

RE445

**Recent Work Relating
Modern Physics and Religion**

A Discussion of
The Tao of Physics
and
The “Anthropic Principle”

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Contents

Contents	i
Abstract	ii
1 Introduction	1
2 Quantum Mechanics	5
2.1 Introduction	5
2.2 Outline of Quantum Mechanics	6
2.3 Uncertainty and Complementarity	7
2.4 Wholeness and Taoism	10
2.5 Conclusion	21
3 The Anthropic Principle	24
3.1 Introduction	24
3.2 Outline of “The Anthropic Principle”	25
3.2.1 Cosmology	26
3.2.2 Nuclear reactions in stars	26
3.3 Scientific criticisms	27
3.4 Philosophical and Religious Criticisms	29
3.5 Conclusion	37
4 Conclusion	41
Bibliography	48

Abstract

The scientific story of creation touches on the central problems of man's existence: What am I? How did I get here? What is my relation to the rest of the universe?

Robert Jastrow¹

Discussions about religious and scientific ways of describing the nature of the fascinating universe in which we find ourselves, and our relationship to this universe, have a long, and sometimes acrimonious, history. This essay examines two of the recent attempts to relate modern physics to religious ideas.

Chapter 1 is an introductory chapter, which briefly outlines some of the history of discussions, and introduces recent work.

In chapter 2 the ideas of Capra² relating the idea of wholeness as it is found in modern quantum mechanics to Eastern religions, are discussed.

In chapter 3 recent work on what has come to be called "the anthropic principle"³ is discussed. This seems to indicate that the Christian idea of creation has some hacking from modern science.

In the conclusion it is argued that although both these are of importance in the ongoing attempts to relate religion to the scientific age in which we live, yet they both seem to assume that it is possible to draw conclusions about religion from science or vice versa. It is argued that both these attempts are to a greater or lesser extent misguided. Rather than clarifying, and contributing to, profitable discussions about the relative merits and demerits of religious and scientific ways of talking about the universe around us, these recent works seem to be, to some extent, contributing to the idea that science is supreme and that religious ways of thinking have had their day.

¹Jastrow, Robert: *Stars, Planets and Life*. London, Heinemann, 1968. Page xi.

²Capra, Fritjof: *The Tao of Physics: An exploration of the parallels between modern physics and eastern mysticism*. London, Flamingo (Fontana Paperbacks), 1976.

³Barrow, John D. and Tipler, Frank J.: *The Anthropic Cosmological Principle*. Oxford, Clarendon Press, 1986.

Chapter 1

Introduction

Scientists themselves divide into two camps. There are those who believe that, in principle, science can explain the universe in its entirety. The others insist that there is an irreducible supernatural or metaphysical element to existence that cannot be tackled by rational enquiry. The scientific optimists, if we may call them that, are not so bold as to claim that we will ever achieve a complete working knowledge of every detail of the cosmos, but they do maintain that every process and every event conforms strictly with the rule of natural law. Their opponents deny this.

Paul Davies¹

Since the dawn of human consciousness, human beings have always been interested in things other than the immediate necessities of life. Going back 100,000 years, members of the species *homo sapiens neanderthalensis* buried their dead² surrounded by flowers. There is even a small amount of evidence that their predecessors, *homo erectus*, engaged in ritual actions of some kinds. As far back as written records go there have been people who have been fascinated by and studied the movements of the sun, moon and stars. In many cases this study was associated with religious cults of one kind or another. By the middle of the first millennium BCE the Egyptians had developed empirical methods of predicting eclipses of the sun and moon, and had some rough ideas about the motion of the planets. Greek science produced Ptolemy and his epicycles, which managed to explain the motions of the planets, but in a manner which was greatly influenced by their ideas of the perfection of the heavens.

¹Paul Davies: *Superforce: The Search for a Grand Unified Theory of Nature*. London, Unwin Paperbacks, 1985. Pages 8, 9.

²Constable, George and the Editors of TIME-LIFE Books: *The Neanderthals*. Netherlands, TIME-LIFE International, 1973.

It was into this world that Christianity was born. It did not take very long for disputes to arise about the nature of the physical world. During the second century AD there were heated arguments about whether the earth was flat, as implied by Holy Scripture, or round, as held by the learned world³. There were also arguments about the size of the earth. In spite of the fact that Eratosthenes had obtained a fairly accurate value for the diameter of the earth in the 3rd century BCE, there were people who preferred to take the scriptures as a scientific treatise. After agreement was reached that the earth was round, the next question was about the possibility of there being any inhabitants of the Antipodes. In the absence of any other information, Scripture was taken to be the sole guide.

Arguments about science and scripture have continued to this day, and the compilation by White⁴ lists some of the issues which have arisen. The most famous of the disputes are those involving Galileo and Darwin. It is only fairly recently that Galileo has been rehabilitated in the eyes of the Catholic church. Darwin's ideas are still a sore point with many Christians, though there are an increasing number, of widely divergent theological persuasions, who see no conflict between evolution and their faith.

There have always been those who have tried to maintain that the two ways of looking at the natural world, the scientific and the religious, are not contradictory but can be mutually beneficial. In his early 5th century commentary on Genesis Augustine⁵ wrote

It often falls out that a Christian may not fully understand some point about the earth, the sky, or the other elements of this world — the motion, rotation, magnitude, and distances of the stars; the known vagaries of the sun and moon; the circuits of the years and epochs; the nature of animals, fruits, . . . Now it is too absurd, yea, most pernicious and to be avoided at all costs, for an infidel to find a Christian so stupid as to argue these matters as if they were Christian doctrine; he will scarce be able to contain his laughter at seeing error written in the skies, as the proverb says. The worst of the matter is not that a person in error should be laughed at, but that our authors should be thought by outsiders to hold the same opinions, . . . For when infidels refute any Christian on a matter which they themselves thoroughly understand, they

³See White, Andrew Dickson: *A History of the Warfare of Science with Theology in Christendom*. Gloucester, Massachusetts, 1978. Originally published in 1896. Chapter 2.

⁴*ibid.*, *passim*

⁵Augustine, Aurelius: *De Genesi ad litteram*, i.19. Quoted on pages 207 and 208 of Drake, Stillman: *Discoveries and Opinions of Galileo*. New York, Doubleday 1957.

thereby evince their slight esteem for our Bible.

These words sound remarkably like criticisms of modern creationism. After the reformation Calvin, in his commentary on Genesis⁶ wrote, concerning the firmament:

For, to my mind, this is a certain principle, that nothing is treated of here but the visible form of the world. He who would learn astronomy and other recondite arts, let him so elsewhere.

While their writings are not explicit enough to be absolutely certain, it seems likely that both Augustine and Calvin were suggesting that where the natural world is concerned, the scriptures should not take precedence over careful investigations made by people. Augustine even implies that a careful investigation by an unbeliever is to be preferred to dogmatic statements by a believer. In Augustine's day there was no such thing as science, in the modern sense of the word. When Calvin wrote astronomy was in its infancy, but there were no other sciences. In these situations their statements seem to be far ahead of their times.

In recent years there has been a resurgence of interest in the relationship between the scientific and the religious ways of looking at the natural world. But there is a major difference from these earlier writings. Far from trying to keep religion and science in separate areas, many of the recent writings have claimed that science is, at long last, catching up with what religious people have been saying all along. Others have claimed that we now have scientific evidence that the universe was designed as "a home for man". In previous times it was mostly Christians who were involved in the discussions. Recently however, as interest in Eastern religions has become more widespread, there has arisen a school of thought which has tried to relate modern physics to Eastern religion. There is also at least one paper⁷ which attempts to relate biology to Taoism.

Here we will restrict attention to attempts to relate various religious ideas to some aspects of 20th century physics (or vice versa). Consideration will be further restricted to topics at opposite ends of the scale of sizes, more specifically, to topics concerning the universe as a whole and to topics in atomic and nuclear physics.

⁶Calvin, John: *Genesis*. Edinburgh, The Banner of Truth Trust, 1965. Originally published in 1554.

⁷Burnett, Raymond J.: Taoism and Biological Science. *Zygon*, vol. 21, no. 3 (September 1986), 297–317.

In chapter 2 some discussion will be given about quantum mechanics with special reference to the book by Capra⁸ and, to a lesser extent, the work of Zukav⁹. These both try to show that much of quantum mechanics is compatible with Taoism.

In chapter 3 attention is focussed on a recent revival of the “argument from design”, known as “the anthropic principle”¹⁰. This looks at findings from cosmology and, to a lesser extent, quantum mechanics, which seem to indicate that the universe was “designed”. This is fairly firmly in the tradition of Christian thinkers such as Aquinas and Paley, but the arguments are much more sophisticated and highly technical in places. It has been used to relate the Christian doctrine of creation to findings in modern physics and astronomy.

In chapter 4 it is argued that both of these approaches are misguided. They both appear to place a high value on current theories and experimental results from physics. They both rather overlook the tentative nature of explanations in science, and the possibility of drastic changes in our current understanding of the universe. While any comparisons between science and religious beliefs are interesting, trying to link, even in a tentative way, two such disparate approaches to reality can lead, at best, to confusion, and, at worst, to the disparagement of both areas of study.

Footnotes are numbered separately within each chapter, and there is a consolidated list of references at the end.

⁸Capra, Fritjof: *The Tao of Physics: An exploration of the parallels between modern physics and eastern mysticism*. London, Flamingo (Fontana Paperbacks), 1976.

⁹Zukav, Gary: *The Dancing Wu Li Masters: An Overview of the New Physics*. London, Fontana Paperbacks, 1980.

¹⁰Barrow, John D. and Tipler, Frank J.; *The Anthropic Cosmological Principle*. Oxford, Clarendon Press, 1986.

Chapter 2

Quantum Mechanics, Uncertainty and Wholeness

The reason for this paradoxical appearance of reality — at least, atomic reality as observed by physicists — is that no clear dividing line exists between ourselves and the reality we observe to exist outside of ourselves. Instead, reality depends upon our choices of what and how we choose to observe. These choices, in turn, depend upon our minds or, more specifically, the content of our thoughts. And our thoughts, in turn, depend upon our expectations, our desire for continuity.

Fred Wolf¹

2.1 Introduction

Quantum mechanics was formulated in the mid-1920s, after much work extending from the closing years of the 19th century, and has had resounding success in predicting a vast number of phenomena. In common with many other notable advances in science, it unified many seemingly different phenomena under one umbrella, but at the same time it attracted opposition from within the scientific community as well as outside it. One of its more notable opponents was Albert Einstein, with his famous phrase “God does not play dice with the cosmos.” The concepts of uncertainty and randomness, which so bothered Einstein, were seen, by some religious writers, as scientific evidence that the purely deterministic world view was erroneous, and that, at last, there was room for the miraculous.

¹Wolf, Fred Alan: *Taking the Quantum Leap. The New Physics for Nonscientists*. San Francisco, Harper and Row, 1981. Page 128.

