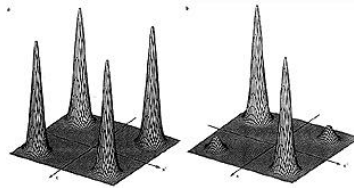


Deep Beauty:

Mathematical Innovation and the Search for an Underlying Intelligibility of the Quantum World



A Symposium and Book Publication Program
Sponsored by Princeton University's Department of Philosophy
Supported by a Grant from the John Templeton Foundation
Celebrating the Life and Legacy of John von Neumann and the
75th Anniversary of the Publication of His Classic Text:

*The Mathematical Foundations of Quantum Mechanics**

Symposium:

October 3 – October 4, 2007
Princeton, New Jersey

Revised 09-11-07, PContractor

* von Neumann, Johann. *Mathematische Grundlagen der Quantenmechanik*. Berlin: J. Springer, 1932.



John von Neumann, 1903-1957

Courtesy of the Archives of the Institute for Advanced Study (Princeton)*

The following photos are copyrighted by the Institute for Advanced Study, and they were photographed by Alan Richards unless otherwise specified. For copyright information, visit <http://admin.ias.edu/hslib/archives.htm>.

*[ED. NOTE: ELLIPSIS WILL WRITE FOR PERMISSION IF PHOTO IS USED;
SEE <http://www.physics.umd.edu/robot/neumann.html>]

Project Overview and Background

DEEP BEAUTY: Mathematical Innovation and the Search for an Underlying Intelligibility of the Quantum World celebrates the life and legacy of the scientific and mathematical polymath John Von Neumann 50 years after his death and 75 years following the publication of his renowned, path-breaking classic text, *The Mathematical Foundations of Quantum Mechanics*.*

The program, supported by a grant from the John Templeton Foundation, consists of (1) a two-day symposium sponsored by the Department of Philosophy at Princeton University to be held in Princeton October 3–4, 2007 and (2) a subsequent research volume to be published by a major academic press. The symposium will be chaired by Hans Halvorson of Princeton’s Philosophy Department; he will also subsequently serve as volume editor.

As one of the most creative minds of the 20th century, von Neumann developed a new basis of mathematical insight that paved the way for many further advancements in the field of quantum mechanics. He was also a pioneering influence on the development of one of the most momentous technologies in the history of the world: computer science. In addition, von Neumann left an extraordinary legacy of excellence that enhanced the culture of math and science teaching for children and young adults in the city of Budapest, Hungary, where he was educated in his youth.

During and after World War II, von Neumann was a much sought-after technical advisor in the United States. He served as a member of the Scientific Advisory Committee at the Ballistic Research Laboratories, the Navy Bureau of Ordnance, and the Armed Forces Special Weapons Project. He was a consultant to the Los Alamos Scientific Laboratory and was appointed by President Dwight D. Eisenhower to the Atomic Energy Commission. Among his honors were the Albert Einstein Commemorative Award, the Enrico Fermi Award, and the Medal of Freedom.

Von Neumann’s astonishing life work and influence on mathematics and computer science made him one of the outstanding figures of Princeton’s scientific culture. His involvement in the development of game theory and of three “world-shaking” technologies—the A & H bombs and the computer—led to important historical discussions on issues such as the massive impact and power of creative genius operating within the scientific enterprise. His breakthrough thinking and that of Princeton’s other famous émigré geniuses—Einstein, Gödel, Wigner, and others like them—will continue to generate new ideas and insights that in turn will generate new transformative technologies. The impact of their scientific genius will continue to transform the human condition on a massive global scale.

The purpose of this program is to better understand the nature of quantum mechanics since von Neumann and thereby probe further into the nature of the universe. Exploring ways to advance mathematical insight into the deep nature of quantum reality may help determine whether quantum mechanics can become more comprehensible in the way it models the ordered structure of nature. A dozen symposium participants from multidisciplinary fields—philosophy, history and philosophy of science, mathematics, logic, quantum computing and information, and various branches of physics—will aim to cultivate cross-fertilization and creative breakthroughs in the mathematical and philosophical foundations of quantum theory. Questions asking how mathematical advances might foster progress in answering “big philosophical questions” about causality, free will, and emergence, among other topics, may be explored.

