

A Celebration of the

# Explorer I Mission and the Discovery of Earth's Radiation Belts

January 31, 2018



*The National  
Academies of*

SCIENCES  
ENGINEERING  
MEDICINE

#Explorer1

# AGENDA

- 12:30 pm Welcoming Remarks**  
*Marcia McNutt, National Academy of Sciences*  
*Michael Moloney, National Academies of Sciences, Engineering, and Medicine*
- 12:45 pm Introduction to Moderated Talks**  
*Thomas Zurbuchen, NASA*
- 12:50 pm The Van Allen Radiation Belt: U.S. Historical Perspective**  
*Louis Lanzerotti, New Jersey Institute of Technology*
- 1:20 pm The Vernov Radiation Belt: Russian Historical Perspective**  
*Alexander Moiseev, NASA*
- 1:50 pm Latest Results from Van Allen Probes**  
*Daniel Baker, University of Colorado Boulder*
- 2:20 pm Astonishing Achievements in Observing and Understanding Earth Systems**  
*Michael Freilich, NASA*
- 2:50 pm Coffee Break**
- 3:20 pm Moderated Talks with Next Generation Leaders**  
*Moderators: Thomas Zurbuchen, NASA*  
*Daniel Baker, University of Colorado Boulder*
- 3:25 pm Small Sat to Small Sats: Earth/Space Environment**  
*Robyn Millan, Dartmouth College*
- 3:50 pm Cutting Edge of Radiation Belt Research**  
*Allison Jaynes, University of Iowa*
- 4:15 pm Advances in Theoretical Modeling of Earth's Radiation Belts**  
*Wen Li, Boston University*
- 4:40 pm Moderated Discussion with Next Gen Leaders**
- 5:10 pm Closing Remarks**  
*Daniel Baker, University of Colorado Boulder*

**MARCIA MCNUTT** is a geophysicist and president of the National Academy of Sciences. From 2013 to 2016, she served as editor-in-chief of the Science journals. Prior to joining Science, she was director of the U.S. Geological Survey (USGS) from 2009 to 2013. During her tenure, the USGS responded to a number of major disasters, including earthquakes in Haiti, Chile, and Japan, and the Deepwater Horizon oil spill. McNutt led a team of government scientists and engineers at BP headquarters in Houston who helped contain the oil and cap the well. She directed the flow rate technical group that estimated the rate of oil discharge during the spill's active phase. For her contributions, she was awarded the U.S. Coast Guard's Meritorious Service Medal. Before joining the USGS, McNutt served as president and chief executive officer of the Monterey Bay Aquarium Research Institute (MBARI), in Moss Landing, California. During her time at MBARI, the institution became a leader in developing biological and chemical sensors for remote ocean deployment, installed the first deep-sea cabled observatory in U.S. waters, and advanced the integration of artificial intelligence into autonomous underwater vehicles for complex undersea missions. From 2000 to 2002, McNutt served as president of the American Geophysical Union (AGU). She was chair of the Board of Governors for Joint Oceanographic Institutions, responsible for operating the International Ocean Discovery Program's vessel JOIDES Resolution and associated research programs. McNutt began her academic career at the Massachusetts Institute of Technology (MIT), where she was the E.A. Griswold Professor of Geophysics and directed the Joint Program in Oceanography/Applied Ocean Science & Engineering, jointly offered by MIT and the Woods Hole Oceanographic Institution. Her research area is the dynamics of the upper mantle and lithosphere on geologic time scales, work that has taken her to distant continents and oceans for field observations. She is a veteran of more than a dozen deep-sea expeditions, on most of which she was chief or co-chief scientist. McNutt received a B.A. in physics from Colorado College and her Ph.D. in Earth sciences at the Scripps Institution of Oceanography. She holds honorary doctoral degrees from the Colorado College, the University of Minnesota, Monmouth University, the Colorado School of Mines, University of Miami, and Uppsala University. McNutt is a member of the American Philosophical Society and the American Academy of Arts and Sciences, and a Foreign Member of the Royal Society, UK and the Russian Academy of Sciences. She is a fellow of AGU, the Geological Society of America, the American Association for the Advancement of Science, and the International Association of Geodesy. In 1988, she was awarded AGU's Macelwane Medal for research accomplishments by a young scientist, and she received the Maurice Ewing Medal in 2007 for her contributions to deep-sea exploration.

