Astrobiology Science Strategy for the Search for Life in the Universe

Committee

Barbara Sherwood Lollar

Chair

BARBARA SHERWOOD LOLLAR is a university professor at the University of Toronto in the Department of Geology. She is also director of the Stable Isotope Laboratory and Canada Research Chair in Isotopes of the Earth and Environment. She leads research programs in deep crustal fluids, hydrocarbon geochemistry, the deep subsurface biosphere, and groundwater quality and remediation. Her work in geochemistry and microbiology have led her to research the habitability of the isolated, deep hydrosphere and its implications for life elsewhere in the solar system. Dr. Sherwood Lollar is a Companion to the Order of Canada and a former president of the Geochemical Society. She has received the NSERC John C. Polanyi Award, the Eni Prize for the Protection of the Environment, and the GSA Geomicrobiology and Geobiology Division Award. Dr. Lollar received her Ph.D. in Earth sciences from the University of Waterloo. She has served as a member of the Academies' Space Studies Board, a member of the Future of U.S. Civil Space Policy: A Workshop, the Committee on Astrobiology and Planetary Science, and the Committee on the Origins and Evolution of Life.

Sushil K. Atreya

Member

SUSHIL K. ATREYA is a professor of climate and space sciences and engineering at the University of Michigan. He is also director of the Planetary Science Laboratory at the University of Michigan. His research focus is the origin and evolution of planetary and satellite atmospheres (including giant planets, Titan, Mars, and Venus), planetary habitability, and exoplanets. He has served as a co-investigator on many planetary exploration missions including NASA's Mars Science Laboratory, Juno Jupiter Polar Orbiter, ESA's Mars Express, Cassini-Huygens, Galileo, Voyager, Venus Express, and a number of Roscosmos and JAXA missions. He has received the David Bates Medal of the European Geosciences Union for exceptional contributions to planetary and solar system sciences, the NASA award for exceptional scientific contributions to the Voyager missions to the giant planets, the NASA Group Achievement Awards for outstanding scientific contributions with the Voyager Ultraviolet Spectrometer, for exceptional technical innovations in surface operations of MSL Prime Mission, for outstanding scientific contributions with the Galileo Probe mass spectrometer, and for outstanding contributions to the Galileo Project at Jupiter. Dr. Atreya is a fellow of the American Association for the Advancement of Science, a member of the International Academy of Astronautics, and a distinguished visiting scientist at the Jet Propulsion Laboratory. He is the author of Atmospheres and Ionospheres of the Outer Planets and their Satellites as well as editor of Origin and Evolution of Planetary and Satellite Atmospheres and two other books. He has served as a co-chair of the Venus Exploration Analysis Group (VEXAG) and as a member of the Steering Committee of the Outer Planets Assessment Group (OPAG). He earned his B.S. and M.S. in physics from the University of Rajasthan, an M.S. in physics from Yale, and his Ph.D. in atmospheric and space science from the University of Michigan. Dr. Atreya has served as a member on the Academies' Committee on the Assessment of Solar System Exploration, the Panel on Space Sciences, and the Committee on Astrobiology and Planetary Science.

Alan P. Boss

Member

ALAN P. BOSS is a research staff member at the Carnegie Institution. Dr. Boss's research addresses the formation of stars and planetary systems by using both theoretical models of solar system formation and observational instruments and techniques. He helped develop the disk instability model of solar system formation. Dr. Boss is a member of the American Academy of Arts and Sciences, and is a fellow of the American Association for the Advancement of Science, the Meteoritical Society, and the American Geophysical Union. He chairs NASA's Exoplanet Exploration Program Technology Assessment Committee and NASA's Exoplanet Exploration Program Analysis Group. He is also a member of NASA's Astrophysics Advisory Committee. Dr. Boss earned his Ph.D. in physics from the University of California at Santa Barbara. He has served on the Academies' Astro2010 Panel on Electromagnetic Observations from Space, the Committee on Planetary and Lunar Exploration, and the Committee for US-USSR Workshop on Planetary Sciences.

Paul G. Falkowski

Member

PAUL G. FALKOWSKI, NAS, is the Bennett L. Smith Professor of Business and Natural Resources at Rutgers, the State University of New Jersey. He is also director of the Rutgers Energy Institute. His research interests focus on three areas including the origin of life, electron transfer mediation, and how organisms transformed terrestrial geochemistry. In pursuing these interests, he is involved with research into biogeochemical cycles, biological oceanography, molecular biology, physiological adaptation, and plant physiology. He is also the lead principal investigator in the Environmental Biophysics and Molecular Ecology Program, which focuses on molecular biology and biophysics to address key questions in biological oceanography and marine biology. Dr. Falkowski's awards include the Rutgers University Board of Trustees Award for Excellence in Research and the European Geosciences Union's Vernadsky Medal. He earned his Ph.D. in biology from the University of British Columbia. Dr. Falkowski has served on many National Academies' committees, including the Committee on Environmental Science and Assessment for Ocean Energy Management, the Committee on Geoengineering Climate: Technical Evaluation and Discussion of Impacts, and the 2015 NAS Class VI Membership Committee. He has served as chair of Section 63: Environmental Sciences and Ecology in the NAS.

