

MASTHEAD: Pictured here are some of the most famous mathematicians in history (or artistic renderings of imagined likenesses) and equations associated with their work.

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

PURPOSE

M athematics plays an important role in the human exploration of reality both in respect to its own kind of reality and also as a heuristic tool for other kinds of investigation. Often seen as the paradigm of rationality, mathematics has been shown by Gödel, in one of the greatest discoveries of the twentieth century, to be startlingly open in its logical structure. The nine scientists and philosophers coming together in Castel Gandolfo, a small town southeast of Rome overlooking Lake Albano, take an intellectual, experience-based approach to non-physical reality in their exploration of the significance of mathematics. The topics engaging them emerge from the following sets of observations and questions:

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- The majority of mathematicians see their subject as discovery and not mere invention. The implication is that mathematical entities exist in a noetic realm to which the human mind has access. The Mandelbrot Set (with its endlessly proliferating complexity deriving from a deceptively simple definition) did not come into existence when Benoit Mandelbrot first began to consider its definition, but he *found* it. Many will see his discovery as being an encounter with a noetic reality lying beyond the merely material.
- Evolutionary survival seems to require little more than simple arithmetic and a little Euclidean geometry. Whence then has come the human ability to explore noncommutative algebras and to prove Fermat's last theorem? An adequate evolutionary anthropology seems to require a richer context than afforded by conventional neo-Darwinism.
- It is a technique of discovery in fundamental physics to seek theories whose equations are endowed with the unmistakable character of mathematical beauty, since only theories of this kind have proved to have the long-term fruitfulness that persuades us of their verisimilitudinous character. How should we understand this "unreasonable effectiveness," as Nobel laureate E. P. Wigner's famously put it, of abstract mathematics in physical science? Theologically, the deep rational transparency and rational beauty of the universe can be understood as reflecting the rationality of the universe's Creator.

Gödel showed that axiomatised mathematical systems including the integers are either incomplete (not all stateable results are proveable results) or inconsistent. What does this imply for the possibility of the formulation of grand unified theories in physics? Apophaticism, it appears, is not restricted to theology.

The gathering in the Alban Hills, under the aegis of the John Templeton Foundation in partnership with the Centre for Advanced Research in Theological and Religious Studies, Cambridge, and the Vatican Observatory, begins a conversation to be continued at Cambridge University.



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MASTHEAD: Pictured here are some of the most famous mathematicians in history (or artistic renderings of imagined likenesses) and equations associated with their work. Top row (left to right): Pythagoras of Samos (c. 569 - c. 475 BC), leader of the secret Greek society that bore his name and often described as the first 'pure' mathematician, though he also noticed the connection between simple fractions and musical harmony; Euclid of Alexandria (c. 325 - c. 365 BC), whose treatise, The *Elements*, endured for two millennia as the principle text on geometry; **Archimedes** of Syracuse (c. 287 - c. 211 BC), whose contributions to geometry revolutionized the subject and anticipated the integral calculus; Pierre de Fermat (1601-1665), renowned for his work in number theory, in particular his last theorem, co-founder (with Pascal) of the theory of probabilities, and anticipator of the differential calculus; Middle row (left to right): Blaise Pascal (1623-1662), who in addition to laying the foundations of probability theory, contributed important theorems in projective geometry and is remembered especially for his work on the arithmetical triangle, bionomial coefficients, and the cycloid; Sir Isaac Newton (1642-1727), one of the foremost scientific intellects of all time and the author of the Principia (a treatise on the mathematical principles of natural history), made contributions to all branches of mathematics, but is especially acclaimed for showing how planetary motions, including the famed Kepler laws, followed from principles of universal gravitation, and is generally regarded as having independently invented the calculus (along with Leibniz), thereby determining, for example, tangents to curves and areas bounded by curves; Gottfried Wilhelm Leibniz (1646-1716), whose invention of the present day notations for differential and integral calculus assured his place in the history of mathematics, also developed the binary system of arithmetic that is the basis of virtually all modern computer architectures, formulated many different approaches to determinants, laid the foundation of a theory of envelopes, and made important contributions to dynamics; Leonhard Euler, (1707-1783), the most prolific writer on mathematics of all time, made major advances in the study of modern analytic geometry and trigonometry as well as calculus and number theory, was responsible for foundational contributions to dynamics, and introduced much of the modern mathematical terminology and notation, particularly for mathematical analysis; Bottom row (left to right): Johann Carl Friedrich Gauss (1777-1855), one of the great