2.2 Outline of Quantum Mechanics

By the 19th century the idea that matter was composed of small, indivisible particles, called “atoms”, was widely accepted. But it was still assumed that energy came in continuously varying amounts, and could be divided into arbitrarily small amounts. By the end of the century there were several phenomena, none of any very great practical importance, which did not fit in with this simple idea. Max Planck, and later Albert Einstein, suggested that these phenomena could be explained if energy came in small packets, called “quanta”, and could only be obtained in multiples of a certain small amount. The idea was revolutionary, but it did explain the discrepant phenomena, and a few predictions were made which agreed with experimental results. After several years work by various scientists, quantum mechanics was born, in essentially the form it takes today,

The major difference between quantum mechanics and the earlier classical theories is that, in quantum mechanics, determinism is lost. In radioactive decay of atoms it is impossible to predict when any particular atom will decay, and the laws governing the decay only permit predictions of the average number (of a large group) which will decay in any particular interval of time. In a similar manner, if two elementary particles collide it is not possible to predict the directions of rebound, but only the probabilities of rebound in various directions. Not only is it not possible to predict the outcome of various happenings, but there are various events which, on our present understanding, have no determining cause. One of these is radioactive decay, already mentioned. The atoms decay in accordance with the appropriate probabilities, but, for any particular atom, the decay takes place without any determining cause. This abandonment of the fundamental law of cause and effect, which had formed the bastion of science in earlier days, has so far received little attention from philosophers or religious writers.

Some physicists, notably Einstein as mentioned earlier, have found this lack of determinism unappealing. There have been various attempts to modify the theory by introducing what are called “hidden variables” in order to restore determinism. The variables are called “hidden” because they are not directly observable, and lurk in the background. The major modern proponent of this line of thought is David Bohm, and his recent book² devotes a whole chapter to the topic. In spite of any philosophical leanings towards determinism, it has been shown (see, for example, chapter 5 of Squires³ that any simple “hidden variable” theory which agrees, as well as quantum mechanics

²Bohm, David: *Wholeness and the Implicate Order*. London, Ark Paperbacks, 1983. Originally published in 1980.

³Squires, Euan: *The Mystery of the Quantum World*. Bristol, Adam Hilger, 1986.

does, with predictions must conflict with special relativity. Since relativity is one of the most firmly grounded theories in physics, few believe that it is worth rejecting it simply to restore determinism, when there are ample experiments which appear to support lack of determinism. As Barbour⁴ puts it

However, most physicists expect these deficiencies to be corrected not by discarding but by developing further the existing probabilistic quantum theory, which has proved its power in case after case over the last forty years. Unless someone can actually develop an alternative theory that can be tested, we had better accept the theories we have and give up our nostalgia for the certainties of the past.

2.3 Uncertainty and Complementarity

Most of quantum mechanics is highly mathematical in nature, but there are two concepts involved which have gained a wide, if not wholly accurate, circulation. These are the ideas of uncertainty and complementarity, and a certain amount of discussion of these two topics is warranted.

Perhaps the most significant difference between measurements on the atomic scale and measurements in the macroscopic world is the interaction involved in the measuring process. When a doctor takes the temperature of a patient, the thermometer absorbs a small amount of heat. Thus the temperature of the patient will drop slightly, and the measured temperature will not be exactly the same as before. However the effect is so small that, in practice, it can be ignored. On the atomic scale, however, things are very different. In order to obtain an accurate measurement of the position of an electron (or other elementary particle), since it is so small, light of a very short wavelength must be used. To improve the accuracy of measurement of position the wavelength of the illuminating light must be decreased. But as the wavelength is decreased, the energy of the light quantum is increased. Since we can only know the position of the electron if the light interacts with it, there will be an unavoidable minimum of energy transmitted to the electron. This will have the effect of changing its speed by an unpredictable amount, and in an unpredictable direction. The shorter the wavelength of light (in order to find the position more accurately), the more energy will be transferred, and so the more the speed will be changed. On the other hand, if it is desired to measure the speed without changing it significantly, low

⁴Barbour, Ian: *Issues in Science and Religion*. London, SCM Press, 1966. Page 301.

energy light must be used. This will have a (relatively) long wavelength, and so the position of the electron cannot be determined accurately. To sum up, it is impossible to measure both the position and speed of an electron (or other small particle) with an unlimited accuracy. This is Heisenberg's famous "Uncertainty Principle". The product of the error in measuring the position and the error in measuring the momentum (that is, the mass multiplied by the speed) cannot be less than Planck's constant. On the microscopic scale this is quite serious. On the macroscopic scale, however, there is virtually no limit to the attainable accuracy. For example, if the position of a light object such as a table tennis ball is measured at some time with an accuracy of the diameter of an atom, its speed can, theoretically, be measured (at the same time) so accurately that the distance it would travel in a thousand years would be known to an accuracy of the diameter of an atom. Thus we see that a simple extrapolation of Heisenberg's uncertainty principle to the macroscopic world can be made, but rather than uncertainty holding, there is virtually absolute certainty about the positions and speeds of macroscopic objects. It cannot, of course, be denied that there may be other effects associated with "uncertainty" which would have significant consequences in the macroscopic world. For example, the radioactive decay of some unstable isotope could be used to trigger an alarm of some sort. The time at which the alarm was triggered would be a "random" event, and could easily be envisaged as having some long-term consequences. All this serves to indicate that in any discussion about "uncertainty" it should be made quite clear just what is being discussed.

The other aspect of quantum mechanics about which there has been a considerable amount of confusion is what is known as "complementarity". There are some cases, such as in a TV tube, where it is possible to give a quite accurate description of the motion of an electron by treating it as though it were a macroscopic particle. In other cases, such as an electron microscope, electrons can best be visualised as waves. The question suggests itself — are electrons really waves or particles? Some, but by no means all, physicists have written about the "complementary" nature of electrons, and have transferred the concept of "complementary" to the theological area.

This approach betrays, amongst other things, a lack of confidence in the findings of the subject under study. There is no *a priori* reason why electrons should be expected to behave as either particles or waves. In the 19th century there were many attempts to find a mechanical description of the "aether" through which light was propagated (see, for example, chapter IX of Whittaker⁵). It was eventually realised that the "aether" had its own

⁵Whittaker, Edmund: *A History of the Theories Aether and Electricity: The Classical*

particular properties and could not be satisfactorily described in mechanical terms. In the same way electrons have their own types of behaviour, and religious concepts have their own special connotations which need not bear any relationship to the same words used in other disciplines.

There have been a number of theological writers who have used the words “uncertainty” and “complementary” to draw conclusions about the nature of theological ‘truth’. For example chapter 10 of Barbour’s well-known book⁶ is entitled “Physics and Indeterminacy”. This mentions a number of approaches which have been taken (including the common assertion that science and religion are “complementary”, but gives a warning about the too facile equating of concepts from different areas. In the conclusion to the chapter, on page 316, he writes:

It was suggested, however, that human freedom must be approached through the distinctive experience of the self in decision, for which no model taken from physics is satisfactory. Freedom and indeterminacy thus occur at very different levels, but both exhibit the novelty and openness of the world.

Writing about complementarity in a somewhat later paper MacKay⁷ is rather more forthright. On page 225 he writes:

The most obvious objection, of course, is that such a blanket use of the term is logically empty unless we can say what it would mean for two statements not to be complementary. By what criteria are we to distinguish statements that show genuine complementarity from those which are totally unrelated, related but only supplementary, or related but flatly contradictory? How can we prevent complementarity from becoming yet another fashionable escape gate from intellectual integrity in theology?

Both Barbour and MacKay have placed their respective fingers on the crucial point. If the terms “indeterminacy” or “complementarity” are to be used in religious discussions, then they should be appropriately defined, and not simply transferred from the unrelated field of physics. In the latter part of the 19th century the word “evolution” was similarly transferred from biology, where much evidence had been produced to support the concept, to such

Theories. London, Thomas Nelson, 1951.

⁶Barbour, Ian: op. cit.

⁷MacKay, D.M.: “Complementarity” in *Scientific and Theological Thinking*. *Zygon*, vol. 9, no. 3 (September, 1974), pp. 225–244.

diverse areas as history, anthropology and religion. In many cases little concrete evidence was adduced in support of an evolutionary approach, and it became almost a new god, whose name was Evolution.

Those who write about and discuss religion in the latter part of the 20th century should beware of repeating some of the mistakes of their predecessors. It is noteworthy that Swinburne in his recent book⁸ has paid virtually no attention to arguments based on specific aspects of modern physics. In chapter 8 on teleological arguments he mentions the fundamental particles as the basic building blocks of the universe, but does not make any great use of this, other than as an illustration of the orderliness of the natural world. Indeterminacy in quantum mechanics is relegated to a footnote on page 29, where he points out that indeterminacy on the microscopic scale is compatible with determinism on the macroscopic scale. Complementarity does not even rate a mention in the book.

2.4 Wholeness and Taoism

In 1975 there appeared the book *The Tao of Physics*⁹. This almost immediately drew a following, of what may best be described as a cult. The subtitle of the book is “An exploration of the parallels between modern physics and Eastern mysticism”. It is likely that the popularity of the book was, to a considerable extent, due to the renewed interest in Eastern religions and mysticism which had occurred in the community over the previous decade or so.

The book is divided into three sections: I: The Way of Physics; II: The Way of Eastern Mysticism; and III: The Parallels. The headings of the second and third sections are quite accurate as descriptions of the contents, but that of the first is somewhat misleading. Rather than an exposition of physics it is more a mixture of quotations from the philosophical writings of various physicists who were eminent in the earlier part of this century and from various writings associated with Eastern religions.

The book is one of the results of a mystical experience Capra had. This is described in the Preface, where he also states¹⁰ “. . . I had become very interested in Eastern mysticism and had begun to see the parallels to modern physics.”. But he is also quite aware of the difference between science and

⁸Swinburne, Richard: *The Existence of God*. Oxford, Clarendon Press, 1979.

⁹Capra, Fritjof: *The Tao of Physics: An exploration of the parallels between modern physics and eastern mysticism*. Revised edition. London, Flamingo (Fontana Paperbacks), 1983.

¹⁰*ibid.*, pages 11, 12.

religion. Two consecutive paragraphs in the Preface¹¹ are worth quoting *in extenso*, to see something of what Capra intended by the book.

This book is intended for the general reader with an interest in Eastern mysticism who need not necessarily know anything about physics. I have tried to present the main concepts and theories of modern physics without and mathematics and in non-technical language, although a few paragraphs may still appear difficult to the layperson at first reading. The technical terms I had to introduce are all defined where they appear for the first time and are listed in the index at the end of the book.

I also hope to find among my readers many physicists with an interest in the philosophical aspects of physics, who have not yet come in contact with the religious philosophies of the East. They will find that Eastern mysticism provides a consistent and beautiful philosophical framework which can accommodate our most advanced theories of the physical world.

In attempting “to present the main concepts and theories of modern physics without any mathematics” Capra has undertaken an almost impossible task. The main theories of modern physics are essentially mathematical in nature, and there are even some parts of mathematics which have been developed principally for their use in theoretical physics. This part of the book is not very successful. It would be more correct to say that he has presented the *findings* of modern physics without any mathematics and as far as possible in non-technical language. There is, however, an irreducible minimum of technical language which must be used in any academic discipline, and it is not really a service to any interested person to minimise the difficulties which must be faced in the early stages of study.

