Elementary Particle Physics: Progress and Promise

Committee

Maria Spiropulu

Co-Chair

Maria Spiropulu is the Shang-Yi Ch'en Professor of Physics for the Division of Physics, Mathematics, and Astronomy at the California Institute of Technology. Spiropulu is an experimental particle physicist whose research program encompasses searches for new physics, the search for dark matter, and cross-disciplinary questions across particle physics, astrophysics and cosmology. Spiropulu was named a fellow of the AAAS "for her leadership in experimental high-energy physics, in particular for her pioneering efforts in the experimental search for supersymmetry and extra dimensions;" and was named an American Physical Society fellow ”for pioneering searches for supersymmetry and extra dimensions at the Tevatron, innovative searches for new physics and the study of the Higgs boson at the Large Hadron Collider and key contributions to triggering and data flow for the Collider Detector at Fermilab and the Compact Muon Solenoid” Spiropulu previously served as member of the High Energy Physics Advisory Panel to the U.S. Department of Energy and the National Science Foundation and chair of the Forum of International Physics. Spiropulu received a Ph.D. in physics from Harvard University.

Michael S. Turner

Co-Chair

Michael S. Turner, NAS, is the senior strategic advisor at the Kavli Foundation and the Bruce V. and Diana M. Rauner Distinguished Service Professor, Emeritus at the University of Chicago. Turner has played a major role in bringing together elementary particle physics and astrophysics/cosmology through research into inflationary cosmology, particle dark matter, and the nature of dark energy. Turner previously served as director of the Kavli Institute for Cosmological Physics and as president of the American Physical Society (APS). Turner's research has been recognized with the APS's Lilienfeld Prize, and the American Astronomical Society's Warner Prize; Turner is a fellow of the APS, the American Association for the Advancement of Science and the American Academy for Arts and Sciences and a winner of the Klopsted Prize of the American Association for Physics Teachers. Turner received a Ph.D. in physics from Stanford University.

Nima Arkani-Hamed

Member

Nima Arkani-Hamed (NAS) is a professor at the Institute for Advanced Study. Arkani-Hamed is a theorist with wide-ranging interests, including the relation between theory and experiment, with a special focus on current and future particle accelerators as well as cosmological observations. Arkani-Hamed has made wide-ranging contributions to theoretical physics ranging from proposals for new models of particle physics and cosmology to the discovery of new mathematical structures in quantum field theory. For this work, Arkani-Hamed received a Ph.D. in physics from the University of California, Berkeley.

Barry C. Barish

Member

Barry C. Barish (NAS) is the Linde Professor of Physics, Emeritus at the California Institute of Technology. Among Barish's noteworthy experiments were those performed at Fermilab using high-energy neutrino collisions to reveal the quark substructure of the nucleon. These experiments were among the first to observe the weak neutral current, a linchpin of the electroweak unification theories of Glashow, Salam, and Weinberg. Barish initiated an ambitious international effort to build a sophisticated underground detector to search for the magnetic monopole and make observations in the emerging area of particle astrophysics. Experiments conducted underground in the Gran Sasso Tunnel in Italy provided some of the key evidence that neutrinos have mass. Barish served as director of the Laser Interferometer Gravitational-Wave Observatory (LIGO) project to build two large facilities to search for gravitational waves from astrophysical sources. Barish received the Klopsteg Award of the American Association of Physics Teachers. Barish is an elected fellow of the American Academy of Arts, the American Association for the Advancement of Science and the American Physical Society (APS), is a past vice president of the APS, and an alumnus of the National Science Board. Barish received a Ph.D. in physics from the University of California, Berkeley.

John F. Beacom

Member

John F. Beacom is the Henry L. Cox Professor of Physics and Astronomy as well as an Arts and Sciences Distinguished Professor at the Ohio State University. He is also the Director of the Center for Cosmology and AstroParticle Physics. His research interests focus on the intersections of the fields of astrophysics, particle physics, and nuclear physics, especially neutrinos. Prior to joining the Ohio State University, Beacom was a David N. Schramm Fellow of the Theoretical Astrophysics Group at Fermilab, and a Sherman Fairchild Postdoctoral Scholar at Caltech. He is the recipient of numerous recognitions, including being a Fermilab Distinguished Scholar, a Divisional Associate Editor of Physical Review Letters, a Fellow of the American Physical Society, and the winner of two major teaching awards at the Ohio State University. Beacom received his Ph.D. in physics from the University of Wisconsin. He has previously served as Co-Chair of the Panel on Particle Astrophysics and Gravitation for Astro2020.

