

FROM PHYSICS TO METAPHYSICS: THE CHANGING FACE OF SCIENTIFIC IMAGINATION

Institution: The Hebrew University of Jerusalem

Instructors: Dr. Avihu Zakai, Department of History

Dr. Ayval Ramati, Department of History

Since the scientific revolution of the seventeenth century, scientists have sought to seek new knowledge in a relatively straightforward, traditional manner. Experiments would be performed, hypothesis tested, and science would slowly and gradually progress as new data accumulated. Every now and then, of course, a sudden great leap would occur which unveiled some significant and unexpected new discovery. Today, however, there are some scientific fields in which the frontiers have been pushed so far forward -- such as in "superstring" and "hyperspace" theories which deal with "parallel universes," "time warps" and the "tenth dimension" - that scientists have found themselves asking questions that have always been considered to be metaphysical, not scientific, in nature. Nobel prize winning physicist Sheldon Glashow and his Harvard university colleague Paul Ginsparg have likened "superstring theory" to medieval theology: "For the first time since the Dark Ages," they write, "we can see how our noble [scientific] search may end, with faith replacing science once again." An important transformation seems to be occurring in the scientific imagination from physics to metaphysics whereby teleological and theological considerations begin to dominate once again scientific thought.

The primary goal of the course is to explore the profound change that has taken place in the scientific imagination from the scientific revolution of the seventeenth century to modern scientific culture, and to illuminate this transformation in scientific thought as based upon the shift from physics to metaphysics. Its goal is to show that this "metaphysical turn" is the result, in part, of the growing convergence between scientific and religious thought. Broadly speaking, scientific imagination during the medieval period was founded primarily on the Christian theological teleology of sacred order inherent in the fabric of the universe, which resulted in the medieval enchantment of the world of nature: nature possesses inherent qualities and intrinsic powers instilled in it by God. In contrast, the scientific revolution imagination led to the disenchantment of the natural world by constructing a radical new concept of the nature of reality, envisioning a one-dimensional realm of reality that is throughout homogeneous, uniform and symmetrical, and therefore nonhierarchical. Seventeenth century mechanical imagination thus replaced Aristotle's conception of nature as an organic being achieving maturity through self-development with the view of nature as a huge machine. Today, however, modern scientific imagination is witnessing the "metaphysical turn," clad in a highly abstract mathematical language, which leads once again to the re-enchantment of the world. Abstract scientific theories, such as "hyperspace," "superstring" and models of infinite universes, which may not be tested or proved, begin to dominate the horizon of scientific imagination and determine the edges of science. These metaphysical considerations are cultivated within a well-defined and established mathematical

community, which allows a mathematical metaphysics to flourish as a disciplined and precise inter-subjective discourse capable of exploring what lies beyond experimental results.

In this course we will emphasize the continuities and discontinuities between the medieval and the new scientific worldviews, to illuminate the growing convergence of scientific and religious thought, and to show how modern scientific thought leads once again to the re-enchantment of the world.

SYLLABUS

Introduction: The Transformations of Materiality from Classical Physics to Twentieth Century Physics Weeks 1-2

From Near Equilibrium Deterministic and Passive Matter to far-from Equilibrium Indeterministic Matter. From atomic material billiard balls to wave-like and particle-like matter.

From three-dimensional space and one-dimensional time to higher dimensions.

Readings:

Ilya Prigogine and Isabelle Stengers, *Order out of Chaos*, Bantam, 1984.

Dana Zohar, *The Quantum Self*. London, Harper Collins, 1991.

Michio Kaku, *Hyperspace*, New York: Oxford University Press, 1994.

Science and Theology during the Middle Ages: Copernicus, Galileo and the Church Weeks 3-4.

The Dialogue between Science and Religion during the Middle Ages and the Enchantment of the World

Readings:

D. C. Lindberg and R. L. Numbers, *God and Nature*, 1986.

J. H. Brooke, *Science and Religion*, 1991.

I. Bernard Cohen, *Revolution in Science*, 1985.

Etienne Gilson, *Reason and Revelation in the Middle Ages*, 1938.

Gordon Leff, *The Dissolution of the Medieval Outlook*, 1976.

James M. Lattis, *Between Copernicus and Galileo*, 1994

David C. Lindberg, *The Beginning of Western Science*, 1992

The First Stage of the Transformation: Excluding of Metaphysics from Physics and the Disenchantment of the World during the Scientific Revolution
Weeks 5-7

The Scientific Revolution's disenchantment of the natural world. The transformation of materiality into a non-hierarchical, uniform, and passive entity. Divine omnipotence and the laws of nature. Counterfactual laws and inertia: Galileo, Descartes, and Newton. Inductive reasoning and experiments: hypothesis and crucial experiments (Francis Bacon, Boyle, and Pascal).