The final sentence of the paragraph addressed to physicists would, probably, be accepted by most adherents of Eastern religions, but not in the sense in which Capra intended it to be taken. A philosophical framework is needed for almost any type of investigation of the “real world”. For most scientists, if they think at all about it, the framework could be summed up in two simple sentences:

1. There is a physical reality external to our minds.
2. This reality is governed by unchanging laws.

¹¹ibid., pages 12, 13.

The second of these is the one about which there is virtually no disagreement. With the exception of creationists (the following quotation¹² is typical)

The imposition of the principle of decay and death on the original creation was the result of man's sin.

there is virtual unanimity that the laws of nature are invariant. This, of course, allows for the possibility that the "constants" of physics could change their values slowly in accordance with some law, which is itself invariant.

There is less agreement about the first sentence, however. It would appear to be in conflict with some interpretations of some Eastern religions, which take the human mind to be the only reality of which we are cognizant. However Capra, in common with Bohm¹³, would accept the first, with perhaps a small change. They would seem to want to modify it so that the implied distinction between our minds and the external reality was not so sharp. Most of the third section of Capra's book deals with the way in which quantum mechanics brings in the concept of the interaction between an observer and the external reality which is being observed.

This distinction has been called into question in recent years, though the relationship with the human mind has not been altogether clarified. Space does not permit any significant discussion of this, but a few words are in order. In the 1960s John Bell produced a theorem relating special relativity and quantum mechanics. He showed that the two ideas that there was some sort of reality, independent of observation, and that information could not be transmitted from one place to another faster than the speed of light, were in conflict with some predictions from quantum mechanics. Tests have since showed that experimental results are in agreement with the predictions of quantum mechanics, and conflict with the simple picture of reality. The philosophical problems which have surfaced here have not yet been clarified. Perhaps some sentences from Paul Davies¹⁴ may serve to underline the confusion which still exists.

Some people have emphasised that quantum physics implies a world in which individual particles of matter do not really exist in their own right as primary entities. Instead, only the collection of all particles treated as a whole, including those that so to make up the measuring apparatus, has the status of 'reality'.

¹²Morris, Henry M.: *The Remarkable Birth of Planet Earth*. Minneapolis. Bethany Books, 1972. Page 18.

¹³Bohm, David: *op. cit.*, chapters 2, 3.

¹⁴Davies, Paul: *Superforce: The Search for a Grand Unified Theory of Nature*. London, Unwin Paperbacks, 1985. Pages 48, 49.

The more traditional view of reality based on classical Newtonian physics is quite different. . . . This picture is appealing because we can easily visualise myriads of these elementary particles like solid balls, locked together to form a familiar object such as a rock. All the properties possessed of the rock can then be attributed to the atoms, or whatever building block is fashionable. The rock is *made up of* elementary particles and the particles are simply fragments of the rock. Nothing more.

...

In quantum physics this simplistic classical relationship between the whole and its parts is totally inadequate, The quantum factor forces us to perceive particles only in relation to the whole. In this respect it is wrong to regard the elementary particles of matter as *things* that collectively assemble to form bigger things. Instead, the world is more accurately described as a network of *relations*.

To the naive realist the universe is a collection of objects. To the quantum physicist it is an inseparable web of vibrating energy patterns in which no one component has reality independently of the entirety; and included in the entirety is the observer. [emphases in the original]

Davies' words "some people" at the beginning of the quotation indicate the lack of agreement which still exists among the scientific community about the implications of Bell's theorem. Capra makes a brief mention of this in the Afterword¹⁵ to his book, but does not take up the thought that there may not be any physical reality independent of the human mind. One of the points of confusion here is the concept of an "observer". To most people, including some physicists, this implies a human being. However this is not necessarily so — a photographic plate can equally well serve to record the results. At some stage humans must interpret whatever is recorded by the camera, and it is at the point at which the mind is introduced in the process of observation, whether early or late, that confusion starts to develop. Even eminent physicists such as Barrow and Tipler¹⁶ are not immune from this confusion, as the following words show:

In classical physics Man seemed entirely superfluous to the Universe. He was only a cog — and a rather small cog at that —

¹⁵Capra, Fritjof: op. cit., pages 341–346.

¹⁶Barrow, John D. and Tipler, Frank J.: *The Anthropic Cosmological Principle*. Oxford, Clarendon Press, 1986. Page 458.

in the Newtonian world machine. However, his role in the Cosmos appears greatly enhanced in quantum mechanics, According to the so-called Copenhagen Interpretation of the quantum mechanical formalism — and this interpretation is the most widely accepted interpretation among contemporary physicists — Man, in his capacity as the observer of an experiment, is an essential and irreducible feature of physics.

The second section of Capra's book is the briefest, which is perhaps not surprising since the book is primarily intended for "the general reader with an interest in Eastern mysticism". It consists of brief chapters on Hinduism, Buddhism, Chinese thought, Taoism and Zen. These give, within the brevity of the space allotted, accurate accounts of these religious movements.

It seems rather doubtful that Capra would have achieved his aim of showing physicists, who have not come into contact with these before, that they could form a suitable framework for "our most advanced theories of the physical world". It is far from clear just what Capra means by "our most advanced theories". In the book he only considers relativity and quantum mechanics. These were, at the time of writing, among the most advanced theories, particularly in their combination known as quantum electrodynamics. But Capra seems to imply that Eastern religions could form a philosophical basis for any advanced theory. The essential part of Capra's book deals with the concept of "unity", both as expressed in Eastern religions and in quantum mechanics.

At present this is still one of the "most advanced theories", but only one. One of the theories of modern physics which has rather gripped the imagination of the popular media, though rather inaccurately, is "big-bang" cosmology. Capra pays very little attention to cosmology. He has a whole chapter¹⁷ entitled "The Dynamic Universe", but less than four pages of this are devoted to general relativity and the expanding universe. He chooses to accept only one of the possibilities which relativity provides, that of a universe which oscillates and goes through the same cycle of expansion from the "big bang" and contraction to the "big crunch" over and over again. This model is in agreement, as he says, with some Hindu ideas about the cyclic nature of all things. But in Hinduism the successive cycles are regarded as virtually identical; in the oscillating universe there are changes from one cycle to the next. This would not appear to be in agreement with any Eastern religion.

But this is not the most serious failing of this part of Capra's book. Modern research (see the next chapter for a more detailed discussion) shows that

¹⁷Capra, Fritjof: *op. cit.*, chapter 13.

the expansion of the universe is such that it appears to be on the dividing line between a universe which will expand indefinitely and one in which the expansion eventually reverses itself and the universe collapses. If the expansion goes on indefinitely, eventually there will be a universe devoid of stars and life. This is not in accord with the Hindu idea of repeated cycles. Indeed it seems not to be in accord with any reasonable interpretation of statements to be found in other Eastern religions. This is probably because in such religions there is very little interest in either cosmogony or cosmology, and not much interest in cosmography. If Capra wishes to tie his understanding of cosmology to one particular scientific model, which may be found to be incorrect, he runs the risk of following in the steps of the medieval church which tied its interpretations of parts of the Bible to Aristotle, and found itself in difficulties when Aristotelian ideas came under challenge.

Since *The Tao of Physics* appeared there have been a number of significant advances in physics, which clearly could not have been foreseen. Capra is faced with two alternatives — either Eastern religions are compatible with any changes or advances in fundamental physical theories, or there is a need to show that each new theory is, in turn, compatible with Eastern religions. If the first of these is true, then, by going back into history, we can also say that Eastern religions are compatible with a geocentric universe, or, from even earlier times, a flat earth. From the scientific point of view any framework which fits in with such diverse interpretations of the universe would be regarded, rightly, as essentially irrelevant to the study of nature. It would be seen as something which could not give even any indication of how the study of nature should be approached. On the other hand, if Capra implies that it could be shown that Eastern religions are compatible with future theories in physics, he is faced with the daunting task of rewriting *The Tao of Physics* every few months, as new theories are propounded. After all, one never knows which of the seemingly outrageous theories will turn out to be more in accord with experimental data than the current ones, and eventually be accepted by the scientific community.

The title of the last section of the book, “The Parallels”, immediately raises problems of philosophy and epistemology. If Capra is going to discuss parallels between two approaches, he should first show that the two approaches are, in some way, comparable. In other words, he should first show that at least some of the Eastern religions have some interest in the physical world, and are interested in the sort of detailed description which modern science attempts to develop. This he has not done. His major effort is directed towards the idea of the unity of the observer and the observed. This is shown quite clearly by the first chapter in the third part of the book, which is entitled “The Unity of All Things”.

In using the word “parallels” Capra is not guilty of the extremes of the modern creationists, who take the Bible to be a scientific textbook. He does, however, make the same error of assuming that scientific and religious descriptions refer, in some sense, to the same things. This seems to be rather in contrast to the opinion expressed in a paragraph in the Introduction¹⁸ which reads:

As far as the contents of the book are concerned, the reader may feel a certain lack of balance between the presentation of scientific and mystical thought. Throughout the book, his or her understanding of physics should progress steadily, but a comparable progression in the understanding of Eastern mysticism may not occur. This seems unavoidable, as mysticism is, above all, an experience that cannot be learned from books. A deeper understanding of any mystical tradition can only be felt when one decides to become actively involved in it. All I can hope to do is to generate the feeling that such an involvement would be highly rewarding.

Here Capra shows quite clearly that he appreciates that the scientific and religious approaches to the world around us are quite different, yet throughout the rest of the book he attempts to relate the findings of science to mystical experiences. There seems to be something rather incongruous in all of this.

But perhaps the most serious criticism which could be made of Capra is the way in which he quotes from various writings associated with Eastern religions. For reasons of space only some of the quotations he makes from the *Tao Te Ching* will be considered, though the same criticisms apply to other writings.

The major Western religions, Judaism, Christianity and Islam, all have sacred writings, which have been collected into a canonical corpus of scripture. These scriptures have an authoritative status within each of the religious traditions, and are regarded as normative for belief and conduct. Capra, as a member of a Western society, appears to have taken this idea of “scripture” and applied it to Eastern writings, without sufficient consideration of whether such a step was justified. Most of his readers would also have been familiar with at least some of the Western scriptures, and would have likewise assumed that Eastern writings were to be treated in the same fashion. There are, of course, some circumstances in which the word “scripture” may be the best available English word to use. As Waley states in his Preface¹⁹

¹⁸ibid., page 13.

¹⁹Waley, Arthur: *The Way and its Power*. New York, Grove Press, 1958. Page 13.

The distinction I wish to make is between translations which set out to discover what such books meant to start with, and those which aim only at telling the reader what such a text means to those who use it today. For want of better terms I call the first sort of translation “historical”, the second “scriptural”.

Such a usage of the word “scriptural” is not controversial. But it is a mistake to treat most Eastern religious writings in the same way as Western scriptures. The very name Tao means “way”, and in Eastern religions it is the way of life, rather than a set of beliefs, which is regarded as the important thing. Capra has entitled the first two sections of his book “The Way of Physics” and “The Way of Eastern Mysticism”. But the title of the first section, as already mentioned, is somewhat misleading. It includes quotations from various eminent physicists about the nature of quantum mechanics, but contains very little about the “way” in which progress is made in physics. Capra had the opportunity here to point out some parallels which he missed, such as sudden flashes of inspiration, which could be likened to some of the sudden insights which adherents of Zen Buddhism gain through meditating on koans. Capra makes some mention of these in the chapter “Beyond Language”²⁰, in the first section of the book, but does not take the discussion far enough. If there is to be any discussion of the “way” of physics, it should at least make some mention of the processes by which new or modified theories are developed. The book by Zukav²¹ also makes mention of some parallels which there seem to be between quantum mechanics and Eastern religions. In contrast to Capra he does discuss at some length not only the way scientific progress is made, but also some of the ways in which students learn about physics, and makes some mention of relationships between psychology and attitudes to physical laws. This would appear to be more of a “way” than Capra’s book. According to the Introduction²²

In the future I hope to write another book specifically about physics and Buddhism.

