



GROSVENOR ESSAY NO. 1

sketches towards a theology of science



**The Doctrine Committee
of the Scottish Episcopal Church**



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Cover illustration

We have chosen a Celtic Cross as the image on our front cover. The meaning of its ancient symbolism is a subject of debate. Some believe that the circle represents the sun, which pre-Christian Celts worshipped as the source of life. Early missionaries to the Celts appropriated this symbol for the God who created not only the sun, but everything else as well. So the Celtic cross unites creation with redemption, a symbolism that we think is befitting for an Essay on a theology of science.

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Preface

The present Essay is the first of a series to be published annually by the Doctrine Committee of the Scottish Episcopal Church, in which we explore issues relevant to Christian discipleship in the modern world: science, the arts, gender and sexuality, and so on. They are called 'Grosvenor Essays' simply because the Committee meets at Grosvenor Crescent in Edinburgh. These essays are not formal discussion documents; but we do hope that they will help readers in our Church (and beyond) grapple with important issues. Nor are they statements of official positions; but we do believe that what we say is in keeping with the teaching of our Church.

The first Essay is concerned with 'science and theology'. While there are already many fine contemporary contributions to this important dialogue, this Essay is distinctive in a number of ways. First, many contributions to the science-theology dialogue to date explore how the methods and results of science should (or should not) influence theology. In the following Essay, we wish to take the reader in a different direction: to theologize about science, to ask how as disciples of Christ we should think about the scientific endeavour. In other words, our concern is with developing a *theology of science*.

Secondly, this Essay is based on a series of focused, face-to-face science-theology dialogue between members of the Doctrine Committee: a Bishop, a diocesan dean, three university academics in theology and religious studies, a teacher in a theological institute with a chemistry doctorate, and a physics professor who has some biological expertise. Our conversations took place over a two-day residential meeting. The written contributions submitted by all Committee members following this meeting are edited together to form the following Essay.

We have called our Essay *Sketches towards a Theology of Science* because it is necessarily preliminary and incomplete. Moreover, the style is deliberately polyphonic in bringing together contrasting voices. These features serve as reminders of the dialogical process of the Essay's genesis, and of its containing only working 'sketches' towards a future canvas. But if it serves to stimulate reflection and discussion amongst those in our Church and beyond about science, the Essay would have served its purpose. Please tell us the fruits of your reflection and discussions!

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1. Introduction: Are the Church and science strange bedfellows?

Mention ‘the Church’ and ‘science’ in any conversation, and the chances are that the words ‘Galileo’ and ‘the Inquisition’ would follow hot on their heels. The way such a conversation is likely to develop is captured succinctly by the actor Richard Griffiths¹, who played the part of Galileo in a production of Bertolt Brecht’s play *The Life of Galileo*: ‘By stifling the truth, which was there for anyone to see, the Church destroyed its credibility with science.’ Griffiths’ caricature, or something like it – that ‘science’ and ‘religion’ are mutually hostile to one another – is strongly embedded in the popular imagination. Before we can attempt to build a theology of science, a certain amount of ‘ground clearing’ is necessary.

First we will show that the one-sided ‘conflict’ model of the relation between science and religion has little *historical* basis. Of course, there has been friction, and the friction has frequently arisen out of a putative incompatibility between science and the *Bible*. We therefore move on to a consideration of the nature of biblical and scientific texts by way of the opening chapters of Genesis. Finally, science and theology are often conceived as necessarily incompatible because of the latter’s appeal to *authority*. We end this section with a consideration of the nature of authority in science and theology, showing that it plays a surprisingly similar role in the two disciplines.

1.1 History: moving beyond the ‘conflict’ metaphor

Historians have in recent decades revisited a number of historical ‘flashpoints’ which have been presented as occasions when ‘theology’ took on ‘science’, inevitably resulting in a bloody nose for the former. Take, for example, the celebrated cases of Galileo (in the seventeenth century) and Darwin (in the nineteenth).

Galileo, it is true, was condemned by the Roman Catholic Church for teaching that the earth orbited the sun. But the scientific evidence for a moving earth was simply *not* ‘there for anyone to see’. (The reader may consider how s/he might convince a skeptic using seventeenth knowledge and technology. After all, to an observer on the surface of the Earth there is no sensation of movement, whilst the sun visibly moves across the sky during the course of a day!) The moons of Jupiter, seen by Galileo through his telescope, could at best be an *illustration*, but not a proof. On a wider intellectual front, Galileo’s contemporaries were committed to finding truth in ancient texts interpreted according to tradition. Most of them thought that there was no compelling evidence to change their interpretation of what these texts said about the earth. Galileo remained a faithful Catholic to the end, while many of his opponents were astronomers in holy orders. To read the episode as just a fight between science and theology is not only simplistic: it risks missing a most important lesson – the difficulty of convincing *whatever* dominant authority of the day. (Mitchell Feigenbaum, who made the revolutionary discovery that certain patterns of behaviour of chaotic systems are universal using little more than his pocket calculator, took two years to get his first paper accepted for publication, testament to the conservatism of *today’s* scientific establishment.)

Darwin never pronounced on theological matters. He was on good terms with many clergymen throughout his life, and his evolutionary theories were defended by

¹ We have deliberately eschewed the formal academic apparatus of footnotes and bibliographic references, although authors whose work we use are named in the text. On the other hand, we give an annotated list of further reading for those who want to explore the issues raised in more depth.

several of them. Darwin's loss of faith later in life was triggered primarily by the death of his daughter, rather than by his science. On his death, no protests were made when he was interred in Westminster Abbey. However, a number of his supporters – most famously Thomas Henry Huxley – insisted that evolutionary theory was opposed to the Church's teaching, and would brook no compromise with the ecclesiastical authorities. To understand what was going on in this case, we must remember that in Huxley's day the profession of 'scientist' did not exist. The 'scientists' of his day, in England at least, were leisured amateurs – indeed, many of them were clergymen. Huxley was determined to wrest control of the scientific establishment from such people; hence his anti-clerical crusade. Again, what lay behind this affair was not the relationship between theology and science *per se*, but rather the particular political and social conditions which obtained at that time. Unfortunately, people with political and social agendas have continued to pit 'science' and 'religion' against each other ever since.

Such analysis has repeatedly shown the inaccuracy and poverty of appealing exclusively to the 'conflict' metaphor in explicating the multi-faceted relationship between science and theology in history. In fact 'conflict' is only one of the four ways in which science and theology could relate, according to the theologian, philosopher and one-time physicist Ian Barbour:

- *Conflict* – the kind of view propagated by the popular retellings of historical cases such as those above. The biologist Richard Dawkins and the physical chemist Peter Atkins are well known contemporary proponents of this view.
- *Independence* – this view assumes that science and theology are both important, but they address different aspects of the human search for truth. It might be argued that science is about generating knowledge, whilst theology is concerned with the right use of that knowledge – with questions of ethics, for example. The paleontologist Stephen Jay Gould's talk of 'non-overlapping magisteria' is a contemporary example of this view.
- *Dialogue* – some commentators are not content with simply affirming that science and theology are important, but separate. They insist that useful and stimulating insights can be had from the dialogue of the two. The majority of writers today on 'science and theology' adopt this view.
- *Integration* – some scholars (such as T. F. Torrance and, in some respects, Barbour himself) believe that it might be possible to produce a comprehensive system which embraces theological and scientific insights.

Note that we need not take these as four 'cut and dried' compartments: indeed, some scholars have developed far more complex schemes (usually involving these four elements) in their attempts to be more nuanced in their approaches to the relationships between science and theology.

1.2 The Bible: how we read texts

In many of the historical episodes in which science and religion were supposed to be in head-on collision, one of the underlying issues had been a putative disagreement between what the Bible said and what science taught. Historically, as well as today, such issues often come to a head over the first few chapters of

Genesis, especially Chapter 1. We turn now to examine these texts as a 'test case' to tease out some of the reasons why the Bible may be deemed to conflict with science.

