence in Mentoring (2017), and College of Engineering awards for excellence in teaching (2014), research (2018), and equity and diversity efforts (2021). She is a Fellow of the IEEE (2009), AAAS (2021), AIMBE (2022), and NAI (2022).

Eleventh Liebe Lecture

Ground-Based Microwave Radiometers:

Missing Puzzle Pieces in Laying the Picture of the Atmospheric State

Ulrich Löhnert
University of Cologne, Germany

Abstract: Currently, there is a world-wide observation gap of wind, temperature, and humidity profiles in the Atmospheric Boundary Layer (ABL), particularly as operational numerical models are approaching the km to sub-km scale. Ground-based passive microwave radiometers (MWR) can simultaneously deliver information on atmospheric humidity and temperature profiles, as well as on the column integrated liquid water path. As opposed to other remote sensing methods, MWRs can profile continuously throughout the entire troposphere, even in the case of optically thick water clouds. State-of-the-art MWR operate robustly 24/7 during all-weather conditions, are commercially available (and affordable) and are consequently being implemented in different observational networks worldwide. However, their vertical resolution is limited, especially above the atmospheric boundary layer, constraining the information content of the measurements.

This lecture will review stand-alone performance of state-of-the-art MWR and give a status report on their implementation within current observational networks. A major focus will be on how MWR can be used complementary with other (remote) sensors to fill the existing observational gap in the ABL. This includes the synergy with standard meteorological observations, collocated ground-based remote sensors such as lidar, radar or infrared spectrometer, as well as different current and future satellite sensors (e.g. geostationary infrared sounders). Existing and future network configurations of MWR will be presented and what benefits these provide for applications such as nowcasting of atmospheric stability and short-term weather forecasting. Also, the potential of using elevation and azimuth scanning MWR configurations for measurement quality control as well as for detecting horizontal atmospheric inhomogeneities will be discussed.

Biographical Sketch: Prof. Ulrich Löhnert is professor for Meteorology at the University of Cologne, and since 2020 leads the research group Exploiting Observations in Meteorology. Before becoming an extraordinary professor in 2020, he co-led the research group on Integrated Ground-based Remote Sensing since 2007. In 2012 he obtained his habilitation in Meteorology from the University of Cologne following a time as assistant professor at the Meteorological Institute, Ludwig-Maximilians-University Munich (2004–2006). His main research interest lies in using ground-based remote sensing for enhanced atmospheric process understanding and improving numerical models. He has been coordinator of German research network projects funded by the German Ministry for Research and Education (BMBF) and has acted as PI in numerous nationally funded projects (German Research Foundation, DFG and BMBF). He has established strong research with the German Weather Service (DWD) and since 2020, he is PI within the ACTRIS-D initiative, which is part of the ACTRIS ERIC (European Infrastructure Consortium). He is currently co-chair of the WMO

WWRP working group on Data Assimilation and Observation Systems (DAOS) and has also been working group leader and management committee member of several EU-funded COST actions. His research also benefits from long lasting collaborations with US-researchers in active and passive atmospheric remote sensing.

Short Course, Tutorials and Workshop

Workshop

Hands On Phased Array Beamforming Workshop

Jon Kraft, Analog Devices
Laila Fighera, University of Colorado – Boulder

Phased array communications and radar systems are finding increased use in a variety of applications. This places a greater importance on training engineers and rapidly prototyping new phased array concepts. However, this has historically been difficult and expensive. But a recent open source offering, the CN-0566 Phaser, allows real beamforming hardware to be used for education, project proposals, and product development. This workshop will introduce that offering with lectures and hands on labs covering: phased array beamforming (steering angle and beam formation), antenna impairments (side lobes/tapering, grating lobes, beam squint), monopulse tracking implementation, and jammer mitigation through null steering. Each of these topics will be addressed with a short lecture, followed by the participants using the Phaser hardware to directly explore the lecture topic.

Biographical Sketch: Jon Kraft joined Analog Devices in 2007, after spending 9 years at Motorola/ON Semiconductor. He is now a principal field applications engineer with a focus in software-defined radio and phased array radar. He posts examples of these concepts, using simple hardware and software, at www.youtube.com/@jonkraft. He is also the architect, and perpetual explorer, of the CN0566 Software Defined Phased Array Radar project, commonly called the "Phaser." He received a B.S.E.E. from Rose-Hulman, a M.S.E.E. from Arizona State University, and has 10 patents issued.

