THE HUMBLE APPROACH INITIATIVE A symposium sponsored by the

John Templeton Foundation

Understanding Our Place in the Universe:

Beyond the Legacy of Stephen Hawking

Mishkenot Sha'ananim Conference Center, Jerusalem 17, 18 and 19 March 2019

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ABOVE: No one has ever seen a black hole directly, though there is plenty of data confirming the existence of these massive singularities that warp the spacetime continuum. The cover is an artist's simulation. But astronomers believe they may be on the verge of capturing their 'shadow' based on observations made by the Event Horizon Telescope (EHT) of very high-quality data at very high resolutions, which are in the process of being analyzed and vetted by scientists external to the EHT collaboration. Though the huge mass of a black hole produces such gravitational force that not even light can escape, EHT is expected to have attained the first direct image of the silhouette of the supermassive black hole at the center of the Milky Way, Sagittarius A*, which is 26,00 lightyears from Earth. The contribution to black hole physics of the late Stephen Hawking, pictured on this

Contact: Mary Ann Meyers, Ph.D., Senior Fellow

page, was immense as were his contributions to cosmology, relativity theory, and the search for a theory of everything. Not least among his achievements was his success in generating public interest in some of the deepest questions in science and the inspiration he provided in his fight against disability.

Credit: ESO/M. Kornmesser

Purpose

Stephen Hawking's theories about the origin of the universe and his theoretical exploration of the nature of black holes reveal the universe as a place of wonder. The work of the renowned physicist and cosmologist, who died on the 14th of March 2018, links the two overarching concepts of 20th century science—general relativity and quantum theory. The purpose of this symposium, taking place in one of the world's oldest cities, is to review recent scientific advances in key areas of astronomy and to consider their implications for underlying theological and philosophical questions of meaning.

Drawing on the current work of scientists, some of which the John Templeton Foundation has had the privilege of funding, we will review the latest findings on the properties of:

- The cosmic dawn
- Black holes
- Gravitational waves
- Dark matter and dark energy
- Nature of space and time
- Fine tuning

We also intend to explore the theological implications for our place in the universe of modern astronomy's revolutionary discoveries, addressing, for example:

- Why is there something rather than nothing?
- Why is reality like this and not that?
- Where did the laws of physics come from?
- Is God necessary to explain the cosmos?
- What is our role in creation?
- What future can we predict for the universe and for humanity?

The scholars and scientists gathered in Jerusalem to ponder these questions meet in a conference center overlooking the 16th-century walls of the Old City. Mishkenot Sha'ananim is a symbol of a dynamic and evolving Jerusalem, a city dating from perhaps 1000 BCE, sacred to Jews, Christians, and Muslims, the capital of a country that has existed as an independent state for just over seven decades.

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The inscription on Stephen Hawking's commemorative slate stone in Westminster Abbey is a translation in English of a phrase that appears in Latin on Isaac Newton's gravestone a few feet to the right in the nave of the abbey. Charles Darwin's memorial is located directly to the left of the spot where Hawking's ashes were interred on 15 June 2018. The stone on Hawking's grave depicts a series of rings, surrounding a darker central ellipse. The ten characters in the equation express Hawking's seminal idea that black holes are not entirely black but emit thermal radiation, theoretically visible as a glow, due to quantum effects near the event horizon. The monumental discovery, whose implications are still being unveiled, became known as Hawking radiation.

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Approach

The symposium is part of the John Templeton Foundation's Humble Approach Initiative. The goal of the initiative is to bring about the discovery of new spiritual information by furthering high-quality scientific research. The "humble approach" is inherently interdisciplinary, sensitive to nuance, and biased in favor of building linkages and connections. It assumes an openness to new ideas and a willingness to experiment. Placing high value upon patience and perseverance, it retains a sense of wondering expectation because it recognizes, in Loren Eiseley's haunting phrase, "a constant emergent novelty in nature that does not lie totally behind us, or we would not be where we are." A fundamental principle of the Foundation, in the words of its founder, is that "humility is a gateway to greater understanding and open[s] the doors to progress" in all endeavors. Sir John Templeton believed that in their quest to comprehend foundational realities, scientists, philosophers, and theologians have much to learn about and from one another. The humble approach is intended as a corrective to parochialism. It encourages discovery and seeks to accelerate its pace.