There is more than one version of the creation story in the Hebrew Bible – and Genesis 1 is somewhat odd among ancient narratives of this kind in *not* starting with a great mythic war between opposing forces, one of them God. Conceivably liturgical in origin, its climax is verse 26, the creation of humankind; and its intention is to address the question 'why' rather than 'how'. In other words it might be said that it addresses the issue of creation from the opposite (but not necessarily opposing) perspective to science. Science begins with observation and accumulates data that prompt questions, while Genesis 1 begins with a theological given ('God created') and seeks to understand the nature and purpose of creation, with its focus in humankind, from its given origins (verse 2). It declares the presence of God's creative activity in all things, and at the same time the radical distinction between Creator and creature. The theological insistence on the doctrine of *creatio ex nihilo* ('creation out of nothing') is certainly implicit in the early verses of Genesis, but its fundamental concern is to establish the principle of creation out of chaos and of 'ordering'. It is this with its faith in the 'larger hope' of God's purpose, far more than any arguments from literal readings of the biblical text, that falls foul of evolutionary principles that find their most celebrated expression in the work of Charles Darwin.

Generalizing from this reading of Genesis 1 and its possible relationship with science, we can say that theology and science should be regarded as different *modes of discourse* (and there are many others). It might be suggested that pre-Reformation understanding of the Bible, that readily sustained four- or five-fold readings of the biblical texts, would have been less susceptible to the nineteenth century controversies between religion and science than biblical interpretation after Luther and Calvin, which suggested that there was only one way of reading and understanding a text. The medieval Franciscan scholar Nicholas of Lyra, for example, proposed four ways of reading the texts of Scripture: literal, allegorical, moral and anagogical (that is, pertaining to eternal truths). These readings are different, but not contradictory. After the Reformation, biblical interpretation became more 'scientific'. Indeed, the literature scholar Peter Harrison has recently argued that this 'hermeneutical turn' (as it is known) at the Reformation was itself one of the immediate factors that led to the rise of modern science – it gave Western intellectuals the cue they needed henceforth to read the book of *nature* in an equally literal manner, without looking for hidden levels of meaning. Interestingly, however, this 'new hermeneutics' from the Reformation also gave rise to the potential for divergence between the Bible and scientific enquiry in the long run. Quite simply, there was a danger that they were trying to occupy the same space in the enterprise of faith and understanding.

So, if we are to move towards a theology of science, we need to be acutely aware of the nature and claims of biblical language, as also of the language of science. Thus, to turn to a related passage in the New Testament, when John 1 uses the expression 'in the beginning' it is not a temporal statement so much as a claim for the nature of 'being' ('all things came into *being* through him'). It is, in a sense, a metaphor. Both theology and science use metaphors, but in rather different ways, and for different purposes. In the words of the philosopher Paul Ricoeur, we need to clarify both the distinction between and the collective unity of 'modes of discourse as modes of use, such as poetic discourse, scientific discourse, religious discourse, speculative discourse, and so on.'

The biblical accounts of creation are poetic discourses, probably closely linked to liturgical praxis and the government of the way we live in relationship with one

another and with God. Their metaphors have a dramatic intensity that is quite distinct from the predominantly scientific understanding of the nature and purpose of text that underlies most of our post-Reformation biblical hermeneutics. Scientific accounts are also metaphorical, but their purpose is quite different, being outside the necessary context of a relationship with God (or even one another). Keeping these distinctions in mind will help us avoid unnecessary problems in the science-theology dialogue.

1.3 Authority: who you listen to

Theology and science are often seen as incompatible because the way theologians are supposed to 'defer to authority' in their work, whether it be written authority (chief among which is the Bible) or authoritative persons (most obviously, the Pope for Catholics). We therefore move to discuss the understanding of authority which obtains in science and religion. To do so, we must first identify the questions which it is believed may be answered by an appeal to authority. Reference to authority is usually made as part of a process of settling disagreement. Disagreement may be in the field of individual belief or in the field of corporate practice. We can therefore usefully begin by considering the notion of belief.

Within the activity of science we may ask the question: If we are taking part in the activity of science, what moves us to give our assent to a particular theoretical point of view? The answer to this question would have many components in it. We may refer to the comprehensiveness of the theory and its ability to explain a wide range of phenomena. We may cite its predictive power. We may make reference to its 'intrinsic beauty' and simplicity. We may see these and other factors as contributing to a cumulative case in favour of our giving our assent to it. There will in addition be a family of factors which can move us to assent, but which operate in a different way. We may be impressed by the fact that Professor X believes this theory, and as we have respect for him we may find ourselves tending to believe likewise. The fact that a theory is branded in the literature as new and exciting and suggests a large number of research opportunities may move us to adopt it. Such factors can make our adoption and eventual 'belief' in a particular theoretical position personally compelling.

Likewise within theology we may ask: If we are taking part in the activity of theology, what is it here that moves us to give our assent to a particular point of view? We may point to its ability to do justice to our foundational scriptures. We may cite its consistency with views expressed in the tradition as it is developed in many parts of the world. We may point to its ability to explain points where deviation from that tradition appears to be advocated. We may cite its consonance with other beliefs that we hold in other fields. Also, as in the case of science, there will be another family of factors which also move us to belief. The person who advocates the view in question may have a particular sanctity, or be seen as having gone through the hard knocks of life and have an inherent authority to speak. The position may be a position advocated by a very charismatic and powerful personality. It may be a position exciting in its newness, and whose cracks and flaws have still to emerge.

Thus within science and theology there can be factors that invite us to give our assent by seeking to *justify* the belief, and factors that invite us to give our assent by citing factors about the belief that make assenting to it an *attractive* option, which eventually compels our heart and mind. The adoption of certain beliefs by 'authoritative persons' is one example of the second kind of factor. But in neither science nor theology is this the only factor. Within both disciplines argument, discussion and debate among individuals, groups and traditions is part of the rational

process by which beliefs are shared and tested, and, sometimes, conviction is achieved.

What about practice? Science is not just a set of theories, it is a corporate and shared activity. Theology too cannot be isolated from practices that it entails – the practices of a particular religion. Thus we face the question of authority concerning practice. Here we face the family of questions, not concerning our intellectual assent in matters of belief, but questions as to who has the right to direct our activity in a particular way, in the field of either science or theology.

This question arises because the activity in each area is corporate, and individuals who share in the activity have often entered into some sort of informal contractual or covenantal relationship, with others in the field, to work collaboratively together. There has been a tradition within the western world that universities have a right to direct research. Government and industry too set up research projects, and have authority in the direction of resources. The need to have corporate loyalty within a research programme is important. So too within the field of religion: constraints governing the behaviour of adherents of that religion, their following common practices concerning baptism, worship etc., is also part of its life. The question arises as to who has the right to give direction. In both instances, 'authority' is a key notion because of the importance of the *corporate* in both scientific and religious life.

Science and religion are not matters that one pursues as an isolated individual (though an isolated individual may have great insights to contribute), but they are corporate activities where decisions concerning the norms within which they are practised need to be made, and so questions of authority regarding the direction of particular practice arise. In science there are those who set the framework for a research programme (albeit with due consultation) and there are those who agree to operate within the framework that has been set. Within religion there are those who have responsibility for continuing to shape the norms within which a religion is practised (albeit collaboratively).

Within both science and religion, however conceived, there will be that element analogous to what within political theory is referred to as '*the paradox of democracy*'. That is to say that, as a democratic individual, I do believe that the will of the majority must prevail. However, in a vote to determine what should happen I may often find myself with the minority. This means that I am both in favour of the proposal (as I favour the majority will prevailing), and I am against the proposal (as expressed in my vote against it).