Readings:

Amos Funkenstein, *Theology and the Scientific Imagination*, Princeton, 1986.

Shapin and Schaffer, *Leviathan and the Air Pump*, Princeton, 1985.

Alexander Koyre, *From the Closed World to the Infinite Universe*, Baltimore, 1957.

Cohen, Bernard. *The Birth of a New Physics*, New York, W. W. Norton, 1985.

(Selected Reading from Descartes, Bacon, Newton, Boyle, and Pascal.)

The Second Phase of the Transformation: The Rise of Abstract Mathematical Formulations and the Displacement of Tangible Mechanical Models.
Week 6

From Newtonian forces and atomic billiard balls to abstract Fields. Mathematical formulations manifesting predictive power displacing former tangible mechanical explanations. Abstract mathematical formulations verified by tangible experimental results.

Readings:

Bruce Gregory, *Inventing Reality*, New York, 1988.

Mar Midgley, *Science as Salvation: A Modern Myth and Its Meaning*, 1992.

Willem B. Drees, *Beyond the Big Bang: Quantum Cosmologies and God*, 1990.

Ian Barbour, *Religion in an Age of Science*, 1990.

Towards a New Third Phase: The Prevalence of Symmetry and the Transformation of Materiality into a Holistic, Interactive, and Inter-related Being.
Weeks 7-10

Special and general relativity: the space-time manifold and the relation between matter and energy. Quantum physics: particle-wave duality, virtual particles, and the living vacuum.

QED and QCD: hidden forces and abstract symmetry breaking.

Readings:

Benjamin Gal-Or, *Cosmological Physics and Philosophy*, New York, 1981.

Paul Davies, *Superforce*, New York: Simon and Schuster, 1984.

Bruce Gregory, *Inventing Reality*, New York, 1988.

Richard Feynman, *QED: The Strange Story of Light and Matter*, Princeton, 1985.

P. Galison & D. J. Stump, eds. *The Disunity of Science*, 1996

The Third Phase: The Shift from Physics to Metaphysics and the Search for a New Convergence between Science and Religion.
Weeks 11-12

More about the Quantum Void. GUT, Superstrings, and Hyperspace: spatial dimensions invisible, hidden and curled up into spaces much smaller than the size of the proton.

Readings:

Dana, Zohar, *The Quantum Self*, London: Harper Collins, 1991.

Michio Kaku, *Hyperspace*, New York: Oxford University Press, 1994.

Paul Davies, *Superforce*, New York: Simon and Schuster, 1984.

Bruce Gregory, *Inventing Reality*, New York, 1988.

What Kind of Metaphysics are We Witnessing in this Curled up Invisible Spatial Dimensions?
Weeks 13-14

God and the New Metaphysics. Mysticism, Spirituality, and the new Metaphysics.

Mathematics as the language of Metaphysics. Medieval Metaphysics versus Mathematical Metaphysics.

Readings:

Michio Kaku, *Hyperspace*, New York: Oxford University Press, 1994.

Davies, Paul. *God and the New Physics*, New York, Simon and Schuster, 1983.

---- *The Mind of God*, London: Penguin, 1994.

Zohar, Dana. *The Quantum Self London*, Harper Collins, 1991.

Capra, Fritjof. *The Tao of Physics*, London: BBC Publications, 1977.

---- *The Turning Point*, New York, Simon and Schuster, 1982.

Gary Zukav, *The Dancing Wu Li Masters*.

**God, Creation and Modern Scientific Thought and Imagination
Weeks 14-16**

God, Science and Creation Science: Some Teleological and Theological Considerations

Readings:

N. Whitehead, *Science and the Modern World*.

Jurgen Moltmann, *God the Creator*, 1985.

John Polkinghorne, *Science and Creation*, 1988.

----, *Science and Providence*, 1989

Michael Walker, "What is Creation," *Theology Today*, 1991

Arthur Peacocke, *God and the New Biology*, 1986.

Jan Fennema and Iain Paul, eds. *Science and Religion: One World -- Changing Perspectives on Reality*, 1990.

Charles C. Gillispie, *Genesis and Theology*, 1951.

Christopher Kaiser, *Creation & the History of Science*, 1991.

Timothy Ferris, *The Whole Shebang: A State of the Universe(s) Report*, 1997.

Brian Greene, *The Elegant Universe*, 1999.

Steven Weinberg, *Dreams of a Final Theory*, 1992.

Heinz R. Pagels, *The Cosmic Code*, 1982.