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The discovey in 2016 of gravitational waves, distortions in spacetime predicted by Einstein a century ago, has been among the most monumental discoveries of 21st century science, providing fundamental insights into the nature of the universe. Pictured here is a 3D artist's rendering of the cosmic ripples whose existence indicate the universe is peppered with black holes.

Credit: posteriori/Shutterstock.com

Chair

Eric R. Priest, an applied mathematician and widely recognized authority on the subtle, and often nonlinear, interaction between the Sun's magnetic field and its plasma interior, is an emeritus professor at the University of St. Andrews, where he previously held the Gregory Chair of Mathematics and a Bishop Wardlaw Professorship. He has made major contributions to many of the unsolved problems in solar physics with research focused on the fundamental physical properties at work in the solar corona. His scientific writing explains how our understanding of numerous aspects of the Sun has been revolutionized by current spacecraft observations and mathematical models he and others have constructed of the Sun's complex processes. His more recent writing about science and religion assumes the two realms are part of an underlying unity. He challenges the idea that the sciences are coldly inhuman and purely logical in contrast to the humanities that, on this view, involve only our emotions and imagination, as well as contesting the notion that science is monolithic and reductionistic. The elegant mathematics governing the behavior of the Sun inspire his sense of wonder at the universe of space, time, and matter he has studied for half a century. A graduate of Nottingham University, where he took first-class honors in mathematics, Dr. Priest earned a Ph.D. in applied mathematics at Leeds University in 1969. He had begun his teaching career at St. Andrews the previous year. Promoted to reader in 1977, he was awarded a personal chair in theoretical solar physics in 1983 and named to the Gregory Chair in 1997 and the Wardlaw Professorship in 2002. He was awarded a two-year Leverhulme Emeritus Fellowship following his retirement in 2010. Dr. Priest previously held a Science Engineering Research Council senior fellowship at St. Andrews for five years. He has served as president of the Commission on Solar Activity of the International Astronomical Union, chair of the European Space Agency's Solar Physics Planning Group, vice president of the Royal Astronomical Society (RAS), and chair of the Fachbeirat of the Max Planck Institute for Solar System Research, as well as serving as a member of the board of advisors and a trustee of the John Templeton Foundation and a member of the board of advisors of the Faraday Institute for Science and Religion. A fellow of the Royal Society, he is also a fellow of the Royal Society of Edinburgh and a member of the Norwegian Academy of Sciences, the European Academy of Sciences, and Academia Europaea. He was awarded an honorary

degree from St. Andrews in 2013, and his numerous awards include the Hale Prize of the American Astronomical Society, the gold medal of the RAS, the Cecelia Payne-Gaposchkin Medal and Prize of the Institute of Physics, and the Hannes Alfén Medal of the European Geophysical Union. Dr. Priest is the author of more than 480 papers published in scientific journals, the editor of seventeen books, and the author or co-author of four others, including a major and still widely-used textbook, *Solar Magnetohydrodynamics* (1982), (with J. G. Kirk and D. B. Melrose) *Plasma Astrophysics* (1994), (with T. G. Forbes) *Magnetic Reconnection: MHD Theory and Applications* (2005), and *Magnetohydrodynamics of the Sun* (2014). His most recent edited volume, *Reason and Wonder: Why Science and Faith Need Each Other*, was published by SPCK in 2016.

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Bernard J. Carr is professor emeritus of mathematics and astronomy at Queen Mary University of London (QMUL), where he was a member of the astronomy unit. His special interests are the early universe, primordial black

holes, dark matter, Population III stars, and the anthropic principle. But he also has focused on the phenomenon of consciousness, which he believes is a fundamental rather than incidental property of the universe. He is developing a new psycheo-physical paradigm, which attempts to link matter, mind, and spirituality. A long-standing interest in the relationship between science and religion (especially Buddhism) dates from his student days at Trinity College, Cambridge, where he took first-class honors in mathematics. He went on to do doctoral research in relativity and cosmology under Stephen Hawking at the Institute of Astronomy in Cambridge and at the California Institute of Technology. After completing his Ph.D. in 1976, he was elected a research fellow at Trinity College. In 1979 he was awarded a Lindemann Fellowship for post-doctoral research at several American universities, and in 1980 he became an advanced Science and Engineering Research Council fellow at the Institute of Astronomy. He joined the QMUL faculty in 1985 and retired just this past summer. Dr. Carr has held visiting professorships at Kyoto University, Tokyo University, and the Fermi National Accelerator Laboratory. In connection with his interests in consciousness and spirituality, he has served as president of the Society for Psychical Research and as chair of the Scientific and Medical Network in the United Kingdom. Dr. Carr is the author of more than two hundred scientific papers and his monograph, "Cosmological Gravitational Waves," won the 1985 Adams Essay Prize. He is the editor of Universe of Multiverse? published by Cambridge University Press in 2007 and author (with Xavier Calmet and Elizabeth Winstanley) of Quantum Black Holes, which was published by Springer in 2013.