Philip H. Bucksbaum

Member

Phillip H. Bucksbaum (NAS) is the Marguerite Blake Wilbur Professor in Natural Science appointed to the Departments of Physics, Applied Physics, and Photon Science. He formerly directed the Photon Ultrafast Laser Science and Engineering Institute at

Stanford University. Dr. Bucksbaum received his Ph.D. in Physics from the University of California at Berkeley in 1980. Following a postdoctoral year at Lawrence Berkeley National Laboratory, he joined the staff of Bell Telephone Laboratories in New Jersey,

first as a postdoc at Holmdel, and later as a member of the technical staff at Murray Hill. He was appointed Professor of Physics at the University of Michigan in 1990, where he became the Otto Laporte Collegiate Professor in 1998 and the Peter Franken University

Professor in 2005. At Michigan, he also was the Associate Director for Science at the Center for Ultrafast Optical Science, and the Director of the FOCUS Center, a National Science Foundation Physics Frontier Center. In 2006, Bucksbaum moved to the SLAC National Accelerator Laboratory and Stanford University, and in 2009, he became the Marguerite Blake Wilbur Professor in Natural Science. He has joint appointments in the Physics Department, the Applied Physics Department, and the SLAC Photon Sciences Department, and he served as Department Chair of Photon Science from 2007-2010. He also currently directs the Chemical Sciences Research Division at SLAC. Dr. Bucksbaum has more than 200 publications. He has contributed to several areas of atomic physics and ultrafast science, including strong-field laser-atom interactions, Rydberg wave packets, ultrafast quantum control, and ultrafast X-ray physics. Most recently, he has helped to pioneer ultrafast research at X-ray free electron lasers. He has served on several NRC committees, including as chair of the Board on Physics and Astronomy, Co-Chair of the Committee on AMO2010 – An Assessment of and Outlook for Atomic Molecular and Optical Science, and Committee on Atomic, Molecular, and Optical Sciences (CAMOS). He has been a member of numerous advisory committees, including for the Department of Energy Division on Basic Energy Sciences and the National Institute of Standards and Technology’s Committee for Physics. Dr. Bucksbaum was President of Optica in 2014, and President of APS in 2020. He has served on the

Editorial Board of Physical Review Letters, and was the founding editor of the American Institute of Physics Virtual Journal of Ultrafast Science. At Stanford and SLAC, he has served as Chair of the Photon Science faculty and also Director of the Chemical Science

Division. He is a member of the National Academy of Sciences, and a Fellow of the American Academy of Arts and Sciences.

Marcela Carena

Member

Marcela Carena is the Executive Director of the Perimeter Institute for Theoretical Physics in Canada. Carena is also jointly appointed as a particle physicist at Fermi National Accelerator Laboratory (Fermilab) and a physics professor at the University of Chicago, where Carena has been a member of both the Enrico Fermi Institute and the Kavli Institute for Cosmological Physics. Carena's previous positions include Chair of the Theoretical Physics Department and Director of the Theory Division at Fermilab. Carena is a renowned particle physicist who has advanced our understanding of fundamental mysteries of science related to sourcing the mass of the fundamental particles in nature, the origin of matter in the universe and the nature of dark matter. Carena has been a leader in exploring radical concepts such as electroweak baryogenesis, supersymmetry and warped extra dimensions, particularly in showing how these ideas can be tested in terrestrial experiments or cosmic observatories. Carena's most recent research program explores particle physics and quantum information to tackle problems of quantum theory in the early universe. Carena is an original co-author of the Status of the Higgs Boson review of the Particle Data Book. Carena is a fellow of the American Association for the Advancement of Science and the American Physical Society and was appointed to the National Academy of Exact, Physical and Natural Sciences of Argentina. In 2022 Carena was honored as a U.S. DOE Office of Science Distinguished Scientist Fellow. In 2013 Carena was a Simons Distinguished Visiting Scholar at the Kavli Institute in the University of California, Santa Barbara. Carena was a staff member and a John Stuart Bell Fellow at CERN and was awarded a Marie Sklodowska-Curie Fellowship of the European Commission to conduct research at Deutsches Elektronen-Synchrotorn DESY. Marcela Carena received her Diplome in Physics from the Balseiro Institute, University of Cuyo in Argentina and her Ph.D. in physics from the University of Hamburg, Germany.