prodigies of mathematics, had immense influence on many mathematical fields, including number theory, which he systematized, analysis, differential geometry to which he contributed the idea (named after him) of Gaussian curvature, and geodesy, undertaking a major geodesic survey of the German state of Hanover, and among other achievements introduced the hypergeometric function and made important contributions to approximate integration, mathematical statistics, and the study of terrestrial magnetism, as well as theoretical astronomy; Augusta Ada Byron, Lady Lovelace, (1815-1852), recognized the potential of the calculating machine invented by her friend Charles Babbage and prepared detailed notes for a memoir about his Analytic Engine that specified a method for using it to calculate Bernoulli numbers-a feat recognized by historians as the world's first computer program; Bernhard Riemann (1826-1866), who made important contributions to complex analysis, real analysis, number theory, and differential geometry, some of which paved the way for the later development of the theory of general relativity, and whose Riemann hypothesis remains the most famous (and arguably the most important) unsolved problem in mathematics to this day; and Georg Ferdinand Ludwig Philipp Cantor (1845-1918), founder of set theory who introduced the concept of infinite numbers (cardinal numbers and ordinal numbers) and advanced the study of trigonometric series.

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APPROACH

"An equation for me has no meaning, unless it represents a thought of God." Srinivasa Ramanujan



Voyage to the Mandelbrot Set, www.mizuno.org Credit: Ryoichi Mizuno (The University of Tokyo and Prometech Software, Inc.)

he symposium is part of the 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 Eisley'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 believes 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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CHAIR

The distinguished particle physicist and author **John Charlton Polkinghorne**, the winner of the 2002 Templeton Prize for Progress Toward Research or Discoveries About Spiritual Realities, has been a leading figure in the dialogue of science and religion for more than two decades. His most recent book, Quantum Physics and Theology (Yale University Press, 2007), argues that, despite their different subject matter, these two truth-seeking inquiries employ rational strategies that bear a cousinly relationship to each other. Ordained a priest in the Church of England in 1982, Dr. Polkinghorne took up his new vocation in mid-life after playing a role in the discovery of the *quark*, the smallest elementary particle of matter. A graduate of Cambridge University, where he was a fellow of Trinity College and earned a Ph.D. in theoretical physics in 1955, he was forty-eight years old when he resigned his Cambridge professorship of mathematical physics to begin studies at Westcott House, an Anglican seminary in Cambridge. He went on to serve as a curate in a working-class parish in South Bristol and as vicar of Blean, a village outside of Canterbury. In 1986, he accepted a call to return to Cambridge as dean of the chapel at Trinity Hall, and in 1989, he was named president of Queens' College, a position he held until his retirement in 1996. A Fellow of the Royal Society and a member of the Society of Ordained Scientists, Dr. Polkinghorne was granted the senior Sc.D. degree by Cambridge in 1974 in recognition of his contributions to research and has received honorary degrees from the universities of Kent, Exeter, Leicester, and Durham in the United Kingdom, as well as Marquette University in the United States and Hong Kong Baptist University. He was knighted by Queen Elizabeth II in 1997 and is currently a fellow of Queens'. He also serves on the board of advisors of the John Templeton Foundation. In addition to an extensive body of writing on theoretical elementary particle physics, including most recently Quantum Theory: A Very Short Introduction (2002), he is the editor or co-editor of four books, the co-author (with Michael Welker) of Faith in the Living God: A Dialogue (2001), which has been translated into Korean and Chinese, and the author of fifteen other books on the interrelationship of science and theology in which he explores questions about God's action in creation. Among them are: Belief in God in an Age of Science (1998), a volume composed of his Terry Lectures at Yale University; Science and Theology (1998); Faith, Science and Understanding (2000); Traffic in Truth-Exchanges between Theology and Science (2001); The God of Hope and the End of the World (2002); Living with Hope

(2003); and *Science and the Trinity: The Christian Encounter with Reality* (2004), a volume based on his Warfield Lectures at Princeton Theological Seminary that represents a new stage in the science and religion conversation in which the author deeply engages a specifically Christian subject. In a book published earlier this year by Yale University Press, *Exploring Reality: The Intertwining of Science and Religion*, he ponders the limits of an empirical approach to all that is and argues that human experience comes fully into focus only in religious belief.