So too within religion an individual can agree to operate practically within the 'orthodox' framework, but in terms of belief hold a critical attitude to it. Within science a person may agree to pursue good research within a framework that personally they would rather alter. In both there can be a healthy critical engagement between the individual and those currently holding authority. If this reaches crisis point in science a scientific project will break down, as trust and enthusiasm evaporates. If this reaches crisis point in religion a major reformation may take place.

The activity of the laboratory and the activity of the church congregation may seem initially very different, but each consists of individuals with integrity, open to conviction on matters that concern them, seeking to work together, despite real differences that may obtain. In both areas the interaction between an individual's belief (shaped in debate), and corporate practice, can be either stimulating or destructive. It is the task of those in authority, in both science and religion, to ensure that the former is the norm.

1.4 Summary

Science and religion are often perceived to be at war. We have seen that this is certainly a simplistic caricature of the complex ways in which these two areas of human endeavour have interacted historically. Elements of conflict, independence, dialogue and integration can be discerned in many episodes and in the work of many scholars. Often, lying behind the element of conflict was (and is) a supposed disagreement between the Bible and science. We have suggested that this arises because of a failure to understand that the Bible and science belong to different 'modes of discourse'. Finally, theology's appeal to the Bible or other sources of 'authority' is often seen as setting it apart radically from science; but we have seen that things are not as simple as that, there being significant parallels between the role of authority in both science and theology.

2. Critical voices

Science is one of the most powerful forces shaping the way we live today; it is also potentially one of the most powerful forces shaping the way we think about the world and about ourselves. In many ways, science has been a force for good – the application of science to healthcare and food production has led to a near doubling of life expectancy in the Western world since the middle of the eighteenth century. But to many, science has also been a *mixed* blessing, with a multitude of undesirable side effects – from pushing out God from our beliefs, to pushing out species from rainforests. That is why many commentators on science have had some rather critical things to say about it.

Meanwhile, scientists themselves spend little (if any) time thinking about the wider implications of their work. When scientists do venture beyond the confines of their disciplines and encounter these critics of science, their knee-jerk reaction is to hear their criticisms as ‘anti-science’. It is true that a minority of science critics today *are* ‘anti-science’ – at least, their writings give the impression that science has been an unmitigated disaster, and we would be much better off without it. But many, if not the majority, of the critical commentators on science today welcome the good that it brings, whilst being keen to see that it does less harm. In this respect, therefore, Christians welcome the contribution of these critics – we, too, seek a science that contributes toward, rather than works against, the healing of the whole creation.

In this part, we seek to engage with science critically, with help from some of its critics. This exercise will uncover many of the issues that any theology of science needs to address.

2.1 Science and absolute claims

Science as it is now generally understood refers to a set of disciplines – physics, chemistry, biology and others – which explore aspects of the material world, and which share at least elements of a common methodology in trying to analyse and understand their subject-matter. The word ‘science’ derives from a Latin word, *scientia*, which has a long history, and which originally meant that which could be known from first principles, on logical grounds alone. For us, though, the word ‘science’ means the ‘natural’ and ‘social’ sciences. These, characteristically, are the ways of knowing that are derived from empirical observation of our world.

In the popular imagination, science is often held to be a generator of hard fact, or certain knowledge. This is a view of science which was heavily promoted in the late nineteenth and early twentieth centuries, by scientists and by some philosophers (particularly those associated with the movement known as logical positivism). Such a characterisation of science would see it as:

- *Rational* – that is to say, only logical thought-processes and reasoning is of relevance to science;
- *Objective* – that is to say, scientific information does not depend on individuals. When I do an experiment, it will yield the same result as the same experiment performed by you;
- *Deterministic* – that is to say, science analyses successions of events which are wholly determined by those preceding events which have caused them;
- *Inductive* – that is to say, science proceeds from making particular observations to devising general theories consistent with those observations; and

- *Reductionist* – that is to say, scientists try to understand how things work by breaking them down into the smaller things of which they are made.

Some elements of this characterisation relate to assumptions made about the natural world, and some relate to the method by which scientists approach it. All of them, however, have been challenged in the past few decades by philosophers of science. The majority of these scholars do not deny the importance of the many good things which science – and the technological applications of science – have made possible. Nor do they demean science as a discipline: still less scientists as practitioners of it. These philosophers *do* suggest, however, that some of the more extreme ‘absolute’ claims that have been made on behalf of science – for example, those which suggest it should be seen as the sole generator and arbitrator of truth – do not stand up to close scrutiny.

Such philosophers have noted that the history of science is riddled with occasions when scientists have solved complex and difficult problems not by reasoning out solutions, but by flashes of inspiration, or by intuition, or even in a dream (the nineteenth-century chemist August Kekulé, for example, famously solved a frustrating riddle of his day regarding the structure of the benzene molecule when he saw the solution in a day-dream). They have suggested that a scientist, in making observations, actually *selects* the data being recorded, and thus plays a significant role her- or himself in taking science forward (indeed, in the realm of quantum physics the crucial role of an observer in an experiment in determining that experiment’s outcome has long been recognised). Quantum mechanics even teaches that events such as the radioactivity decay of an unstable nucleus can happen that are not in any meaningful sense ‘caused’.

Philosophers as long ago as David Hume in the eighteenth century have noted the weaknesses of the inductive method in establishing general truths: just because many observations all seem to confirm the same theory does not mean the theory has been proved, because at any time an observation might be produced which refutes it. More recently, Karl Popper has famously contended that science can never prove anything: it can only disprove statements. Scientists, on this view, should always seek to falsify their theories, rather than to confirm them. On the other hand, scientists do make the leap from limited observations to comprehensive theories. Here it is clear that they necessarily must use extra-scientific criteria such as beauty, coherence, and economy to help them select between rival formulations more or less equally consistent with their observations.

Finally, it has been pointed out that there are circumstances in which whole things influence the behaviour of the parts of which they are made. For example, genes are not free-roving, ‘selfish’ entities, as has been suggested, but in fact have the range of opportunity for expression open to them constrained by the fact that they are contained within larger organisms. Such observations indicate that holistic approaches to some phenomena should be preferred to reductionist ones.

There is much that is valuable in such philosophical critique for constructing a theology of science, although we must use this resource itself critically. For example, some of these philosophical critiques, especially when set in the context of a postmodern aversion to overarching storylines (‘metanarratives’), can easily be seen as arguments in favour of total relativism. One scholar who has shown us that this need not be so is Michael Polanyi. Having made distinguished contributions to the understanding of chemical reaction rates and the strength of solids, Polanyi turned his attention to philosophy of science. He demonstrated that scientific knowledge, like any other forms of human knowledge, was deeply ‘personal’ – scientists are persons-

living-in-society. Thus far, he agrees with many strands of the critique we have been reviewing. Importantly, however, Polanyi went on to show that some forms of personal knowledge, including science, could legitimately have 'universal intent'. Polanyi's picture of science – personal knowledge with universal intent – shows that there can be much common ground between theologians and scientists.

2.2 Science and gender

One sustained modern attempt to address the more absolutist claims of science has come from feminist scholars. Their insistence on taking the side of the weak and underprivileged, specifically (but not exclusively) that of women, means that Christian theologians should listen to them carefully (if not uncritically).

Many feminist scholars of science are themselves scientists; their starting point is often autobiographical. Thus, the feminist scientist and scholar, Donna Haraway recounts that one of her colleagues had begun to 'question her pleasure in the playful world of pure science'. Martha Crouch, a biologist like Haraway, had come to the conclusion that scientists including herself were being encouraged to think and work in a very questionable way:

...she judged that one of the ways that scientists like her are inhibited from developing a broad critical approach to their work *as part of their core science* is by learning to craft an identity that encourages a permanently childlike innocence. In the lab itself, even to a significant degree in industrial sites ... in exchange for extraordinarily hard work and total commitment, the scientist is free, privileged, allowed to play for a living – and highly rewarded for being on the 'cutting edge.'