* Von Neumann, Johann. *Mathematische Grundlagen der Quantenmechanik*. Berlin: J. Springer, 1932.

Short papers summarizing the presentations will be distributed among the speakers before the symposium to encourage informed discussion during the meeting. Following the symposium, the speakers will be invited to revise and expand their short papers into full-length chapters for the related research volume, which will be published by a major academic press in 2009 and edited by Hans Halvorson. A few select others will be invited to contribute to the book. The target audience consists of scholars in philosophy, history and philosophy of science, mathematics, logic, quantum computing and information, various branches of physics, and graduate students and post-doctoral students in these areas, as well as highly educated and others interested in cross-disciplinary education and a furthering of our understanding of the nature of quantum mechanics—and of the universe.

Symposium Agenda

Day 1: Wednesday, October 3, 2007

- 8:30 – 9:00 *Continental Breakfast*
- 9:00 – 9:30 Welcome and Introductory Comments
CHARLES HARPER (CONVENER), HANS HALVORSON (CHAIR)
- 9:30 – 10:20 Session #1, Keynote Presentation: “Spans of Groupoids and the Foundations of Quantum Theory”
JOHN BAEZ
- 10:20 – 10:45 Session #1 Q&A and Open Discussion
- 10:45 – 11:05 *Break*
- 11:05 – 11:50 Session #2: Presentation Title TBA
SIMON KOCHEN
- 11:50 – 12:10 Session #2 Q&A and Open Discussion
- 12:10 – 1:20 *Informal Buffet Lunch*
- 1:20 – 2:05 Session #3: “The Principle of General Covariance”
KLAAS LANDSMAN
- 2:05 – 2:25 Session #3 Q&A and Open Discussion
- 2:25 – 3:10 Session #4: “The Logic of Quantum Mechanics—Take II”
BOB COECKE
- 3:10 – 3:35 *Break*
- 3:35 – 3:55 Session #4 Q&A and Open Discussion
- 3:55 – 4:40 Session #5: “Topos Theory in the Foundations of Physics”
ANDREAS DÖRING
- 4:40 – 5:00 Session #5 Q&A and Open Discussion
- 5:00 – 5:20 General Group Discussion and Wrap-Up, Day 1
- 6:00 – 8:00 *DINNER*

Day 2: Thursday, October 4, 2007

<i>8:30 – 9:00</i>	<i>Continental Breakfast</i>
9:00 – 9:45	Session #6: “Yet More Ado About Nothing: The Remarkable Relativistic Vacuum State” <i>STEPHEN SUMMERS</i>
9:45 – 10:05	Session #6 Q&A and Open Discussion
10:05 – 10:50	Session #7: “An Operational Framework for a Theory of Quantum Gravity” <i>LUCIEN HARDY</i>
<i>10:50 – 11:10</i>	<i>Break</i>
11:10 – 11:30	Session #7 Q&A and Open Discussion
11:30 – 12:15	Session #8: “Von Neumann on Probability in Quantum Mechanics” <i>JEFFREY BUB</i>
12:15 – 12:35	Session #8 Q&A and Open Discussion
<i>12:35 – 1:45</i>	<i>Informal Buffet Lunch</i>
1:45 – 2:30	Session #9: “Operational Independence of Quantum Systems” <i>MIKLÓS RÉDEI</i>
2:30 – 2:50	Session #9 Q&A and Open Discussion
2:50 – 3:35	Session #10: “Quantum Physics and the Finiteness of Information” <i>ČASLAV BRUKNER</i>
<i>3:35 – 3:55</i>	<i>Break</i>
3:55 – 4:15	Session #10 Q&A and Open Discussion
4:15 – 5:00	General Group Discussion and Future Possibilities
<i>6:00 – 8:00</i>	<i>DINNER</i>

Symposium Participants

CHAIR:

Hans Halvorson, Department of Philosophy, Princeton University, United States
hhalvors@princeton.edu
<http://www.princeton.edu/~hhalvors/cv.pdf>
<http://web.princeton.edu/sites/philosph/bios/halvorson.htm>