This book has not yet appeared — it could very well provide a helpful antidote to some of the excesses of Capra’s book.

As well as these problems, there is another difficulty associated with quotations from Eastern writings. There are, in general, few problems involved

²⁰Capra, Fritjof: op. cit., chapter 3.

²¹Zukav, Gary: *The Dancing Wu Li Masters: An Overview of the New Physics*. London, Fontana Paperbacks, 1980.

²²ibid., page 25.

in translating the various Western scriptures. But for Eastern writings, and in particular the *Tao Te Ching*, which is written quite tersely there are a number of uncertainties. This is revealed if two different translations are compared — many more divergences will be found than in two different translations of Western scriptures. As Creel²³ says

The terse and cryptic nature of the sayings in the Lao Tzu had consequences not foreseen by their authors. They could be, and were, interpreted in various and even opposite ways.

Capra has taken his quotations from the translation by Ch'u Ta-Kao, published in 1970. This has not been sighted, but some of the renderings are significantly different from those in the easily accessible translation by Lau²⁴. To illustrate some of the differences, and also show the way in which Capra has treated the *Tao Te Ching* as scripture, two passages will be given, both as cited in Capra and from Lau's translation. These will be accompanied by some comments on the way Capra applies these to physics.

As the first example, on page 47 Capra tries to distinguish between what he calls the “rational” and the “intuitive” modes of the mind.

Scientists are familiar with direct intuitive insights from their research, because every new discovery originates in such a sudden non-verbal flash. But these are extremely short moments which arise when the mind is filled with information, with concepts and thought patterns. In meditation, on the other hand, the mind is emptied of all thoughts and concepts and thus prepared to function for long periods through its intuitive mode. Lao Tzu speaks about this contrast between research and meditation when he says:

He who pursues learning will increase every day; He who pursues Tao will decrease every day.

When the rational mind is silenced, the intuitive mode produces an extraordinary awareness; the environment is experienced in a direct way without the filter of conceptual thinking.

The quotation is from chapter 48 of *Tao Te Ching*, which Lau renders in the words:

²³Creel, Herrlee G.: *What is Taoism? and Other Studies in Chinese Cultural History*. Chicago, University of Chicago Press. 1970. Page 6.

²⁴Lau, D.C.: *Lao Tzu: Tao Te Ching*. Harmondsworth, Penguin Books, 1963.

In the pursuit of learning one knows more every day; in the pursuit of the way one does less every day.

The differences between the two translations here are not particularly significant. There are several points, however, where one could disagree with Capra. For a start, his statement that “every new discovery” comes from a sudden flash of inspiration would be widely challenged. Many discoveries, particularly in experimental areas, are purely fortuitous. As one example, the 1965 discovery by Penzias and Wilson of the microwave radiation, which is one relic of the “big bang” came from an attempt to develop devices to receive signals from very distant spacecraft. Then there is the statement that “Lao Tzu speaks about this contrast between research and meditation . . .”. There is a vast difference between learning, as understood in the Tao, and research, as understood today. In the previous chapter (47, citation from Lau) we find something of how learning is to be interpreted.

Without stirring abroad One can know the whole world; Without looking out of the window One can see the way of heaven.

This appears, at first sight, to be rather close to the Aristotelian approach of discussing the “real world” without actually investigating it experimentally. However such an interpretation would be a misunderstanding of the whole process by which an understanding of things is obtained in Taoism. There is nothing in it which could be classified as trying to gain some sort of understanding of the way in which phenomena in the “real world” are related by a chain of cause and effect.

Another example of the way in which Capra seems to have misunderstood, or at least misapplied, the Tao can be found in chapter 11, entitled “Beyond the World of Opposites”. On page 158 Capra writes

Opposites are abstract concepts belonging to the realm of thought, and as such they are relative. By the very act of focussing our attention on any one concept we create its opposite. As Lao Tsu says, “When all in the world understand beauty to be beautiful, then ugliness exists; when all understand goodness to be good, then evil exists.” Mystics transcend this realm of intellectual concepts, and in transcending it they become aware of the relativity and polar relationships of all opposites.

This concept of the existence of opposites runs throughout Taoism. But it is not always as simple as Capra has made out. In fact, Lau’s rendering of these words (which come from chapter 2 of *Tao Te Ching*) is rather different.

The whole world recognizes the beautiful as the beautiful, yet this is only the ugly; the whole world recognizes the good as the good, yet this is only the bad.

These two renderings are a good example of what Creel²⁵ described as “opposite ways”. To the Western, scientific mind the two distinct renderings (that the existence of beauty implies the existence of its opposite, ugliness, or that beauty and ugliness are both parts of the same thing) are mutually contradictory. In Taoism, however, not only is the existence of opposites an important concept, but even the existence of opposite interpretations is permitted. The resulting tension is not regarded as a problem, but as one of the strengths of the discipline.

There is clear evidence in the quotation from Capra that he has treated the *Tao Te Ching* as though it were some sort of authoritative scripture. He then compounds this error by what could best be described as a glaring example of faulty hermeneutics.

In subsequent parts of the chapter Capra applies the idea of opposites to various parts of physics. On page 167 he writes:

Force and matter, particles and waves, motion and rest, existence and non-existence — these are some of the opposite or contradictory concepts which are transcended in modern physics.

Of the four groups Capra mentions, only one — existence and non-existence — really fits into the category of opposites. Motion and rest depend on the frame of reference — the moon moves around the earth, but to an astronaut on the moon, the moon would be at rest. The opposite of an electron as a particle would not be an electron as a wave, but the electron’s antiparticle, the positron — of opposite charge and spin. Force and matter are neither the same nor opposites — they are just different.

It seems likely that Capra has fallen into this error because he pressed the parallel far beyond any reasonable limit. To use his own words, he used an “intuitive mode”, where the “rational mode” was the appropriate one.

There is another point which seems to have escaped Capra’s attention. The idea of opposites is not just restricted to Eastern religions. In the standard two-valued logic used in all scientific reasoning, an object either has an attribute or it does not. This dichotomy could, quite legitimately, be described as involving the concept of “opposites”. It would then be possible to argue that the whole of Western science is based on the use of “opposite” ideas, but this would clearly be a gross misunderstanding of the true state

²⁵Creel, Herrlee G.: loc. cit.

of affairs. Similarities in the form of arguments prove nothing. The coldly logical type of most scientific reasoning is clearly not of the same nature as the “intuitive” type of thought characteristic of Eastern religions.

There is one point strongly in favour of Capra’s attempt to relate Eastern religious thought to one aspect of modern science. In the modern world science is regarded as almost a god, with scientists as modern-day high priests. To many people the only valid form of argument is a scientific one — science is even used in advertising “Scientific tests show that Blogg’s toothpaste is better!” — and religious reasoning has been discounted. Capra has pointed out the importance of considering religious ways of looking at the world around us, as well as scientific ways. He has at least tried to build what may be called “hermeneutic bridges” between one religious tradition and the modern scientific world. His attempt has not been particularly successful, but that should not discourage others from trying to do the same, and doing it for other religious traditions as well.

2.5 Conclusion

Perhaps the major conclusion which can be drawn from the preceding is that there is a great need to ensure that the appropriate forms of language are used in any discussions about the natural world. In the context of the topics discussed in this chapter, this would mean that it is important to distinguish between religious and scientific uses of words, especially when the same English words are used. Considerable confusion has been caused in the past by using a word, which has a precisely defined meaning in science, in religious discourse, without first making sure that the religious meaning (or meanings) were clearly understood all participants in the discussion.

There is also a certain amount of confusion about Eastern religions. These are not nearly as homogeneous as seems to be assumed by for example, Capra. The three major Western religions have considerable points of overlap, since Christianity grew out of Judaism, and Islam grew out of a world in which both Judaism and Christianity were prominent. There is no such unifying thread among the Eastern religions, in spite of the fact that the original Buddhist ideas have divided into a number of rather distinct religions.

As pointed out earlier, Christian theologians have, mostly, abandoned any attempts to base their theological explanations on the ideas of uncertainty and complementarity from quantum mechanics. There is still a certain amount of discussion going on, in theological circles, which attempts to relate the ideas of wholeness to Christian theology with the work of Bohm²⁶

²⁶Bohm, David: *op. cit.*

taken as a starting point. There is a very grave danger of introducing here yet another version of the “God-of-the-gaps” theology. This was pointed out quite strongly by Peters at a conference in 1983. After raising a number of theological issues, he writes, in the concluding paragraph of the article²⁷

It is with this possibility in mind that we have raised a few theological questions and suggested some cautions. Although Bohm’s cosmology might very well become allied to Christian theology in the mind of some theorists, it is fortunate at this point that Bohm has refrained from simply labelling his holomovement “God.” Whether by accident or design he shows wisdom in following Parmenides in this regard. To call it God would be to produce another god of the philosophers, a divine principle posited to save the other principles of the system from collapse. It would be a god-of-the-gaps philosophy.

Capra’s approach to quantum mechanics rather smacks of special pleading. He has only considered one small part of modern science. If he wishes to have his work taken seriously by scientists, he would need to show that other parts of science also fitted in with Eastern religions. It would be easy to find some examples where this could be done. For example, the opposite of the splitting up of one of the plates which make up the crust of the earth (Africa and South America separating to make the Atlantic Ocean) would be two plates joining to make one (India joining Asia and forming the Himalayas in the collision). Thus it could be argued that plate tectonics is firmly in the mould of Taoism. Zukav²⁸ has given another example, but also from physics:

What we considered to be a planet with its own gravitational field moving around the sun in an orbit created by the gravitational attraction (force) of the sun is actually a pronounced curvature of the space-time continuum finding its easiest path through the space-time continuum in the vicinity of a very pronounced curvature of the space-time continuum.

There is nothing but space-time and motion and they, in effect, are the same thing. Here is an exquisite presentation, in completely Western terms, of the most fundamental aspect of Taoist and Buddhist philosophies.

²⁷Peters, Ted: David Bohm, Postmodernism, and the Divine. *Zygon*, vol. 20, no. 2 (June 1985), pp. 193–217. Page 216.

²⁸Zukav, Gary: op. cit., pages 199, 200.

But unless it is possible to obtain some help in formulating additional hypotheses in science, or indicating possible directions for future research, these parallels remain simply interesting parallels. It is noteworthy that these writings about the relationships between Eastern religions and modern science all seem to come from Western writers. There have been very few, if any, writings on this topic by either Eastern scientists or by other people from Eastern cultures who adhere to the various religions. This is in marked contrast to Western religion and science, where there is a long history of both scientists and theologians writing about the relationships between science and religion, particularly Christianity. The most likely cause for this would appear to be the great distinction between the attitude to the universe held in the different religions. In Eastern religions the universe is, more or less, accepted as it is, as something which is there. By contrast, the Western religions attribute the universe to creation by a transcendent God. Since God created the world in which we live, it is our duty to try and understand the physical universe, and to relate our understanding to our religious ideas.