Biographical Sketch: Laila Fighera Marzall received her B.S. degree in electrical engineering from the Federal University of Santa Maria in 2006; her M.S. in electrical engineering from Aeronautics Institute of Technology, ITA, in 2009, in Brazil, and her Ph.D. degree in electrical engineering from the University of Colorado Boulder in 2022. She works as a Postdoctoral Associate at the University of Colorado Boulder Microwave Group. Her research is focused on broadband phased arrays and non-reciprocal devices, like circulators and phase shifters, as well as MMIC power amplifiers. She is a Senior Member of the IEEE and a URSI Associate Member.

Workshop

Successful Proposal Writing for Sustainable and Impactful Research – From Tenure-Track Through the Long-Game

Jonathan Chisum, University of Notre Dame
Chris Anderson, United State Naval Academy

Whether you are a graduate student or a post-doc seeking your first faculty appointment, a tenure-track assistant professor working to establish a research group, or a full professor looking to increase your impact, successful proposal writing is an essential skill. Unfortunately, proposal writing is often learned by immersion or, when taught, is treated in such a general manner that it lacks relevance. This tutorial panel will provide concrete examples of both funded and unfunded proposals to share the "do's and don'ts" of proposal writing. The panel comprises researchers at various stages in their career, spanning a variety of disciplines, with experience in academia, government labs, and non-profits. They will provide concrete suggestions that are immediately useful for attendees. The discussion will present a systematic approach to proposal writing that can not only lead to a sustainable flow of funding, but will also help generate original ideas, refine research plans, establish vibrant collaborations, and make an impact. Our panelists will discuss: the funding landscape including NSF, DoD, industry, non-profit, and international organizations; how to pursue small, medium, and large research programs; how to contact program managers, how to construct white papers and survive a visit (or virtual meeting) to DC; the key elements of a proposal and how to make your proposal irresistible (a

"must fund" proposal); telling a compelling and complete story (leaving no major doubts); developing a cadence for proposal writing, execution, and paper writing; and more. Example of successful proposals will be presented.

Biographical Sketch: Jonathan D. Chisum received the Ph.D. in Electrical Engineering from the University of Colorado at Boulder in Boulder, Colorado USA, in 2011. He is currently an Associate Professor of Electrical Engineering at the University of Notre Dame. From 2012 to 2015 he was a Member of Technical Staff at the Massachusetts Institute of Technology Lincoln Laboratory in the Wideband Communications and Spectrum Operations groups. His work at Lincoln Laboratory focused on millimeter-wave phased arrays, antennas, and transceiver design for electronic warfare applications. In 2015 he joined the faculty of the University of Notre Dame. His research interests include millimeter-wave communications and spectrum sensing using novel and engineered materials and devices to dramatically lower the power and cost and enable pervasive deployments. His group focuses on gradient index (GRIN) lenses for low-power millimeter-wave beam-steering antennas, nonlinear (1-bit) radio architectures for highly efficient communications and sensing up through millimeter-waves, phase-change materials for reconfigurable RF circuits for wideband distributed circuits and antennas, and microwave/spin-wave structures for low-power and chip-scale analog signal processing for spectrum sensing and protection. Dr. Chisum is a senior member of the IEEE, a member of the American Physical Society, and an elected Member of the U.S. National Committee (USNC) of the International Union or Radio Science's (URSI) Commission D (electronics and photonics). He is the current Chair for USNC URSI Commission D: Electronics and Photonics. He is also an Associate Editor for IET Electronics Letters.

Biographical Sketch: Christopher R. Anderson joined the National Telecommunications and Information Administration (NTIA) Institute for Telecommunication Sciences (ITS) in 2023 following a distinguished 16-year tenure at the United States Naval Academy (USNA) as an Associate Professor in the Electrical Engineering Department. At USNA, he founded and directed the Wireless Measurements Group, a specialized research team focusing on spectrum, propagation, and field strength measurements in diverse environments and frequencies ranging from 300 MHz to 28 GHz. During 2016-2018, Dr. Anderson served as a Visiting Researcher for the NTIA ITS Theory Division, concentrating on the development of propagation models for cluttered environments. Currently, his primary interests lie in enhancing spectrum coexistence between active and passive technologies and improving wireless coverage in rural or under-served areas. Dr. Anderson is a former Editor of the IEEE Transactions on Wireless Communications, the Chair of the UAV and V2V Channel Modeling Subgroup of the IEEE P.1944 Mobile Communication Network Standards Committee, and the Chair of the URSI US National Committee Commission A Electromagnetic Metrology.

