SCIENCE AND RELIGION

Course Number: PHILOSOPHY 2740
Institution: University of Shumen, Shumen, Bulgaria
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PURPOSE

The purpose of this course is to provide an introduction to the relationships between science and religion directed primarily to university students.

In the modern world people, especially the young, are impressed by the achievements of science in understanding the world, and by the technological revolution that has flowed from it. There are many who tell them that science provides a sure road to a prosperous future, and that religion is a thing of the past, outmoded and useless. We no longer need pray for health; we simply make sure that we have good medical attention.
Some religious people, rightly horrified by the aggressive secular propaganda, retaliate by criticising science. This is a great mistake, and serves only to further alienate the young.

It is essential to realise that scientific knowledge is essentially good, because it tells us about God's world. Likewise the applications of science are generally good, although we must recognise that sometimes, like all God's gifts, they can be used for evil purposes. Scientific research provides us with knowledge of the physical and biological worlds, and this is of inestimable value. It is incapable, however, of answering the far more important questions of the meaning and purpose of our lives. Why are we here on earth? What is the purpose of life? What will happen to us after death? How should we live our lives? Do we have any duties to others? Can we just do as we please? What is the meaning of life and death, sin and goodness, love and hatred? On all these questions science can say nothing. Our Christian faith provides us with answers to these questions. They are not always easy answers, and it is some-times difficult to understand how best to put them into practice. These considerations show the importance of relating science and religion. We need them both, not separately but together, and this course aims to provide an introduction to this relationship.

The course begins with a study of what it means to believe, in science and in religion. This is done partly philosophically and partly historically. How do we come to know anything? How can we get started? How did science get started? If we look at the great civilizations of the past we find many very clever people skilled in reasoning, with writing and mathematical skills, but in spite of all this they did not develop science as we know it. Only in our own European civilization did science develop into the self-sustaining enterprise that we know today. Why is this? We can try to answer this question by asking what are the beliefs about the material world that must be held if science is to begin, and we then find that these are all Christian beliefs. So we understand that science is some alien way of knowing that has somehow to be related to Christianity but is entirely consistent with it and historically can be said to have grown in up in the heart of the first Christian civilization.

Having studied the origin of science, we go on to consider its growth to maturity in the Renaissance, and the intense discussions that took place at that time on the relationship between science and religion. One of the main problems concerned the Copernican theory that earth goes round the sun, which seemed to some to be contrary to the Bible. These debates continued through the following centuries, and reached a new peak with the theory of evolution proposed by Darwin in the nineteenth century. The first decade of the present century saw a radical change in our ideas of space, time and matter. Einstein proposed relativity and Planck discovered the quantum. These provided a way to understand the atomic and nuclear worlds, but there were serious problems that were only resolved by the development of quantum mechanics in the nineteen twenties. Some believed that relativity raised fundamental religious questions, and quantum mechanics appeared to imply a view of the microworld that was uncertain and indeterminate. These developments of modern physics made it possible for the first time to study the universe as a whole, and to examine how it has evolved over the ages. It now seems to be established that it has expanded to its present state from a singularity about fifteen billion years ago. Some have seen this as the moment of creation, whereas others think that this is not a scientific but a religious question. All these and many related questions will be discussed during the course, with special attention to the scientific discoveries of the present century.

SUMMARY
The course comprises eight lectures:

1. The Nature of Belief. What does it mean to say that we believe something in science or in religion? How do we know that our beliefs are true? What criteria do we apply, and how do we know that these criteria are the right ones? These and related questions we asked centuries ago, notably by the ancient Greeks, and what they said is still valuable today. Mathematics and logical reasoning were both studied, and many observations were made of the stars and the planets, and of physical and biological phenomena. They achieved much of lasting value, but Greek science failed to become a self-sustaining enterprise.