Chapter 3

The Anthropic Principle and the Argument from Design

The argument from design tries to prove God’s reality by examining the universe. In the form given to it today by those naming themselves “creation scientists” it earns the fury of genuine scientists. I shall show why most reputable thinkers consider it long dead and buried. But afterward I plan to demonstrate that recent developments make it very much alive, though not in any shape that creation science would welcome.

John Leslie¹

3.1 Introduction

The argument from design has had a long and rather checkered career. A survey of some of the arguments, with an extensive bibliography, can be found in chapter 1 of Barrow and Tipler². Probably the best known names associated with the argument are Aquinas and Paley. It is generally agreed that their arguments are defective. However in recent years the argument has staged a come-back, under the name of “The Anthropic Principle”. This phrase seems to have been first used by Brandon Carter. It became widespread, at least in astronomical circles, as a consequence of two of the many meetings held to commemorate the 500th anniversary of the birth of Nicholas

¹Leslie, John: Modern Cosmology and the Creation of Life. Pp. 91–120 in Ernan McMullin (ed.), *Evolution and Creation*. Notre Dame, University of Notre Dame Press, 1985. Page 91.

²Barrow, John D. and Tipler, Frank J.: *The Anthropic Cosmological Principle*. Oxford, Clarendon Press, 1986.

Copernicus. At a symposium held at Cracow in September 1973 Brandon Carter³ gave a brief outline of some of the evidence which had accumulated in scattered scientific papers. John Wheeler⁴ spoke at a symposium held at the Smithsonian Institution in April 1973 organised to discuss the general nature of science and changes in scientific ideas since the 16th century. Since then there has appeared the book by Paul Davies⁵ which is somewhat technical, but intended for scientists who are not specialists in the area. The recent *magnum opus* by John Barrow and Frank Tipler⁶ contains the most up-to-date exposition of the principle, but is highly technical in many places.

3.2 Outline of “The Anthropic Principle”

In various papers scattered throughout the scientific literature a number of scientists, independently, remarked that the structure of the universe (its rate of expansion, the fact that, on the large scale, there appeared to be no preferred directions in space, etc.) seemed to be remarkably adapted to human life. As further evidence, it was pointed out that many of the physical constants involved in the basic structure of the universe seem to have just those values needed for the existence of intelligent observers.

There are two major facets to the principle, relating to objects at opposite ends of the scale for size. The first relates to gravity and the universe as a whole, and the second to atomic physics, and in particular to the nuclear reactions which are responsible for generation of energy in stars. Barrow and Tipler⁷ mention a number of other topics, such as why the universe has three dimensions of space, the nature of chemical bonding, the significance of the particular properties of water, and so on. Many of the particular items they mention can be traced back to some more fundamental questions: why do the physical constants which are found in the universe (the gravitational constant, Planck’s constant, the speed of light, etc.) have precisely those values which seem to be needed for the existence of intelligent life? The gravitational constant is tied up with the rate at which the expansion of the universe is changing, and Planck’s constant is inextricably bound up with

³Carter, Brandon: Large Number Coincidences and the Anthropic Principle in Cosmology. Pp. 291–298 in M.S. Longair (ed.), *Confrontation of Cosmological Theories with Observational Data*. Dordrecht, D. Reidel, 1974.

⁴Wheeler, John: The Universe as Home for Man. Pp. 261–296 in Gingerich, Owen (ed.), *The Nature of Scientific Discovery*. Washington, Smithsonian Institute Press, 1975.

⁵Davies, Paul: *The Accidental Universe*. Cambridge, Cambridge University Press, 1982.

⁶Barrow, John D. and Tipler, Frank J.: op. cit.

⁷ibid.

quantum mechanics, atomic physics and nuclear reactions in stars, For these reasons, and also from limitations of space, just the two particular issues mentioned above will be considered here.

3.2.1 Cosmology

The expansion of the universe, following its origin (or creation) in the “big bang”, is well known. For many years there have been attempts to measure this rate of expansion sufficiently accurately to decide whether the universe will continue to expand indefinitely, or whether the expansion is slowing down and will eventually reverse itself, leading inexorably to what has been called the “big crunch”. It is generally agreed that measurements to date do not provide an answer to this question, and that the rate of expansion appears to be very close to the critical value separating the two types of behaviour. Accompanying theoretical investigations have shown that the conditions immediately after the “big bang” are critical, as far as the future development of the universe is concerned. If the rate of expansion were slightly greater, it would have been sufficient to overcome the attractive force of gravity and matter would have dispersed without condensing into galaxies, stars and planets. This would clearly be incompatible with the existence of material observers. On the other hand, if the rate of expansion were slightly less, gravity would have overcome the expansion, and the universe would have collapsed in a “big crunch” after only a few million years or less, clearly too short a time for the formation and evolution of intelligence as we know it. Thus the universe as a whole appears to be “designed” for our existence.

3.2.2 Nuclear reactions in stars

Life, as we know it, is based on carbon, with hydrogen and oxygen playing essential roles. Initially (just after the “big bang”) there were only hydrogen nuclei around. During the next few minutes about a quarter of the hydrogen fused to make helium (see Weinberg⁸). Then, billions of years later, heavier elements (carbon, oxygen, phosphorus, etc.) were formed by nuclear reactions in stars, and were then dispersed into space by supernovae explosions (see Kippenhahn⁹). These subsequently condensed into planets. The rates at which these nuclear reactions proceed depend on the relative strengths of the forces between nuclei of atoms, and these strengths appear to be severely

⁸Weinberg, Steven: *The First Three Minutes: A Modern View of the Origin of the Universe*. Glasgow, Fontana/Collins, 1978.

⁹Kippenhahn, Rudolf: *100 Billion Suns: The Birth, Life and Death of the Stars*. London, Unwin Paperbacks, 1985.

restricted in value if carbon, oxygen, etc., are to be formed in appropriate amounts for the existence of life.

If the strong nuclear force between hydrogen nuclei were slightly stronger, then in the few minutes immediately after the “big bang” virtually all the hydrogen would have been transformed into helium. This would mean that there could not be, at a later stage, any significant amounts of substances with hydrogen, and clearly life could not exist in the absence of water. A slight change the other way would mean that nuclear reactions would take place very slowly except in very massive stars. These have very high surface temperatures, and the radiation from them would probably be inimical to life.

Other problems relate to the formation of carbon in stars. There is a critical energy level in carbon nuclei, which means that carbon can be formed rather more easily, and hence in greater amounts, than would be possible otherwise. There is no such critical energy level in oxygen, and this means that carbon is not rapidly transformed into oxygen, and can accumulate. There is, however, slow production of oxygen. Both these phenomena seem to be necessary for the existence of life: there must be adequate amounts of carbon and sufficient oxygen. The laws of nuclear physics appear to have been ‘designed’ for the existence of life.

3.3 Scientific criticisms

Both these aspects of the anthropic principle have the same faults as the old ‘argument from design’. They assume that the only possible form of intelligent life is that with which we are familiar.

The old argument tended to concentrate on the “watchmaker” idea popularised by Paley. There are also a number of writings which consider that the distance of the earth from the sun, the thickness of the earth’s atmosphere (determined in turn by the size of the earth) and the distance of the moon are just right for life. The simple objection to these arguments is that if things were somewhat different then either (a) we would be different enough to cope with the changed environment, or (b) we would be elsewhere, where the environment would be suitable. Two passages from Leslie¹⁰ put the objections quite succinctly:

Essentially we have here *an argument from analogy*, and all such arguments are insecure. This particular one, though, is far worse

¹⁰Leslie, John: op.cit., page 92.

than most because its analogy is ludicrously weak. God is conceived on the model of a watch designer, yet the realm of stars and planets is not much like a watch, neither is the realm of living organisms or the individual organism. Put watches, pumps, and windmills in among earthworms, elephants, and cabbages, and any child can tell the difference.

...

Besides, the rules of analogy tell us *not to jump from the finite to the infinite*. Hence, instead of introducing an omniscient, omnipotent designer, one would better limit oneself to believing in a bumbling committee of demigods laboriously developing ever-more sophisticated plans. [emphases in original]

These simple objections appear to be unsatisfactory as criticisms of the new arguments. It seems that if the physical constants were slightly different then life, as we know it, or even modified forms of life, would not be possible anywhere in the universe. This may well be true, for carbon-hydrogen-oxygen-nitrogen-phosphorus based forms of life. But life, as we know it, is not the only conceivable form in which intelligence may develop.

Writers of science fiction are adept at envisaging different societies or advanced technologies. They are less proficient in concocting completely alien forms of life, based on changes in the basic laws of physics. There are, however, at least two books which are relevant here.

Taking them in the order in which topics have been considered earlier, *Dragon's Egg*¹¹ considers a society which has developed on the surface of a neutron star. The beings live and evolve at a rate approximately a million times faster than organisms on the earth. From the origin of life to the development of a high technology society took only 5,000 years. In these circumstances arguments that a stronger gravitational constant would mean collapse of the universe in a few million years, rather than billions of years, and thus not allow enough time for evolution to produce intelligent beings, would seem to have little force.

*The Gods Themselves*¹² treats universes in which the nuclear forces have different strengths, and hence the behaviour of stars is vastly different to that we know. Asimov constructs intelligent life forms, and suggests that there would be forms of intelligent life in many types of universe. It would appear that insufficient attention has been paid to these aspects of the "anthropic principle".

¹¹Forward, Robert L.: *Dragon's Egg*. London, New English Library, 1981.

¹²Asimov, Isaac.: *The Gods Themselves*. St. Albans, Panther Books, 1973.

Paul Davies has raised these questions and poses another problem for the acceptance of the anthropic principle as a scientific theory. Towards the end of *The Accidental Universe*¹³ he writes

Of course, such arguments are no substitute for a proper physical theory. It is hard to see, for example, how the anthropic principle can ever be used to make a testable prediction, because any physical theory that is inconsistent with our existence is manifestly incorrect anyway. Moreover, in the absence of knowledge about extra-terrestrial life, we have only rather general arguments about the physical prerequisites for biology. Perhaps life can form under a much wider variety of conditions than hitherto assumed.

The most telling criticism here is about testable predictions. If a theory is to be accepted as a scientific one, it must be, at least in principle, capable of being shown false, by producing predictions which could conflict with experimental results. If it does not make predictions, or experimental data can always be interpreted to agree with the theory, then the theory is not scientific. This is one of the major criticisms of modern creationism.

3.4 Philosophical and Religious Criticisms

Before discussing some of the points which have been raised, either in favour or against the anthropic principle, we should clearly state just what is being discussed. There are two forms of the principle, the weak and the strong. The weak form is, in some respects, a reaction against an extreme Copernican viewpoint. After it was generally accepted that the earth was not the stationary centre of the cosmos, but travelled around the sun, the privileged place man held in the universe seemed to vanish. It did not take long for this idea to be extended to the assumption that man's place in the universe was in no way special. An almost natural corollary of this was that God's special place in the sky had been removed. As Schwarz¹⁴ puts it

The shift from a pre-Copernican to a Copernican world view has caused an ever increasing sense of homelessness for the idea of a theistically conceived God.