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**MICHAEL H. MOLONEY** is the Director for Space and Aeronautics at the Space Studies Board and the Aeronautics and Space Engineering Board of the U.S. National Academies of Sciences, Engineering, and Medicine. Since joining the ASEP/SSB Dr. Moloney has overseen the production of more than 60 reports; including five decadal surveys—in astronomy and astrophysics, Earth science and applications from space, planetary science, microgravity sciences, and solar and space physics—prioritizations of NASA space technology roadmaps, a major report on the rational

for and future direction of the U.S. human spaceflight program, as well as reports on issues such as NASA's Strategic Direction, lessons learned from the decadal survey processes, the science promise of cubesats, the challenge of orbital debris, the future of NASA's astronaut corps, NASA's aeronautical flight research program, and national research agendas for autonomy and low-carbon propulsion in civil aviation. Since joining the Academies in 2001, Dr. Moloney has also served as a study director at the National Materials Advisory Board, the Board on Physics and Astronomy (BPA), the Board on Manufacturing and Engineering Design, and the Center for Economic, Governance, and International Studies. Dr. Moloney has served as study director or senior staff for a series of reports on subject matters as varied as quantum physics, nanotechnology, cosmology, the operation of the nation's helium reserve, new anti-counterfeiting technologies for currency, corrosion science, and nuclear fusion. Before joining the SSB and ASEB in 2010, Dr. Moloney was associate director of the BPA and study director for the 2010 decadal survey for astronomy and astrophysics (New Worlds New Horizons in Astronomy and Astrophysics). In addition to his professional experience at the Academies, Dr. Moloney has more than 7 years' experience as a foreign-service officer for the Irish government—including serving at the Irish Embassy in Washington and the Irish Mission to the United Nations in New York. A physicist, Dr. Moloney did his Ph.D. work at Trinity College Dublin in Ireland. He received his undergraduate degree in experimental physics at University College Dublin, where he was awarded the Nevin Medal for Physics. Dr. Moloney is a corresponding member of the International Academy of Astronautics and a Senior Member of the American Institute of Aeronautics and Astronautics. He is also a recipient of a distinguished service award from the National Academies of Sciences, Engineering, and Medicine.

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**THOMAS ZURBUCHEN** is the associate administrator for the Science Mission Directorate at NASA Headquarters in Washington, D.C. Previously, Dr. Zurbuchen was a professor of space science and aerospace engineering at the University of Michigan in Ann Arbor. He was also the university's founding director of the Center for Entrepreneurship in the College of Engineering. Zurbuchen's experience includes research in solar and heliospheric physics, experimental space research, space systems, and innovation and entrepreneurship. During his career, Zurbuchen has authored or coauthored more than 200 articles in refereed journals on solar and heliospheric phenomena. Although he has never worked for NASA, Zurbuchen has connections to the agency. He has been involved with several NASA science missions -- Ulysses, the MESSENGER spacecraft to Mercury, and the Advanced Composition Explorer (ACE).

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**LOUIS J. LANZEROTTI**, a native of Carlinville, Illinois, graduated in Engineering Physics from the University of Illinois and received AM and PhD degrees in physics from Harvard University. He joined AT&T Bell Laboratories in 1965, near the beginning of the commercial communication spacecraft era. He spent 37 years at Bell Labs