Jack D. Farmer

Member

JACK D. FARMER is a professor of geological sciences at Arizona State University in the School of Earth and Space Exploration. His research interests include microbial bio-sedimentology and the evolution of Earth's early biosphere. He is particularly interested in understanding the factors that control biosignature preservation and how that knowledge can be translated into strategies for the search for evidence of past life on Mars. Prior to joining the faculty at Arizona State University, Dr. Farmer was a research scientist in the Exobiology Branch of NASA's Ames Research Center. He was instrumental in the selection of the landing sites for Mars Pathfinder and the Mars Exploration Rovers. Dr. Farmer served on the science definition team for the Mars Odyssey and Mars Reconnaissance Orbiter missions. He has chaired the NASA Astrobiology Institute's Mars Focus Group and the community-based Mars Exploration Program Analysis Group. Dr. Farmer is a Sequoyah Fellow of the American Indian Science and Engineering Society. Dr. Farmer is a past member of NASA's Space Sciences Advisory Committee. He earned his Ph.D. in geology and paleobiology from the University of California, Davis. He has served on several Academies' boards and committees including the Space Studies Board, the Committee to Review the NASA Astrobiology Institute, the Committee for the Review of NASA Science Mission Directorate Science Plan, and the Committee on the Review of Planetary Protection Requirements for Mars Sample-Return Missions, which he chaired.

Olivier Guyon

Member

OLIVIER GUYON is an associate astronomer and associate professor of optical sciences at The University of Arizona in the Department of Astronomy and Steward Observatory. There, his research focuses on innovative techniques for detecting and imaging extrasolar planets, coronography, and wavefront sensing techniques for adaptive optics. He is also an affiliate of the Astrobiology Center of the National Institutes of Natural Sciences of Japan and of NASA's Jet Propulsion Laboratory. He serves as a member of NASA's science and technology definition teams for the WFIRST, HabEx, and LUVOIR mission concepts. Previously, Dr. Guyon worked as a project scientist with the Subaru Telescope of the University of Hawaii. He has been the recipient of the MacArthur fellowship, of the Presidential Early Career Award for Scientists and Engineers, and of the Daniel Guinier young researcher award of the French Society of Physics. Dr. Guyon earned his Ph.D. in astronomy from the Pierre and Marie Curie University.

Gerald F. Joyce

Member

GERALD F. JOYCE, NAS/NAM, is a professor at the Salk Institute for Biological Studies. He is also institute director of the Genomics Institute of the Novartis Research Foundation (GNF). Broadly, Dr. Joyce's research concerns the origin of life itself. He is a pioneer in the field of in vitro evolution, which re-creates the biomolecules of early life, their assembly into RNA, and their evolution, all within the laboratory environment. His work has furthered the understanding of how life arose from abiotic chemistry. For this work, he has received the U.S. National Academy of Sciences Award in Molecular Biology and the U.S. National Academy of Sciences Miller Award. Dr. Joyce received his Ph.D. in neurosciences and chemistry and his M.D. in medicine from the University of California, San Diego. He previously served on the Academies' Committee on International Security and Arms Control and the 2004 NAS Award in Molecular Biology Selection Committee.

James F. Kasting

Member

JAMES F. KASTING is the Evan Pugh Professor at The Pennsylvania State University in the Department of Geosciences. His research interests include atmospheric evolution, planetary atmospheres, paleoclimates, and the search for habitable planets beyond the solar system. Previously, Dr. Kasting worked at the National Center for Amotpheric Research in Boulder, Colorado and the Space Science Division at NASA-Ames Research Center. He is a fellow of the American Association for the Advancement of Science, the International Society for the Study of the Origin of Life, and the American Geophysical Union. He has published dozens of papers and three books. Dr. Kasting earned his Ph.D. in atmospheric sciences from the University of Michigan. He has served on several Academies' committees, including the Committee on Astrobiology and Planetary Sciences, Searching for Life Across Space and Time: A Workshop, and the Committee on the Astrophysical Context of Life.