¹³Davies, Paul, op.cit., pages 129–130.

¹⁴Schwarz, Hans: God's Place in a Space Age. *Zygon*, vol. 21, no. 3 (September 1986), pp. 353–368. Page 353.

The weak anthropic principle takes issue with this rather extreme form — it states that our position within the universe, both in space and in time, must be such that we could be aware of the rest of the universe. Thus it rules out the possibility of intelligent life forms existing in the centre of stars, and being aware of what was outside the stars. In a like manner, any intelligent life form which managed to exist in the hot ionised mixture of hydrogen and helium during the first few hundred thousand years after the “big bang” could not be aware (on our current understanding of physics) of anything outside itself. These matters are relatively uncontroversial, and are, in fact, virtually a tautology. After all, any universe in which intelligent observers find themselves must be compatible with the existence of such intelligent observers; or, as Leslie¹⁵ puts it:

Were the laws of our cosmos not such as to produce life then we would not be here to contemplate them.

Most of the discussions, however, have centred around the strong form of the principle. This, in essence, says that the universe has many of the properties it has because it was, in some sense, “designed” so that intelligent life would develop in it at some stage of its history. An extreme case of this is the phrase “participatory universe”, introduced by Wheeler. At the 1973 meeting at the Smithsonian there was a discussion moderated by Thompson¹⁶ about the paper presented earlier by Wheeler¹⁷. In his introductory remarks to the discussion Wheeler said¹⁸

But in brief, one is led to ask whether the universe has the size it does, and whether it lives the length of time it does, because only in this way will life be possible; what is the good of a universe where there is nobody around to look at it?

These remarks are anthropomorphic in the extreme. Wheeler does not so far as to say that the sole purpose of the creation of the universe by God was so that humankind could praise the creator, but it is only a small step from his statement to the words of the Shorter Catechism, “What is the chief end of man? To glorify God and to enjoy him forever.”

¹⁵Leslie, John: God and Scientific Verifiability. *Philosophy*, vol. 53 (1978), pp. 71–79. Page 74.

¹⁶Thompson, William I. (moderator): Discussion on “The Universe as Home for Man”. Pp. 575–587 in Gingerich, Owen (ed.), *The Nature of Scientific Discovery*. Washington, Smithsonian Institution Press, 1975.

¹⁷Wheeler, John: op.cit.

¹⁸Thompson, William I.: op.cit., pages 575, 576.

Here attention will be concentrated on one or other form of the “strong” anthropic principle, since this seems to be the major argument in favour of the universe being “designed” for humankind. There is little written about the anthropic principle from the point of view of philosophy or religion. This is probably because there are so few philosophers or theologians who feel happy with highly involved arguments using advanced mathematics or physics. John Leslie, from whom the quotation at the head of this chapter was taken, is a philosopher who has taken an interest in philosophical problems associated with modern cosmological ideas. As far as is known no prominent theologian has written at any length on the topic.

One of the major problems which needs to be tackled, and about which there is still not unanimity, is “What is a law of science?” It is particularly important that this question be tackled with respect to any questions relating to the universe, either as a whole or for any parts of it. Science works by making generalised statements about phenomena, mostly on the basis of a number of particular cases which have been examined in some detail. There is quite a lot of information available about the universe, or about various parts of it. But there is a fundamental problem involved — is the universe we have investigated the only possible universe (or the only possible type of universe), or are there whole classes of universes, of which we have only one example? The situation is somewhat like that of the origin of the solar system — are the distances of the planets from the sun (and their masses) such that they must be determined by any satisfactory theory, or could there be a whole range of distances (and masses) compatible with a correct theory? Until relatively recently nobody knew whether other stars had non-luminous bodies circling them, but now there is evidence that such planets exist in other parts of the universe. But when it comes to the universe, by definition we cannot observe other “universes”, and so there is absolutely no way of knowing whether some of the properties we find in the universe are or are not characteristic of any possible “universe”. Does a satisfactory theory need to explain everything we find in the universe, or only some things? If it need only explain some, which ones are they?

In quantum mechanics there is an interpretation (different from the standard Copenhagen interpretation) known as the “Many Worlds Interpretation”, of quantum mechanics. This is not widely held, but it has sufficient supporters not to be rejected out of hand. It essentially sets around the problem of indeterminacy by saying that at each instant the universe splits into two or more distinct, isolated universes, depending on how many outcomes there are for each system being considered. Each observer is conscious of only one universe, for him or her things are quite definite, and the observer is quite unconscious that he or she also splits into several observers which

are isolated from each other. Barrow and Tipler in section 7.3 (entitled “The Friedman Universe from the Many-Worlds Point of View”)¹⁹ take up this issue from the criticism that the initial conditions in the expansion from the “big bang” need to be very closely specified if life is to develop subsequently. They claim²⁰ that this does not conflict with Occam’s principle of parsimony:

It is necessary to raise the Universal initial conditions to the status of physical laws to resolve this problem on the classical level. We also have to allow additional physical laws to account for wave function reduction. No additional laws need be invoked if we adopt the MWI [many-worlds interpretation], for here all the points in initial data space — classical universes — actually exist. The question of why does this universe rather than that universe exist is answered by saying that *all* logically possible universes do exist. What else could there possibly be? The MWI cosmology enlarges the ontology in order to economize on physical laws.

The ontological enlargement required by the MWI is precisely analogous to the spatial enlargement of the Universe which was an implication of the Copernican Theory. [emphasis in the original]

Davies²¹ disagrees with this interpretation of Occam’s principle of parsimony.

The world-ensemble concept can be criticized on a number of grounds, some philosophical, some physical. It may appear unattractive that nature should indulge in such profligate duplication. Can we really believe in limitless numbers of universes, created but never observed, serving no purpose except to ensure that, somewhere among the vast array of wasted worlds, will be the occasional cognizable accident? To explain the coincidences by invoking an infinity of useless universes seems like carrying excess baggage to the extreme.

The disagreement here is over just what interpretation should be placed on the first word in “*Entia non sunt multiplicanda praeter necessitatem*” (these exact words are not found in Occam). It is usually understood as something along the lines of “entities”. It seems doubtful whether a single scientific theory (which leads to an infinite number of “universes”) should be counted as increasing things beyond the necessary number needed.

¹⁹Barrow, John D. and Tipler, Frank J.: op. cit., pages 490–496.

²⁰ibid., pages 495–496.

²¹Davies, Paul: op.cit., pages 127–128.

The many worlds interpretation has been taken both to be in conflict with and to be compatible with religious ideas. Leslie²² writes:

Let us not forget that the Many Worlds hypothesis may face serious competition from the God hypothesis.

By “the God hypothesis” Leslie means the idea that there is only one universe, which was created by God with the specific properties which make it suitable for life. Leslie here seems to have fallen into the common trap of placing two hypotheses, of quite different natures, on an equal footing. The “Many Worlds hypothesis” is an interpretation of quantum mechanics, within the general area of science: the “God hypothesis” is clearly a religious one, and cannot be included within science. Davies²³ puts forward an alternative view:

The famous coincidences then acquire a rather more concrete status. Imagine the Creator equipped with a pin, blindly choosing one of the universes at random from among the vast collection of contenders. The chances of His picking a universe compatible with life as we know it is then exceedingly small. . . .

Many people of a religious persuasion will no doubt find support from these ideas for the belief that the creator did not aim the cosmic pin at random, but did so with finely computed precision, with the express purpose of selecting a universe that would be suitable for habitation.

Since we have no knowledge of whether other universes exist or not, and, on the current theories, we never can have any such knowledge, the choice must be made on non-scientific grounds. There is nothing in the least reprehensible in making a choice on religious or philosophical grounds, provided such a choice is not claimed to be based on science.

There is one point in relation to the nature of scientific laws which has so far received much more attention from scientists than from philosophers of science. Leslie²⁴ puts it in these words:

²²Leslie, John: Observership in cosmology: The Anthropic Principle. *Mind*, vol. XCII (1983), pp. 573–579.

²³Davies, Paul: op.cit., page 123.

²⁴Leslie, John: Modern Cosmology and the Creation of Life. Pp. 91–120 in Ernan McMullin (ed.), *Evolution and Creation*. Notre Dame, University of Notre Dame Press, 1985. Page 110.

What really would ruin all the evidence would be that it could somehow be shown that only one system of laws, constants and initial conditions could be self-consistent, or else that all self-consistent systems would be life-generating ones.

This, if it could be shown, would be getting rather close to the Aristotelian approach of making deductions about nature solely on the basis of some system of logic, without any consideration of the external world. This approach was, generally rejected by the world of science after the Renaissance (strictly speaking, it was rejected as modern science developed after the Renaissance). There have been, however, scientists in recent years who have tried without success, to construct theories along these lines.

Two such attempts date back about half a century. Milne and Eddington produced theories which attempted to show that many of the laws of the universe and the values of various physical constants could be obtained from first principles, without any experimental knowledge or investigation. Their efforts are summarised in two impressive books^{25, 26}. These are now regarded as of little more than historical interest, and the theories have joined the long list of others which have fallen by the wayside. The major reason for rejecting them is that they both made predictions, about particular properties of matter in the universe, which were found to be erroneous as the accuracy of measurements improved. For example, Eddington initially claimed to show that the fine structure constant (which occurs in relativistic quantum mechanics) had the value $1/136$ exactly which agreed reasonably well with the value measured at the time. When more accurate measurements indicated that the value was closer to $1/137$, he revised his theory²⁷ to show that the value was exactly $1/137$. But the most recent value for this²⁸ is $1/137.036004$, and the accuracy shown here makes it clearly incompatible with Eddington's value.

In a series of lectures prepared for delivery at the University of Birmingham, which were never given due to his death but were edited and published posthumously, Milne²⁹ tried to relate his theory to Christian doctrine. The

²⁵Milne, E.A.: *Kinematic Relativity: A Sequel to Relativity, Gravitation and World Structure*. Oxford, Clarendon Press, 1948.

²⁶Eddington, the late Sir A.S.: *Fundamental Theory*. Cambridge, Cambridge University Press, 1948.

²⁷ibid., pages 66–67.

²⁸Petley, B.W.: *The Fundamental Physical Constants and the Frontier of Measurement*. Bristol, Adam Hilger, 1985. Page 309.

²⁹Milne, E.A.: *Modern Cosmology and the Christian Idea of God: Being the Edward Cadbury Lectures in The University of Birmingham for 1950*. Oxford, Clarendon Press, 1952.

book says much about his theory but relatively little about God, and virtually nothing about why his theory is more in line with Christian doctrine than the theory of general relativity, which he tried to replace.

From the point of view of orthodox Christian doctrine, it is possible to raise objections to attempts such as those of Milne and Eddington to explain the universe without investigating it experimentally. One basic doctrine is the contingency of the natural world, and that God was not bound in any way to construct a universe after any particular pattern which mere mortals could deduce. If it is possible, by merely thinking about it, to deduce God's plan, does this not place humankind on the same level as God? It comes very close to suggesting that humankind is omniscient!