home | approach | chair | participants



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PARTICIPANTS

Michael Detlefsen Mary Leng Peter Lipton Roger Penrose Gideon A. Rosen Stewart D. Shapiro Mark Steiner

Michael Detlefsen is a professor of philosophy at the University of Notre Dame. A logician with interests in metaphysics, epistemology, especially as applied to mathematics and logic, and the history and philosophy of mathematics, he is writing (with Timothy McCarthy) a major study of Kurt Gödel's incompleteness theorems. Dr. Detlefsen received his bachelor's degree from Wheaton College and a Ph.D. in philosophy in 1976 from Johns Hopkins University. He began his teaching career as an assistant professor at the University of Minnesota-Duluth and moved to Notre Dame as an associate professor of philosophy in 1984. He was named to his present position five years later. Dr. Detlefsen has held visiting posts at the University of Paris, the University of Konstanz, and the University of Split in Croatia. He has held research grants from the National Endowment for the Humanities, the Fulbright Program, the IREX (International Research and Exchange Board), and the Alexander von Humboldt Foundation. The chief editor of the Notre Dame Journal of Logic since 1984, he also serves on the editorial boards of Philosophia Mathematica and the Journal of Universal *Computer Science.* He served as subject editor for logic and the philosophy of mathematics for the recently published Routledge Encyclopedia of Philosophy. He has published more than forty articles in academic journals and is the editor of two books, Proof, Logic and Formalization and Proof and Mathematical Knowledge, both published by Routledge in 1992. He is the author of *Hilbert's Program: An Essay on* Mathematical Instrumentalism (D. Reidel, 1986). In addition to the book on Gödel's theorems, Dr. Detlefsen is working on a book on the emergence of the axiomatic method in arithmetic, a project provisionally entitled 'Where Concepts Fail'. He argues that the development of the number-concept is marked by an important element of freedom and that the most plausible understanding of this freedom is that it is a freedom to create instruments of a broadly formalist character. Another ongoing project is a study on constructive ideals in the history of mathematics.



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Michael Detlefsen Mary Leng Peter Lipton Roger Penrose Gideon A. Rosen Stewart D. Shapiro Mark Steiner Mary Leng is a lecturer in philosophy at the University of Liverpool. Her research focus is the philosophy of mathematics, and she has been particularly concerned with the nature of mathematical knowledge. She is currently working on the issue of ontological commitment to mathematical objects and on the applicability of mathematics in natural science. Educated at Balliol College, Oxford, where she took her baccalaureate degree with honors, she earned a Ph.D. in philosophy from the University of Toronto in 2001. Dr. Leng has been a visiting fellow in the Department of Logic and the Philosophy of Science at the University of California at Irvine, and after a postdoctoral fellowship in the humanities at the University of Toronto, she held a research fellowship at St. John's College, Cambridge, for four years. She was appointed to her present position last autumn. Dr. Leng has been a visiting junior fellow at the Peter Wall Institute for Advanced Studies at the University of British Columbia. In addition to papers published in professional journals, she is the co-editor (with Alexander Paseau and Michael Potter) of Mathematical Knowledge, which will be published by Oxford University Press (OUP) later this year, and the author of *Mathematics and Reality*, which OUP will publish in 2008.