2. Science as we know it began in Western Europe and its roots can be traced back into the Middle Ages, when for the first time in history there was a society based on Christian beliefs. They believed that the world is good because it was made by God, that it was rational and open to the human mind. It is good to study it, and whatever we learn must be freely shared. These are just the beliefs that are the necessary foundation of science and thus we see why science started at that time. The Christian belief in the creation of the world out of nothing played a critical role in the development of the concept of inertia that lies at the basis of dynamics and hence of all science.

3. Science came to maturity in the Renaissance with the work of Kepler, Copernicus, Galileo and Newton. Kepler determined the orbit of the planet Mars, and showed that it is

an ellipse. Copernicus proposed that the earth moves round the sun. Galileo studied the motions of projectiles and established mathematical relations between the times taken and the distance travelled. Newton put it all together with his laws of motion and hypothesis of universal gravitation. From this he deduced the results of Kepler and Galileo and thus unified celestial and terrestrial motions. This was the first comprehensive mathematical theory, and it was so successful that it provided a paradigm that exerted a great influence thereafter. All this new knowledge interacted strongly with religious beliefs and in particular there were intense debates about the relation of the heliocentric theory with the world view implicit in the Bible. The very success of Newtonian dynamics raised the possibility that the world is a vast machine so that, once God had created it, all subsequent events followed without any further interventions from God.

4. The voyages of discovery in the fifteenth and sixteenth centuries brought back to Europe a vast range of hitherto unknown fauna and flora and greatly stimulated the biological sciences. Geological studies raised questions about the age of the earth, and it soon became clear that vastly greater times are needed than the six thousand years implied by a literal interpretation of the Bible. It had been generally believed that each species was created individually by God, and this was challenged when Darwin proposed his theory of evolution by natural selection. His theory furthermore implied that man evolved in the same way, undermining the uniqueness of man. These developments raised additional difficulties for the fundamentalist interpretations of the Bible, and led to intense debates.

5. The nineteenth century also saw great advances in the physical sciences. Dalton proposed the atomic theory of matter, and many other chemists applied this to analyse all substances into atoms and molecules. Joule and other physicists showed that the various forms of energy, thermal, electrical, mechanical and gravitational, can be converted to each other in quantifiable amounts. Faraday investigated electrical and magnetic phenomena, and Maxwell showed how they could be understood in a unified way by his equations of the electromagnetic field. This provided the second example, after Newtonian dynamics, of how a vast range of phenomena can be understood as consequences of a few simple differential equations. It seemed to many at that time that physics was essentially complete.

6. This confidence was shown to be premature by the development of the theory of relativity and the discovery of the quantum in the early years of the twentieth century. Einstein asked himself what a light wave would look like to someone travelling alongside it, and found that there is no such solution of Maxwell's equations. He realised that the transformation from one reference frame to another must be that of Lorentz, and applied it generally, showing that it explained why Michelson and Morley had failed to detect motion of the earth through the aether. Planck studied the spectrum of radiation from heated black bodies, which he realised is a fundamental property of all matter. He found a mathematical expression that fitted the spectral distribution, but to derive it he had to assume that radiation is transmitted in discrete amounts that he called quanta. This provided the foundation of our understanding of atoms and nuclei.

7. Making use of the radioactive substances found by Becquerel, Rutherford showed that atoms consist of a small central nucleus surrounded by electrons. Bohr used the quantum theory to calculate the radiation emitted by the hydrogen atom, but making assumptions inconsistent with classical physics. This problem was resolved by the development of quantum mechanics in the nineteen twenties. There were great debates about the meaning of the wave function, and many concluded that atomic and nuclear phenomena are inherently indeterministic, and that the law of causality no longer held. This was thought to undermine traditional theology, and also to provide a way to understand the freedom of the will and the possibility of God's action in the world. There are however other interpretations of quantum mechanics that allow the world to be a fully deterministic system. These problems are at the centre of many lively debates at the present time.