The turning point came about when Crouch investigated the social context of her research into clonally propagated oil palm plantations in Asia and Central America, a project sponsored by Unilever. As a result of setting up the plantations, she discovered that indigenous people were being displaced from the rainforests where they lived by the plantations which also introduced various kinds of pollution threatening the whole delicate ecosystem of the area. And by upsetting the local economy and introducing a variety of new food products, health and wellbeing in the local population was seriously affected for the worse. Crouch was unimpressed by the suggestion that pure science and politics inhabited two different spheres. For her, science had become politicised.

Crouch's reaction is characteristic of a feminist approach. In other words, according to this approach, it is claimed typically that science cannot be described unproblematically as a 'pure' search for 'objective' truth. At every level, starting with the very basic notion of deciding what is and what is not worth investigating, feminist scholars have recognised that people do not all start on a level playing field in a world still characterised by a general privileging of white male European and North American scholarship. Approaches to science have tended to reflect this privileging. Consequently the world has come to figure largely as an object to be studied and exploited rather than, for example, a partner within a relationship of interdependency. Detachment and a definitively disembodied rationality are the characteristics of this knowledge.

As the philosopher (and one-time biophysicist) Evelyn Fox Keller notes, this vision of science is also gendered in terms of 'the rhetoric that conjoins the domination of nature with the insistent image of nature as female'. This image is nowhere more familiar than in the writings of the Elizabethan scholar Francis Bacon,

who essentially formulated the modern, western 'scientific method' of careful observation and controlled, methodical experiment. Keller writes 'For Bacon, knowledge and power are one, and the promise of science is expressed as "leading to you Nature with all her children to bind her to your service and make her your slave"'. Bacon championed the power of 'mankind' over the natural world with a reference to Genesis. Feminist scholarship has been loud in its condemnation of such attitudes. However one of the problems with this response, is that, the temptation then sometimes arises for women 'to abandon their claim for representation in scientific culture and, in its place, to invite a return to a purely "female" subjectivity, leaving rationality and objectivity in the male domain, dismissed as products of a purely male consciousness.'

Countering this view, the philosopher and feminist theorist of science Sandra Harding has developed 'standpoint theory'. She argues that women's social experience – their standpoint – gives them a view that reveals the bias of science so understood. She suggested that this approach can claim a *stronger* 'objectivity' than standard 'male-neutral "theories of knowledge"' because the latter are blind to some of the most significant underlying assumptions they rest upon. The implicit and contestable claim of such 'male-neutral' theories to occupy the 'God's eye view' results in what Sarah Coakley calls 'an epistemic *disadvantage*.' Harding suggests that this account of standpoint delivers not less but greater or 'stronger' objectivity.

Standpoint theory has its critics. In general terms its weakness could be seen as the implicit tendency towards relativism and the problematics of describing 'women's experience' when there are so many different women in different situations. Nevertheless, many feminists remain convinced that, in Harriet Harris' words, we 'must not give up on the truth, but that we should work to disclose truth, particularly by exposing unacknowledged partiality and dishonesty.' This, these feminists would argue, requires some common understanding of goals and processes of rational thinking to which we can all aspire if only the hope of being honest and just rather than deluded and destructive.

Donna Haraway is not a Christian feminist and in her work she opposes tendencies she sees within the modern techno-scientific cultures of white Europeans and North Americans to draw science into an identifiably Judaeo-Christian mythology which she believes equates truth with the 'Sacred Image of the Same', an image that is potentially identifiable with a masculinist, patriarchal view of the divine, as the final and absolute truth. Nevertheless, in her continuing commitment to the endeavour of science we can see her vision of honesty and justice:

'Biology is a political discourse, one in which we should engage at every level of the practice – technically, semiotically, morally, economically, institutionally. And besides all that, biology is a source of intense intellectual, emotional, social and physical pleasure. Nothing like that should be given up lightly – or approached only in a scolding mode '

Such a vision might well be shared by Christians determined to step away from the injustices and distortions of a purely masculinist, patriarchal scholarship (whether it be in science or theology) yet still aspiring to knowledge and the search for the truth that will set them free.

2.3 Summary

Science is a powerful force in shaping both our world view and our world today. That is why it is important for the Church to engage with it. As part of our attempt to theologise about science, we have, in this section, listened to a number of voices critical of contemporary science – critical of the kind of absolutist claims (e.g. about

objectivity) it often makes or which are made on its behalf, and of the ways in which it contributes, knowingly or unknowingly, to the exploitation of the weak and vulnerable. To use the terminology of Section 1, these critical voices should not be seen as being in 'conflict' with science, but rather, as constructive contributions in a collective effort to ensure that science works for rather than against the 'reconciliation of all things'. Listening to these critical voices from outside the Church is therefore a key exercise in our effort to construct a theology of science.

3. Sketches towards a theology of science

Having ‘cleared the ground’ by showing that science and theology are not such strange bedfellows, and listened to a number of voices critical of science, we are ready to move towards sketching a theology of science. Perhaps not surprisingly, our sketches show each of the four elements in Barbour’s typology introduced in section 1.1. The very attempt to sketch a theology of science means that we are seeking ‘dialogue’. In this dialogue, Christian theologians will find themselves being critical of certain aspects of science. Such ‘conflict’, however, should be creative: it should move us towards a more godly science, a science that contributes to the healing of all creation. As part of a theology of science, we will want to understand why it is that science is able to make progress in understanding the world apparently *without* the ‘god hypothesis’ – such *de facto* ‘independence’ turns out to be the starting point of deep theological reflection about God the Creator. Finally, if any theology of science succeeds, it should have significant ‘integrative’ power, healing the split between ‘fact’ and ‘value’.

3.1 The theological roots of the fact-value split and its consequences

Scholars such as Michael Buckley and Amos Funkenstein have insistently reminded us that, for better or for worse, many of the characteristics of modern science as we know it have deeply theological roots. To delineate these dependences is an essential part of constructing a theology of science. Here we give one example of such an analysis by tracing the theological roots of the ‘fact-value split’. We have already listened to philosophers and feminist scholars who have shown how problematic it is for science to claim that it is a ‘value-free’ search for ‘facts’ while ethics is left as a sphere of humanly invented ‘values’ with no relation to factual accounts of the material ‘stuff’ of creation. Here we trace the theological genesis of this dichotomy.

Until the Middle Ages Christian cosmology spoke not only of the mind and soul of humanity but of all the forces and beings of nature as being moved and directed by a beneficent God. The first theologians understood the events of the life, death and resurrection of Jesus Christ as being the means by which the creator acted to redeem the world, both physical and spiritual. For St Paul, and for Irenaeus of Lyons in the second century, the Incarnation and the Resurrection represented the triumphant vindication of the original order of creation by its maker and redeemer, a vindication which would eventually appear in the form of the ‘recapitulation’ (Ephesians 1:10) of all that God had made in pristine form. Moreover for the first theologians the physical world of nature was always, and at the same time, both a physical and a spiritual reality. The Fathers believed, for example, that God acted on the physical world through the agency of wisdom or the divine Word and the divine messengers, the Angels who moved the forces of nature to conform to the divine law which governed the physical world. Wisdom was a core theme.

The Fathers believed, moreover, that there is a relationship between how the world is constructed and the way in which humans and other creatures are to live in it – that, in other words, the universe represents a moral and spiritual order and not just a realm of brute matter, which the minds and spirits of human beings are empowered to reorder after their own purposes. This traditional cosmology set significant boundaries on how humans were to exercise their dominion over nature. The kind of wholesale reordering of natural order which modern science-informed societies have advanced would therefore have been resisted by traditional Christian cosmology.