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Michael Detlefsen Mary Leng **Peter Lipton** Roger Penrose Gideon A. Rosen Stewart D. Shapiro Mark Steiner Hans Rausing Professor and chair of the History and Philosophy of Science at Cambridge University, **Peter Lipton** is also a fellow of King's College, Cambridge. Much of his work concerns explication and inference in science, but his interests extend broadly across many of the major areas of philosophy. A graduate of Wesleyan University in Middletown, Connecticut, he continued his studies at Oxford University where he earned a B. Phil. and then a D. Phil. in philosophy in 1985. Dr. Lipton served as a tutor in the philosophy of science at Oxford and an assistant research professor at Clark University in Worcester, Massachusetts, before being appointed an assistant professor of philosophy at Williams College, a post he held for five years. He returned to England in 1991 as a assistant lecturer in philosophy at Cambridge and was promoted to lecturer three years later. He was named to his present professorship in 1997. Dr. Lipton has delivered named lectures at Edinburgh University, Williams College, and, in 2004, at The Royal Society and Bristol University, where he gave the Medawar Lectures, and at Cambridge, where he gave the Darwin Lecture. A fellow of the Academy of Medical Sciences and a member of the Nuffield Council on Bioethics and former chair of its Working Party on Pharmacogenetics, he also serves on the board of directors of the Williams College in Oxford Program. He was formerly consulting editor of Studies in the History and Philosophy of Science and is currently the journal's advisory editor as well as a member of the editorial advisory panel of the British Journal for the Philosophy of Science and of the editorial board of the Ashgate series on New Critical Thinking in Philosophy. The author of numerous articles published in academic journals, Dr. Lipton is the editor of Theory, Evidence and Explanation (1995) and editor or co-editor of three special issues of Studies in the History and Philosophy of Science. He is also the author of Inference to the Best Explanation, which was first published by Routledge in 1991 and in an enlarged and revised edition in 2004.



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PARTICIPANTS

Michael Detlefsen Mary Leng Peter Lipton **Roger Penrose** Gideon A. Rosen Stewart D. Shapiro Mark Steiner Roger Penrose, the Rouse Ball Professor of Mathematics Emeritus at Oxford University and an emeritus fellow of Wadham College, Oxford, is widely acclaimed for his original and broad-based work in mathematical physics, particularly his contributions to general relativity theory, the foundations of quantum theory, and cosmology. He also has written on the link between fundamental physics and human consciousness. A graduate of University College, London, where he took first class honors in mathematics, he went on to study at St. John's College, Cambridge, and was awarded his Ph.D. in algebraic geometry by Cambridge University in 1958. While in his first year as a graduate student, Dr. Penrose rediscovered the generalized inverse of matrices, finding many new applications, and he later made other exceedingly significant contributions to physics and geometry, notably demonstrating in 1965 that, irrespective of symmetry, a massive star collapsing under the force of its own gravity will inevitably be crushed to a singularity, where densities and spacetime curvatures are expected to become infinite-an insight that soon led him and Stephen Hawking to provide theoretical confirmation of a similar status for the Big Bang as a singularity. Two years later, he introduced the "twistor" theory, a proposal for uniting quantum ideas with spacetime structure that takes spacetime points as a secondary notion, built up, in effect, from "light rays," which has recently found significant application in high-energy physics. His tilings of the plane (he devised "Penrose tiles" whose assembled patterns never repeat however large the area they cover) underlie the newly discovered quasicrystals, whose atoms seemed to be arranged in pentagonal symmetry. Among his notable contributions to cosmology is a model suggesting the geometrical nature of the Big Bang and its fundamental role in the second law of thermodynamics (which says, in effect, that things get more random as time progresses). In his widely discussed book The Emperor's New Mind (1989), winner of the 1990 Science Book Prize, Dr. Penrose argued that the known laws of physics are inadequate to explain the phenomenon of human consciousness and hinted at the characteristics of a new physics, which he said must provide a bridge between classical and quantum mechanics. He subsequently developed his theories in Shadows of the Mind: A Search for the Missing Science of Consciousness (1994) and The Large, the Small and the Human Mind (1997) in which he proposes using a non-computational model for explaining consciousness. After beginning his teaching career as an assistant lecturer in pure mathematics at Bedford