8. Cosmology and Theology. Einstein's general theory of relativity made it possible to study the universe as a whole. Hubble's discovery of the recession of the galaxies showed that the universe has expanded from a minute singularity about fifteen billion years ago, and some identified this with the creation. But can science identify the absolute beginning, or is this a theological question? Many features of cosmic evolution seem to be very finely tuned so as to produce living beings. Is this just chance, or is it evidence of design by God? The course is designed to study all these and related questions in a spirit of humble enquiry, taking full account of the established scientific results. Some understanding of the historical development, in particular the continuous inter-play between scientific and religious ideas, is essential if we are to understand the debates of the present time. It is very often found that many current problems have been accurately formulated and in some cases solved, a long time ago. It is planned to develop the course in response to the perceived needs of the students. We want to find out what are the problems concerning the relation of religion to science that are of most importance to them, and to study them in detail.

A COURSE OF EIGHT LECTURES ON SCIENCE AND RELIGION
The rise of science during the last three hundred years to its present dominant place in our culture has challenged traditional religions in many ways. In this course we will explore the resulting problems of science and belief in a historical context from antiquity to the present. We will show how science and theology interacted with each other over the centuries; theological beliefs about the nature of the material world stimulated the development of science, and this in turn revealed new features of the world that raised, or appeared to raise theological questions. We will try to understand why science as we know it never developed in any of the ancient civilizations of India and China, Greece and Rome, and yet finally came to fruition in the present millennium. To do this we will study the relations between science and the world views of ancient cultures, the Middle Ages and the Renaissance. Science came of age with Newton's classical mechanics and this profoundly influenced theology. Further interactions occurred in the eighteenth and nineteenth centuries as geological and biological discoveries provided evidence for evolution, and this altered our views on the relation of man to nature. These questions will be considered by examining the ideas of Newman and Chesterton. In the twentieth century Einstein's relativity and Planck's quantum theory raised new problems about our knowledge of the world, and this in turn influenced theology.

GENERAL READING LIST

The Old and New Testaments.
Crombie, A. C., Styles of Scientific Thinking in the European Tradition. Duckworth, 1994.
Dawson, C., Progress and Religion. Sheed and Ward, 1929.
de la Saudee J. de Bivot (Ed), God, Man and the Universe. Burns Oates, 1954.
Dijksterhuis, E. J., The Mechanisation of the World Picture. Oxford, 1961.
Gilson, E., The Unity of Philosophical Experience. Sheed and Ward, 1938.
Goodman, D. C. (Ed), Science and Religious Belief 1600 - 1900. Open University, 1973.
Jaki S. L., The Relevance of Physics. Chicago, 1966.
_____. The Road of Science and the Ways to God. Chicago, 1978.
_____. Science and Creation. Scottish Academic Press, 1974.
Ronan, C. A. The Cambridge Illustrated History of the World's Science. Cambridge University Press, 1983.
Templeton, J. M. and R. L. Herrmann, Is God the Only Reality? Continuum, 1994.
Whitehead, A. N. Science and the Modern World. Cambridge, 1925.
Wightman, W. P. D. The Growth of Scientific Ideas. Yale, 1951.

I. THE NATURE OF BELIEF: PHILOSOPHY AND SCIENCE IN ANCIENT GREECE

1. Types of belief. How do we obtain knowledge and how do we know that it is true? Degrees of belief. The beginning of knowledge. Do we just receive and order sense impressions? Which is fundamental: our mind, or external reality directly perceived by our mind? The epistemic cycle: building up our knowledge not by passively receiving sense impressions, but by interacting with our surroundings. Pattern recognition. The problem of innate ideas and its resolution by the epistemic cycle. Higher epistemic cycle. Language and reality. Ontological realism.

2. Early Man. Discoveries in Serengeti, Sterkfontein and Peking. Cave paintings in Lascaux and Altimira. The bone-markings of Ishango. The uniqueness of man.

3. Early civilisations. Sumeria, Babylon, Assyria, Egypt, India, China.

4. Greece. The art of asking the correct questions and the first attempts to find ways to answer them. The Ionian philosophers Thales, Anaximander and Parmenides. The atomists Democritos and Leucippus. Socrates, Plato and Aristotle. The development of logic and the mathematics of Euclid. The problem of change. The mathematical structure of the world. The world as an organism. Celestial and terrestrial matter. Theories of motion. Essentialist and descriptive theories of nature. The problem of time: is the universe eternal or cyclic?