involved in research related to studies of the space environment around Earth, the giant outer planets, and the interplanetary medium. Since 2002 he has served as a Distinguished Research Professor at the New Jersey Institute of Technology. He has been Co-I or PI on numerous NASA missions (currently as PI on the Van Allen Probes mission), and has conducted ground-based research in the U.S., the Antarctic, and the Canadian North. Much of this research has been directed toward fundamental understandings of space weather and its effects upon technologies, especially communications systems. Lanzerotti has also participated as a member or chair of many committees and boards of NASA, NSF, and the National Academies, including as a past chair of the Academies Space Studies Board. President George W. Bush appointed him in 2004 to the National Science Board. He has been elected to the National Academy of Engineering (NAE) and the International Academy of Astronautics (IAA). His research and his policy contributions have resulted in many recognitions, including the Arthur M. Bueche Award of the NAE, the Basic Science Award of the IAA, the William Bowie Medal and the William Kaula Award of the American Geophysical Union (AGU), the William Nordberg Medal of COSPAR, the Space Weather Award of the American Meteorological Society, two NASA Distinguished Public Service Medals, the NASA Scientific Achievement Medal. He was founding Editor of the AGU journal Space Weather. He is a Fellow of the Institute of Electrical and Electronics Engineers, the American Institute of Aeronautics and Astronautics, the AGU, the American Physical Society, and the American Association for the Advancement of Science. Asteroid 5504 Lanzerotti recognizes his space-related research and Mount Lanzerotti (74°50' S, 71°33' W) recognizes his research in the Antarctic. He served three elected terms on his local school board and seven elected terms on his township governing body, including four years as mayor.

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**ALEXANDER MOISEEV** is a principal research scientist at NASA Goddard Space Flight Center (GSFC) and the University of Maryland, College Park. His research interest and expertise include experimental aspects of high energy astrophysics, cosmic antimatter, dark matter and techniques in particle physics, and he is currently the instrument scientist for the All-sky Medium Energy Gamma-ray Observatory (AMEGO) mission concept study. Dr. Moiseev has participated in many international space science missions, such as the Gamma-1 telescope (Russia), the Payload for Antimatter-Matter Exploration and Light-nuclei Astrophysics (PAMELA), the Balloon-borne Experiment with Superconducting Spectrometer (BESS), the Calorimetric Electron Telescope (CALET), and the Fermi Large Area Telescope (LAT), for which he was a lead scientist of one of the observatory's subsystems and led the investigations of high-energy cosmic-ray electrons. He has received numerous recognitions, including the Robert Goddard Exceptional Science Achievement Award, along with several NASA/GSFC and USRA Awards. Dr. Moiseev earned his PhD in physics from the Moscow Engineering Physics Institute.

**DANIEL N. BAKER** is director of the Laboratory for Atmospheric and Space Physics, University of Colorado – Boulder Campus. He is Distinguished Professor of Planetary and Space Physics at CU and is Professor of Astrophysical and Planetary Sciences and Professor of Physics. Dr. Baker received his Ph.D. working under Prof. James A. Van Allen and subsequently worked with Prof. Edward C. Stone as a Research Fellow in the Department of Physics at the California Institute of Technology. He was Group Leader for Space Plasma Physics at Los Alamos National Laboratory and was Division Chief at NASA's Goddard Space Flight Center. Dr. Baker presently holds the Moog-Broad Reach Endowed Chair of Space Sciences at the University of Colorado Boulder. He has edited eight books and published over 750 papers in the refereed literature. He is a Fellow of the American Geophysical Union, the International Academy of Astronautics, the American Institute of Aeronautics and Astronautics, and the American Association for the Advancement of Science. Dr. Baker was chosen as a 2007 winner of the University of Colorado's Robert L. Stearns Award for outstanding research, service, and teaching and was the CU Distinguished Research Lecturer in 2010. Dr. Baker also was the 2010 winner of the AIAA James A. Van Allen Space Environments Medal. He currently is lead investigator on several NASA space missions including the NASA Magnetospheric Multiscale (MMS) mission and the NASA Radiation Belt Storm Probes (Van Allen Probes) mission. He was a member of the 2006 Decadal Review of the U.S. National Space Weather Program and chaired the National Research Council's 2013-2022 Decadal Survey in Solar and Space Physics. In 2015 Dr. Baker was chosen as the Vikram A. Sarabhai Professor of the Indian Physical Research Laboratory. He also received the Shen Kuo Medal of the International Association of Geomagnetism and Aeronomy (IAGA) for his interdisciplinary leadership in space and Earth sciences. He was chosen in 2016 as winner of the Colorado Governor's Award for High-Impact Research related to his Space Weather research.