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Trained both as a philosopher and as a theoretical physicist, **Erik Curiel** is an assistant professor at the Munich Center for Mathematical Philosophy (MCMP) at Ludwig-Maximilians-Universität. His current research in

theoretical physics focuses on the intersection of general relativity, quantum field theory, and thermodynamics, primarily in the physics of black holes, early-universe singularities, and related gravitational phenomena. In general philosophy of science, he works primarily on the semantics of scientific theories. Dr. Curiel also writes about the ancient Greeks and the history of twentieth-century analytic philosophy, and he pursues interests related to the mathematical foundations of classical mechanics and various problems in classical general relativity. Educated at Harvard University, where he earned a baccalaureate degree with honors as a double major in physics and philosophy, he studied physics as a graduate student at the University of Chicago, working in a research group at the Enrico Fermi Institute, and took a Ph.D. in philosophy in 2005. He had previously held a lectureship in philosophy and a humanities fellowship at Stanford University and was subsequently appointed a tutorial fellow in the Department of Philosophy, Logic, and Scientific Method at the London School of Economics. Dr. Curiel was awarded a postdoctoral fellowship at the Rotman Institute of Philosophy at the University of Western Ontario in 2010, and, three years later, he became a post-doctoral research fellow at the MCMP. He accepted his current faculty appointment in 2016, the same year he was named a senior research fellow at Harvard's Black Hole Initiative. Currently, he is also a senior research fellow at the Smithsonian Astrophysics Observatory, and he has been a visiting scholar at Trinity College, Cambridge, and an Erasmus Fellow in the Department of Letters and Philosophy at the University of Florence. He will be a visiting scholar later this spring at the University of California, Irvine. The author of some twenty papers published in scientific and philosophical journals, Dr. Curiel is the editor (with Thomas Pashby and James Weatherall) of a special issue of Studies in the History and Philosophy of Modern Physics entitled "The Philosophy of Howard Stein," which will be published later this year.

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Roger Llewelyn Davies is the Philip Wetton Professor of Astrophysics and founding director of the Hintze Centre for Astrophysical Surveys (HCAS) at Oxford University. His research centers on cosmology and the evolution and

formation of galaxies. One of the so-called Seven Samurai collaborators, he and his colleagues discovered a concentration of galaxy clusters, known as the Great Attractor, thousands of times more massive than the Milky Way, in intergalactic space in the direction of the constellation Centaurus where absorption by the dust in the Milky Way makes it challenging to observe in visible wavelengths. Dr. Davies has a longstanding interest in astronomical instruments and telescopes, and he developed the scientific case for the United Kingdom's involvement in the 8m Gemini telescopes project. He has pioneered the use of a new class of astronomical spectrograph to measure the masses and ages of galaxies, as well as to search for black holes in their nuclei. Educated at the John Leggott Grammar School in North Lincolnshire, he took first-class honors in physics at University College London and continued his studies at Churchill College, Cambridge, and the Institute of Astronomy, earning a Ph.D. in astronomy in 1979. The next year he was a Lindemann Fellow at the Lick Observatory at the University of California, Santa Cruz, before returning to Cambridge to take up a junior research fellowship at Christ's College and the Institute of Astronomy. In 1982, Dr. Davies joined the staff of the United States' Kitt Peak National Observatory in Arizona, where he worked for six years before moving to Oxford to become the UK Project Scientist for the 8m Gemini Telescope. Appointed a University lecturer in physics and elected a fellow of St. Peter's College in 1992, he was appointed professor and head of astronomy at the University of Durham two years later. Dr. Davies returned to Oxford as the first Wetton Professor and a Student (member of the governing board) of Christ Church in 2002. He subsequently served as head of astrophysics and then head of the Department of Physics and was appointed director of the HCAS in 2014. Dr. Davies has been a visiting professor at Beihang University in Beijing, a distinguished visitor at the Australia Astronomical Observatory, and a Visiting Hunstead Fellow at the University of Sydney. A former president of the Royal Astronomical Society (RAS), he has held Leverhulme and PPARC (Particle Physics and Astronomy Research Council) fellowships and is the recipient of the Dalwa-Adrian Foundation Prize, the Royal Society Wolfson Merit Award, and the RAS Group Achievement Award for the SAURON Survey of Early-Type Galaxies in the Nearby Universe. Dr. Davies was awarded an honorary degree from the University Claude Bernard in Lyon in 2006. He is the author of some 200 papers published in scientific journals.