Hans Halvorson is Associate Professor in the Department of Philosophy at Princeton University. Professor Halvorson graduated from Calvin College with a Bachelor's Degree in Philosophy. This was followed by Master's Degrees in Philosophy and Mathematics from the University of Pittsburgh and a Ph.D. in Philosophy from the University of Pittsburgh. He became Assistant Professor of Philosophy at Princeton in 2001 and received tenure in 2005. At Princeton, Professor Halvorson teaches primarily in philosophical logic and philosophy of science; he also advises independent work in metaphysics, philosophy of science, and philosophy of religion. His research focuses on the conceptual and mathematical foundations of contemporary physics, especially quantum field theory and quantum information theory. Professor Halvorson has been a short-term Fellow with the Perimeter Institute for Theoretical Physics (2006), a Behrman Fellow with the Princeton Council of the Humanities, and Associate Fellow with the Center for the Philosophy of Science at the University of Pittsburgh. He has been the recipient of such awards as the Mellon New Directions Fellowship (2007), the Cushing Memorial Prize in the History and Philosophy of Physics (2004), Best Article of the Year by a Recent Ph.D. (Philosophy of Science Association, 2001), and Ten Best Philosophy Articles of the Year (*The Philosopher's Annual*, 2001 and 2002).

KEYNOTE SPEAKER:

John Baez, Department of Mathematics, University of California, Riverside, United States
baez@math.ucr.edu
<http://math.ucr.edu/home/baez/>

John Baez is Professor of Mathematics at the University of California, Riverside. He obtained his B.A. in Mathematics from Princeton University (1982) and his Ph.D. in Mathematics from the Massachusetts Institute of Technology (1986). He was elected Fellow of the American Association for the Advancement of Science (1999). Known for his work on spin foams in loop quantum gravity, his recent research has focused on applications of higher categories to physics. His books include *An Introduction to Algebraic and Constructive Quantum Field Theory* (1992), authored with Irving Segal and Zhengfang Zhou, and *Gauge Fields, Knots, and Gravity* (1994), authored with Javier Muniain. He edited *Knots and Quantum Gravity* (1994). He writes an online column entitled "This Week's Finds in Mathematical Physics" and helps run The n-Category Cafe, which is a blog on mathematics, physics, and philosophy.

SPEAKERS:

Časlav Brukner, Institute of Quantum Optics, Quantum Nanophysics, and Quantum Information, Faculty of Physics, University of Vienna, Austria
caslav.brukner@univie.ac.at
http://www.iqoqi.at/people/cv/brukner_caslav.pdf
<http://homepage.univie.ac.at/Caslav.Brukner/cv.htm>

Časlav Brukner obtained his M.S. in Physics from the University of Vienna (1995) for his thesis *Diffraction of Matter Waves in Space and Time*. He earned a Doctor of Technical Sciences from the Vienna University of Technology (1999) under the supervision of Professor Anton Zeilinger for his thesis *Information in Individual Quantum Systems*. Subsequently, he was awarded the Habilitation in Quantum Physics for his thesis *Information-Theoretical Foundations of Quantum Entanglement, Bell's Theorem and Quantum Communication Complexity*. Professor Brukner has been Associate Professor, Faculty of Physics, at the University of Vienna (since 2003). In addition, he has been a Faculty member in the Doctoral Program "Complex Quantum Systems" at the University of Vienna, Vienna University of Technology, and the University of Innsbruck (since 2006), as well as Chair Professor at Tsinghua University, Beijing (since 2005). Professor Brukner also was Senior Researcher at the Institute for Quantum Optics and Quantum Information at the Austrian Academy of Sciences (2005–2006) and a Marie Curie Fellow at the Imperial College London Physics Department (2004). He was Assistant Professor, Institute of Experimental Physics, at the University of Vienna (1999–2003) and Scientific Researcher, Institute of Experimental Physics, at the University of Innsbruck (1996–1999). Professor Brukner is a Member of the Foundational Questions Institute (FQXi), which supports and disseminates research on questions about the foundations of physics and cosmology.