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**MICHAEL FREILICH** is the director of the Earth Science Division of the Science Mission Directorate (SMD) at NASA Headquarters. He also currently serves as vice-chair of the US Global Change Research Program and as the NASA principal to the Committee on Earth Observation Satellites (CEOS). Prior to joining SMD, Dr. Freilich was a professor and associate dean at Oregon State University and a researcher at the Jet Propulsion Laboratory, where he led the NSCAT, QuikSCAT, and SeaWinds scatterometer satellite missions. He previously served as chair of the Committee on Earth Observation Satellites Strategic Implementation Team. Dr. Freilich is an elected Fellow of the American Meteorological Society (AMS) and has received numerous awards and recognitions, including the JPL Director's Research Achievement Award, the NASA Public Service Medal, and the AMS Verner Suomi Award. He earned his Ph.D. from Scripps Institution of Oceanography, studying nonlinear interactions in nearshore waves. Dr. Freilich has served on the National Research Council's (NRC) Ocean Studies Board and Space Studies Board, chaired the NRC Committee on Earth Studies, and he was selected to deliver the NRC/Smithsonian Roger Revelle Commemorative Lecture.

**ROBYN MILLAN** is the Margaret Anne and Edward Leede '49 Distinguished Professor of Physics and Astronomy at Dartmouth College. Her research includes the use of high-altitude scientific balloons and satellites to study Earth's radiation belts. Dr. Millan was principal investigator for the Balloon Array for Radiation belt Relativistic Electron Losses (BARREL), which studies radiation belt electron loss in conjunction with NASA's Van Allen Probes. She also served as secretary for the Space Physics and Aeronomy section of the American Geophysical Union from 2013-2016. In 2017, she was awarded a NASA Exceptional Public Achievement Medal and the Dartmouth John M. Manley Huntington Award for Newly Promoted Faculty. Dr. Millan earned her Ph.D. in physics at the University of California, Berkeley. She has served on the National Academies Committee on the Role and Scope of Mission-Enabling Activities in NASA's Space and Earth Science Missions, the Panel on Solar Wind-Magnetosphere Interactions for the Committee for a Decadal Strategy for Solar and Space Physics (Heliophysics), and the Committee on Achieving Science Goals with CubeSats. She is currently serving as Co-chair for the COSPAR Roadmap study, "Small Satellites for Space Sciences", and is a member of the Space Studies Board standing Committee on Solar and Space Physics.

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**ALLISON N. JAYNES** is an assistant professor in the Department of Physics and Astronomy at the University of Iowa. Her research is focused on experimental space physics, using satellites and sounding rockets to study high-energy particle dynamics of the radiation belts and inner magnetosphere, solar driving of the near-Earth space environment, and the physics of the aurora in the ionosphere, with an emphasis on student involvement in fundamental research and hardware. Dr. Jaynes previously served as a member of the radiation belts research group at the Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, where she became a Co-Investigator for NASA's Van Allen Probes and Magnetosphere Multiscale (MMS) missions. Dr. Jaynes earned her Ph.D. in Physics from the University of New Hampshire.

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**WEN LI** is an assistant professor in the Department of Astronomy and the Center for Space Physics at Boston University. Her research is focused on the study of space plasma waves, the physics of Earth's radiation belts, solar wind magnetospheric coupling, energetic particle precipitation, and Jupiter's magnetosphere and aurora. Dr. Li previously served as an associate researcher in the Department of Atmospheric and Oceanic Sciences at the University of California Los Angeles (UCLA). She has received numerous awards and recognitions, including the James B. Macelwane Medal from the American Geophysical Union and the Air Force Young Investigator Award. Dr. Li earned her Ph.D. in Atmospheric and Oceanic Sciences from UCLA.

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