5. Reasons for the failure of science in all ancient cultures. The myth of the eternal return and the Great Year.

READING LIST

Brandon, S. G. F. Creation Legends of the Ancient Near East. Hodder and Stoughton, 1963.
Brody, T.A. The Philosophy behind Physics. Springer, 1993.
Chesterton, G. K. The Everlasting Man. Hodder and Stoughton, 1975.
Clagett, M. The Exact Sciences in Antiquity. Collier Books, 1963.
Copelston, F. C. The History of Philosophy, Vol. 1, Greece and Rome. Burns, Oates and Washbourne, 1944.
Dawson, C. Progress and Religion. Sheed and Ward, 1929.
Dicks, D. R. Early Greek Astronomy to Aristotle. Cornell, 1970.
Farrington, B. Greek Science. Pelican.
Frankfurt, H. Before Philosophy. Pelican.
Frazer, J. G. The Golden Bough. London, 1911.
Gilson, E. Methodical Realism. Christendom Press, 1990.
Holton, G. and D.H.D.Ridler, Foundations of Modern Physical Science. Addison-Wesley, 1958.
Leakey, R. and R. Lewin, Origins Reconsidered: In Search of What Makes us Human. Little, Brown and Co. 1992.
Marschak, A. The Roots of Civilisation. Wiedenfeld and Nicholson, 1972.
Neugebauer, O. The Exact Sciences in Antiquity.
Sambursky, S. The Physical World of the Greeks. Routledge and Kagen Paul, 1956.
Van Melsen, A. G. From Atomos the Atom: A History of the Concept 'Atom'. Duquesne, 1953.

II. THE HIGH MIDDLE AGES: THE ORIGIN OF SCIENCE

1. The founding of the universities. Adelard of Bath and the distinction between the action of the Creator and the natural workings of His creation. Robert Grosseteste, the founder of experimental science, refined the two essential bases of science, logical coherence and experimental verification, by insisting on the use of mathematics and precise measurements. Application to light.

2. Technology in the Middle Ages. The monasteries as centres of technological innovation in building, farming, cloth-making, metallurgy and book-making. There were windmills and watermills, and increasingly sophisticated clocks to regulate the hours of work and prayer. International trade flourished, with international banking and a reliable monetary system.

3. The Origin of science. The teaching of Aristotelian philosophy in the universities. Discussions on creation and the motion of bodies. The condemnation of 1277 by Tempier. Buridan and the problem of motion. The concept of impetus and the break with Aristotelian physics. Belief in the order of nature. Duhem's work on the origin of science. Science in Eastern Christendom.

4. The rise of Islam. The insistence on the freedom of Allah relative to His rationality. Internal and external criteria for the development of science.

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Clagett, M. The Science of Mechanics in the Middle Ages. Madison, 1959.
Crombie, A. C. Augustine to Galileo, The History of Science 400-1650. Falcon, 1952.
_____. Robert Grosseteste and the Origins of Experimental Science 1100-1700. Oxford, 1953.
Dawson, C. Progress and Religion. Sheed and Ward, 1929.
_____. Religion and the Rise of Western Culture. Sheed and Ward, 1950.
Gilson, E. The Spirit of Medieval Philosophy. Sheed and Ward, 1936.
_____. The History of Christian Philosophy in the Middle Ages. Sheed and Ward, 1954.
Gimpel, J. The Medieval Machine. Pimlico, 1992.
Grant, E. Physical Science in the Middle Ages. Cambridge, 1977.
_____. Planets, Stars and Orbs: The Medieval Cosmos 1200-1687. Cambridge, 1994.
Heer, F. The Medieval World. Wiedenfeld and Nicholson, 1961 (Ch.12).
Huff, T. E. The Rise of Early Modern Science: Islam, China and the West. Cambridge, 1993.
Jaki, S. L. Science and Creation. Scottish Academic Press, 1986.
_____. Uneasy Genius: The Life and Work of Pierre Duhem. Martinus Nijhoff, 1984.
_____. The Physics of Impetus and the Impetus of the Koran. Science and Censorship: Helene Duhem and the Publication of the Systeme du Monde. Chapters 9 and 11 in the Absolute Beneath the Relative. University Press of America, 1988.
_____. Reluctant Heroine: The Life and Work of Helene Duhem. Scottish Academic Press, 1992.
_____. Medieval Christianity: Its Inventiveness in Technology and Science. Article in: Technology in the Western Political Tradition. Ed. M.R. Zinman. Cornell U. Press, 1993.
Lindberd, (Ed.), D. C. The Science in the Middle Ages. Chicago, 1978.
Weisheipl, J. A. The Development of Physical Theory in the Middle Ages. Sheed & Ward, 1959.
Whitehead, A.N. Science and the Modern World. Cambridge, 1926.