However in the late Middle Ages a new tendency was abroad in theology that increasingly described God as distant and wholly 'other,' a God whose arbitrary will and purposes could not be known either from the works of the creation, or from the plain sense of scripture. Only the mediation of the Church as the presence of God on earth could make the mysterious purposes of God known to the human mind. This shift in scholastic theology produced a new philosophy which placed the human mind and will at the heart of subsequent cosmological speculations. It also paved the way for Renaissance humanism in which humanity became the 'measure of all things'.

This new humanism involved a radical rejection of the earlier Christian understanding of creatureliness, an understanding that set humans in some significant ways on a par with the creatureliness of other beings. Thus for St Francis of Assisi, as for the Psalmists, all creatures are called to praise and worship God, and for Thomas Aquinas all creatures are owed respect and reverence because in all the things that are made, humanity is able to see 'the invisible things of God'. But for Renaissance thinkers such as Francis Bacon, who anticipated in a powerful way the modern scientific-technological project, nature is in service not to God, but to humanity. The work of humanity in extending its power and dominion over nature is a work which is 'truly divine'. Nature for Bacon neither has intrinsic value, nor is it redolent of spiritual purposes – it is ordered for human use and it is the human vocation to reorder it; for, in the progressive extension of human power over nature, humans are the redeemers of the fallen world of nature. But this human power over nature can only be acquired by careful attention and discernment of nature's laws: the believer-scientist must remember that 'nature cannot be conquered except by obeying her'. The purpose of contemplation is no longer to discern the workings of the invisible God but rather the conquest, even the rape, of nature. (Feminist critics of science have particularly drawn attention to the *violent* language Bacon used about a *feminine* nature.)

The insights of Bacon and other Renaissance humanists lent themselves to the gradual secularisation of the conception of human history as one of progressive growth in human power over the natural order. Reasoned observation of the natural world displaced the narratives of scripture as the locus of cosmological understanding and natural wisdom. Bodies, space, material relations were no longer transparently creatures of the divine purpose – only human reason could discern their true meaning. From the Jewish Kabala to the alchemical quest for gold, the spirit of early modern scientific observation thus arose in the context of a new theology. Funkenstein has shown us that, over time, this new theology was itself to become absorbed into the increasingly atheological account of the universe as mechanism. Automatism and chance have since become the driving principles behind the unfolding of life, and God is now really excluded from view.

The response of philosophers and theologians to the growing cultural influence of scientific description, and of the predictive power of the new scientific method of empiricism, was inevitably a project both to emulate the new centrality of reason and to sequester reason's products in relation to their accounts of God and of human flourishing. Immanuel Kant and David Hume both elaborated accounts of the human good which clearly distinguished it from descriptions of physical bodies and properties, and so the fact-value distinction was born.

The modern project 'ethics' – 'the science of values' – thus takes its rise in very significant ways from the cultural power of modern scientific description. The human good is identified through rational principles which are said to be universally knowable by all reasonable people, such as Kant's 'never treat a person as a means but always as an end', or John Stuart Mill's 'the greatest good for the greatest

number'. But the reductionism of these conceptions of the human good has meant that over time the moral procedures which they have fostered have proved inadequate. It has become hard for a modern individual to account for their sense of right and wrong other than in the terms of their own personal intuition – 'I *believe* this is right, and that is wrong'. In prescient recognition of this eventuality, David Hume proposed that individual intuition is indeed the locus of morality. G. E. Moore went further when he suggested that there is no logical relationship between descriptions of the world and of bodies – 'facts' – and what humans mean when they indicate that an action is good – 'values'. Science on this schema was the language which described what 'is,' while morality was the discourse which described how we 'ought' to live. And thus Peter Singer can suggest that for moderns 'ethics is no part of the structure of the universe'.

This split between fact and value leaves the cosmos, and human life itself, uniquely open to human manipulation and reordering in modern societies. The order of nature on this account has no intrinsic moral wisdom or spiritual significance prior to its construction and reordering by the human mind. Peasant (Luddite) and intellectual (Romantic) forms of resistance to the dramatic and reconstructive powers of modern science-informed industrialism were consequently undermined not only by the growing social power of industrialism and the growing authority of the scientist, but also by the displacement of naturalist and theological accounts of the human good, and of natural wisdom, with humanist philosophy and social theory. Philosophers such as René Descartes adopted an anthropocentric frame which did not allow that even those bodies which were closest to the human body – primates and other sensate animals – might actually experience flourishing in ways which are truly analogous to human flourishing, with the consequence that they viewed vivisection and other kinds of scientific experimentation on live animals as of no moral significance. Such animals might appear to feel pain but, lacking reason and will, this was not what humans experience as pain. Analogously, scientists themselves frequently failed to perceive that their own bodies might be affected by the experiments and observations they engaged in, as was tragically evidenced in the deaths from radiation poisoning of some of the first nuclear physicists. This duality between mind and mechanism is equally evident in the larger disconnection between modern urban industrial society and the flourishing of the ecological communities on which life itself, including human life, depends. Global warming is a powerful example of this problem. For decades, despite growing evidence of local and continental climate change linked to human activities such as deforestation, climatologists resisted the idea that the human species was able to influence the earth's climate. This failure to recognise the feedback which exists in the relationship between human activities and natural systems reveals the extent to which a modern, science-informed culture has turned away from the divinely originated wisdom which biblical writers discerned in the character and constitution of the non-human creation.

3.2 Wisdom: a Biblical resource

It has been suggested that a locus for the re-integration of science and meaning is wisdom: that is, the ability to make the right use of the kinds of knowledge which science produces. An examination of wisdom, indeed, shows it to be a very significant resource for building a theology of science. It is, moreover, a biblical resource. The Bible is the primary source for Christian theology, yet it has exercised strangely little influence on the shape of the current science-theology dialogue.

The Bible teaches that the physical universe is a creation, and that it is therefore infused with meaning. Thus, it is not only legitimate, but imperative, that we enquire about 'the ethos of the cosmos' (to borrow the title of a book by the Old Testament

scholar, William Brown). Amongst the different genres of material in the Bible, it is perhaps the so-called Wisdom literature that most clearly witnesses to this theme. This literature includes a number of the Psalms (such as 19 and 104), and the books of Proverbs, Ecclesiastes and Job. (If we include the Apocrypha, then there is also the Wisdom of Solomon.) We cannot survey in any depth this rich and extensive corpus of material. Instead, we will pick out a few elements which would seem to us to be key in constructing a theology of science.

In the words of the Old Testament scholar R. E. Clement, this literature presents Wisdom as the 'inalienable bond that unites the creative intention of God with the experienced working of the world.' One of the most profound poetic expressions of this is Proverbs 8. The chapter begins (vv. 1-21) and ends (vv. 32-36) with Wisdom appealing to us to listen to her and follow her precepts (i.e. how we should live in the world): 'To you, O People, I call, and my cry is to all that live. ... For whoever finds me finds life and obtains favour from the LORD.' (vv. 4, 35, NRSV) In the middle of the chapter (vv. 22-31), we find an astonishing poem telling us that Wisdom was a witness to the unfolding drama of creation. That, apparently, is the basis of her appeal to us to live wisely, and therefore happily – the verse immediately following the creation poem reads: 'And now, my children, listen to me: happy are those who keep my ways.' This is the theological foundation for the practice found elsewhere in the book of using certain kinds of animal behaviour – for example storing food in response to the seasons – as displaying a wisdom that humans do well to follow. This contrasts with modern science-informed agriculture which tends to neglect animal wisdom, as when farmers feed animal protein to herbivores and, almost certainly, reap BSE as a result.

It is striking that the poem in Proverbs 8:22-31 ends on a note of playful delight: 'I was at his side each day, his darling and delight, playing in his presence continually, playing on the earth, when he had finished it, while my delight was in mankind.' (vv. 30-31, NEB) Significantly, the verb translated as 'playing' here can denote play or *laughter*. Wisdom's 'hilarious play' is the climax of Yahweh's creational activities (which, incidentally, throws considerable light on the theology of Sabbath rest). What is intimated here is memorably put by William Brown: 'Creation is essentially Wisdom's playhouse, the formative context and setting in which Wisdom matures as player and moral agent.'