Short Course

Reconfigurable Intelligent Surfaces for Communications and Radars

Kumar Vijay Mishra, United States DEVCOM Army Research Laboratory

In recent years, reconfigurable intelligent surfaces (RISs) have shown promising abilities to control and manipulate electromagnetic (EM) waves through modified surface boundary conditions. These surfaces are electrically thin and comprise an array of spatially varying sub-wavelength scattering elements (or meta-atoms). Through careful engineering of each meta-atom, RISs can transform an incident EM wave into an arbitrarily tailored transmitted or reflected wavefront. Recent developments in RISs have opened exciting new opportunities in antenna design, as well as communications and radar systems. RISs - wherein meta-atoms are embedded with active components - lead to the development of low-cost, lightweight, and compact systems that can produce programmable radiation patterns, jointly perform multi-function communications, and enable advanced radars for next-generation military platforms. This short course will introduce RISs and their various applications in designing simplified communications and radar systems, wherein the RF aperture and transceiver are integrated within the RIS. For example, dynamic reconfiguration of the RIS aperture in a wireless communications transmitter facilitates beam steering, frequency agility, and phase modulation without conventional front-end devices such as phase-shifters, mixers, and switches. We will present our recent work on reconfigurable RIS control, RIS-enabled direct signal modulation, and deep learning-based RIS design. Finally,

we will present deploying RIS as a reflector in the wireless channel for aiding non-line-of-sight radar and joint radar-communications.

Biographical Sketch: Kumar Vijay Mishra (S'08-M'15-SM'18) obtained a Ph.D. in electrical engineering and M.S. in mathematics from The University of Iowa in 2015, and M.S. in electrical engineering from Colorado State University in 2012, while working on NASA's Global Precipitation Mission Ground Validation (GPM-GV) weather radars. He received his B. Tech. summa cum laude (Gold Medal, Honors) in electronics and communication engineering from the National Institute of Technology, Hamirpur (NITH), India in 2003. He is currently Senior Fellow at the United States Army Research Laboratory (ARL), Adelphi; Technical Adviser to Singapore-based automotive radar start-up Hertzwell and Boston-based imaging radar startup Aura Intelligent Systems; and honorary Research Fellow at SnT - Interdisciplinary Centre for Security, Reliability and Trust, University of Luxembourg. Previously, he had research appointments at Electronics and Radar Development Establishment (LRDE), Defence Research and Development Organisation (DRDO) Bengaluru; IIHR - Hydroscience & Engineering, Iowa City, IA; Mitsubishi Electric Research Labs, Cambridge, MA; Qualcomm, San Jose; and Technion - Israel Institute of Technology.

Dr. Mishra is the Distinguished Lecturer of the IEEE Communications Society (2023-2024), IEEE Aerospace and Electronic Systems Society (AESS) (2023-2024), IEEE Vehicular Technology Society (2023-2024), and IEEE Future Networks Initiative (2022). He is the recipient of the IET Premium Best Paper Prize (2021), U. S. National Academies Harry Diamond Distinguished Fellowship (2018-2021), American Geophysical Union Editors' Citation for Excellence (2019), Royal Meteorological Society Quarterly Journal Editor's Prize (2017), Viterbi Postdoctoral Fellowship (2015, 2016), Lady Davis Postdoctoral Fellowship (2017), DRDO LRDE Scientist of the Year Award (2006), NITH Director's Gold Medal (2003), and NITH Best Student Award (2003). He has received Best Paper Awards at IEEE MLSP 2019 and IEEE ACES Symposium 2019.

Dr. Mishra is Chair (2023-present) of the Synthetic Apertures Technical Working Group of the IEEE Signal Processing Society (SPS) and Vice-Chair (2021-present) of the IEEE Synthetic Aperture Standards Committee, which is the first SPS standards committee. He is the Vice Chair (2021-2023) and Chair-designate (2023-2026) of the International Union of Radio Science (URSI) Commission C. He has been an elected member of three technical committees of IEEE SPS: SPCOM, SAM, and ASPS, and IEEE AESS Radar Systems Panel. Since 2020, he has been Associate Editor of IEEE Transactions on Aerospace and Electronic Systems, where he was awarded Outstanding Editor recognition in 2021. He has been a lead/guest editor of several special issues in journals such as IEEE Signal Processing Magazine, IEEE Journal of Selected Topics in Signal Processing, and IEEE Journal on Selected Areas in Communications. He is the lead co-editor of three upcoming books on radar: Signal Processing for Joint Radar-Communications (Wiley-IEEE Press), Next-Generation Cognitive Radar Systems (IET Press Radar, Electromagnetics & Signal Processing Technologies Series), and Advances in Weather Radar Volumes 1, 2 & 3 (IET Press Radar, Electromagnetics & Signal Processing Technologies Series). His research interests include radar systems, signal processing, remote sensing, and electromagnetics.