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The Starbridge Lecturer in Theology and the Natural Sciences in the Faculty of Divinity at Cambridge University, **Andrew Paul Davison** is a fellow and director of studies at Corpus Christi College, Cambridge. He is also canon

philosopher of St. Albans Cathedral in Hertfordshire. Dr. Davison's work is informed by his engagement with the radical orthodox movement within the Church of England in which he was ordained a priest in 2004 and served a curacy, working with children and youth, at St. Dunstan's Church, Bellingham, in southeast London. His current research interests are broad and involve theological understandings of finitude and causation, as well as a continuing concern with the question of how the universe relates to its Creator, which he explores in terms of how the world comes to have its being and qualities as 'participation' in the life and nature of an eternally transcendent God. Educated at Merton College, Oxford, where he read chemistry, Dr. Davison earned a D.Phil. in biochemistry at Oxford in 2000. He then went on to Corpus Christi College, took first-class honors in theology and religious studies, and received a Ph.D. in theology from Cambridge in 2012. He began his teaching career as a tutor in Christian doctrine at St. Stephen's House, Oxford, and was a tutor in doctrine at Westcott House, Cambridge, from 2010 until his appointment to his present position in 2014. In addition to papers published in academic journals and contributions to volumes of collected works, he is the editor of four books for general readers, including, most recently, (with John Hughes) The God We Proclaim: Sermons of the Apostles' Creed (2017), and the author or co-author of six other books: (with Alison Millbank) For the Parish: A Critique of Fresh Expressions (2010), Why Sacraments? (2012), The Love of Wisdom: An Introduction to Philosophy for Theologians (2013), which has been translated into Dutch, Blessings (2014), and (with Sioned Evans) Care for the Dying: A Practical and Pastoral Guide (2014). Dr. Davison's latest book, Participation in God: A Study in Christian Doctrine and Metaphysics, is a comprehensive investigation of a fundamental theme in Christian theology, namely that creatures possess their being and characteristics by derivation from God, as their source, and that redemption involves a restoration of an impaired relationship. It will be published later this year by Cambridge University Press (CUP). He is also completing another book for CUP entitled A Million Alien Gospels: Astrobiology and Christian Doctrine and one for Catholic University of America Press on Finitude: The Quantitative and Qualitative in Christian Doctrine and Metaphysics.

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Adam D. Hincks, S.J. is an associate scholar at the Vatican Observatory who currently is working on a master's degree in theology at Regis College, the Jesuit School of Theology at the University of Toronto. He will be ordained to the Roman Catholic priesthood in May of 2019. His principal area of scientific research is observational cosmology. A graduate with high distinction of the University of Toronto, he was awarded a Natural Sciences and Engineering Research Council of Canada postgraduate scholarship and went on to earn a Ph.D. in physics at Princeton University in 2009. His doctoral work was focused on helping to deploy the Atacama Cosmology Telescope (ACT), an observatory in Chile for measuring the cosmic microwave background (CMB). His thesis included analysis of some of its first scientific results. Dr. Hincks entered the Society of Jesus in 2009 and earned a diploma in philosophical studies at Regis College in 2013. After a postdoctoral fellowship in experimental cosmology at the University of British Columbia, during which he worked on the Canadian Hydrogen Intensity Mapping Experiment and at the ACT, he began studies for a graduate-level degree in theology at the Pontifical Gregorian University in Rome. He was awarded his STB (Bachelor of Sacred Theology) summa cum laude in 2018, the year he was ordained a deacon. While completing his degree, he worked as a part-time researcher at the Experimental Cosmology Laboratory Group at the Sapienza University of Rome, and in 2017 he also became an associate member of the Simons Observatory, a new facility for CMB measurements in Chile's northern Andes. His association with the Vatican Observatory began the same year, and, at present, he is also a part-time visitor at the Canadian Institute for Theoretical Astrophysics in Toronto. The co-author of some seventy-five papers published in scientific journals, Dr. Hincks has written for the Jesuit magazine America and for various internet blogs. He took part in a project, sponsored by the University of Notre Dame and Oxford University, to examine the Christian doctrine of God's creation of everything from nothing in the light of modern science and new work in theology and philosophy. His essay from the perspective of physical cosmology is included in the resulting volume: (eds. Gary Anderson and Markus Bockmuehl) Creation ex nihilio: Origins, Development. Contemporary Challenges, which was published in 2017 by Notre Dame Press.