Rich seams of implications are here to be mined for a theology of science. In particular Proverbs 8 critiques the one-sidedly utilitarian motivation for doing science in our society. Positively, it encourages scientists to see at least part of their vocation as helping all of us recover a little of that sense of playful delight and wonder with which we all, as infants and children, first encountered the diversity of this wondrous world. It also impels us to see the creation as generative of meaning and values, and so to practise a science that, both in its internal methodologies and in the way it relates to other disciplines, seeks to go 'with the grain of the Universe' (the title of Stanley Hauerwas' 2000-2001 Gifford Lectures at St. Andrews University).

So, Wisdom says to us, 'Listen to me: happy are those who keep my ways.' But that was not Job's experience. He lived wisely (Yahweh considers him a 'blameless and upright man who fears God and turns away from evil' – Job 1:8, NRSV), but lost all his possessions, his children and his health in quick succession (1:13-2:8). Job's friends insisted that his suffering could only be due to his unrepented sin (= 'unwise living'). Job protested his innocence, and called on God for an explanation. At the very end of the book, God appeared out of a whirlwind and spoke to Job. Astonishingly, the answer took the form of a grand tour of creation – the earth, the sea, the weather and the animals (including, famously Behemoth, 40:15-24, and

Leviathan, 41:1-34) – accompanied by a running commentary from the Creator himself. The book of Job's critique of 'conventional Wisdom' is therefore still based on a meditation of the relationship between Wisdom and creation.

Again, we cannot hope to treat the closing chapters of Job in any detail. To draw out but one implication for a theology of science, we note that God asks Job to consider the *non-human* creation from a perspective that ignores any possible utility for humans. Thus, pointedly, God 'brings rain on a land where no one lives, on the desert, which is empty of human life.' Why? 'To satisfy the waste and desolate land!' (38:25-27, NRSV). All but one of the animals mentioned in 38:39-39:30 are undomesticated and associated with wild and desolate places. The one exception, the horse, is discussed in terms of its untamed strength rather than its usefulness to humans. Repeatedly Job was invited to take the wild animal's point of view: the lion's hunger, the vulture's feeding, etc. These motifs are reinforced by the passages about Behemoth and Leviathan, creatures that stood on the border between the real and the imaginary. Their existence is as far removed from human interest and concerns as possible: God created them for his own purposes (including, perhaps, as playmates; 41:5 hints at as much).

Contrast this cosmic perspective with Job's horizon, which he himself powerfully summarises in his closing speech (chapters 29-31). Job's vision begins at home and ends at the city gate; his sense of self worth is largely founded on a web of human social relationships where hierarchical dependency is of the essence. Throughout Job's speeches, we find that his sense of moral order is tightly bound up with his sense of cosmic order. If he cannot make sense of his suffering, then the whole universe might as well be de-created (3:1ff). A hierarchical view of the animal world comes out clearly – God, albeit a God whom Job does not currently understand, is like a 'lion' (10:16), while Job's sense of ruin is expressed as becoming 'a companion of ostriches' (30:29), one of the lowest of the low.

Against this perspective, God invites Job to *decentre*: there is a cosmos out there that exists and has intrinsic value wholly independent of humans. In other words, whatever else it may mean, the minimum 'take-home message' of the divine speech in Job is that we cannot even begin to reflect rightly on theodicy unless we first learn to take a decentred, cosmic perspective.

The implications of such a reading of Job for a theology of science are many. Here we just note that the one area of human intellectual endeavour that has most insistently pointed to such a 'decentred' perspective over the last three hundred years is science: Copernicus and Galileo displaced humans from the centre of the physical universe, while Darwin finished the job in the biological universe. Theologically therefore, science should have the potential of contributing to the tradition of Wisdom that Job champions – a Wisdom that recognises *God's* interest in his creation quite apart from any human utility – a perspective that is consonant with much of what feminist critics of modern science would want to say. On the other hand, a theology that takes seriously the ethos of science may hope to cut new ground in the vexed question of theodicy ('justifying God' in the face of suffering).

To summarise, even a cursory exposition of Proverbs 8 and the closing chapters of Job suggests that the Hebrew Wisdom tradition should be a valuable resource for constructing a theology of science. This tradition was, of course, taken up and transformed in distinctively Christian ways in the New Testament – the life, death and resurrection of Jesus being the supreme manifestation of the wisdom of God, so much so that Christ is, in Paul's language, 'our Wisdom'. The implications of all of

this for a theological understanding of science remain largely to be worked out (but see the book by Celia Deane-Drummond under 'Further Reading').

3.3 Liturgy and science: a framework for reflection

Liturgy is a central part of the Christian religious experience; it is also the custodian and transmitter to succeeding generations of deeply-held and cherished beliefs. The experience of participating in liturgy in its varied forms, eucharistic and non-eucharistic, has implications for what participants might think of as an appropriate 'spirit' of scientific enquiry and therefore for any theology of science. Here we offer a framework for theologizing about science from a liturgical perspective. In doing so, we are aware that we raise far more questions than we provide answers; we also leave many issues unexplored – one obvious omission is the question of time in liturgical experience, and its possible implications for scientific enquiry.

3.3.1 *Worship*

At the heart of any liturgy is worship. And at the heart of worship is an affirmation, as central to all reality, of a distinction between creator and created, or between 'Being' and 'the beings'. That distinction could be further expressed as a basic stance about being human – human beings lose themselves in the attempt to be self-determining or autonomous, but find themselves in the realization of creaturely dependence upon God. And it could also be expressed as radical opposition to any world-view which denied the distinction, for example by claiming that life as we experience it is a matter of chance and not the outcome of purposive divine activity – opposition understood, of course, as including the obligation to engage seriously with contrary opinions and to develop credible arguments in relation to them. Any form of scientific enquiry, therefore, which leaves open the possibility of upholding a distinction between creator and created and its implications for human being would merit positive appraisal by liturgical theology; and any form of scientific enquiry which radically rejected such possibilities, either because it was predicated upon their rejection, or because it issued in the claim that all right-thinking people *should* reject them, would merit serious criticism and credible counter-argument by liturgical theology, because it would be bound to regard it as either founded upon, or bringing forth, untruth. So, liturgical theology will seek allies among the sciences and will also seek to engage non-allies.

3.3.2 *Consecration*

Although there are diverse understandings of consecration in liturgical life, not least in eucharistic life, the offering of material things such as water, oil, bread, wine to become sacramental signs in the process of a liturgical celebration, to be, in some understandings, bearers of the divine promise or life or energies into the midst of creaturely life, has further implications for any theology of science. These liturgical actions, which are always understood not just to be about specific material things, but about these things becoming highly-charged symbols of the meaning and purpose of all life in relation to God (and not just human life) imply a *sacramental* vision of that very material world which is always being investigated, uncovered and 'explained' by scientific enquiry. Any view of these things, and of that world, which claims that they are fully and adequately described and understood in solely material, this-worldly terms merits the criticism of a theology which takes liturgical experience seriously. The supreme case of this, at least in our experience, is, of course, the collection of substances we call a human being, but the concern of theology is not limited to this case. Liturgical theology would seek to preserve the possibility of a more-than-material description of the potential of the material world, partly in the interests of reverence for the human person and a proper stewardship of the goods of creation,

that is to say, for moral and ethical reasons, but also as a matter of holding to what it deems a true vision of reality, a sacramental vision. One question would therefore be where allies could be found in the scientific enterprise and where wisdom could be shared. Or is it simply the case that science cannot really be expected to have anything to offer in this regard as the subject must necessarily elude its means of investigation, arguing and reaching hypotheses?