Jeffrey **Bub**, Department of Philosophy, University of Maryland, College Park, United States
jbub@umd.edu
<http://carnap.umd.edu/philphysics/bub.html>

Jeffrey Bub obtained his Ph.D. in Mathematical Physics at London University (1966). Currently, he is Distinguished University Professor in the Department of Philosophy and the Institute for Physical Science and Technology at the University of Maryland. Professor Bub has held appointments at Yale University and the University of Western Ontario, as well as visiting appointments at Yale, Princeton University, Tel Aviv University, the University of California at Irvine, the University of California at San Diego, the Center for the Philosophy of the Natural and Social Sciences at the London School of Economics and Political Science, and the Perimeter Institute for Theoretical Physics in Waterloo, Canada. Professor Bub has published numerous articles in scientific and scholarly journals on the conceptual foundations of quantum mechanics and is the author of two books: *The Interpretation of Quantum Mechanics* (Reidel, 1974) and *Interpreting the Quantum World* (Cambridge University Press, 1997; revised paperback edition, 1999), which won the prestigious Lakatos Award in 1998 for providing a unified reconstruction and systematic assessment of quantum mechanics. His current research is focused on foundational questions arising in the field of quantum information and computation. Professor Bub was awarded the Kirwan Faculty Research and Scholarship Prize in 2005 for his work in this area.

Bob **Coecke**, Computing Laboratory, University of Oxford, United Kingdom
bob.coecke@comlab.ox.ac.uk
<http://web.comlab.ox.ac.uk/oucl/people/bob.coecke.html>

Bob Coecke is University Lecturer in Quantum Computer Science, EPSRC Advanced Research Fellow, and Fellow of Wolfson College, Oxford University. He obtained his Ph.D. in Theoretical Physics from the Vrije Universiteit, Brussels and held postdoctoral positions at Imperial College, McGill University, and the University of Cambridge. Professor Coecke was awarded the 2004 Biennial Prize for Meritorious Research in the Field of Quantum Structures. With Abramsky, Professor Coecke co-authored the first paper on quantum informatics to ever have been accepted by the IEEE conference on Logic in Computer Science. This paper initiated the axiomatization of quantum mechanics in terms of monoidal categories. He currently coordinates a 2M European STREP entitled "Foundational Structures in Quantum Information and Computation" and is finishing a number of volumes of commissioned chapters in Springer's *Lecture Notes in Physics* book series entitled *New*

Structures for Physics. Professor Coecke runs the interdisciplinary OASIS research seminar series at Oxford University's Computing Laboratory and regularly organizes workshops on structural research in physics and computer science.

Andreas **Döring**, Theoretical Physics Group, Blackett Laboratory, Imperial College of Science, Technology & Medicine, London, United Kingdom

a.doering@imperial.ac.uk

http://www.imperial.ac.uk/physics/about/staff/staff_detail.aspx?id=1401

Andreas Döring began his study of physics in 1995 at the Johann Wolfgang Goethe-Universität, Frankfurt am Main. His diploma thesis in mathematical physics, *Kinematik diffeomorphismeninvarianter quantisierter Eichtheorien* (in German, 2000; supervisor, Professor Hans F. de Groot, Frankfurt) considered kinematical aspects of loop quantum gravity. In 2001, Dr. Döring switched from physics to mathematics, shifting his research interests to operator algebras and some of their applications in physics. In particular, he worked on the classification of the so-called Stone spectra of finite von Neumann algebras. Dr. Döring also proved a generalization of the famous Kochen-Specker theorem, which clarifies the situation for all von Neumann algebras. The new proof is related to Christopher Isham and Jeremy Butterfield's work on presheaf reformulations of the Kochen-Specker theorem. His Dr. Döring's thesis, *Stone spectra of finite von Neumann algebras and foundations of quantum theory*, was finished in December 2004. Subsequently, he found a certain generalization of the Gelfand transform. Around that time, he became interested in category and topos theory and gave a lecture on these topics at Frankfurt University. In July 2005, Dr. Döring organized a small workshop on new mathematical structures in the foundations of quantum theory. From December 2005 on, he has worked with Christopher Isham at Imperial College, London. Recently, they proposed a new scheme for the formulation of physical theories using topos theory in which formal languages encoding an intuitionistic logic play a central role.