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A theoretical cosmologist, **Anna Ijjas** is a Simons Fellow at the Institute for Theory and Computation at Harvard University and the Harvard-Smithsonian Center for Astrophysics (HSCA), as well as a visiting researcher at the Gravity Initiative at Princeton University. She is the principal investigator on a project on cosmological bounces and bouncing cosmologies as part of the Origins of the Universe Initiative funded by the Simons Foundation. Her research has been particularly focused on studying different models of the very early universe with the aim of ultimately developing a cosmology that provides an explanation of observational data. Educated at Ludwig-Maximilians-Universität (LMU) in Munich, where she took a combined B.A. and M.A. in mathematics and philosophy and then in physics, she went on to earn a Ph.D. in the philosophy of physics at LMU in 2010. After pursuing research as a Fritz Thyssen Graduate Research Fellow at the HSCA and at Princeton University, she received a Ph.D. in theoretical physics in 2014 from the Max Planck Institute for Gravitational Physics and Humboldt University in Berlin. Dr. Ijjas had served as an assistant professor in LMU's Institute for Philosophy and Religious Studies from 2010 to 2012, and the next year, she held a research fellowship in philosophy and cosmology at Rutgers University. For three years following the receipt of her doctorate in theoretical physics, she was the inaugural John A. Wheeler Postdoctoral Fellow at the Princeton Center for Theoretical Science. She was named a Simons Fellow and appointed to her present visiting position at Princeton in 2017. She spent the first year of her fellowship at the Columbia University Center for Theoretical Physics before moving on to Harvard. Dr. Ijjas is the recipient of a research prize given by the European Society for the Study of Science and Theology. A co-author of nearly twenty papers published in academic journals, she is the author of a book in German, Der Alte mit dem Würfel: Ein Beitrag zur Metaphysik. der Quantenmechanik (The Old One with the Dice: A Contribution to the Metaphysics of Quantum Mechanics), which was published in 2011, and is an editor (with Barry Loewer) of an Introduction to the Philosophy of Cosmology, which Oxford University Press will publish later this year.

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Abraham (Avi) Loeb, a theoretical physicist and one of the world's leading space researchers, is Frank B. Baird Jr. Professor of Science at Harvard University and director of the Institute for Theory and Computation (ITC) at