3.3.3 *The Eucharistic Prayer – Preface*

It is characteristic of the basic eucharistic prayer in our modern liturgy, as compared with prayers emanating more directly from the Prayer Book tradition, to lay much greater stress on thanksgiving for the work of God in creation. *All power is yours, you created the heavens and established the earth; you sustain in being all that is....* Of course, this is set in the context of belief about God ‘restoring and bringing to completion all that is His’, and so is never simply about creation *tout court*. Nevertheless this celebration of God as creator and sustainer of all that is ought to encourage liturgical theology to welcome the extraordinary investigations of science into the way things are, and into their origins and development over time, as such study gives serious and wonderful content to this aspect of liturgical life. Liturgical theology should take very seriously the capacity of science to inspire awe and wonder in the face of what believers understand as God’s creation, not only in its practitioners, but also in a much wider constituency through the efforts of those who try to communicate its findings beyond the academic community. The more we grasp the extent of ‘all that is’ through the work of modern science, the more resonant this particular liturgical theme becomes. In this context science can be seen as very much the ally of liturgical experience, for it helps us to know more fully that for which we offer our thanksgivings and praises to God.

3.3.4 *Community*

It is a basic premise of liturgical experience that the participating community grounds its identity in a more-than-human reality. This is why, of course, the preface to the eucharistic prayer, briefly considered above in relation to creation, goes on to speak of communion between human and divine in Christ, of new birth effected by the Holy Spirit and of a ‘creation restored by love’. It is usually understood by participants that this ‘more-than-human-reality’ which constitutes their identity is encountered as that to which the data of ordinary, accessible, human experience, not least in community, are gradually to be brought into conformity (transformation, restoration, redemption, etc.) – and this is especially true of a religion which has at its centre the ‘Word made flesh’, the ‘flesh’ being God’s flesh and thus, while still entirely human, radically transformed or re-orientated. It seems that this feature of liturgical life would compel liturgical theology to insist that there are simply some areas of human life which are not best understood by scientific enquiry unless it is open to the claims of theology about creation and the human person. Here a theology rooted in celebration of the Holy Mysteries wishes to say that we are dealing with mystery. It is, for example, very hard to see how one could *scientifically* investigate the one instance in human history of a human being who is actually a divine person with both a divine nature and a human nature – the doctrine which lies behind ‘our life and yours are brought together in a wonderful exchange’ – without such openness. In other words, any theology of science which is informed by liturgical experience will inevitably have to say something about the *limits* of science and at one and the same time to insist that reality persists beyond these limits. And it may well wish to press this well beyond the realm of faith towards other important areas of human experience – for example, the imaginative encounter with texts of various kinds. Theology, not least liturgical theology, cannot escape mystery and the limitations it reveals in human thought, and perhaps it has to encourage science to acknowledge its own limitations in the face of mystery too.

3.3.5 *Drawing some threads together: presence and absence*

Liturgy mediates the *presence* of God – in each other and in the sacraments. On the other hand, for many today, both scientists and non-scientists, the overwhelming religious message from science is the *absence* of God. Since the physicist Pierre Simon Laplace told Napoleon that he had no need of the ‘god hypothesis’, scientists have proceeded to explain a vast range of phenomena without any apparent reference to the divine. We have seen that our liturgical experience should rightly make us wary of any claim that such scientific explanation is exhaustively adequate for every category of phenomena and experience. Surprisingly, however, theology in general, and liturgical theology in particular, can also offer a more positive line of reflection concerning this felt absence of God in the scientific endeavour.

It may be suggested that it is part of the ‘risk’ of creation that such a thing as the pursuit of scientific investigation without reference to God can arise. Science takes things seriously as they are, as they can be observed, described and analysed; it has many and increasingly sophisticated means of doing this. At the same time, theology insists that created things are not God but have an existence and life and purpose of their own. Of course, they owe their existence and purpose to the divine will, but they exist ‘at a distance’ from God, sufficient to preserve their distinction from God, to secure the integrity of their own existence. And they have freedom to develop, change and evolve and bring forth new things. Liturgical theology in particular will wish to propose that they may ‘bear’ the divine presence in the world or become symbolic of divine reality, but it will also insist that they do not thereby lose their creaturely character, that they are not God. The very sacramentalism that wishes to assert this capacity of created things to bear the uncreated must also maintain their distance from the creator. It is this distance which makes it possible for scientific investigation of the world to proceed without reference to God as explaining observable phenomena, for God is at a distance. In this possibility, the believer will detect the intimations of tragedy – but tragedy is inescapable evidence of the ‘risk’ of creation, of God’s allowing to be that which is not God.

A most interesting question arises when liturgical theology seeks to articulate a sacramental vision of reality which depends upon the idea of a suitable distance between God and the creation. Are all parts of the creation at an equal distance from God; or, to put it another way, are all parts of the creation equally capable of being sacramental? Theology has traditionally drawn a sharp distinction between the human and non-human elements of creation, with the human closer to God than anything else, except of course for the angels (who are created but non-human persons, and in a category all their own). Only human beings are understood to be in ‘the image of God’, so that it is persons who are most capable of being sacramental and who are therefore most to be valued and protected when it comes to moral concerns. This is not to deny the value of non-human sacramentals, especially since they are understood to share in the praise of all creation – concern for the integrity of all creation in relation to ecology and ideas of the intrinsic value of the natural, non-human world, are coming much to the fore in theological discussion, largely in response to increasing interest in these matters in society at large – but to suggest that it is of a different order. All of this seems to indicate that the scientific investigation of the human person without reference to God is even more tragic than the scientific investigation of the non-human world in the same manner. Such investigation is seriously deficient, and is likely to have tragic results unless guided by insights from theology.

To sum up: the place where God is *absent* is the place where a distinctively *Christian* theology should start looking, the least likely place. Thus the following seems to be the main plank of a response by liturgical theology to Laplace: the reality and integrity of creation, i.e. that it should be something worth bringing into being, requires a distinction from God, a 'being at a distance', that accounts for science being able to proceed without reference to God. This possibility is one result of the risk God takes in creating at all. When pursued in isolation from (and un-informed by) the worship of God, it represents a tragic misuse of human freedom. Theology needs to take this into account when appraising scientific investigation of human life and behaviour.

4. Summary and conclusion

It is time to summarise. We started by ‘clearing the ground’ – showing that science and theology are not necessarily at loggerheads. Historical ‘flashpoints’ can seldom be characterised simply as ‘conflicts between science and religion’. Supposed disagreements between the Bible and science arise when we do recognise that they represent different modes of discourse. Moreover, theology is not the only discipline to appeal to authority; authoritative persons and institutions are just as important in the sciences. After the ground clearing exercise, we turned to listen to a number of critical voices – philosophers who question certain absolutist claims often made by or on behalf of science, and feminist scholars who point out the problematic nature of a science that is dominated by white, male Europeans.

In the final part of this Essay, we turned to making working sketches that should contribute towards a future theology of sciences. First, we saw one example of the theological roots of some of the characteristics of modern science – in this case, the split between ‘fact’ and ‘value’. This split ultimately results in an ineffectual ethics, leaving the way open to exploitative applications of science. Then we reviewed the Wisdom literature in the Bible, and saw how it offered a substantial resource for Christian reflection on science. Finally, we offered a liturgical framework for theological engagement with the scientific enterprise – a framework that is critical of certain assumptions and practices of sciences, but also welcoming to the results of science that inspire awe and wonder in creation. Moreover, liturgical theology emphasizes the distance between God and his creation – a distance that both makes possible for the material to be bearers of the divine without losing their creatureliness, and allows science to proceed without the ‘god hypothesis’.

