Chapter 6 COSMOLOGY, CREATION AND THE BIBLICAL RECORD

John R Pilbrow & Allan J Day

CONTENTS – CHAPTER 6

6.1 INTRODUCTION

During the past two centuries, physics has been extraordinarily successful. As an emerging discipline in its own right it was well established by the end of the 19th Century, known very often in those days as *Natural Philosophy*. During that time physics has underpinned much of modern technology including electricity, the steam engine, the internal combustion engine, electronics, automation, computers and modern information systems. Physics is the primary scientific discipline, it depends on the use of mathematics as both a tool and a language and it remains the fundamental science directed to understanding the processes of nature. Physics makes particular use of symmetry principles which are essential and provide an economy of logic.

Much of what will be said about 20th Century physics can be found in *Quarks, Chaos and Christianity* by Polkinghorne (1994), in other books by Polkinghorne and several of the other titles listed in the references. Polkinghorne has articulated two very important principles:- First he notes the amazing fruitfulness of the world both cosmologically and biologically. Then he states (Polkinghorne, 1994, p.43)

> *the 'evolving world (is) to be understood theologically as a world allowed by the Creator to make itself to a large degree'.*

That is, creation is a continuous process and we do not live in a clockwork universe. Secondly, he reminds us that there are different categories of statements and we should differentiate between e.g. theological and scientific statements.

For the moment it will suffice to realise that physics provides a consistent understanding of the physical processes that occurred in the early universe and up to the present time. We understand that the age of the universe is about 13.7 billion years. We have a good picture of the conditions required for the production of hydrogen, helium and lithium and the formation of the rest of the 92 elements, the subsequent evolution of galaxies, stars, supernovae etc., and the formation of our own solar system and similar entities elsewhere in the universe. The question for Christians in particular is what impact should this new understanding of our world that has come from physics have on our theology of Creation? We shall need to heed Polkinghorne's warning that science and theology use different categories.

6.2 BIBLICAL DOCTRINE OF CREATION

"I Believe in God the Father Almighty, Creator of Heaven and Earth" from the Apostles Creed was originally prepared as a statement against Gnosticism. In Polkinghorne's Gifford Lectures, published as *Science and Christian Belief*, each chapter is based on a statement from the Creed.

6.2.1 Aspects

Creation Originans

The understanding of creation as the beginning of space and time. Such an understanding has been a basic understanding of theology. Augustine perceived the cosmos to be created not so much in time but with time. Before creation, only God existed. The 20th century has seen a remarkable change in the scientific level of understanding of the creation of the universe based on new understandings in physics. This has called into question the literal interpretation of Genesis and how God acts in the world – then and now. It is necessary to move well away from the notion of the watchmaker God (Deism) who wound up the clock and left it to run by itself. Thoughtful Christians would not hold that view today. As scientific knowledge has developed those who have sought to deny the existence of God have found in scientific arguments a reason for their position. We shall argue in this chapter that the existence of God is not dependent on how much we know about the world.

Creation Ex Nihilo - Creation out of nothing

We can still affirm creation by the will of a transcendent God. The theological and biblical concept is of creation *ex nihilo*: God bringing into being, that which had no being. The notion of 'ex nihilo' creation has been a hard doctrine to grasp for those who can only understand something as being made out of something that already exists. Before creation only God existed. It leads inevitably to the question who made God as if he were of the same substance as our universe, and ourselves. We shall see that the origin of the universe at a singularity in space-time does not require any prior matter.

Creation Continua - General Providence, Sustenance

God's immanence leads to a theology of providence which holds that God is involved in the universe always and at all times. We are not able to say how that occurs.

6.2.2 Genesis input

Gen 1:1

The fundamental presupposition of the Bible is of creation '*ex nihilo',* out of nothing but not out of chaos, although the basic motif of Gen. 1 is of God bringing order out of chaos. The beginning statement of Genesis is the primary faith statement regarding our attitude to God as Creator.

Genesis 1:1-2:4a

Two accounts are given, the first in Gen. 1:1-2:4a. The six day framework paints a picture of creation by command. "God spoke and it was done." Those of us who adopt the modern cosmology see the Genesis 1 account as a literary device establishing the nature of God and of his creation. It is set in the context of Ancient Near East (ANE) cosmology, but should not be seen as a scientific account, nor the days as six actual 24-hour days.

Genesis 2,3

The second creation account is set in a much more narrative and anthropomorphic style. Fundamentally, Genesis chapters 2 & 3 emphasise the relationship between God and humanity. In particular, Gen. 2: 7 indicates the special relationship between us and the universe – we are made from the same stuff as the rest of the universe, in fact from the remnants of burnt-out stars.

6.2.3 Not just in Genesis

The role of God as creator is a recurrent theme throughout both Old and New Testaments and provides us with a picture of the nature of God as an object for worship rather than as a "mechanism" for creation. Scripture texts referring to creation have no explanatory power in the sense of modern science and have a different on-going purpose, to call us to worship.

Psalms

Psalms 8:3-8; 19; 104:10-14, 24-29, 147:8-9, 148:5-6. Many of the Psalms express the wonder of the created order. It is a response of gratitude to the God to whom all is attributed. It is the language of faith and of worship. God's actions in both creation and sustenance (making the grass to grow etc.) are affirmed.

Wisdom

Job 9:5-12; Job 38:39-40; Proverbs 8 and Ecclesiastes 12. Passages from the Wisdom Literature of the Bible affirm the role of God as Creator. It is to God as creator and sustainer that Job is referred in his problems.

Prophets

Amos 5:8, Isaiah 42:5-9, 66:22. Again God as creator forms an important emphasis. It is the God of creation that is the God of Israel, to whom they are responsible.

New Testament

The prologue to John's Gospel (John 1), the great statement of Colossians 1:15 and the quote from Paul's Areopagus sermon in Acts 17:24 stand as the great New Testament statements that affirm God (as Trinity) as Creator (and sustainer).