the Harvard-Smithsonian Center for Astrophysics. He also chairs Harvard's astronomy department and is the founding director of Harvard's Black Hole Initiative, the first interdisciplinary center in the world dedicated to the study of black holes, which was launched in 2016 at a ceremony attended by Stephen Hawking. In addition, Dr. Loeb chairs the advisory committee for Breakthrough Starshot, a privately-funded effort that aims to launch lightweight spacecraft toward the nearest stars using a powerful laser, as well as serving as science theory director for all the initiatives of the Breakthrough Foundation. His own research has not only focused on the formation and evolution of massive black holes and the search for extra-terrestrial life, but also on the origin of the first stars and the future of the universe. A number of his some 700 papers published in scientific journals are considered pioneering in areas that are now investigated by established communities of astrophysicists. He was among the first theorists to trigger the research frontier on the "cosmic dawn," an epoch after the so-called Dark Ages of the early universe. In a series of papers with his students and post-doctoral fellows, he addressed how and when the earliest stars and black holes formed and what effects they had on the young cosmos. He also led a team that discovered tentative evidence for the birth of a black hole in the nearby supernova SN1979C, and he developed a new technique for imaging black hole silhouettes. Educated at The Hebrew University of Jerusalem, where he studied physics and mathematics as an undergraduate and earned a Ph.D. in plasma physics at 1986, Dr. Loeb headed a theoretical group on electromagnetic propulsion in Israel for five years before moving to the Institute for Advanced Study in Princeton in 1988 to begin his work on theoretical astrophysics. He came to Harvard in 1993 as an assistant professor of astronomy and was named a full professor four years later. He was appointed director of the ITC in 2007 and named to the Baird chair in 2012. The previous year, Dr. Loeb was named the Sackler Senior Visiting Professor in the School of Physics and Astronomy at Tel Aviv University, and he also holds a visiting professorship at the Weizmann Institute of Science in Rehovot, Israel. He has been the Sackler Lecturer in Astronomy at Leiden Observatory in The Netherlands, a Distinguished Visiting Scientist at the Carnegie Observatories in Pasadena, and a Merle Kingsley Distinguished Visitor at the California Institute of Technology. He has held a Miegunyah Distinguished Visiting Fellowship at the University of Melbourne, an Australia-Harvard Distinguished Fellowship, an Einstein Minerva Fellowship at the Weizmann Institute, and a John Simon Guggenheim Memorial Foundation Fellowship. Chair of the Board on Physics and Astronomy of the National Academies, he is a fellow of the American Academy of Arts and Sciences, the American Physical Society, and the International Academy of Astronautics. Dr. Loeb is the recipient of the Galileo Galilei Chair Award of the Scuola Normale Superiore in Pisa, Italy, the Bergmann Memorial Award of the United States-Israel Binational Science Foundation, and the Kennedy Prize of The Hebrew University of Jerusalem. He currently serves on the editorial board of Nature as head of astrophysics and as editor of the Journal of Cosmology and Astroparticle Physics. In addition to his scientific papers, he is the author or co-author of six books: (with Andrea Ferrara and R.S. Ellis) First

Light in the Universe (2008), How Did the First Stars and Galaxies Form? (2010), (with Steven R. Furlanetto) The First Galaxies of the Universe (2013), From the Stars to the End of Time (2015), and, most recently, From the First Star to Milkomeda, a Kindle book for general readers on the frontiers in astronomy that also gives an account of the author's career path from an adolescent interest in philosophy as a farm boy in Israel to the pinnacle of academic theoretical physics. His newest book (with Manasvi Lingam), Extraterrestrial Life: From Biological Signatures to Technological Signatures, will be published by Harvard University Press later this year. Dr. Loeb frequently writes opinion pieces on science policy for science journals, newspapers, and online.

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A professor of astronomy and physics at Yale University, **Priyamvada Natarajan** is a theoretical astrophysicist who also serves as the Sophie and Tycho Brahe Professor at the Dark Cosmology Centre at the Niels Bohr Institute of the University of Copenhagen. She is noted for her work in mapping dark matter and dark energy, gravitational lensing, and black hole physics. Her research involves making maps of the detailed distribution of dark matter in the universe by exploiting the bending of light en route to Earth from distant galaxies. She also has been developing the methodology and techniques to utilize gravitational lensing to test dark energy models. In seeking to understand the mass assembly history of black holes over cosmic time, she is exploring a new growth channel for the formation of the first black holes and its observational consequences at high and low wave lengths of emitted radiation. Dr. Natarajan was educated at the Massachusetts Institute of Technology (MIT), where she was elected to Phi Beta Kappa, Sigma Xi, and Tau Beta Pi. After earning undergraduate degrees in physics and in mathematics, she enrolled in MIT's Program in Science, Technology, and Society and received an M.A. in 1993. She continued her graduate education at the Institute of Astronomy at Cambridge University, studying with England's Astronomer Royal, Lord Martin Rees, and was awarded a Ph.D. in astrophysics in 1998. Following a Title A Research Fellowship at Trinity College, Cambridge, she was appointed an assistant professor of astrophysics at Yale in 2000. Dr. Natarajan was named a full professor nine years later, and she currently serves as director of Yale's Franke Program in Science and the Humanities. The recipient of a John Simon Guggenheim Memorial Foundation Fellowship, she was a visiting fellow at the Joint Institute for Laboratory Astrophysics in Boulder, Colorado, and a visiting professor at the Institute for Theory and Computation (ITC) at the Harvard-Smithsonian Center for Astrophysics in the 2010-2011 academic year. She also has been a visitor at the Institute for Advanced Study in Princeton, a Kavli Frontiers Fellow of the National Academy of Sciences, an Emeline Bigelow Conland Fellow at the Radcliffe Institute for Advanced Study at Harvard University, and a Caroline Herschel Distinguished Visitor at the Space Telescope Science Institute in Baltimore. A fellow of the Royal Astronomical Society, the American Physical Society, and the Explorers Club, she is the recipient of an award for academic achievement from the Global Organization for People of Indian Origin, a Face of the Future Award of the India Abroad Foundation, and an India Empire NRI Award for Achievement in the Sciences. Dr. Natarajan's keen interest in the public dissemination of science has led her to serve on the advisory board of NOVA ScienceNow, a primetime series on PBS television stations. The author of more than 150 papers published in scientific journals or in volumes of collected works, she is a regular contributor to The New York Review of Books. Her first book, Mapping the Heavens: The Radical Scientific Ideas That Reveal the Cosmos, was published in 2016 by Yale University Press. Intended for a general audience, the highlypraised volume provides a tour of cosmological discoveries-the ideas, all once at the forefront of research, that reshaped our understanding of the universe over the past century-and explains how radical scientific theories gain acceptance within the scientific community.