One aspect of the universe which has impressed both philosophers and theologians is the order which is found. Most of the chapter "Teleological Arguments" in Swinburne³⁰ is devoted to consideration of order, both spatial and temporal. He makes much of the fact that there are only relatively few basic building blocks involved in the structure of the universe (electrons, protons, etc.) and that these seem to be carefully arranged to give just the things we see around us. He states that one explanation of the orderliness would be that both the existence of the universe and its orderliness are not to be separated, but both have their origin in the same cause, which he describes (on page 141) as "... a being of infinite power, knowledge, and freedom ...". These attributes are, in part, those associated with the Christian idea of God. This orderliness is essentially another aspect of the anthropic principle.

The many coincidences between the properties of the universe which we find and those which seem to be necessary for the existence of life were what started scientists first thinking about the anthropic principle. No single observation or experiment, by itself, is sufficient to establish a theory and the anthropic principle (or theory) is no exception. However when we have so many different aspects of the universe all indicating that there is something special about our surroundings, we need to consider the matter fairly carefully. Leslie³¹ puts it in the following words:

No single one of these alleged items of evidence adequately establishes Design, yet an accumulation of clues, each only hinting at guilt can convince a jury. The strongest argument in support of Design is that life's prerequisites are so numerous.

³⁰Swinburne, Richard: *The Existence of God*. Oxford, Clarendon Press, 1979. Chapter 8.

³¹Leslie, John: God and Scientific Verifiability, *Philosophy*, vol. 53 (1978), pp. 71–79. Page 79.

This sounds very plausible, but there is a fatal scientific flaw lurking in the background. What if all these properties which are claimed to be essential are just consequences of some single law, which we have not been clever enough to discover? We are here up against one of the problems which regularly plagues those who write about the relationships between religion and science — how long will it be before some new scientific theory or discovery removes one (or more) of the foundation stones of the discussion? The history of conflicts between the religious establishment and scientific advances should be sufficient to discourage people from basing their religious ideas on the current state of scientific knowledge, but this seems a vain hope.

As far as the anthropic principle goes, there are already suggestions that many of the seemingly independent conditions for the existence of life are not, in fact, independent, but have their origin in one simple phenomenon. It was mentioned near the beginning of this chapter that the rate of expansion of the universe appears to be on the borderline between that which would lead to eventual collapse, and that where the expansion will continue indefinitely. The energy associated with the gravitational attraction of the various parts of the universe is, by definition, negative, while the energy associated with mass and the motion of expansion is positive. If the universe was expanding at just the critical rate the total energy would be zero.

Here we need to use a slightly different form of Heisenberg's uncertainty principle, quoted in the last chapter. It can be shown, from quantum mechanics, that if the energy of some system is measured, then the error in measuring the energy, multiplied by the error in determining the time at which the energy was measured, cannot be less than Planck's constant. A corollary of this is that it is possible for a system to 'borrow' energy from a vacuum, provided the amount 'borrowed' is 'repaid' within a time limit set by the uncertainty principle. This idea is fundamental to much of quantum electrodynamics.

Quantum mechanics is believed to apply to systems of any size, up to and including the universe as a whole, not just those of atomic dimensions. If we now apply the above result to the universe as a whole, we see something remarkable. If the total energy of the universe were quite small, but not exactly zero, the required energy could be 'borrowed' for a very small fraction of a second (due to the smallness of Planck's constant) before it had to be 'repaid'. Then the universe would vanish back into the vacuum after this extremely small time interval. But if the total energy of the universe is *exactly* zero, and observation indicates that it is certainly very close to zero, then it would be possible to 'borrow' this amount (zero) of energy for an arbitrarily large time. In other words, the whole universe could have arisen by a simple fluctuation in a vacuum. The first scientist to have suggested

this seems to be Tryon³² in a brief note. The idea did not attract much attention at the time, but it has recently been included in what is called the “inflationary scenario” of the “big bang”. Guth³³ has shown that many of the seemingly puzzling properties of the universe appear as natural consequences of the zero total energy situation. Barrow and Tipler³⁴ give a rather small amount of space to consideration of “inflation” and creation from a quantum fluctuation. In view of their remarks³⁵

The inflationary idea is especially interesting when viewed from an anthropic perspective. Formerly, one could identify a number of independent properties of the universe each of which plays a key role in creating a cosmic environment that is life-supporting; but inflation is able to link together a large number of these properties.

the amount of space they have devoted to the topic seems quite inadequate. The topic of “the inflationary universe” is so new that it has received only minor consideration by philosophers such as Leslie. In his original paper Tryon wrote³⁶

If it is true that our Universe has a zero net value for all conserved quantities, then it may simply be a fluctuation of the vacuum, the vacuum of some larger space in which our Universe is embedded. In answer to the question of why it happened, I offer the modest proposal that our Universe is simply one of those things which happen from time to time.

Such statements are perhaps more typical of scientists than suggestions that there is some reason behind our existence, and the properties of the universe which enable us to live where we do.

3.5 Conclusion

The topics which have been considered in this chapter lie quite close to the frontiers of research in science. Thus it is not to be expected that any very

³²Tryon, Edward P.: Is the Universe a Vacuum Fluctuation?. *Nature*, vol. 246 (December 1973), pp. 396–397.

³³Guth, Alan H.: Inflationary universe: A possible solution to the horizon and flatness problems. *Physical Review D*, vol. 23, no. 2 (January 1981), pp. 347–356.

³⁴Barrow, John D. and Tipler, Frank J.: op. cit., pages 430–444.

³⁵ibid., pages 434–435.

³⁶Tryon. Edward P.: op.cit., page 397.

definite conclusions could be drawn about how the findings of physics relate to religious beliefs, and, in particular, to the doctrine of creation as found in Western religions.

The basic picture of the universe, as revealed to us by modern astronomy and physics, seems fairly clear. What is far from clear, however, is how the universe came into being. There would appear to be two major competing philosophies, which may be termed the “God hypothesis” and the “chance hypothesis”, to borrow some words from Leslie. Within each of these there are two different interpretations, each of which is compatible with one of the major interpretations of the scientific evidence. Perhaps it is easier to see this if the four possible combinations are set out systematically.

1. God created one universe, and designed it with the particular properties it has, so that intelligence would, inevitably, arise somewhere (or, possibly, at many places) within it at some time.
2. Out of infinitely many possible universes, God chose the one which had the right properties for intelligent beings to develop.
3. The universe developed from some chance quantum fluctuation in a vacuum; any long-lived universe, which is the only type in which life could, by chance, develop, would have the properties we find in our universe.
4. There are infinitely many universes which have developed by successive splitting (quantum-mechanical fashion) in a random manner: most of them are lifeless, and only one in which the laws were compatible with life could give rise to intelligent observers.

The first two are “God made”, the others are “random”. Numbers 1 and 3 are “single universe” models, numbers 2 and 4 are “many worlds” models.

Of the four cases listed, only number 1 can be strictly described as a case of design. However the other three could be included under this term if we are willing to be somewhat flexible in our interpretation of just what we mean by “design”.

A parallel with one interpretation of biological evolution allows us to consider number 2 as a modified version of design. Many Christians accept what they call “theistic evolution”, by which they mean that in some sense God directed the course of evolution. The random nature of evolution, they say, is only apparent, and it has been directed so that eventually thinking organisms could develop, which would even be able to think about their Creator. By analogy the infinite number of lifeless universes are simply part

of the way God went about designing a universe suitable as a habitation for human beings. There is a theological problem here, for this scenario envisages God as not being quite competent enough to design a universe without some form of trial and error — the same objection can be raised against some forms of theistic evolution.

It is less easy to see how numbers 3 and 4 could come under the heading of “design”, but here, too, it depends on just how we define the subject. It is commonly thought that design implies some immediate form of action. This, however, is not necessarily the way a designer works. There are many stages in the design of, for example, a new building. The initial step would be to specify the main outlines, such as the height and floor area. The designer would work within the confines laid down. In a similar manner, if we examine the alleged examples of the behaviour of matter within the universe, which are claimed to show “design”, we discover that there are certain underlying laws. These laws are quite few in number, and they could be the basis of a claim that even the apparent random nature of quantum mechanical behaviour is “designed”. In fact, as time proceeds, the number of laws needed to explain the world seems to become fewer and fewer, as more and more comprehensive laws are discovered. Chemistry started off with many laws. When Mendeleev produced the periodic table many laws were seen to be a simple consequence of the orderly arrangement of elements. Quantum mechanics gave a simple explanation of the periodic table. Now quantum mechanics appears to follow from the properties of symmetry held by a few elementary particles. No doubt further simplifications lie ahead.

It is acknowledged that at any particular time there are frontiers to scientific knowledge, even though the frontiers change position as more is discovered about the universe. Speaking about the way modern research has pushed the frontier back towards the moment of creation Trefil³⁷ says

This does not, however, alter the fact that there is a frontier. All it does is to transfer our attention from the material form of the universe to the laws that govern its behaviour. I can hear a twenty-first century philosopher saying, “Very well, we agree that the universe exists because of the laws of physics. But who created those laws?” And even if, as some physicists have suggested, the laws of physics we discover are the only laws that are logically consistent with each other (and therefore the only laws

³⁷Trefil, James S.: *The Moment of Creation: Big Bang Physics from Before the First Millisecond to the Present Universe*. New York, Macmillan Publishing Company, 1983. Pages 222, 223.

that could exist). our philosopher would ask, “Who made the laws of logic? ”

This is where we reach an impasse in arguments about design. It is always possible to trace matters back, but, since each argument takes some finite amount of time, at some stage we have to stop and consider the point we have reached. In this instance, it is possible to argue that the random nature of numbers 3 and 4 has been “designed” into the structure of the universe by God, or some non-personal entity which is called the Designer. The argument here does not derive from either science or philosophy. It is essentially a religious statement that calls the Designer “God”. Even dignifying the Designer with a capital letter says something about the religious (or philosophical) inclinations of those engaged in the discussion.

Do modern discoveries about the universe provide evidence that it has been designed? It all depends on one’s outlook. As Leslie said in the quotation cited at the beginning of this chapter, creationists, who insist that the universe is only a few thousand years old, have cut themselves off from this modern evidence that the universe has been designed. But, in the final outcome, evidence of design to one person can be simply evidence that the universe is governed by laws to another.

Chapter 4

Conclusion

Science and religion represent two great systems of human thought. For the great majority of people on our planet, religion is the predominant influence over the conduct of their affairs. When science impinges on their lives, it does not do so at the intellectual level, but practically through technology.

Paul Davies¹

In this essay we have covered two aspects of modern physics, the very small world of the atom and the world of everything there is, the universe. This century we have discovered more about these than in the whole of humankind's previous history. In some respects more has been discovered in the past two decades than in the preceding two millennia.

The discoveries have sparked off renewed discussions about the place humankind holds in the universe. The main argument has been the perennial one, is humankind (or, more generally, intelligent beings of some sort) in some sense involved as an essential part of the universe, or is the universe a hostile place and humankind simply an accidental occurrence within it?