6.2.4 Theological affirmations

The doctrine of Creation is summarised in a number of affirmations, none of which refer to the way in which the cosmos originated, or the scientific mechanisms of cosmology. John Thompson (2007) comments regarding Genesis 1-3,

> *"That whatever one's view of the literary nature of these chapters reasonable agreement could be reached as to what were the basic assumptions which find expression here. One man may affirm that these chapters should be read quite literally denying all use of metaphorical or symbolic language. Another may affirm that the chapters are in the style of poetry, being full of symbolic language, figures of speech and artificially constructed literary forms. But whatever view is adopted in regard to the literary nature of the chapters, the definition of the central affirmations should be approximately the same, for they represent beliefs about the nature of God of man and of the world".*

These affirmations may be listed as under:-

Creation is separate from God

All that is created is not God, that which is not created is God. This is clear from Genesis 1.1 and throughout Scripture. The Biblical writers avoid the trap of pantheism. (See Chapter 3.)

Creation is contingent, dependent on God

The biblical writers all agree that creation depends on God. God is the only "necessary" being i.e. one not dependent on anything else. Creation is dependent on God for both its origination and its continuance, for its order and its beauty.

Creation is good

Our experience affirms the statements following each day in Genesis 1 'and God saw that it was good'. When we see a beautiful scene, a beautiful sunrise or sunset or in the scientific lab when one realises the intrinsic beauty of an atom or a molecule, we are affirming that it is good. Nevertheless we shall have to contend with why not everything is perfect: some are born with genetic disorders, there is evil operating in the world, and the fall from which humanity (if not the whole creation) needed to be redeemed.

Therefore there can be:-

<u>*No polytheism*</u>

That is a multitude of gods. Christianity, Judaism and Islam are all monotheistic religions. Christianity goes further as trinitarian with the Trinity as a model of how the Christian church has tried to grapple with the nature of God given the revelation in Christ and the role and work of the Holy Spirit.

No monism, pantheism

That God is identical to the universe, the universe and God being one, or the universe being divine or god.

No dualism re good/evil

That is the presence of two distinct principles of good and evil, with a struggle for supremacy. None of these theological affirmations (of monotheistic creation) are at odds with modern science. Indeed many of them form the basis of modern science (see Chapter 1). Other concepts of God associated with Eastern religions or with supernaturalism, associated as they are with either a circular and eternal universe or a disordered, unpredictable universe, are much more at variance with a scientific world picture. (See Chapter 3).

6.2.5 Misconceptions

Several misconceptions which lead to difficulty in the science faith debate need to be laid to rest.

Genesis 1-3 is not history

The early chapters of Genesis are not history in the modern sense. In Gen. 1-11, the so-called Genesis Prologue, we are dealing with what has variously been called "myth", "saga", "protohistory". Genesis 1 and the second creation account in Chapter 2 are not historical or literal statements. They remain valid for us today at the start of the 21st century precisely because they are the story of the universe, expressed in a non literal form.

Genesis 1-3 is not science

These stories are set in the ancient near-east in the context of a three-decker universe. The cosmology implied appears quaint to us at the beginning of the 21st century. Yet as modern people we have no difficulty relating to it and seeing our own response in awe at the creation as we experience it or to realise that Genesis 3 describes the journey all of us have taken.

Genesis 1-3 is, rather, a theological statement about the nature of God.

The primary purpose of the Genesis accounts of creation (Chapters 1 & 2) is to attribute all we see around us, the whole universe, as being due to the will of God. It addresses the relationship between human beings and God and the world.

6.2.6 Importance

The importance of creation lies in its being **foundational to Christian doctrine.** Genesis 1 & 2 establish God as Creator and Sustainer of the Universe. This is the Christian God. We also find the universe to be a fundamentally good place and we depend on its functioning for our survival. For example we depend on weather and successful growth of crops somewhere in the world, otherwise we'd not survive. Creation and science are integrally bound together.

A basis for Christian worship

We have already referred to the place of the Psalms, in particular those that affirm the origin of our world, in worship. In many respects Gen. 1 might be considered a hymn of praise to the God of Israel who creates effortlessly by a word. Israel were not primarily interested in the scientific details of origins, but rather who their God was —"The Creator of heaven and earth" — not just some tribal deity.

6.3 SCIENTIFIC PICTURE OF ORIGINS

6.3.1 Developments in physics up to 1900

The 19th century physicists held a deterministic view going back at least to Newton; and the equations they discovered appeared to support that idea. However, the elegant developments of thermodynamics and statistical mechanics by Boltzmann and Gibbs left open issues that ultimately required the ideas of quantum physics and the results of statistical outcomes. Newton's great contributions of the 17th century remained paramount in mechanics and astronomy. The world seemed to be well ordered.

Towards the end of the 19th century, physics appeared to have reached its zenith. It was rounded off through Maxwell's equations of electromagnetism and the prediction that there should be electromagnetic radiation. There was a great deal of optimism that physics was more or less complete. The prevailing view was of a deterministic universe and there was nothing in the physics of the day to suggest otherwise. That changed dramatically in 1900 with Planck's quantum hypothesis which successfully tidied up outstanding problems with electromagnetic radiation.

The 19th century heralded many discoveries in physics as the new knowledge that was going to do away with the need for God. Something like this happened in response to Darwinism. As a re-run of the same tape, many herald the developments in genetics and molecular biology as being able to do just that. Paul Davies, not a Christian, acknowledges that there are still a lot of scientists who are Christians — and that surprises and continues to embarrass him.

6.3.2 Nature of physical laws

Physical laws are descriptions of physical events, defined after usually much painstaking data gathering. They are not what make things happen! The underlying mathematical form in which the 'laws' are expressed leads people like Paul Davies to speculate about what lies behind them. God?

6.3.3 The revolution in 20th century physics

The turning points were Planck's quantum radiation theory in 1900 and Einstein's famous paper on Special Relativity in 1905. These have changed the way we think about the world far more dramatically than could have been imagined 100 years ago. The linking of space-time and the fact that observers in different frames of reference would view the same events differently marked the most significant paradigm shift in human thought since Newton, notwithstanding Darwin's contributions to biology. It has not stopped there in the 20th century and while physics may have been more recently overshadowed by developments in biology, the level of understanding of our world and of cosmology is remarkable and one of the great developments in human history. Quantum mechanics not only changed our view of atoms, molecules and solids, but continues to raise important metaphysical questions about the role of indeterminacy (or chance) in individual events, and the limits to the measurement process itself. In our day we are very aware of the rise of clever and accessible technology. The notebook computer on which this chapter was prepared is, in some sense, a miracle and yet even now we are apt to take it for granted. The modern PC and notebook computer required a basic understanding of quantum mechanics and solid state physics and a few Nobel Prizes along the way.