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Bernard F. Schutz, a leading expert in the field of general relativity research, is a professor of physics and astronomy at the University of Cardiff and was one of the founding directors of Max Planck Institute for Gravitational

Physics (MPIGP) in Potsdam, Germany. Now director emeritus at MPIGP, he developed important principles for the observation of the universe with gravitational waves (ripples in the fabric of spacetime) and continues to play a key role in the development of both earth-based and space-based gravitational wave observatories. He pioneered the use of supercomputers to solve Einstein's field equations and study black holes. Dr. Schutz is a graduate of Clarkson University in Potsdam, New York, and earned a Ph.D. in physics from the California Institute of Technology, where he was elected to Sigma Xi, in 1972. Awarded a National Science Foundation fellowship for postgraduate work at Cambridge University, he worked in Stephen Hawking's research group, and he also did post-doctoral research at Yale University before joining the faculty of Cardiff University as a lecturer in applied mathematics and astronomy in 1974. He was promoted to full professor in 1985. Ten years later, he joined MPIGP and helped build it into the world's largest research institute for gravitational wave physics and technology. He also established the open-access journal, Living Reviews in Relativity, which has become the highest-impact open-access journal in the world, along with five other journals in the Living Reviews family. After retirement as MPIGP director in 2014, Dr. Schutz returned to Cardiff where he divides his time between the School of Astronomy and Physics and the Data Innovation Research Institute. He also serves as an adjunct professor of physics at the Georgia Institute of Technology and as an honorary professor of physics at both Leibniz Universität in Hannover and at Germany's University of Potsdam. He is principal investigator in charge of data analysis for the GEO600 collaboration, which is part of the LIGO (Laser Interferometer Gravitational Wave Observatory) Scientific Collaboration, a member of the executive committee of LIGO, and, until recently, he was a member of the steering committee for the European Space Agency's LISA (Laser Interferometer Space Antenna) mission. Dr. Schutz also co-chairs the Reproducibility Interest Group of the International Research Data Alliance. An honorary fellow of the Royal Astronomical Society (RAS) and a fellow of the Institute of Physics, the American Physical Society, and the International Society of General Relativity and Gravitation, as well as a member of the Swedish Royal Academy of Arts and Sciences, the Learned Society of Wales, and Leopoldina, the German national academy of science, he was awarded an honorary degree by the University of Glasgow in 2011. He is the recipient of Amaldi Gold Medal of the Italian Society of General Relativity, the Communitas Prize of the Max Planck Society, and the 2019 Eddington Medal of RAS for his theoretical discovery that gravitational waves can be used to measure the cosmic expansion rate. The author of more than 250 papers published in scientific journals, he is the editor of two books, Gravitational Wave Data Analysis (1989) and (with C. W. F. Everitt, M. C. E. Huber, Reinald Kallenbach, Gerhard Schäfer and B. F. Treumann) Probing the Nature of Gravity: Confronting Theory and Experiments in Space (2009), and the author of three others: Geometrical Methods of Mathematical Physics (1980), A First Course in General Relativity (1985 and 2009), and Gravity from the Ground Up: An Introductory Guide to Gravity and General Relativity, which was published by Cambridge University Press in 2003.