Bonnie T. Fleming

Member

Bonnie T. Fleming is Deputy Director for Science and Technology and Chief Research Officer at Fermi National Accelerator Laboratory. Fleming's research interests include neutrino physics both to understand their nature and to learn what they can tell us about the universe. Specifically, Fleming participates in primarily accelerator based long and short baseline neutrino experiment studying neutrino oscillations, neutrino cross sections, and searches for beyond the standard model physics using neutrinos. Fleming also researches new detector technologies relevant primarily for neutrino physics and dark matter experiments. Fleming is a fellow of the American Physical Society (APS) and a recent recipient of the APS Division of Particles and Fields's mentoring award. Fleming served most recently as a co-chair of the U.S. Department of Energy's Basic Research Needs Study on Instrumentation in Particle physics. Fleming is currently co-chairing a HEPAP subpanel on International Benchmarking in High energy physics. Fleming co-chaired the DOE/NSF High Energy Physics Advisory Panel (HEPAP) International Benchmarking Subpanel from February 2022-December 2023. Fleming received a Ph.D. in physics from Columbia University.

Fabiola Gianotti

Member

Fabiola Gianotti (NAS) is research physicist and director general at CERN. Gianotti's thirty-year-long scientific activity inscribes itself in the field of particle physics at high-energy accelerators. Gianotti participated in the design and detector research and development and construction of the liquid-argon electromagnetic calorimeter for the ATLAS experiment, a device used to detect and measure electrons and photons with high precision. Gianotti has also been a member of several international scientific committees, including the Scientific Council of the CNRS (France), the Physics Advisory Committee of the Fermilab Laboratory (USA), the Scientific Council of the DESY Laboratory (Germany), and the Scientific Advisory Committee of NIKHEF (Netherlands). Gianotti was also a member of the Scientific Advisory Board of the UN Secretary-General. Gianotti was awarded the honor of “Cavaliere di Gran Croce dell’ordine al merito della Repubblica”, the Special Breakthrough Prize in Fundamental Physics Prize), the Enrico Fermi Prize of the Italian Physical Society, the Medal of Honour of the Niels Bohr Institute of Copenhagen and the Tate Medal of the American Institute of Physics for International Leadership. Gianotti received a Ph.D. in particle physics from the University of Milan.

David J. Gross

Member

David Gross (NAS) is the Chancellor’s Chair Professor of Theoretical Physics and former director of the Kavli Institute for Theoretical Physics (KITP) at the University of California, Santa Barbara. Before joining KITP, Gross was the Thomas Jones Professor of Mathematical Physics at Princeton University. Gross was awarded the 2004 Nobel Prize in Physics (with Politzer and Wilczek), “for the discovery of asymptotic freedom in the theory of the strong interaction.” Other awards include: Sakurai Prize, MacArthur Fellowship, Dirac Medal, Oskar Klein Medal, Harvey Prize, High Energy and Particle Physics Prize (European Physical Society), Grande Médaille d’Or (French Academy of Sciences). Memberships include: American Academy of Arts and Sciences, American Philosophical Society, Indian, Chinese and Russian Academies of Science. Gross is former President of the American Physical Society. Gross received a Ph.D. in physics from the University of California, Berkeley.