Modern physics from Newton to the present day depends on mathematical equations to clothe its ideas. There is a relatively small but finite number of basic equations that define the whole of physics and by means of which we produce the cosmology of the Big Bang. These are Newton's law of gravitation (17th century), Maxwell's equations of electromagnetism (19th century), Einstein's equations of

special and general relativity, the Schrodinger equation in quantum mechanics and the equations of quantum field theories, all of which belong to the 20th century. Are these equations invented or discovered? We don't know but what we do know is that they form the most consistently tested theoretical basis of anything known in human history. The reliability of the mathematical description is quite remarkable and there is the ring of truth about them! Paul Davies is quick to acknowledge that fact. Davies also comments, as have others such as Dirac, on their intrinsic beauty. Thus there is an important aesthetic quality about the mathematical statements of physics that has sometimes been used as a guide to theoretical physicists.

6.3.4 The rise of quantum mechanics

Planck's radiation theory - the birth of quantum physics (1900)

The birth of quantum physics was Planck's theory of electromagnetic radiation. Planck introduced the idea of quanta of energy – whether visible light, gamma rays or radio waves or any part of the electromagnetic spectrum – which solved the dilemmas of the previous century. Even though quantum physics went through two further phases of development viz. the Bohr model of the hydrogen atom (1912-3) and the independent discoveries by Heisenberg and Schrodinger of quantum mechanics in 1925, Planck's theory remains correct today. It is still used to measure the temperatures of the surfaces of stars, to determine the microwave background from the remnant of the Big Bang and to work out the properties of solar collectors!

Quantum mechanics

Quantum mechanics is based on the idea of a wave function to describe the way e.g. an electron is spread out in its orbit about the nucleus of an atom. The quantum mechanical picture of the physics at the atomic and molecular scale is very accurate. Theory and experiment have been tested to great precision. It turns out that at its heart, in quantum mechanics there is an intrinsic level of uncertainty (or indeterminacy), and this has opened up the debate about chance and determinism. It is Heisenberg's famous *uncertainty principle* that limits our knowledge of systems at the scale of atoms or smaller. While measurements of individual events lead to a scatter of data, on average one always gets the same answer. An example is the emission of light by atoms of, say, hydrogen. The spectral lines (*'colours'*) are always the same whenever one makes the measurements but we cannot predict where the light from a particular atom will sit on the particular spectral curve. A battle raged between Bohr (and his Copenhagen School) and Max Born in Germany about how to interpret the wave function of quantum mechanics. Matter has a wavelike character at some times and at other times a particle-like nature. It depends on what experiment one is doing. In the end it was Max Born who recognised that quantum mechanics deals in probabilities. Nonetheless, we still recognise the need to hold the wave and particle pictures in tension. The majority of physicists find there is no conflict. In electron diffraction, important in probing the structures of solids, the electrons must be thought of as waves. In an electron accelerator in high energy physics, *the particle picture is what is needed.*

Heisenberg indeterminacy

The uncertainty principle leads to the insight that the very making of observations influences the outcome. The most familiar statement is that it is impossible to know where an electron is and at the same time to know how fast it is moving. The point is that measurements always use photons of electromagnetic energy (which might be X-rays, visible light or microwaves) and they interact with the very object one is measuring. Thus quantum mechanics spells the end of the deterministic universe.

The four forces in Nature and ultimate structure

An alternative way to summarise physics is through the **four different forces** in nature which imply the finite number of equations referred to earlier. They are:-

- *Gravity* which holds up to astronomical distances. It is believed to operate through particles called gravitons which have not yet been detected.
- *The electromagnetic force:* that force which holds atoms together. The force between electric charges is mediated by photons, which are the quanta of electromagnetic radiation (including light). This is the force that holds atoms together and underpins chemistry and biology.
- *The weak nuclear force* which gives rise to radioactivity. Under the conditions in the early universe after the Big Bang, the weak nuclear force and the electromagnetic force were first of all the same but later became distinct through what is called *symmetry breaking*.
- *The strong nuclear force* which acts on trios of quarks to form protons and neutrons. It should hold together neutrinos! This force is mediated by elementary particles called gluons!

6.3.5 Einstein's Special and General Relativity

Special Relativity

Einstein's Special Relativity (1905) is based on two assumptions:- the speed of light is constant for all observers, and, the laws of physics are the same to observers moving at a constant speed relative to one another This led to the ideas of length contraction and time dilation. That is, an observer seeing a moving object pass at a constant speed measures a characteristic reduction in its length (Fitzgerald contraction) and says that the clock in the moving frame runs slow (time dilation). The latter leads to the Twin Paradox. If one twin stays on earth and the other twin travels for 20 years in a space ship at a constant speed relative to the earth, when he returns, he will be younger! Is this true? About 20 years ago, two Boeing 707's equipped with atomic clocks (with an accuracy of 1 part in about 1 billion) flew around the earth in opposite directions. The differences in the time recorded by the atomic clocks on both aircraft based on their relative speeds fitted Einstein's equation exactly! The decay of cosmic rays entering the earth also confirms this time dilation! For objects travelling close to the speed of light, things look very different to someone observing from say the earth. Thus we must abandon the distinction between our three space coordinates and add time as a fourth dimension. Thus we speak of space-time. In Special Relativity, gravity enters as in Newtonian or classical physics – the force between point objects (or spheres) varies as one divided by the square of the distance between them.

General Relativity

In General Relativity (1916), gravity leads to the curvature of spacetime. It is a very different perspective. This means that a beam of light passing near a massive object such as a star, is bent. Light travels in straight lines but if the space is itself warped, then the light can be shown to have been deflected. This has been observed for light from objects in space. It is also used in what is known as *gravitational lensing*, used to observe very distant objects which lie behind massive objects such as black holes. Of course if the light gets too close to a black hole it will be sucked in and disappear! General relativity calculations are accurate to 1 in 10^{14} (limited by the accuracy of earth clocks). General relativity predicts the occurrence of black holes under some circumstances and in its original form predicts the expansion of the universe from a Big Bang. We shall consider cosmology later.