College, London, Dr. Penrose was appointed a research fellow at St. John's College, Cambridge. He subsequently was awarded a NATO Research Fellowship that brought him to the United States for work first at Princeton and then at Syracuse University. Returning to England, he spent two years as a research associate at King's College, London. In 1963, he accepted a visiting associate professorship at the University of Texas at Austin, and the next year, he was appointed a reader in mathematics at Birkbeck College, London. He was promoted to professor of applied mathematics in 1966, a post he held until being named the Rouse Ball Professor of Mathematics at Oxford seven years later. Dr. Penrose became emeritus in 1998, the year he was appointed to the three-year post of Gresham Professor of Geometry at Gresham College, London. He has been a guest professor at a wide variety of institutions and remains the Francis and Helen Pentz Distinguished (Visiting) Professor of Physics and Mathematics at Pennsylvania State University and a visiting professor of physics at Queen Mary College, London. A Fellow of the Royal Society, a foreign associate of the National Academy of Sciences, and a fellow of the European Academy of Sciences, he was knighted for his services to science by Queen Elizabeth II in 1994 and awarded Britain's Order of Merit in 2000. Among his other honors are Cambridge University's Adams Prize, the Dannie Heinemann Prize of the American Physical Society, the Eddington Medal (shared with Stephen Hawking) of the Royal Astronomical Society, the Royal Society's Royal Medal, Israel's Wolf Foundation Prize for Physics (shared with Stephen Hawking), the British Institute of Physics's Dirac Medal and Prize, the Albert Einstein Prize and Medal of the Albert Einstein Society, the London Mathematical Society's Naylor Prize and its DeMorgan Medal, the first Amaldi Medal presented by the Italian Society for General Relativity and Gravitation, and the Dalton Medal of the Manchester Literary and Philosophical Society. Dr. Penrose holds honorary degrees from fourteen colleges and universities. He has published numerous papers in scientific journals and three technical books. In addition to his books on consciousness, others he has written for more general audiences include one with Stephen Hawking entitled The Nature of Space and Time (1996) that provides a record of a debate between the two scientists at Cambridge's Isaac Newton Institute of Mathematical Sciences. His most recent book, The Road to Reality: A Complete Guide to the Laws of the Universe (2004), was reissued by Knopf in a paperback edition in January to widespread praise as one of the most important works in modern science writing, a volume that reveals the beauty and subtlety that connects nature and the human imagination.



PARTICIPANTS HOME APPROACH CHAIR $P_{2} - P_{1} = -pg(h_{2} - h_{1}) \quad \mathbf{x}^{n} + \mathbf{y}^{n} \neq \mathbf{z}^{n} \int_{a}^{b} F(u, u', x) dx = \min \\ a^{2} + b^{2} = c^{2} \quad F_{g} = G \frac{m_{1}m_{2}}{r^{2}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(\xi_{j}) (x_{j} - x_{j-1})\} \\ 3^{10}/71 < \pi < 3^{1/7} e^{i\pi} = -1 \int_{a}^{c} f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^{2}}{2\sigma^{2}}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(\xi_{j}) (x_{j} - x_{j-1})\} \\ \text{If } p|ab \text{ then } p|a \text{ or } p|b e^{i\pi} = -1 \int_{a}^{c} f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^{2}}{2\sigma^{2}}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(\xi_{j}) (x_{j} - x_{j-1})\} \\ \int_{a}^{c} f(x) dx = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^{2}}{2\sigma^{2}}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(\xi_{j}) (x_{j} - x_{j-1})\} \\ \int_{a}^{c} f(x) dx = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^{2}}{2\sigma^{2}}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(\xi_{j}) (x_{j} - x_{j-1})\} \\ \int_{a}^{c} f(x) dx = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^{2}}{2\sigma^{2}}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(\xi_{j}) (x_{j} - x_{j-1})\} \\ \int_{a}^{c} f(x) dx = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{\sigma\sqrt{2\pi}}} \int_{a}^{b} f(x) dx = Lim\{\sum_{j=1}^{n} f(x) - \sum_{j=1}^{n} f(x)$ d(fg)/dx = g df/dx + f dg/dxMathematics and 21, 22, and 23 June 2007 Its Significance Castel Gandolfo, Italy

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Michael Detlefsen Mary Leng Peter Lipton Roger Penrose **Gideon A. Rosen** Stewart D. Shapiro Mark Steiner A professor of philosophy at Princeton University, Gideon A. Rosen specializes in metaphysics, epistemology, philosophy of mathematics, and moral philosophy. He is a summa cum laude graduate of Columbia University, where he was elected to Phi Beta Kappa, and of Princeton University, where he held a Whiting Fellowship and earned his Ph.D. in philosophy in 1992. He had begun his teaching career three years earlier at the University of Michigan and returned to Princeton in 1993 as an assistant professor of philosophy. He was promoted to associate professor five years later and named to his present position in 2002. Dr. Rosen currently serves as director of Princeton's Program in Humanistic Studies, chair of its Council of Humanities, and director of its Stewart Seminars in Religion. He has been a visiting professor at the University of Auckland in New Zealand. A Mellon Foundation New Directions Fellowship allowed him to spend the 2003-04 academic year at New York University Law School where he took first-year law courses and served as the Hauser Fellow in Global Law. Among his other academic honors are a University of Michigan Distinguished Teaching Award and post-doctoral teaching fellowship and Princeton's Jonathan Dickinson Bicentennial Preceptorship and President's Award for Distinguished Teaching. In addition to some thirty-five articles published in academic journals, Dr. Rosen is the author (with John P. Burgess) of A Subject with No Object: Strategies for Nominalist Reconstrual in Mathematics (Oxford University Press, 1997), in which he argues that while standard mathematics is, in a certain sense, dispensable for most applications, the philosophical significance of this fact has been vastly overstated: the 'dispensability' of mathematics, properly understood, provides no reason whatsoever to doubt the claims of standard mathematics.