Lucien **Hardy**, Institute for Quantum Computing, Perimeter Institute for Theoretical Physics, Waterloo (Ontario), Canada

lhardy@perimeterinstitute.ca

<http://www.iqc.ca/people/person.php?id=114>

http://www.perimeterinstitute.ca/index.php?option=com_content&task=view&id=30&Itemid=72&pi=index.php&e=Faculty&cat_id=433&cat_table=4&e=Lucien%20Hardy%20&f=3&name=Lucien%20Hardy%20&resident_id=1078

Lucien Hardy received his Ph.D. at Durham University (1993) under the supervision of Professor Euan J. Squires. He has held research and lecturing positions in Maynooth, Innsbruck, Durham, Rome, and Oxford. Since 2002, he has been a member of faculty at Perimeter Institute for Theoretical Physics in Waterloo, Ontario, Canada. His primary research area is quantum foundations. In particular, he is interested in applications of quantum foundations to quantum gravity and quantum information. In 1992, he found a very simple proof of non-locality in quantum theory, which has become known as Hardy's theorem. In Rome, he collaborated on the first experiment to demonstrate quantum teleportation. In Oxford, he worked on obtaining an alternative set of postulates for quantum theory. He is currently working on building a framework appropriate for a theory of quantum gravity.

Simon B. **Kochen**, Department of Mathematics, Princeton University, United States

kochen@math.princeton.edu

<http://web.princeton.edu/sites/philosph/bios/kochen.htm>

Simon Kochen has been the Henry Burchard Fine Professor of Mathematics at Princeton University since 1994. He received his Ph.D. from Princeton University in 1958 and joined the Mathematics

Department at Princeton in 1967. He and John Conway proved the Free-Will Theorem in 1994. Having research interests in model theory, number theory, and the foundations of quantum mechanics, he is the author of a number of articles in these fields. In 1968, Professor Kochen was the recipient of the American Mathematical Society Cole Prize in Number Theory.

Nicolaas P. (Klaas) **Landsman**, Institute for Mathematics, Astrophysics, and Particle Physics, Department of Science, Radboud Universiteit Nijmegen, The Netherlands
landsman@math.ru.nl
<http://www.math.ru.nl/~landsman/>

Nicolaas (Klaas) Landsman studied physics, mathematics, and astronomy at the University of Amsterdam (1981–1985). His initial research was in quantum field theory at finite temperature and the quark-gluon plasma. His M.Sc. thesis, published as *Physics Reports 145, 141-249* (1987), has been cited almost 700 times. He earned his Ph.D. in Theoretical Physics (1989). Subsequently, Professor Landsman was a research assistant and then an advanced research fellow at the DAMTP of the University of Cambridge from 1989–1997, interrupted by a year at Hamburg 1993–94. Dr. Landsman switched from theoretical physics to mathematical physics and the history and philosophy of physics under the influence of Michael Atiyah, Jeremy Butterfield, Alain Connes, Klaus Fredenhagen, Rudolf Haag, Stephen Hawking, Christopher Isham, Michael Redhead, Marc Rieffel, and Alan Weinstein. His research interests are a blend of quantization theory, noncommutative geometry, and the mathematical and conceptual foundations of quantum mechanics, the latter also from a historical point of view, leading to publications about Bohr, Einstein, and Heisenberg. Most of his mathematical ideas from that period have appeared in Professor Landsman's book *Mathematical Topics Between Classical and Quantum Mechanics* (Springer, 1998). In 2005, he published a novel, *Requiem for Newton* (in Dutch, due to be translated by Wiley-VCH), about his Cambridge years that was at the same time a history of physics. Professor Landsman became a Royal Society research fellow at the University of Amsterdam, where he became a Full Professor of Mathematical Physics in 2001. He was awarded a "Pioneer" research grant of 1M euro by the Dutch Research Organization in 2002 and moved to the Radboud University Nijmegen in 2004 as a Professor of Analysis. In The Netherlands, Professor Landsman began collaborating with Ieke Moerdijk, under whose influence he increased work on Lie groupoids and became interested in category theory. This interest has led to various proposals of turning quantization into a functor and a generalization of the Guillemin-Sternberg conjecture that "quantization commutes with reduction" to noncompact groups and even to (proper) Lie groupoids. Professor Landsman subsequently became interested in topos theory as a foundation for quantum logic and perhaps even for all of physics, especially quantum gravity, which he is exploring at Nijmegen, where he has taught and worked on educational projects and policy for secondary-school mathematics.