The Search for a Theory of Everything

The search for a Grand Unified Theory (GUT) or Theory of Everything (TOE) is part of the quest undertaken by people like Stephen Hawking and others. Thus far it has only proved possible to unify the electromagnetic force and the weak nuclear force, relevant in the early universe. Steven Weinberg, in a lecture to the American Physical Society Centenary Meeting in Atlanta (March 1999) spoke of a further unification that includes the strong nuclear force. However, without a quantum theory of gravitation, which does not yet exist, it will not be possible to achieve a GUT. Hawking believes that if a GUT is achieved, there will be no need for God for we will know the 'mind of God'.

6.3.6 Chaos theory – a complete surprise!

There is a new class of phenomena discovered only recently. Even in 'classical physics' there are some processes for which the equations lead to two different outcomes. This surprising result occurs within 'deterministic' classical physics! An example often quoted concerns the butterfly in Gabon that flutters its wings leading to changed weather patterns over Asia! Different initial (or starting conditions) lead to different outcomes.

6.3.7 Cosmology - origin of the universe

Harvard astronomer Edwin Hubble showed in 1929 that the galaxies are all moving away from each other and he was able for the first time to address the immensity of the universe. There are known to be more than 100 billion galaxies, each of which contains perhaps 100 billion main sequence stars like our sun. The clear implication is that there was a beginning, now called the 'Big Bang' and that since then space has been expanding. His observations were based on the red-shift of the light received from galaxies which confirms they are moving away from us. Cf. Steady State Theory.

Einstein's Theory of General Relativity was shown early on to lead to an expanding universe and one, therefore, with a beginning. This did not appeal to Einstein who added to the equations of General Relativity what he called the cosmological constant in order to stop the expansion. Fred Hoyle and others after WWII until the mid-60's pushed a Steady State model of the universe – without beginning and without end, in spite of the generally held view of the Big Bang and an expanding universe. Recently Hoyle, Geoffrey Burbidge (an astronomer) and Hoyle's erstwhile student, J V Narlikar (back in Pakistan) have tried to revive their theory. The reason for this is that the idea of a beginning is awkward if you are an atheist!

Evidence for Big Bang - Hubble red shift

Light observed from distant galaxies is red shifted. This means the characteristic spectral lines (or colours if they occur as visible light) have smaller wavelengths than in the laboratory. This correlates with the speeds with which they are moving away from us. Hubble introduced a famous constant, the Hubble Constant whose value is not known precisely. If you divide the Hubble Constant into 1, you get the age of the universe. Since the universe is expanding, an observer on earth would say clocks ought to run more slowly in distant galaxies. Supernova explosions have proved helpful in this regard.

Big Bang cosmology—nature of the cosmos

Several features of the universe can be derived from big bang cosmology. They can be summarised. The universe is

Very large - 100 billion galaxies, 100 billion stars in each

Very old - 15 billion years

<u>*Temporal - Finite*</u> - Time and space both begin at the initial singularity.

Standard cosmology - an expanding universe

The universe began at a singularity, a point of infinite density. Originally there was no space, time or matter! Hawking and Penrose suggested in the 1960's that there was probably a definite origin of the universe. This required the existence of black holes to provide sufficient mass to account for the rate of expansion of the universe. Their ideas were in contrast to the steady state models of Hoyle, Bondi and others popular at the time. The universe had a simple beginning: it was hot, there was a soup of fundamental particles which have strange names — quarks, leptons, gauge bosons (gluons, W/Z bosons and photons). Before 10^{-11} seconds (one hundred billionth of a second) had elapsed, the energy density in the hot particle soup (thermal plasma) was greater than the density of matter. As the universe expanded it cooled. The next level was the development of microstructure: quarks were confined and formed neutrons and protons after t ~ 10^{-5} secs (one hundred thousandth of a second) had elapsed. There was further formation of neutrons and protons, some nuclear fusion of protons to give deuterium, the two forms of helium(^{3}He, ^{4}He) and lithium from about 1/100 of a second to 200 secs. Atoms were formed somewhat later at about 10^{13} secs (3000 years). Large scale structure formation occurred very much later when the matter density exceeded the radiation density at about t=10^{11} sec (100 billion seconds). Gravity acted to form what are referred to as inhomogeneities— galaxies, clusters of galaxies, and superclusters.

Many universes or a particular universe

There has been a good deal of speculation about other worlds, other universes. We may speculate though it is doubtful that it is very fruitful to do so. We have to deal with the fact that there is something and not nothing, that we and other life forms live and life can be sustained on this particular planet. Polkinghorne reminds us that the emergence of any particular form of life is always a possible outcome of evolution but that the world in becoming, in going on creating itself, has a certain unpredictability about it.

Question marks!

There are some outstanding problems, not least of which is the search for dark matter. There is not enough mass in the visible parts of the galaxies to account for the rate of expansion of the universe. This is where Stephen Hawking made his name by postulating and describing black holes— small ultra-high density objects (collapsed neutron stars). Black holes have been observed indirectly, originally by Nobel laureates, Hulse and Taylor, from a binary pulsar – a pair of neutron stars orbiting one another, one of which is dark (deduced to be a black hole). This was inferred from the pattern of rotation of the visible star. If the density inhomogeneities had not occurred, there would be no stars, galaxies, planets, indeed no universe as we know it. Then there is the absence of antimatter.

In 1928, the English physicist, Dirac, predicted that in addition to matter there should be anti-matter. In the early universe matter and anti-matter would have been present in roughly equal amounts but early on the balance tipped towards matter! Anti-matter particles are found in cosmic rays and they can also be produced in accelerator experiments.

Time relations - the nature of singularity, the first 10^{-43} secs

This very short time is known as Planck Time. Physics can say nothing about what happened before that time elapsed. But we don't then jump in and attribute that to God; that would be to return to the God of the Gaps idea where God exists only in the gaps in our knowledge.