Victoria S. Meadows

Member

VICTORIA S. MEADOWS is a professor of astronomy at the University of Washington in the Department of Astronomy. There, she is also director of the Astrobiology Program and principal investigator for the NASA Astrobiology Institute's Virtual Planetary Laboratory. Her research interests include theoretical modeling of terrestrial planetary environments to understand their habitability, the generation and detectability of planetary biosignatures and their false positives, and solar system planetary observations. The overarching goal of her research is to determine how to recognize whether a distant extrasolar planet can or does support life. Previously, Dr. Meadows was a research scientist at the Jet Propulsion Laboratory and an associate research scientist at the Spitzer Science Center at the California Institute of Technology. She is a recipient of several NASA Group Achievement Awards, has been on the SETI Institute Science Advisory Board, and was a Frontiers of Science Kavli Fellow. She earned her Ph.D. in physics from the University of Sydney. Dr. Meadows served on the Academies' Searching for Life Across Space and Time: A Workshop committee.

Philip M. Neches

Member

PHILIP M. NECHES, NAE, is the founder of Teradata Corporation. He is a trustee of the California Institute of Technology and is a lead mentor and venture partner at Entrepreneurs Roundtable Accelerator in New York City. Dr. Neches's interests include big data, information systems architecture, nanotechnology, start-ups, business strategy, and engineering education. He has been an independent consultant, director, and advisor at a number of public and private information technology companies. Previously, he was vice president and group technology officer for the AT&T Multimedia Products and Services Group and senior vice president and chief scientist of NCR Corporation. Dr. Neches has received a Product of the Year Award on behalf of the Teradata Corporation. Dr. Neches received his Ph.D. in computer science at the California Institute of Technology. He has served on several Academies' committees including Searching for Life Across Space and Time: A Workshop, the Committee on A Vision for the Future of Center-Based, Multidisciplinary Engineering Research, and the Panel on Review of the Information Technology Laboratory at the National Institute of Standards and Technology.

Carl B. Pilcher

Member

CARL B. PILCHER is a research scientist at the Blue Marble Space Institute of Science. Previously, he acted as interim director of the NASA Astrobiology Institute (NAI), a position he accepted after retiring as director of the NAI. During his tenure he facilitated numerous multi-disciplinary collaborations, particularly within the Origins of Life research portfolio, and steered the institute toward a more direct, supportive role in spaceflight missions. Before moving to management of the NAI, Dr. Pilcher served as program scientist for NASA's Kepler Mission and NASA's participation in the Keck Observatory. His academic background includes a faculty position in the Department of Physics and Astronomy at the University of Hawaii, where he analyzed Neptune's atmosphere and participated in the discovery of methane ice on Pluto. As a graduate student, he led scientific teams that discovered water ice in Saturn's rings and on three of Jupiter's Galilean satellites including Europa. Dr. Pilcher has received the NASA Exceptional Achievement Medal, numerous Group Achievement Awards, and an Ames Honor Award. He received his Ph.D. in chemistry from the Massachusetts Institute of Technology. He has not previously served on an Academies' committee

Nilton O. Renno

Member

NILTON O. RENNÓ is a professor at the University of Michigan. He is also chair of the department's master's programs, and director of the Master of Engineering program in Space Engineering. Dr. Rennó's research interests include aerosols and climate, astrobiology, aviation, instrument development, planetary science, thermodynamics, and systems engineering. He studies the physical processes that control the climate of Earth and other planets and works on the design and fabrication of instruments for this purpose. Previously, Dr. Rennó was a tenured associate professor in the Department of Planetary Sciences at the University of Arizona. He has received the Space Foundation John L. "Jack" Swigert Jr. Award for Space Exploration, the American Institute of Aeronautics and Astronautics Foundation's Award for Excellence, and the National Aeronautic Association's Robert J. Collier Trophy for his work on NASA's Mars Science Laboratory and Curiosity rover missions, as well as several individual and NASA Group Achievement Awards. He earned his Ph.D. in atmospheric sciences from the Massachusetts Institute of Technology. He has served as a member on the Academies' Panel on Earth Sciences, Committee on the Review of MEPAG Report on Planetary Protection for Mars Special Regions, and Searching for Life Across Space and Time: A Workshop.

Karyn L. Rogers

Member

KARYN L. ROGERS is an assistant professor at Rensselaer Polytechnic Institute in the department of Earth and Environmental Sciences. There, Dr. Rogers' research focuses on the relationships between microbial communities and environmental conditions in extreme ecosystems and is broadly applied to understanding the nature and the origin of life on Earth, the potential for life throughout the solar system, and the extent of life in modern extreme environments. To study these themes and develop a holistic understanding of functional microbial ecosystems, she employs a combination of fieldwork in several terrestrial hydrothermal systems and modern deep-sea mid-ocean ridge environments with extensive laboratory analytical and experimental techniques. Previously, Dr. Rogers worked as a research scientist at the Carnegie Institution of Washington (now Carnegie Institution for Science), as an assistant professor at the University of Missouri, and as a postdoctoral scholar in the Deep Ocean Exploration Institute at Woods Hole Oceanographic Institution. She is associate director of the New York Center for Astrobiology, a member of the Institute for Data Exploration and Applications, and U.S. lead and co-director for the Sloan Foundation Deep Carbon Observatory's PRIME (Peizophile Retrieval Instrumentation for Microbial Explorations) Facility. She serves as co-organizer of the University-National Oceanographic Laboratory System Deep Submergence Science Committee New User Program. Dr. Rogers earned a Ph.D. in earth and planetary sciences from Washington University, an A.M. in earth and planetary sciences from Washington University, an M.S. in geological and environmental sciences from Stanford University, and an A.B. in environmental science and public policy and earth and planetary sciences from Harvard University. She has not previously served on an Academies committee.