To conclude, we want to ‘anchor’ these thoughts in actual pastoral concerns by way of thinking a little about the worshipping scientist. The worshipping scientist encounters daily in his or her work the success of a ‘methodological atheism’ – very substantial success in explaining the workings of nature without recourse to the ‘god hypothesis’. In this context, any scientist who is a Christian believer in God as creator, sustainer and redeemer of the universe, may very well sense him- or herself to be *vox clamantis in deserto*, whose plight is perhaps inadequately recognized or understood by either the community of faith or the scientific community. And he or she may find elements of the desert in the church as well as in their professional life. Such a scientist is caught between a church which fails to engage with the challenges of science, and a scientific community which has abandoned asking questions of meaning in favour of rapid progress.

However, it must be a basic stance of any theology of science that believers are vital to the proper and fruitful practice of science, for they often have deeper insights into, and wisdom about, the ultimate nature of the reality they investigate along with their non-believing colleagues. They are, of all people, most likely to resist the divorce of science from questions of meaning, questions of morals, and concerns for the integrity of the human person and of the creation as a whole. They will regard it as understandable, yet tragic, that God is excluded by many if not most of their colleagues. Their particular witness as disciples is perhaps to be a kind of resistance, perhaps even a subversive element, in their profession. It will be made evident in the nature of their *decisions*, for example where scientific advances feed directly into technology, or where the corporate funding of science undermines the quest for truth, regardless of profit. And it will be evidenced in the kinds of questions they persistently raise with colleagues, with the church, in public arenas – the kinds of questions we have suggested in earlier sections of this essay.

And it is not just practising scientists who can assist in deep reflections on the nature of their discipline and on a theology appropriate to it. Results emerging from science, when they are appropriated sensitively, offer us new glimpses of the Creator's hand. Science, in its many applications, can be used to serve one another and to alleviate suffering; but it can just as easily be used to perpetuate (or even deepen) exploitative relationships. It therefore behoves *all* believers to engage, however they may, with thinking theologically about science – be it over the meaning of the Big Bang or the uses of science in the development of weapons of mass destruction; be it about the future of biological evolution or the ecological crisis. In the search for the wisdom to shape and use a science that plays a positive role in the reconciliation of all things, we have tools at our disposal about which society at large needs to hear. Each believer, in his or her own sphere of influence, can contribute to the formation of a theology of science, by engaging in discussions of scientific issues from a theologically-informed perspective.

This is, of course, a hard calling, and not to be written of lightly. But it is also a calling of inestimable importance for the flourishing of human persons and the proper stewardship of God's creation.

Further reading

The authors below are listed in alphabetical order. We have suggested links to the sections of this essay in square brackets after each citation.

Denis Alexander, *Rebuilding the Matrix* (Oxford: Lion Publishing, 2001) [General]
A popular introduction to this area which is well-informed and very readable.

Ian Barbour, *Religion and Science: Historical and Contemporary Issues* (London: SCM Press 1998) [General]
A comprehensive work, from one of the most important scholar in the field of science and religion.

Ingrid Bartsch and Muriel Lederman, eds. *The Gender and Science Reader* (New York: Routledge 2002) [2.2]
A handy anthology of book chapters and articles from leading feminist scholars concerned with science and technology, including a number of those whose work we referred to in section 2.2.

John Hedley Brooke, *Science and Religion: Some Historical Perspectives* (Cambridge: Cambridge University Press 1991) [1.1]
Perhaps the best all-round introduction to the many-faceted ways in which science and religion have related to each other since the early modern period.

William P Brown, *The Ethos of the Cosmos: The Genesis of Moral Imagination in the Bible* (Grand Rapids, Michigan, Cambridge UK: Eerdmans 1999) [1.2]
An in-depth study by an Old Testament scholar of the Hebrew scriptures' teaching that the cosmos is infused with meaning.

Michael J Buckley, *At the Origins of Modern Atheism*, New Haven ; London : Yale University Press, 1987 [3.1]
A classic study of the factors (science included) contributing to the rise of atheism in modernity.

Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 2nd Edition 1989) [2.1]
A classic text by the Professor of Public Understanding of Science at Oxford, who is a staunch defender of the thesis that science is the only worthwhile way to pursue knowledge, and that religions can only be (at best) a distraction from this.

Celia Deane-Drummond, *Creation Through Wisdom: Theology and the New Biology* (Edinburgh: T and T Clark, 2000) [3.2]
A sustained attempt at thinking through modern biology in the light of Biblical teaching on creation and wisdom by a scholar with doctorates in biology and theology.

Michael Fuller, *Atoms and Icons* (London: Mowbray 1995) [2.1]
A discussion of the ways in which science and theology can interact, aimed at the general reader.

Amos Funkenstein, *Theology and the Scientific Imagination* (Princeton, NJ: Princeton University Press 1986) [3.1]
A hard but rewarding work tracing the theological roots of modern science.

Stephen Jay Gould, *Rocks of Ages* (London: Jonathan Cape 2001) [2.1]

Essay strongly defending the 'independence' model for the relation of science and theology.

Peter Harrison, *The Bible, Protestantism and the Rise of Modern Science* (Cambridge: Cambridge University Press 2001) [1.2, 3.1]

A fascinating study suggesting that the Reformers' way of interpreting the Bible might have been a key factor leading the rise of modern science.

N. A. Manson (Ed.), *God and Design: The teleological argument and modern science* (London: Routledge 2003) [1.1]

A collection of essays by leading scientists, philosophers and theologians assessing the 'design' argument in all its aspects, including the 'fine tuning' of the physical cosmos to produce life, and many aspects of biological evolution.

Michael S Northcott, *The Environment and Christian Ethics* (Cambridge: Cambridge University Press 1996) [3.1]

Provides a key account of the historical roots of the modern ecological crisis, its linkage to the rise of modern science, and the associated rise of overly rationalist theological accounts of nature.

Arthur Peacocke, *Paths from Science towards God* (Oxford: Oneworld Publications, 2001) [3.3]

A recent work from an outstanding scholar in the science and theology area, which outlines his understanding of the relation between nature and sacrament.

Michael Polanyi, *Science, Faith and Society* (Chicago: Phoenix Books 1964) [1.3]

Rather dated in its specifics, but is a rare (perhaps unique) attempt to compare the structure of the scientific community with that of Protestant and Catholic churches, including their respective modes of authority.

Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (London: Routledge & Kegan Paul 1973) [2.1]

A classic treatment of the role of the human person in scientific knowledge, and the proper scientific study of human persons; replete with relevance for theologizing about science. While little of the book is overtly religious, it ends with a tantalizing statement about worship!

John Polkinghorne and Michael Welker, *Faith in the Living God* (London: SPCK 2003) [2.1]

Theologians from scientific and non-scientific backgrounds engage in a lively dialogue, with results that are more than the sum of their parts.

Paul Ricoeur, *The Rule of Metaphor: Multi-Disciplinary Studies of the Creation of Meaning in Language*. Translated, Robert Czerny (Toronto, University of Toronto Press, 1977) [1.2]

A classic study of this subject.

Christopher Southgate (ed.), *God, Humanity and the Cosmos* (Edinburgh: T&T Clark, 1999) [General]

An excellent all-round introduction to the interaction of theology and the sciences, this multi-authored volume gives a variety of insights from differing perspectives.

Geoffrey Wainwright, *Doxology: The Praise of God in Worship, Doctrine, and Life* (New York: Oxford University Press 1984) [3.3]

A celebrated treatment of liturgical theology. In particular, it shows us how we may think about culture (including science) and ethics within a liturgical framework

Keith Ward, *God, Chance and Necessity* (Oxford: Oneworld Publications 1996) [2.1]
A theologian's response to Richard Dawkins and Peter Atkins.

Margaret Wertheim, *Pythagoras' Trousers: God, Physics and the Gender Wars* (London: Fourth Estate, 1997) [2.2]

A highly original reading of the history of science, especially of physics, making a link between the religious origins of modern science and the striking under-representation of women in the community of scientists (again, especially in physics). Along the way, Wertheim also offers very readable accounts of many aspects of physics.