III. THE RENAISSANCE

1. Copernicus and the heliocentric system. Scientific and theological difficulties. The distinction between a real physical explanation and saving the appearances. Brahe and Kepler. The importance of precision. Kepler's determination of the orbit of Mars.

2. Galileo. The invention of the telescope and the observation of the satellites of Jupiter, the mountains on the moon and the spots on the sun. Measurements on the motions of projectiles and of falling bodies. Opposition from the Aristotelian philosophers. Advocate of the Copernican system. Difficulties with the interpretation of Scripture.

3. Newton and the foundation of modern science. Synthesis of the rationalism of

Descartes and the empiricism of Bacon. Laws of motion and theory of universal gravitation. The unification of terrestrial and celestial dynamics. The world as a machine and the theology of deism.

4. The scientific attitude. What does it mean to be a scientist?

READING LIST

Barbour, J. Absolute or Relative Motion: 1. The Discovery of Dynamics. Cambridge, 1989.
Burtt, E. A. The Metaphysical Foundations of Modern Physical Science. Routledge and Kegan Paul, 1932.
Chandrasekhar, S. Truth and Beauty. Chicago, 1990.
Feynman, R. Surely You're Joking, Mr. Feynman?
Hall, A.R. The Scientific Revolution 1500-1800. Longmans, 1954.
Holton, G. Thematic Origins of Scientific Thought: Kepler to Einstein. Harvard, 1973.
Koestler A., The Watershed: Biography of Johannes Kepler. Doubleday, 1959.
Lindberg, D. C. The Beginnings of Western Science. Chicago, 1992.
Shea, W. R. Galileo's Intellectual Revolution. Science History Publications, 1977.
Singleton, C. S. (Ed), Art, Science and History in the Renaissance. Johns Hopkins Press, Baltimore, 1967.
Westfall, R. S. Never at Rest: A Biography of Isaac Newton. Cambridge, 1980.

IV. GEOLOGY, BIOLOGY AND EVOLUTION

1. Biology and geology stimulated by the great voyages of discovery in the seventeenth and eighteenth centuries. First estimates of the age of earth from geology and biology on the one hand and from physics on the other. Eventual solution from modern physics. All these estimates much longer than apparently indicated by the Bible.

2. The Origin of Life and of Species. How can living things come to be: by special creation or by development from non-living matter? Apparent improbability that living organisms can come about by the blind operation of natural forces. Haeckel and Lecomte du Nuoy. The God of the Gaps. Malthus, Darwin and Wallace. Evolution by natural selection.

3. The Debate between Wilberforce and Huxley.

4. Newman on Evolution.

READING LIST

Brooke, J. H. Science and Religion. Cambridge, 1991.
Eiseley, L. Darwin's Century. Scientific Book Guild, 1959.
Gillespie, C. S. Genesis and Geology. Harper, 1959.
Hedley, B. Evolution and Faith. Sheed and Ward, 1931.