Britney E. Schmidt

Member

BRITNEY E. SCHMIDT is an assistant professor at the Georgia Institute of Technology. Dr. Schmidt is the principal investigator of the Ross Ice Shelf and Europa Underwater Probe (RISE-UP), an interdisciplinary astrobiology and oceanographic investigation leveraging remote sensing and autonomous underwater vehicles to examine Earth's ice shelves as analogs for extraterrestrial icy moons and their potential for habitability. Her research interest in the astrobiology of icy systems focuses on Europa, where she models the formation of surface terrain to better understand ice-ocean interactions and works on a variety of instrument technology and platforms for subsurface exploration. Dr. Schmidt is also a participating scientist on NASA's Europa Clipper radar team, a member of the Europa Lander and LUVOIR science definitions teams, and an associate of the Dawn mission. She was previously a postdoctoral fellow at the University of Texas at Austin, where she was named outstanding early career researcher. She is recipient of a NASA Early Career Fellowship and the Eric R. Immel Memorial Award for Excellence in Teaching of the Georgia Tech College of Science. Dr. Schmidt earned her Ph.D. in geophysics and space physics from the University of California, Los Angeles. She has not previously served on an Academies' committee.

Roger Summons

Member

ROGER E. SUMMONS is the Schlumberger Professor of Geobiology at the Massachusetts Institute of Technology. His research focuses on the biogeochemistry and geobiology of microbially-dominated ecosystems, early life on the Earth, indicators of climate change, biomarkers, and terrestrial and extraterrestrial biogeochemical fossils. Dr. Summons is a fellow of the Australian Academy of Science, the Royal Society, the American Geophysical Union, the American Society for Microbiology and the Geochemical Society. He earned his Ph.D. in chemistry from the University of NSW, Wollongong University College. Dr. Summons has previously served on the National Academies' Committee on Astrobiology Strategy for the Exploration of Mars, Committee on the Limits of Organic Life in Planetary Sciences, and Committee on the Origins and Evolution of Life, among others.

Frances Westall

Member

FRANCES WESTALL is a research scientist at the Centre National de la Recherche Scientifique, where she is also director of the Exobiology Group. Dr. Westall and her laboratory lead the biosignature group of the European Space Agency's ExoMars mission Site Selection Committee and are engaged in instrument development for the in situ detection of biosignatures on extraterrestrial bodies. Her research interests include the early Earth environment and geologic context of early life, the formation of prebiotic molecules, the earliest preserved traces of life, and the search for life in the solar system. Previously, Dr. Westall conducted research in geobiology at the Universities of Nantes (France) and Bologna (Italy) and in bacterial palaeontology, prebiotic molecules, and traces of life in Martian meteorites at the Lunar and Planetary Institute and NASA's Johnson Space Center. Dr. Westall has co-authored publications that have been awarded the Gerald A. Soffen Memorial Award and the WITec Paper Award. She earned her Ph.D. in marine geology from the University of Cape Town, South Africa. Dr. Westall served as a member of the Academies' Committee on the Review of MEPAG Report on Planetary Protection for Mars Special Regions.

Shelley A. Wright

Member

SHELLEY A. WRIGHT is an assistant professor at the University of California, San Diego in the Center for Astrophysics and Space Sciences. Dr. Wright is an observational and experimental astrophysicist whose research concentrates on understanding how galaxies and supermassive black holes form and evolve. She is particularly engaged in the design and construction of innovative advanced, near-infrared and optical astronomical instrumentation, and she has led instrument programs at the Lick and Keck Observatories. She is project scientist for the Near-Infrared Integral Field Spectrograph and Imager for AO corrected images (IRIS) on the Thirty Meter Telescope. She is also an instrumentalist for the Search for Extraterrestrial Intelligence (SETI). Previously, Dr. Wright worked as a postdoctoral fellow under the University of California Presidential Postdoctoral Fellowship and Hubble Postdoctoral Fellowship. Dr. Wright earned her Ph.D. in astrophysics from the University of California, Los Angeles. She has not previously served on an Academies' committee.