Weinberg (1977) in *The first three minutes* explains how protons and neutrons were formed in about the first second after the Big Bang, and how Hydrogen and Helium (in the ratio of 3:1) were formed from protons and neutrons after about 3 minutes.

Sequence of events

The following sequence is adapted from Wilkinson (1997, p. 39 Fig 3:2.

Big Bang sequence from singularity to the present

- Today 13.7 Billion yrs
- Planets formed 10 Billion yrs
- Galaxies formed 1 Billion yrs
- Atoms formed 10^5-10^6years
- Nuclei formed 3 minutes
- Quarks to Protons and Neutrons 10^{-4} secs
- Weak nuclear and electromagnetic forces separate 10^{-10} secs
- Strong nuclear force separates 10^{-35} secs
- Planck time 10^{-43} secs
- Big Bang singularity time =0.

Hydrogen to Helium ratio and relative abundances of elements

It has been possible to calculate the relative abundances of the lighter elements to very high precision. The relative abundances of hydrogen (H) (including deuterium or heavy hydrogen, D), the two isotopes of helium (^{3}He, ^{4}He) and lithium (^{7}Li) are key factors in confirming the correctness of our understanding of the events following the Big Bang. Hydrogen is 100,000 times more abundant than deuterium and three times more abundant than helium.

2.7 K Residual Microwave Radiation

One experimental result in 1963 changed everything. Working at the Bell Telephone Labs in the USA, Penzias and Wilson observed the background radiation from the early universe with a radiation curve suggesting a temperature about 2.728K (degrees absolute, cooler than liquid helium). This was crucial evidence but there is more! This radiation comes from the early universe, from the period when electrons and nuclei formed atoms (10^{13} sec or 1000 billion seconds after the Big Bang). This had been predicted in the early 1940's by Alpher, Bethe and Gamow, who also explained how hydrogen produced helium in the Big Bang.

Lumpiness of space

In 1992 using careful satellite data, one remaining puzzle in the jigsaw was solved. The cosmic background is not exactly the same in all directions, something we call anisotropy. There are temperature fluctuations of about 3 parts in 100,000 which imply density fluctuations required for production of the light elements and the formation of galaxies. It is sometimes referred to as the lumpiness of matter.

Destiny of the Universe - Scientific Eschatology

There are only two options in Big Bang cosmology. Either the universe will stop expanding and then turn in on itself (The Big Crunch) or go on expanding forever. Our earth will burn up and become a Red Giant in about 7 billion years so the cosmic history of mankind for instance will not be forever on this planet! The

future of the universe depends on the nature of the balance between gravitational attraction, which depends on mass and distance, and of expansion resulting from the energy of the Big Bang. Thus there are two extreme possibilities but predicting the outcomes is difficult since the mass of the universe is not known accurately.

Our cosmological destiny can be summarised as follows:-

Either, continued expansion and Heat Death

Our sun has about 7 Billion years left! So our local system won't last forever in any case even if the universe were to go on expanding forever.

Or, the Big Crunch

Gravitational collapse to a singularity being the reverse of the Big Bang!

6.4 THEOLOGICAL IMPLICATIONS OF BIG BANG COSMOLOGY

We can respond to scientific cosmology in a variety of ways.

Implications for both Creation and Eschatology

Creation - What has the Big Bang to say about Creation? Eschatology - What has the Big Crunch to say about Christian Hope?

Three approaches:-

6.4.1 Science is wrong - Creation Science approach

Creationists believe that historical science such as cosmology can only be discerned by a literal understanding of Scripture and hence scientific cosmology must be wrong. The so-called creationist idea of a literal six day creation in 4004BC is simply not in accord with the facts as we now know them. The consistency between the cosmological, geological and biological stories of the universe make nonsense of theologies based on out-of-date cosmologies. An important principle is the need for consonance between different types of explanation of reality, creation included.

6.4.2 Science and Religion are separate and unrelated and should be kept so

This is one of the four categories Ian Barbour notes regarding how Science and Religion have often been thought about (See Chapter 5). Surely when theology is seeking to reflect on the meaning of the universe and of creation, and science is speaking about the same things from its own point of view, it makes sense to look for proper connections between them. Indeed it is becoming fairly obvious that theology and science are increasingly asking the same kinds of metaphysical questions, the most fundamental one being why we are here at all.

6.4.3 Consider the implications of modern cosmology in relation to a consideration of creation

This does not mean adapting the theology to the latest scientific theory, but rather to critically examine it in the light of current scientific concepts. When we say that the cosmological, geological and biological stories form a consistent picture of the physical world, we are not implying that they are complete, or that they will not face some changes in the future. What we are saying is that they have such a degree of internal consistency to give us confidence that they do in fact faithfully report reality. Theologies, particularly relating to creation, that ignore or avoid the findings of modern science are of little value and give no credibility to the Faith.

6.5 THEOLOGY AND THE PHYSICISTS

John Polkinghorne, writing as a Christian, has articulated an enlightened view of Natural Theology. We must also credit Paul Davies, not a Christian, with honestly grappling with Natural Theology. The question is how far one can go in finding evidence for God from the world around, from our cosmology, geology and biology. There are as many answers as people asking the questions.

Davies sees in the beauty and simplicity of the equations of physics, a mind, a purpose. God? He remains however essentially a Deist seeing in nature a "mind" behind the equations. However, if one starts from the viewpoint of faith the matter can be turned round the other way. The beauty and apparent simplicity is what we might expect with a bit of experience. It is not only the equations of quantum physics and relativity that have an intrinsic beauty and simplicity; so too have the equations from 19th Century physics such as Maxwell's equations of electromagnetism.

We should not minimise the attempts that Paul Davies, Stephen Hawking and others have made to raise some of the big questions about reality. They have confronted the question of whether there is a God. Their current views are however that knowledge of all of the necessary equations of physics to explain the universe would do away with the Christian understanding of God. Van Beukel gives a readable and useful critique of the much of what Davies and Hawking have written. Big Bang Cosmology has certainly created considerable interest from secular scientists wishing to talk about God.

Some widely discussed approaches are given in the following publications:

Paul Davies, *The Mind of God.*

Hawking, *A Brief History of Time*.