Miklós **Rédei**, Department of Philosophy, Logic and Scientific Method, London School of Economics and Political Science, United Kingdom
m.redei@lse.ac.uk
<http://www.lse.ac.uk/collections/philosophyLogicAndScientificMethod/>
<http://philosophy.elte.hu/redei/>

Miklós Rédei studied physics and philosophy at Lorand Eötvös University in Budapest, Hungary, receiving his Ph.D. in Philosophy from Eötvös University (1982), where he taught in the Department of History and Philosophy of Science and in the Department of Logic. Currently, he is Lecturer in the Department of Philosophy, Logic and Scientific Method at the London School of Economics and Political Science. Professor Rédei has had visiting positions in Europe and in the US: he was a Visiting Fellow and Fulbright Scholar at the Center for Philosophy of Science in Pittsburgh (1994–95) and Senior Resident Fellow in the Dübner Institute at the Massachusetts Institute of Technology (1997–98).

Professor Rédei's research interests concern foundational and philosophical problems of modern physics, especially quantum theory, as well as more general issues in philosophy of science, such as the interpretation of probability and theories of probabilistic causation. He is the author of *Quantum Logic in Algebraic Approach* (Kluwer, 1998), co-editor of the volume *John von Neumann and the Foundations of Quantum Physics*, M. Rédei and M. Stoeltzner (eds.) (Kluwer, 2001), and editor of *John von Neumann: Selected letters* (American Mathematical Society, 2005). Professor Rédei was co-organizer of the three-year European Science Foundation Network "Foundational and Philosophical Problems of Modern Physics" (2003–2005).

Stephen J. Summers, Department of Mathematics, University of Florida, Gainesville, United States
sjs@math.ufl.edu
<http://www.math.ufl.edu/~sjs/>

Stephen J. Summers, Professor of Mathematics at the University of Florida, is a mathematical physicist specializing in the mathematical and conceptual foundations of quantum theory, particularly relativistic quantum field theory. While completing graduate studies in physics at Harvard University (Ph.D. 1979), he was teaching and doing research at the Eidgenössische Technische Hochschule in Zürich (ETH Zürich). After postdoctoral positions at the Centre de Physique Théorique of the CNRS at Luminy outside Marseilles and in the Department of Physics at the University of Osnabrück, Professor Summers returned to the United States in 1985 to become Assistant Professor of Mathematics at the University of Rochester. In 1989, he moved to the University of Florida as Associate Professor of Mathematics. Since his return to the US, Professor Summers has held visiting positions at King's College, London, the University of Provence, the University of Rome, the Erwin Schrödinger International Institute for Mathematical Physics, Vienna, and again at the Centre de Physique Théorique, Luminy. He was also Gauss Professor at the University of Göttingen in 1994.

Other Participants

Discussant and Book Contributor: Jeremy N. Butterfield, Trinity College, University of Cambridge, United Kingdom
jb56@cam.ac.uk
<http://www.trin.cam.ac.uk/butterfield/>

Jeremy Butterfield has been a Fellow at Trinity College at the University of Cambridge since October 2006. His previous position was Senior Research Fellow in the Philosophy of Physics at All Souls College at the University of Oxford. Two of Dr. Butterfield's recent articles on quantum physics are "Stochastic Einstein locality revisited" (forthcoming in *The British Journal for the Philosophy of Science*), and "Reconsidering relativistic causality" (forthcoming in *International Studies in Philosophy of Science*).

Online Discussant and Book Contributor: Hans F. de Groote, Institut für Analysis und Mathematische Physik, Johann Wolfgang Goethe-Universität, Frankfurt am Main, Germany
degroote@math.uni-frankfurt.de
http://www.informatik.uni-trier.de/~ley/db/indices/a-tree/g/Groote:Hans_F_de.html; <http://univis.uni-frankfurt.de/prg?show=info&key=566/persons/2006w:fb12/mathana/mathana/degroote>

Hans de Groote obtained his Ph.D. in Mathematics in 2004 from Johann Wolfgang von Goethe University in Frankfurt, Germany for a dissertation entitled *Stone spectra of von Neumann algebras and foundations of quantum theory*. He received his B.A. in Physics (2000) from Johann Wolfgang von Goethe University. Dr. de Groote is the author of several articles, which include "The

kinematical frame of Loop Quantum Gravity I" (2001), "Kochen-Specker theorem for von Neumann algebras" (2004), and "Stone spectra of von Neumann algebras of Type I_n" (2005).