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A symposium sponsored by the John Templeton Foundation

Michael Detlefsen Mary Leng Peter Lipton Roger Penrose Gideon A. Rosen **Stewart D. Shapiro** Mark Steiner

Stewart D. Shapiro, the O'Donnell Professor of Philosophy at Ohio State University, is also a professorial fellow at St. Andrews University. His research and writing have focused primarily on the philosophy of mathematics, logic, the philosophy of logic, and the philosophy of language. A magna cum laude graduate of Case Western Reserve University, he went on to study at the State University of New York at Buffalo where he earned a master's degree in mathematics and a Ph.D. in philosophy, with distinction, in 1978. Dr. Shapiro then joined the Ohio State philosophy faculty as an assistant professor and was appointed a full professor in 1991. He was named to his present chair five years ago. He has been a visiting lecturer at Hebrew University in Jerusalem and a visiting fellow at Center for Philosophy and Science at the University of Pittsburgh. He spent the 1996-97 academic year as a professor of philosophy at St. Andrews. Awarded fellowships by the National Endowment for the Humanities and the American Council of Learned Societies, he also has received an Ohio State Award for Scholarly Achievement and an Ohio State University Distinguished Scholar Award. Dr. Shapiro is the editor of the Journal of Symbolic Logic and serves on the editorial boards of the Notre Dame Journal of Formal Logic, Philosophia Mathematica, the Philosophical Quarterly, and Philosophical Studies. He has published some eighty articles in scholarly journals and chapters in volumes of collected works. The editor five special issues of journals and three books, including most recently the Oxford Handbook of the Philosophy of Logic and Mathematics (2005), he is also the author of Foundations without Foundationalism: A Case for Second-Order Logic (1991 and 2000), Philosophy of *Mathematics: Structure and Ontology* (1997 and 2000), *Thinking about Mathematics:* The Philosophy of Mathematics (2000), and Vagueness in Context, an account of vagueness in natural language, which was published by Oxford University Press last year. He is completing a new textbook for Oxford tentatively entitled Logic for Philosophers, which will give the basic meta-theory for first-order logic with special emphasis on the philosophical issues encountered along the way.



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Michael Detlefsen Mary Leng Peter Lipton Roger Penrose Gideon A. Rosen Stewart D. Shapiro Mark Steiner A professor of philosophy at Hebrew University in Jerusalem, Mark Steiner has specialized in the philosophy of mathematics as part of his more general attention to the philosophy of science. His work has included a critical account of the mathematical philosophy of Ludwig Wittgenstein. Dr. Steiner, a summa cum laude graduate of Columbia University, studied at Oxford University on a Fulbright Fellowship, and earned his Ph.D. in philosophy at Princeton University in 1972. After beginning his teaching career at Columbia as an assistant professor of philosophy, he was appointed to a senior lectureship in philosophy at Hebrew University in 1977, was promoted to associate professor six years later, and was named to his present position in 1998.Dr. Steiner served as a visiting professor of philosophy in Columbia's summer session for twenty-seven years. His research has been supported by the National Science Foundation, the Dibner Foundation, and the Israel Academy of Sciences and Humanities. In addition to articles in scholarly journals, he is the author of Mathematical Knowledge (1975) and The Application of Mathematics as a *Philosophical Problem*, an attempt to explain the historical utility of mathematics in physics and what this might tell us about the human mind, which was published by Harvard University Press in 1998. His translation from Yiddish into English of Emune un Apikorses (1948) by Reuven Agushewitz, a Lithuanian-born Talmudic scholar who attacked the philosophy of materialism in all its historical versions, was published last year as Faith and Heresy by Yeshiva University Press.