The latter is better than some critics allow and its difficulties lie in the difficulty of the concepts. In many respects Hawking is an excellent communicator with the capacity to ask relevant and important questions. His speculations however should not be confused with his hard science.

Tipler, The Physics of Immortality

Tipler considers religion as a branch of physics and speculates on an immortality (bearing little resemblance to that of Christian hope) derived from an extension of physical laws. Tipler's concepts it must be emphasised while remaining highly speculative and even considered to be science fiction and not generally taken seriously as scientific considerations[1].

Capra, The Tao of Physics

Seeks to equate the uncertainties of modern physics with the mysticism of Eastern Religions. Again a work of speculation, drawing on concepts that many scientists would question

6.6 RESPONDING TO COSMOLOGY

6.6.1 Negative responses

A view particularly from fundamentalists, that God and the Big Bang are alternative explanations and therefore one must be rejected. This is simply a

[1] James Garth has drawn the authors' attention to the fact that serious consideration of Tipler's views has been given by writers such as David Deutsch, Wolfhart Pannenberg and William Dembski. Conversely, his views have attracted strong criticism by others such as George Ellis and Michael Shermer.

rejection of God as a God of the Gaps and such a concept is foreign to the God of Christian Theism.

Hoyle

Fred Hoyle was a long avowed atheist[2]. He was responsible for the term "Big Bang" as a term of derision regarding a universe with a beginning. It is also somewhat ironical that his prediction of the so-called carbon resonance whereby carbon nuclei could be produced in stars from the fusion of three helium nuclei has proved to be one of the cornerstones of Big Bang theory and does not support his own Steady State Theory.

Atkins

Representative of secular humanists who attempt in popular books to use cosmology as a defence for atheism. Atkins P The Creation 1981 states *My aim is to argue that the universe can come into existence without intervention, and that there is no need to invoke the idea of a Supreme Being in one of its numerous manifestations.*

Weinberg

Well known both as a Nobel Laureate and for his excellent book, 'The First Three Minutes". He also however adopts an atheist stance, failing to understand the doctrine of Creation - why is there a universe at all?

6.6.2 Positive Responses

Cosmology provides a picture of a finite (created) universe having a beginning and an end. This would seem to be much more in keeping with a biblical doctrine of Creation. It is valid to ask, 'Are scientists now coming to the same view as the theologians?' Consider the widely quoted statement from Jastow(1978, *God and the Astronomers*. p 116),

> *"At this moment it seems as though science will never be able to raise the curtain on the mystery of creation. For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance: he is about to conquer the highest*

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[2] In his recent book 'God Actually', Roy Williams makes the claim that prior to 1959, Hoyle had been an agnostic, and that he 'converted' to Design based on the apparent 'fine-tuning' of the nucleosynthesis process that produces carbon within stars. The "Hoyle History" website (http://hoylehistory.com/famous-hoyles/fred-hoyle/) provides a slightly different history: it claims that Hoyle was reportedly an atheist for most of his early life, but changed to agnosticism based upon the implications of the aforementioned apparently 'finely-tuned' processes.

Hoyle's own words seem to indicate that his beliefs were, at least, put under some tension by the implications of his work*: "I do not believe that any scientist who examined the evidence would fail to draw the inference that the laws of nuclear physics have been deliberately designed with regard to the consequences they produce in stars. If this is so, then my apparently random quirks have become part of a deep-laid scheme. If not, then we are back again at a monstrous sequence of accidents."* And again; *"Would you not say to yourself, "Some super-calculating intellect must have designed the properties of the carbon atom, otherwise the chance of my finding such an atom through the blind forces of nature would be utterly minuscule." Of course you would . . . A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question*."

The authors are indebted to James Garth for drawing their attention to this fuller insight into Hoyle's views.

> *peak: as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries."*

Pope Pius XII declared in 1951 that the big bang was compatible with the Christian Doctrine of Creation.

> *"Everything seems to indicate that the universe has in finite times a mighty beginning." He went on to claim that unprejudiced scientific thinking indicated that the universe "is a work of creative omnipotence, whose power, set in motion by the Creating Spirit, spread out over the universe"*

Both of these statements need to be critiqued. It is inappropriate to tie theology to a particular scientific theory or to imply that the "originating" God of the big bang is the God of creation *ex nihilo.* God as Creator is just as consistent with the eternal steady state concept.

To make things even more complicated and challenging, Hawking has suggested a non-beginning big bang scenario **(**Hawking, 1988, *A Brief History of Time*, Guild Publishing, London, pp127,128)

> *In 1981 I attended a conference on cosmology in the Vatican. At the end of the conference the participants were granted an audience with the Pope (John Paul II). He told us that it was all right to study the evolution of the universe after the big bang, but we should not enquire into the big bang itself, because that was the moment of creation and therefore the work of God. I was glad then that he did not know the subject of the talk I had just given at the conference - the possibility that space time was finite , but had no boundary, which means that it had no beginning, no moment of creation. I had no desire to share the fate of Galileo……..*

Hawking (1988), pp, 156,157, states,

> *So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place then for a creator?*

6.6.3 Anthropic Principle

The development of conscious beings able to speculate about origins is the result of a very finely tuned universe. The anthropic principle is really about the fine tuning of the universe, the essential fitness of the world as we know it and have learned about it. It does matter that the electromagnetic force and the gravitational force are *inverse square laws* and depend on one over the square of the distance between the charges or masses ($1/d^2$). If, however, the electromagnetic and gravitational laws depended on $1/d^{1.999999}$ or $1/d^{2.000001}$, say, the earth would be too hot or too cold to sustain life, respectively. It might be possible to construct a world that could exist, but it is unlikely to be able to sustain any life forms at all as we recognise them. Worthing (1996, p. 46) gives a most adequate account of both the Weak and Strong forms of the Anthropic Principle.

Weak Anthropic Principle

This is simply a statement of fact based on a retrospective look at the history of the universe. With reference to a book by Barrow and Tipler, he notes for example that the universe must be that age that it is to allow sufficient time for evolution of beings like us to ask the question concerning its age.