Online Discussant and Book Contributor: Christopher J. Isham, Theoretical Physics Group, Department of Physics, Imperial College, London, United Kingdom
c.isham@imperial.ac.uk
<http://www3.imperial.ac.uk/people/c.isham>

Christopher Isham is Professor of Theoretical Physics at Imperial College London. His main research interests are quantum gravity and foundational studies in quantum theory. Professor Isham has done important work on loop quantum gravity and quantum geometrodynamics, and he is well known as one of the foremost proponents (together with John Baez) of the utility of category theory in theoretical physics. Professor Isham is the author of *Prima Facie Questions in Quantum Gravity* (1994) and, with co-author Jeremy Butterfield, he has written *On the Emergence of Time in Quantum Gravity* (1999) and *Spacetime and the Philosophical Challenge of Quantum Gravity* (2001).

Special Guests

Freeman J. Dyson, Professor Emeritus, School of Natural Sciences, Institute for Advanced Study, Princeton, United States
dyson@ias.edu
<http://www.sns.ias.edu/~dyson/>

Freeman Dyson is now retired, having been for most of his life Professor of Physics at the Institute for Advanced Study in Princeton. He was born in England and worked as a civilian scientist for the Royal Air Force in World War II. Professor Dyson graduated from Cambridge University (1945) with a B.S. in Mathematics, went on to Cornell University as a graduate student (1947), and worked with Hans Bethe and Richard Feynman. His most useful contribution to science was the unification of the three versions of quantum electrodynamics invented by Feynman, Schwinger, and Tomonaga. Professor Dyson has written a number of books about science for the general public. He is a Fellow of the American Physical Society, a member of the US National Academy of Sciences, and a Fellow of the Royal Society of London. In 2000, Professor Dyson was awarded the Templeton Prize.

Peter Woit, Department of Mathematics, Columbia University, New York, United States
woit@math.columbia.edu
<http://www.math.columbia.edu/~woit/>

Peter Woit is a mathematical physicist at Columbia University. He obtained his Ph.D. in Particle Theory from Princeton University (1985). This was followed by postdoctoral work in theoretical physics at State University of New York at Stony Brook and mathematics at the Mathematical Sciences Research Institute (MSRI) in Berkeley. Professor Woit spent four years as an Assistant Professor at Columbia University and now holds a permanent position as Lecturer in the Mathematics Department, where he runs the computer system, teaches classes, and continues his research activities, focusing on topics that relate representation theory and quantum field theory. Professor Woit is critical of the domination of particle theory research in recent years by string theory and is the author of the recent book *Not Even Wrong: The Failure of String Theory and the Continuing Challenge to Unify the Laws of Physics*. His weblog on string theory and other topics in mathematics and physics is also entitled *Not Even Wrong* after the category into which speculative theories were dismissed by the discoverer of the exclusion principle, Wolfgang Pauli.

Organizers

CONVENER:

Charles L. Harper, Jr., Senior Vice President, John Templeton Foundation, Philadelphia, United States
charper@templeton.org
<http://www.templeton.org/>

Charles L. Harper, Jr., D.Phil. is Senior Vice President of the John Templeton Foundation. His primary responsibilities are in the areas of strategic planning, program design and development, vision casting, philanthropic networks development, and talent scouting. Dr. Harper has worked to transform philanthropy by instituting innovative entrepreneurial practices in grant making, creating more than \$200 million in grant-based programs ranging widely from the study of forgiveness and reconciliation and enterprise-based solutions for poverty to projects on foundational questions in physics and cosmology and other scientific topics in biochemistry, neuroscience, evolutionary biology, medicine, and the philosophy of science. He is the founding Chairman of Geneva Global, Inc., an innovative philanthropic organization making grants worldwide within the developing world, reflecting his special interests in trade and solutions to poverty that include promoting a vision for major reforms focused on entrepreneurs and wealth creators in the commercial aid sector and avoidance of charitable dependency among aid recipients. Initially trained in engineering at Princeton (B.S.E. 1980), Dr. Harper obtained his D.Phil. in planetary science from the University of Oxford for a thesis on the nature of time in cosmology (1988). He also holds the Diploma in Theology from Oxford (1988) and a Certificate of Special Studies in Management and Administration from Harvard University (1997). In his science career, Dr. Harper was a National Research Council Fellow at NASA's Johnson Space Center (1988–91) and a research scientist in the Harvard Department of Earth and Planetary Sciences and at the Harvard College Observatory (1991–95).