Himmelfarb, G. Darwin and Darwin's Revolution. Chatto and Windus, 1959.
Jaki, S. L. Chesterton, A Seer of Science. Illinois, 1986.
_____. Miracles and Physics. Christendom Press, 1989.
Kitcher, P. Abusing Science: The Case Against Creationism. Open University, 1983.
Lucas, J. R. Wilberforce and Huxley: A Legendary Encounter. The Historical Journal.22.2.313.1979.
Parry, J. H. The Age of Reconnaissance. Mentor, 1963.

V. SCIENCE IN THE NINETEENTH CENTURY

During the centuries following the foundation of dynamics by Newton his work was extended by Laplase, D'Alembert, Lagrange, and Euler. Extremely accurate analyses were made of the motions of the planets, and examination of some small perturbations in the orbit of Uranus led to the discovery of Neptune. Such triumphs greatly strengthened the idea that the solar system is one vast determined machine. Electrical and magnetic phenomena were studied by Volta, Faraday and Ampere, and attempts were made to construct mechanical models to explain the observations. Finally Maxwell succeeded in formulating his equations of the electromagnetic field, and it was realised that the mechanical models were superfluous. Some attempts were made to argue that the aether could carry God's thoughts and thus allow human free-will. Several attempts were made by Michelson and Morley to measure the velocity of the earth, but without success. Extensive studies were made of the various forms of energy, and it was found that heat, electrical, and kinetic energies can be transformed to each other in definite ratios, so that energy is conserved. The science of thermo-dynamics was developed and applied to design steam. Kelvin calculated the lifetime of the sun from its rate of heat emission and found that it is much greater than the 6000 years required by fundamentalist interpretation of the Bible, but much less than that required by the geologists. J. J. Thompson examined electrical discharges in gases and discovered the electron, and Becquerel discovered radioactivity. Many physicists believed at the end of the nineteenth century that physics was essentially compete, and that all that remained to be done was to make some more measurements to higher accuracy. The failure to measure the velocity of the earth through the aether, and the discoveries of Thompson and Becquerel were, however, indications that not all was well with classical physics. In a few years the work of Planck and Einstein ushered in a revolution in our understanding of the world, and with it came new theological problems.

READING LIST

Elkana, Y. The Discovery of the Conservation of Energy. Hutchinson, 1974.
Maxwell, J. C. Aether. Encyclopedia Britannica, 9th Edition.
Michelson, A. A. and E.W. Morley, American Journal of Science, 34.333.1887.
Thomson, J. J. Conduction of Electricity through Gases. Cambridge University Press, 1906.

VI. RELATIVITY AND QUANTUM THEORY

Einstein's special theory of relativity showed how to transform the description of a physical system from one co-ordinate frame to another that the velocity of light always remains constant. This explained the puzzling result of Michelson and Morley and also led to a new conception of space and time. The theory was widely misunderstood as meaning that everything is relative, and this led to many theological speculations. In reality, Einstein's theory shows what remains invariant in physical systems. Max Planck studied the emission of radiation from a black body and found that the observed distribution can only be explained if the light is emitted in discrete bundles of energy called quanta. Einstein showed that this immediately explained the photoelectric effect. Then Rutherford showed that the atom consists of a small central nucleus contained most of the mass and surrounded by a cloud of orbiting electrons. Light is emitted when an electron falls from one orbit to a lower one, and Bohr made use of the idea of light quanta to calculate the frequencies of the radiation emitted from hydrogen. This was very successful, but violated the classical electro-magnetic laws. It was clear that a more profound theory was needed.

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Anderson, J. L. Principles of Relativity Physics. Academic Press, 1967.
Einstein, A. Philosopher-Scientist. Ed. P.A. Schlipp. The Library of Living Philosophers Inc., 1949.
Goldberg, S. Understanding Relativity. Clarendon Press, Oxford, 1984.
Kuhn, T.S. Black-Body Theory and the Quantum Discontinuity, 1894-1912. Clarendon Press, Oxford, 1978.
Leighton, R.B. Principles of Modern Physics. McGraw-Hill, 1959.
Lucas, J. R.and P.E.Hodgson, Spacetime and Electromagnetism. Oxford University Press, 1990.
Pais, A. Subtle is the Lord. The Science and Life Albert Einstein. Oxford University Press, 1992.
Richtmeyer, F. K. and E.H. Kennard. Introduction to Modern Physics. McGraw-Hill, 1942.
Rindler, W. Special Relativity. Oliver and Boyd, 1960.
Ruark, A. E. and H.C. Urey, Atoms, Molecules and Quanta. McGraw-Hill, 1930.
Stranathan, J. D. The Particles of Modern Physics. Blakiston, 1941.
Taylor, E. F. and J. A. Wheeler, Space-Time Physics. Freeman 1963.