Strong Anthropic Principle

Whilst there are several different versions of the Strong Anthropic Principle, we note that they all to some degree note the fitness of the laws of physics for the existence of the universe as we find it in the structure and behaviour of stars and galaxies, for example. The Strong Anthropic Principle has also been used as an argument for design, for a new Natural Theology and the idea of multiple universes. Some of this is rather speculative and the technical details beyond the scope of this course.

6.6.4 Hawking and Creation?

No beginning!

The problem of the first few instants where the laws we know and understand break down. Clearly the initial singularity poses a problem for atheists but in our view, not for Christians. It is not so much that the laws of physics break down, we don't know what laws operated up to the Planck time.

6.6.5 Quantum Gravity

Forces between electric charges are thought to be communicated at the speed of light by photons. To account for the gravitation force in the same way, gravitons travelling at the speed of light have been postulated. Getting the theory in place has not been possible. So a theory of quantum gravity does not yet exist.

6.6.6 Seeking a Theory of Everything

Attempts to combine the laws relating to Gravity, Electromagnetism and both Strong and Weak Nuclear Forces into a TOE or *Theory of Everything* has been referred to elsewhere.

6.6.7 Hartle/Hawking Speculation, No Boundary models - No singularity

While cosmologists such as Hawking recognise the evidence pointing towards the Big Bang which implies a definite beginning to the universe at a singularity in both space and time, they also want a way out. In more speculative frame of mind, Hartle and Hawking have proposed a model in which there would be no boundary to the universe and no sharply defined singularity. The details get rather complicated and are beyond the scope of this chapter. A discussion of these issues are given by Worthing (1996, p 53) in which he points out that the God Hawking gets rid of is the God of the Gaps that we have rejected earlier anyway. We may say that scientific explanations do not, of themselves, answer the 'why' questions about why we are here in the first place.

6.6.8 Who is the Scientists 'God'?

There are several concepts used both to dismiss or to affirm the **God of the Gaps.** That is, God is the explanation for what we don't know. Suppose we were able to know everything that could be known. Then what? Would God be reduced to nothing? The *God of the Gaps* is not the God of Old and New Testaments. The issue can be settled by realising that

`***God does not equal our ignorance***!'

To acknowledge mystery regarding the nature and character of God is necessary, but God does not equal Mystery either.

A remark by the late Charles Coulson (1955) has been quoted often e.g. by Polkinghorne (1986, p 60),

> *"when we come to the scientifically unknown, our correct policy is not to rejoice because we have found God; it is to become better scientists".*

Platonist force

Many scientists conceive God as an impersonal force, the mind of the universe, the source of the laws of physics or even as the laws themselves as something outside nature. It was in this sense that Einstein could say that *"god does not play dice"* or that Hawking could talk about finding the mind of god. His *Brief history of time* concludes with this pregnant thought.

> *However if we discover a complete theory it should be understandable in broad principle by everyone, not just the scientists. Then we shall all, philosophers, scientists and just ordinary people be able to take part in the discussion of why it is that we and the universe exist. If we find the answer to that it would be the ultimate triumph of human reason, for then we would know the mind of God.*
>
> Hawking, *Brief history of time* 1988, p. 193

6.6.9 Is creation 'ex nihilo' consistent with modern cosmology?

Modern cosmology starts with the so-called Big Bang at what physicists call a singularity in space and time which represents the beginning of space and time— a creation *ex nihilo*. The implication scientifically is that space and time were created at the singularity about 13.7 billion years ago. The physics of the very earliest times are not known however, but it is certainly true to say that science and theology find no contradictions. Even if the no boundary speculation of Hawking is true, as discussed above, the theology of creation is concerned with why there is something rather than nothing. Theology and science concur, but are asking different questions.

6.7 IMPLICATIONS FOR GOD'S CONTINUING ACTIVITY—THE GOD OF SPECIAL PROVIDENCE

6.7.1 How does God interact with the world?

We have explained that the scientific evidence supports a dynamic evolving universe. Stars continue to be born and to die and the processes by which that happens are well understood. The universe is not static or fixed! It arises from an interplay of chance and necessity, of being and becoming. Furthermore it is understood that the universe appears to be an open system. It is still becoming, 'going on creating itself' (See Polkinghorne 1994, p.43).

6.7.2 The problem of natural evil

The creation as we see it with its "natural" imperfections expressed by such things as earthquakes and the biological consequences of natural selection might be seen as a dynamic creation "becoming" (not being) as it were— the best of all possible worlds. We perhaps should look at creation (by God) as being on the way, dynamic not static, creation as continuing to a climax, an *eschaton*, not simply being. After all for the Christian, God's activity in creation culminates in the hope of a new creation. We also perhaps need to see natural evil as an expression of the world being what it is. After all the tectonic plates govern the continuing formation of the world as well as they do the eruption of volcanoes or the power of earthquakes. The biological growth processes produce normal development as well as cancer development and the process of natural selection produces the emergence of life capable of aesthetic, moral and religious aspects as well as of nature 'red in tooth and claw'. God has created a world that is free to be itself, but also one where the ultimate result emerges out of an interplay of chance and necessity. These perspectives provide a wider horizon from which to view creation. We can thus be assured that God is both good and in control, but

our perspective may need to be broadened and our time frame lengthened. Having said all this however it remains difficult to come up with a full and satisfactory rational explanation of the problem of evil. In many respects the ultimate answer to the problem of evil is not philosophical but experiential. In a world in which suffering exists, the clear Christian message is that God shares that pain.

6.7.3 Process theology

Process theology sees the World as part of God and God as process - a limited God, a God who develops along with the universe. Such ideas deny the transcendence of God in bending to a "scientific immanence".

6.8 IMPLICATIONS FOR CHRISTIAN HOPE – ESCHATOLOGY

6.8.1 Scientific speculation — Persistence of a non-personal immortality

Tipler and Freeman Dyson address these aspects, but more from the standpoint of science fiction, than science. It is questionable whether there is an interface here in the science theology debate which can be followed at this point.