For the John Templeton Foundation, he has developed a number of science-based interdisciplinary symposia and related research volumes, including THE FOUNTAIN OF YOUTH: CULTURAL, SCIENTIFIC, AND ETHICAL PERSPECTIVES ON A BIOMEDICAL GOAL based on the EXTENDED LIFE, ETERNAL LIFE symposium co-sponsored by the Center for Bioethics at the University of Pennsylvania, March 2000 (Oxford University Press, NY, 2003); SCIENCE AND ULTIMATE REALITY: QUANTUM THEORY, COSMOLOGY, AND COMPLEXITY in honor of the 90th birthday of John A. Wheeler based on the symposium in Princeton, March 2002 (Cambridge University Press, UK, 2004); SPIRITUAL INFORMATION: 100 PERSPECTIVES ON SCIENCE AND RELIGION in honor of the 90th birthday of Sir John Templeton (Templeton Foundation Press, 2005) (the sequel to this book is currently in development); FITNESS OF THE COSMOS FOR LIFE: BIOCHEMISTRY AND FINE-TUNING in honor of the legacy of Lawrence J. Henderson based on the symposium at Harvard University, October 2003 (Cambridge University Press, UK, forthcoming fall 2007); VISIONS OF DISCOVERY: NEW LIGHT ON PHYSICS, COSMOLOGY, AND CONSCIOUSNESS in honor of the 90th birthday of Charles H. Townes based on the symposium at the University of California, Berkeley, October 2005 (Cambridge University Press, UK, forthcoming in 2008); and HORIZONS OF TRUTH: LOGICS, FOUNDATIONS OF MATHEMATICS, AND THE QUEST FOR UNDERSTANDING THE NATURE OF KNOWLEDGE in honor of the legacy of Kurt Gödel based on the symposium at the University of Vienna, April 2006 (Cambridge University Press, NY, forthcoming in 2008). Currently, Dr. Harper is developing several similar symposia and book projects in addition to other special programs for the Foundation. Other scientific publications include more than 50 research articles in scientific journals, including *Nature*, *Science*, and the *Astrophysical Journal*.

PROGRAM DEVELOPER:

Hyung S. Choi, President, Innovative Research & Programs, Inc., Drexel Hill, PA, United States
hsc25@cam.ac.uk

Hyung S. Choi is President of Innovative Research & Programs, Inc. and a Visiting Fellow at St. Edmund's College, University of Cambridge. He received both his M.Phil. and Ph.D. in Theoretical Physics from the Graduate Center of the City University of New York (CUNY) and his M.Div. from Princeton Theological Seminary. Before moving to the United States in 1979, he studied undergraduate physics at Kyung-Hee University and theoretical particle physics at Seoul National University in South Korea. Dr. Choi previously served as Director for Research and Programs in the Natural Sciences at the Metanexus Institute and Director of the Canyon Institute for Advanced Studies in Phoenix, Arizona. He has also been Professor of Mathematical Physics and Philosophy of Science at Grand Canyon University, and he was a Witherspoon Fellow at the Center for Theology and the Natural Sciences in Berkeley, California. A recipient of many honors and awards for research and teaching, Dr. Choi's areas of expertise include the foundations of quantum mechanics, quantum theory of light, and philosophy of science.

Contact

PAMELA M. CONTRACTOR
PRESIDENT & DIRECTOR, ELLIPSIS ENTERPRISES, INC.
SCIENTIFIC / ACADEMIC EDITORIAL & EVENT CONSULTING
23 Bluebird Court, Flemington, New Jersey 08822-5508 USA
Tel: 908-788-0464; Fax: 908-788-1999; Mob: 215-896-2112
pcontractor@ellipsicon.net