VII. QUANTUM MECHANICS

The difficulties inherent in Bohr's theory of emission of light from atoms were resolved by the development of quantum mechanics by Heisenberg and Schrodinger. The formalism is well understood, but there are many different interpretations of quantum mechanics. The most well-known is the Copenhagen interpretation of Bohr and Heisenberg, but there is also the ensemble or statistical interpretation of Einstein and the pilot wave and many-worlds interpretations. There are several quantum paradoxes associated with causality, the single and double slit experiments and Schrodinger's cat. The Heisenberg uncertainty principle. Stochastic electrodynamics. Hidden variables. The wave-particle dualism. The Einstein-Podolsky-Rosen Paradox. The Bell inequalities. The denial of reality. Chance and Providence.

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Belinfante, F. J. A Survey of Hidden Variable Theories. Pergamon Press, 1973.
Bell, J. S. Speakable and Unspeakable in Quantum Mechanics. Cambridge, 1987.
Bohm, D. Causality and Chance on Modern Physics. Routledge and Kegan Paul, 1957.
Brody, T.A. The Philosophy behind Physics. Springer, 1993.
Davies, P. God and the New Physics, Dent, 1983.
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_____. Niels Bohr's Times: In Physics, Philosophy and Polity. Oxford, 1992.
Popper, K. R. Quantum Theory and the Schism in Physics. Hutchinson, 1982.
Schlipp, P. A. (Ed.), Albert Einstein:Philosopher-Scientist. The Library of Living Philosophers Inc., Evanston, 1949.
Stehle,P. Order, Chaos, Order: The Transformation from Classical to Quantum Physics. Oxford, 1991.
Sudbery, A. Quantum Mechanics and the Particles of Nature. Cambridge, 1986.
Swinburne, R. (Ed.), Space, Time and Causality. Reidel, 1983.
Tarozzi, G. and A.van der Merwe, Open Questions in Quantum Physics. Kluwer, 1985.
_____. and A.van der Merwe, The Nature of Quantum Paradoxes. Kluwer, 1988.
Wigner, E. Quantum Theory and Measurement. Princeton, 1983.

VIII.COSMOLOGY AND THEOLOGY

1. The Theology of Creation. Aristotle and the eternity of the universe. Cyclic theories of time in ancient cultures. The Old Testament: Genesis and the Psalms. Creation ex nihilo. Pantheism, dualism and deism. Contingent and necessary worlds. Determinism, indeterminism and randomness. The rationality of God and the free-dom of God. The importance of the theology of creation for the rise of science.

2. The Philosophy of Creation. What does it mean to create? Can there be an absolute beginning?

3. The Science of Creation. History of astronomy. Einstein's general theory of relativity. The universe as an object of scientific study. The expansion of the universe. Hubble's law. Theories of the origin of the universe. The big bang and steady state theories. Lemaitre and the primeval atom. Continuous creation. The oscillating universe. The first three minutes. The microwave background radiation. The origin of the elements. The singularity of the universe. The anthropic principle.

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Barrow, J. D. and F. J. Tipler, The Anthropic Cosmological Principle. Oxford, 1986.
Craig, W. L. and Q.Smith, Theism, Atheism and Big Bang Cosmology. Oxford, 1993.
Drees, W. B. Beyond the Big Bang. Quantum Cosmologies and God. OpenCourt, 1990.
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Sciama, D. Modern Cosmology. Cambridge, 1971.
Weinberg, S. The First Three Minutes. Deutsch, 1977.