Over the past twenty years or so there have appeared many books attempting to deal with these issues. In contrast to previous times, when such books tended to be written by professional theologians, the modern books have, generally speaking, been written by professional scientists, or by theologians who have advanced degrees in a scientific discipline. This has resulted in some novel problems arising. Previous works have been criticised by scientists, because the theologically trained authors either pressed the findings of science beyond legitimate limits, or made mistakes in their interpretations of the theories and results of science. Many of the more recent books have

¹Davies, Paul: *God and the New Physics*. Harmondsworth, Penguin Books, 1984. Page 1.

made the opposite mistake, of pressing religious ideas beyond their legitimate limits, and trying to show that some religious ideas are now found to be compatible with, rather than in tension with, modern science.

But although some of the earlier works were criticised by scientists, there has been virtually no criticism of the more recent works by theologians (or religious experts generally). One possible reason for this is the highly technical nature of many of these recent works. Much of the discussion has centred around a number of highly abstruse arguments, in some cases using advanced mathematical techniques which are not encountered in a standard undergraduate course. Before religious scholars could discuss these, in any reasonable amount of detail, they would have to learn the appropriate tools, and this would normally take an inordinate amount of time which could be put to better use.

Another point of difference between recent works and earlier ones is the extension of discussions between science and religion to Eastern religions. Almost all of the earlier works were written from the point of view of Western religions, and, with very few exceptions, with Christianity as the chief protagonist. This is not particularly surprising since Christianity, perhaps more so than other Western religions, places a considerable emphasis on God as the creator of the universe. The recent upsurge of interest in Eastern religions has led to renewed interest in wholistic ideas, which have generally been ignored previously.

But in spite of the greater sophistication of the arguments, it still remains true, as it did in earlier days, that much of the writing is based on misleading premises. A vast amount of the polemical writing about science and religion (and evolution in particular) is based on the idea that religious writings and scientific writings provide the same sort of information about the same events. This appears to be the case for many on both sides, that is, those attacking religion as well as those defending it. Put as bluntly as this, the error is easy to see. The idea that religion provides us with information about the natural world appears to be restricted to the extreme wings of both the religious and the scientific groups which are involved in the dispute. It is also noteworthy that it is these extreme wings in which extreme dogmatism is to be found.

But in spite of the misleading assumptions which lie in the background of so much of the writings, is there anything of value which can be extracted from the modern renewed interest in the relationships between science and religion? There are at least two points which are worth mentioning: the emphasis on wholism and recent discussions about 'design'. These are the two points considered in detail earlier in this essay.

The Tao of Physics, although an unsatisfactory book in many ways, did at least alert many people in the Western world to the way modern sci-

ence had taken reductionism to extremes. Living organisms are made up of cells, which are composed of various substructures, which contain complicated molecules of various sorts. These molecules are made of atoms, which are composed of protons, neutrons and electrons. Protons and neutrons are made up of quarks, which are composed of . . . , there the story rests, for the moment. But one consequence of this highly successful endeavour to explain the workings of an entity in terms of its subsidiary components has been the (perhaps unintentional) idea that the best explanations can be obtained by looking at the component parts, rather than the whole. Again, put as bluntly as this, most people would probably deny it, but the idea that, for example, human beings are “nothing but a collection of . . .”, and so can be manipulated as “nothing but a collection of . . .” lies at the bottom of many of the problems facing today’s society.

Capra’s discussion of wholism in some aspects of quantum mechanics, and his attempt to relate this to wholism as expressed in Eastern religions, is one reaction to reductionism. But his major error, as mentioned earlier, is taking Eastern religious writings to be saying the same kind of things about the universe as quantum mechanics does. There are perfectly good scientific reasons for rejecting extremes of reductionism. Despite various people who have written arguing otherwise, it is generally agreed that there is no reason to associate any idea of a code, for example, with individual atoms. But when atoms are combined in a particular way, to form a molecule of DNA, a way of coding information, and of transmitting this information to descendants, has appeared. The whole is, indeed, more than the sum of the parts.

Another point in Capra’s favour is that his book was one of the first to put clearly the idea of the interdependence of the observer and the observed, as it is found in modern physics. The idea of interrelationships has been well-known in the social sciences for many years. But, again, Capra has rather wandered off the track in using ideas from modern physics to provide justification for this. The physical and the social sciences (of which religion is one) are each autonomous realms, and just as physics does not need religious support to be valid, neither should religious ideas need any support from physics. If the two appear to agree in some aspects that is interesting, but it should not be taken as justification for looking for other agreements between the two.

As far as recent discussions about ‘design’ are concerned. the observation by Leslie that the argument is “very much alive” is quite justified by recent studies about the structure of the universe. However, here again, there is a certain amount of confusion of language. The ‘argument from design’, properly so called, is an argument arising from within the realms of philosophical or religious ideas. Science can say, with some confidence, that there are no

scientific grounds for rejecting the argument. But this is not the same as saying that there are scientific grounds for accepting the argument, and this is where some of the confusion arises. In previous times it was possible to state, again with some confidence, that it was purely coincidental that conditions on the earth were suited to human life. This argument is still valid, but it no longer holds as a negative argument about ‘design’, since the basic structure of the universe seems to be finely tuned for the existence of intelligent beings.

But there are still problems to be faced by philosophers or theologians who wish to talk about ‘design’. The major problem is that the anthropic principle, like so many arguments from past times, concentrates on just one aspect of the universe, and ignores the many problems associated with other aspects. In particular, the problem of evil is very much still a problem. Over two centuries ago David Hume considered the many imperfections in the universe as one of the arguments against the creation of the universe by an omnipotent, benevolent deity. He argued²

This world, for aught he knows, is very faulty and imperfect, compared to a superior standard; and was only the first rude essay of some infant Deity, who afterwards abandoned it, ashamed of his lame performance; it is the work only of some dependent, inferior Deity, and is the object of derision to his superiors; it is the production of old age and dotage in some superannuated Deity; and ever since his death, has run on at adventures, from the first impulse and active force, which it received from him. . . .

This is the point at which philosophers and theologians have to enter the argument, if they wish to use ideas arising out of discussion of “the anthropic principle”. But they should be aware that science is tentative in all its conclusions, and heed the warnings which some scientists have given.

It is becoming increasingly common to find various physicists concluding semi-popular books with some comments about their religious beliefs. This seems to be a natural consequence of them giving more consideration to the philosophical foundations of the subject, and the greater realisation that science has limitations in providing explanations for the way the world works. To give just one example, the final two paragraphs of the book by Trefil³ read:

²Smith, Norman Kemp (ed.): *Hume’s Dialogues concerning Natural Religion*. Second Edition, with Supplement. London, Thomas Nelson, 1947. Page 169.

³Trefil, James S.: *The Moment of Creation: Big Bang Physics from Before the First Millisecond to the Present Universe*. New York, Macmillan Publishing Company, 1983. Page 223.

My message, then, to those who feel that science is overstepping its bounds when it probes the early universe is simple: don't worry. No matter how far the boundaries are pushed back, there will always be room both for religious faith and a religious interpretation of the physical world.

For myself, I feel much more comfortable with the concept of a God who is clever enough to devise the laws of physics that make the existence of our marvellous universe inevitable than I do with the old-fashioned God who had to make it all, laboriously piece by piece.

This, of course, is a personal view and would not command general assent. Quotations from two other eminent scientists, indicating the extremes of the spectrum of thought, show that, in the final assessment, it is probable that attitudes derived from non-scientific philosophical or religious biases which determine each persons conclusions. Nobel prizewinner Steven Weinberg⁴ has written:

It is almost irresistible for humans to believe that we have some special relation to the universe, that human life is not just a more-or-less farcical outcome of a chain of accidents reaching back to the first three minutes, but that we were somehow built in from the beginning. . . . it is very hard to realize that this all [the earth] is just a tiny part of an overwhelmingly hostile universe. It is even harder to realize that this present universe has evolved from an unspeakably unfamiliar early condition, and faces a future extinction of endless cold or intolerable heat. The more the universe seems comprehensible, the more it also seems pointless.

To contrast with this, the concluding paragraph of a recent book by Paul Davies⁵ reads:

Should we conclude that the universe is a product of design? The new physics and the new cosmology hold out a tantalizing promise that we might be able to explain how all the physical structures in the universe have come to exist, automatically, as a result of natural processes. We should then no longer have need for a

⁴Weinberg, Steven: *The First Three Minutes: A Modern View of the Origin of the Universe*. Glasgow, Fontana/Collins, 1978. Pages 148, 149.

⁵Davies, Paul: *Superforce: The Search for a Grand Unified Theory of Nature*. London, Unwin Paperbacks, 1985. Page 243.

Creator in the traditional sense. Nevertheless, though science may explain the world, we still have to explain science. The laws which enable the universe to come into being spontaneously seem themselves to be the product of exceedingly ingenious design. If physics is the product of design, the universe must have a purpose, and the evidence of modern physics suggests strongly to me that the purpose includes us.

What conclusion can we then draw about the relationships between religion and science, in the light of the previous discussion? The two particular topics discussed in this essay have both attempted to relate religion and science, but from opposite viewpoints. *The Tao of Physics* attempted to show that modern science has now come up with some ideas which, it is claimed, were first put forward by Eastern religions. The “anthropic principle”, on the other hand, seems to have shown that the religious “argument from design” is still alive and kicking. Perhaps the question at the beginning of this paragraph would be better worded to refer to the relationships between religious and scientific ways of thinking.

Thus we have in one case what may be referred to as a religious basis for one aspect of science, and in the other a scientific basis for one aspect of religion! Some people find this an exciting prospect, but no doubt Christian fundamentalists would reject the first, and Buddhist fundamentalists (if there are such) would reject the second. The major problem with this approach is that it falls into the common trap mentioned earlier.

If a religion is to be influential in today’s society it must, in some fashion, have something to say about the physical world around us. But whatever it says, this will not offer the same kind of information that science does. Religion and science are two distinct ways of looking at what we see around us, and in order to gain a more complete understanding of the physical world and the society in which we live both are needed, as well as various other disciplines. There are a few writers, both scientists and theologians, who have tried to point this out over the years. So far their words seem, generally, to have fallen on deaf ears.

Let me conclude by quoting three people who have tried point out that both scientific and religious ways of thinking are useful, and indeed necessary, for a more complete understanding of things. Lighthill⁶ has written:

Overvaluing it [mathematics] is an obvious danger; mathematics is only one of many valuable ways of viewing the fantastic be-

⁶Lighthill, M.J.: *Mathematical Methods in Compressible Flow Theory. Communications in Pure and Applied Mathematics*, vol. VII (1954), pp. 1–10. Page 1.

haviour of things, and it cannot possibly replace the other essential and essentially different ways like physics, biology, statistics, economics, poetry, love and religion.

Much more recently Paul Davies has said the same sort of thing. The concluding sentence of one of his books⁷ reads:

It is my deep conviction that only by understanding the world in all its many aspects, reductionist and holist, mathematical and poetical, through forces, fields, and particles as well as through good and evil, that we will come to understand ourselves and the meaning behind this universe, our home.

The final word on the necessity of the independence of religious discussions should be left to a theologian. In summing up Schwarz⁸ says:

If we want to respond effectively to the challenge posed by a Copernican world model, neither analogies to physics nor to biology suffice. One must meet the challenge on its own turf.

⁷Davies, Paul: *God and the New Physics*. Harmondsworth, Penguin Books, 1984. Page 229.

⁸Schwarz, Hans: God's Place in a Space Age, *Zygon*, vol. 21, no. 3 (September 1986), pp. 353–368. Page 364.

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