Understanding Our Place in the Universe:

Beyond the Legacy of Stephen Hawking

Mishkenot Sha'ananim Conference Center, Jerusalem 17, 18 and 19 March 2019

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A philosopher of science, **Christopher J. Smeenk** is an associate professor of philosophy at the University of Western Ontario (UWO) and the director of UWO's Rotman Institute of Philosophy. His research focuses on scientific

method, the nature of our knowledge of physics, and seventeenth-century natural philosophy. A graduate of Yale University, he earned an M.S. in physics and astronomy and an M.A. in philosophy at the University of Pittsburgh, where he held an A. W. Mellon pre-doctoral fellowship and a Slater Fellowship in the History of Physics awarded by the American Philosophical Society. He also held fellowships for summer study at the Max Planck Institute for the History of Science in Berlin. After receiving his Ph.D. in history and philosophy of science from Pittsburgh in 2003 and completing a post-doctoral fellowship at the Dibner Institute for the History of Science and Technology at the Massachusetts Institute of Technology, Dr. Smeenk joined the philosophy faculty of the University of California, Los Angeles, as an assistant professor. He accepted his present academic position at UWO in 2007. He was appointed interim director of the Rotman Institute five years later and named director in 2015. Dr. Smeenk is currently the co-principal investigator on a "New Directions in Philosophy and Cosmology" project funded by the John Templeton Foundation. He has published some twenty papers in academic journals or volumes of collected works and was an assistant editor of the third and fourth volumes of The Genesis of General Relativity (2007), which was edited by Jürgen Renn and Matthias Schemmel, and the co-editor (with Eric Schliesser) of The Oxford Handbook of Newton, which was published online by Oxford University Press (OUP) in 2017 with a print version scheduled for later this year. He is also the co-editor (with Eric Schliesser and Marius Stan) of Turning Data into Evidence: Festschrift for George E. Smith, which will be published by Springer in 2019, and is completing a book (with J. B. Manchak and Christian Wüthrich) entitled Time and Again: On the Logical, Metaphysical, and Physical Possibilities of Time Travel, which OUP will publish in 2020. With James Weatherall, he is working on another book for OUP, The Aim and Structure of Cosmological Theory, which also will be forthcoming next year.

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David A. Wilkinson, the principal of St. John's College, University of Durham, is a theologian and an astrophysicist who also serves as a professor in Durham's Department of Theology and Religion. His early work focused

on star formation, the chemical evolution of galaxies, and terrestrial mass extinctions. His present work concerns the relationship between science and contemporary culture. Dr. Wilkinson is an ordained minister in the British Methodist Church. He was educated at Durham, where he took first-class honors in physics, and earned a Ph.D. in theoretical astrophysics in 1985. He went on to study at Fitzwilliam College, Cambridge, taking an honors master's degree in theology in 1989, and trained for the ministry at Wesley House, an independent theological college in Cambridge. He then served in a variety of clerical appointments, including churches in Letchworth and Liverpool and as a Methodist chaplain at Liverpool University. Returning to Durham in 1999, he held a fellowship in Christian apologetics at St. John's College and served as associate director of its Centre for Christian Communication, as well as teaching systematic theology. Named Wesley Research Lecturer in Theology and Science at Durham in 2004, he was appointed to his current administrative position two years later. Dr. Wilkinson has been a visiting Beeson International Professor at Asbury Theological Seminary in Kentucky. He is a fellow of the Royal Astronomical Society and the recipient of a Humility in Theology Prize from the John Templeton Foundation. The author of some sixty papers published in scientific and theological journals, he has edited two books and is the author of seventeen books, including: God, the Big Bang and Stephen Hawking (1993), Alone in the Universe? Aliens, X-Files, and God (1998), God, Time, and Stephen Hawking (2001), The Message of Creation (2002), Christian Eschatology and the Physical Universe (2010), Science, Religion, and the Search for Extraterrestrial Intelligence (2013), and, most recently, When I Pray What Does God Do?, an exploration of the old and still thorny problem of how God responds to prayer that blends insights from science, religion, and personal experience and was published by Monarch in 2015.