6.8.2 Is Christian eschatology limited to part of the universe?

The Biblical eschatology of Christian hope, encapsulated in the doctrine of bodily resurrection and a new heavens and earth raise appreciable questions for the science faith debate and are being explored by Christian scholars such as Robert Russell. It might be questioned whether in such areas we are operating outside of science in a new creation or that Christian eschatology is limited to a part of the universe. No easy answers can be given.

6.9 CREATION AND THE BIBLICAL RECORD

The interpretation of the creation accounts has always been varied and biblical interpretation should not be equated with biblical inspiration. Scientific developments may well be an important tool in such interpretation. It is outside the scope of this chapter to consider this matter in any detail, but just to refer to some basic facts.

6.9.1 Historically —many approaches - not just literal/allegorical

Platonist approach

Was typical of many of the Patristics, Augustine, Origen, Basil etc.

Literal – Aristotelian

In the 17th century, Ussher's chronology, following on the literalism of the Reformation, gave rise to a dating of creation (4004 BC) that carried its authority into the margins of many Bibles. Geological studies in the 18th century on the age of the earth however dispensed with such a chronology and left literal and semi-literal interpretations of Genesis to the so called Scriptural geologists (see Chapter 1).

Scriptural geologists

Three scenarios were put forward to maintain a literal interpretation of Genesis. Not all presupposed a young earth. They all attempted to fit the Bible to science by proposing a series of ages corresponding to days, a gap between Gen 1:1 and 1:2, or the proposition that creation including humanity was formed with the appearance of age (Gosse). All of these interpretations are still presented, but are bound to come into conflict with a God who is neither magician, charlatan nor mechanic, but Creator.

6.9.2 Interpretative principles

Again these can only be referred to in outline. One must recognise that the Genesis accounts are expressed in the cosmology of the Ancient Near East (ANE). Such cosmology bears little resemblance to modern science.

Expressed in the literary form of the ANE

The poetic parallelism etc., the "mythic," saga, story are apparent.

Affected by the context of the ANE creation myths — Enuma Elish legends etc.

It is important to discern the truths in such accounts. Nearer home, aboriginal stories e.g. may also be seen to point to Christ and in Christ to see their fulfillment. Aboriginal people often have no problem with the Genesis story as they see it as being like their own stories. It would not occur to them that stories that relate to long periods of time would have to be interpreted literally.

6.9.3 Literary framework

Structure of the seven days — see Thompson (2007).

6.9.4 Literary structure of Gen 1

Introduction 1:1-2, The whole universe

Day I Act 1 Light

Day IV Act 5 Light bearers (1:3-5) (1:14-19)

Day II Act 2 Firmament dividing

Day V Act 6 Birds and sea waters, above and below creatures (1:6-8) (1:20-23)

Day III Act 3 Waters and land

Day VI Act 7 Land animals, separated reptiles (1:9-10) (1:24-25)

Act 4 Vegetation

Act 8 Man (1:11-13) (1:26-31)

Day VII

Conclusion: 2:1-4a God Ceases his creative activity

6.10 CONCLUSIONS

6.10.1 Impact of physics on 21st century cosmology

The impact of 20th century physics on how we think about the world has been of immense magnitude. We have seen the necessary dismantling of our common sense ideas of space and time and the impact of non-deterministic quantum mechanics. The discoveries in atomic, nuclear and particle physics on the one hand and astronomy and cosmology on the other, have changed forever our view of the universe. It is an ever expanding and changing entity. Stars continue to be born and to die. We are able to penetrate even further and further to the outer limits of our universe and that means probing even further and further back in time. We should welcome the new knowledge, not uncritically, but with discernment.

6.10.2 Scientific and theological concepts in consonance

We need to find consonance between what we learn from physics and what we experience as Christians. Put another way, it would be strange indeed if the stories from nature and theology were out of step.

6.10.3 Exegetical principles— genre, culture, context are important

We must discern the substance of the message— not confuse it with the form.

6.10.4 Creation is important for cosmology

It provides a theological and metaphysical basis for the scientific understanding of the universe. A full view of the world is incomplete without this.

6.10.5 Cosmology is important for creation

It gives a new dimension of awe and wonder to the creator, Ps 19:1, "When I see the world the work of thy hands" etc. The experience of understanding a tiny part of our world is as moving as any religious experience in prayer or worship. It is our responsibility to use our intellect to take advantage of all kinds of knowledge and to use them to the glory of God.

6.11 REFERENCES

Atkinson, D, 1990, *The Message of Genesis 1-11*, BST Commentaries, IVP, Leicester.

Coulson, CA, 1955, *Science and religion: a changing relationship,* Cambridge University Press, Cambridge.

Davies, P, 1992, *The Mind of God*, Penquin, London.

Ferguson, K, 1994, *The Fire in the Equations*, Bantam, London.

Gribbin, J, 1987, *In Search of the Big Bang*, Corgi, UK.

Hawking, S, 1988, *A Brief History of Time*, Bantam, London.

Kaufmann, WJ, Comins, NF, 1996, *Discovering the Universe*, 4th Edn, Freeman.

Polkinghorne, JC, 1986, *One World,* SPCK, London.

Polkinghorne, JC, 1988, *Science and Creation,* SPCK, London.

Polkinghorne, JC, 1989, *Science and Providence*, SPCK, London.

Polkinghorne, JC, 1994, *Quarks, Chaos and Christianity*, Triangle, London.

Sherlock, C, *Creation, Creationism and Scripture*, Interchange 35, p.17-32

Thompson JA, 2007, *Gen 1-3 , Science?, History? Theology?,* Acorn/ISCAST, Melbourne (May be ordered on-line at www.iscast.org; an on-line version (1996) appears as an article in *Christian Perspectives on Science and Technology, the ISCAST On-Line Journal* at www.iscast.org).

Van den Beukel, A, 1991, *More Things in Heaven and Earth*, SCM Press, London (translation from Dutch).

Weinberg, S, 1977, *The First Three Minutes*, Deutsch, London.

Wenham, GW, 1991, *Genesis 1-15*, Word Bible Commentary, Word, UK.

Wilkinson D, 1997, *God, the Big Bang and Stephen Hawking,* Monarch, Tunbridge Wells.

Worthing, MW, 1996, *God, Creation and Contemporary Physics*, Fortress, Minneapolis.