Salman Habib

Member

Salman Habib is a Distinguished Fellow and Division Director at Argonne National Laboratory and holds joint appointments at The University of Chicago and Northwestern University. Habib's research interests and contributions cover a broad span of research, ranging across nonequilibrium field theory and quantum information, physics of the early Universe, nonlinear dynamics, and the formation and evolution of cosmological structures. Habib also leads efforts in the areas of algorithms and computational methods, high-performance computing, and advanced statistical methods and machine learning. Prior to joining Argonne, Habib was a staff member in Los Alamos National Laboratory's Theoretical Division. Habib is a Fellow of the American Physical Society and recipient of the IEEE Computer Society's Sidney Fernbach Award for “pioneering fundamental physics applications from the smallest to largest scales on three decades of emerging forefront computing platforms.” Habib received a PhD in physics from the University of Maryland.

Young-Kee Kim

Member

Young-Kee Kim (NAS) is the Louis Block Distinguished Service Professor of Physics at The University of Chicago. Kim’s research interests lie in experimental particle physics at the A Toroidal LHC ApparatuS (ATLAS) experiment with the LHC proton-proton collider at CERN, and accelerator physics at the NSF’s the Center for Bright Beams. Kim chairs the KEK Science Advisory Committee and the TRIUMF Advisory Committee, and serves on the Board at Lawrence Berkeley National Laboratory, and the European Committee for Future Accelerators. Kim is a member of the American Academy of Arts and Sciences, a Fellow of the American Association for the Advancement of Science and the American Physical Society. Kim received a Ph.D. in physics from the University of Rochester.

Piermaria J. Oddone

Member

Pier Oddone (NAS) is director emeritus of the Fermi National Accelerator Laboratory and deputy director emeritus of Lawrence Berkeley National Laboratory. Oddone received the Panofsky Award from the American Physical Society for his invention of a new collider, the Asymmetric B Factory. Oddone is a member of the American Academy of Arts and Sciences, and the Academia Nacional de Ciencias del Perú. Oddone received a Ph.D. in physics from Princeton University.

Fulvia Pilat

Member

Fulvia Pilat is the director of the Research Accelerator Division (RAD) which operates the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. Pilat is responsible for leadership and management of the RAD and overall SNS facility operations management. RAD is responsible for safe, effective, and reliable operation, maintenance and improvement of all aspects of the SNS accelerator, target, programmatic facility infrastructure, and environment, safety, health and quality. Pilat previously worked at Jefferson Lab in Virginia as the deputy associate director for Accelerators and also led the accelerator program for Jefferson Lab's Electron-Ion Collider. Pilat has served as a member of the High Energy Physics Advisory Panel, elected chair of the APS Division of Physics of Beams, and elected chair of the IEEE Nuclear and Plasma Sciences Society (NPSS) Particle Accelerator Science and Technology Executive Committee. Pilat received a Ph.D. in physics from the University of Trieste in Italy.

Natalie Roe

Member

Natalie Roe is the associate laboratory director for the Physical Sciences at Lawrence Berkeley National Laboratory, and is responsible for research programs in particle physics, nuclear physics, cosmology, accelerator science and engineering. Roe's research has ranged from studies of the W boson at the Fermilab Tevatron, to CP violation in B mesons with the BaBar experiment at Stanford Linear Accelerator Center, to dark energy and astrophysics with the Baryon Oscillation Spectroscopic Survey and Dark Energy Spectroscopic Instrument experiments. The development of instrumentation involving solid state detectors and readout has been a primary focus. Roe is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and past chair of the APS Division of Particles and Fields. As of January 2024, Roe is chair of the High Energy Physics Advisory Panel (HEPAP) Facilities Subpanel. Roe received a Ph.D. in physics from Stanford University.

Tim Tait

Member

Tim M.P. Tait is a Chancellor's Professor of Physics and Astronomy at the University of California, Irvine. Tait's research interests include theoretical investigations of physics beyond the standard model of particle physics, particle physics phenomenology, high energy collider physics, and cosmology. Tait's work involves both exploring new models and new phenomena, as well as theoretical interpretation of experiments. Tait is a fellow of the American Physical Society, and recipient of the Friedrich Wilhelm Bessel-Forschungspreis from the Alexander von Humboldt Foundation. Tait received a Ph.D. in physics from Michigan State University.