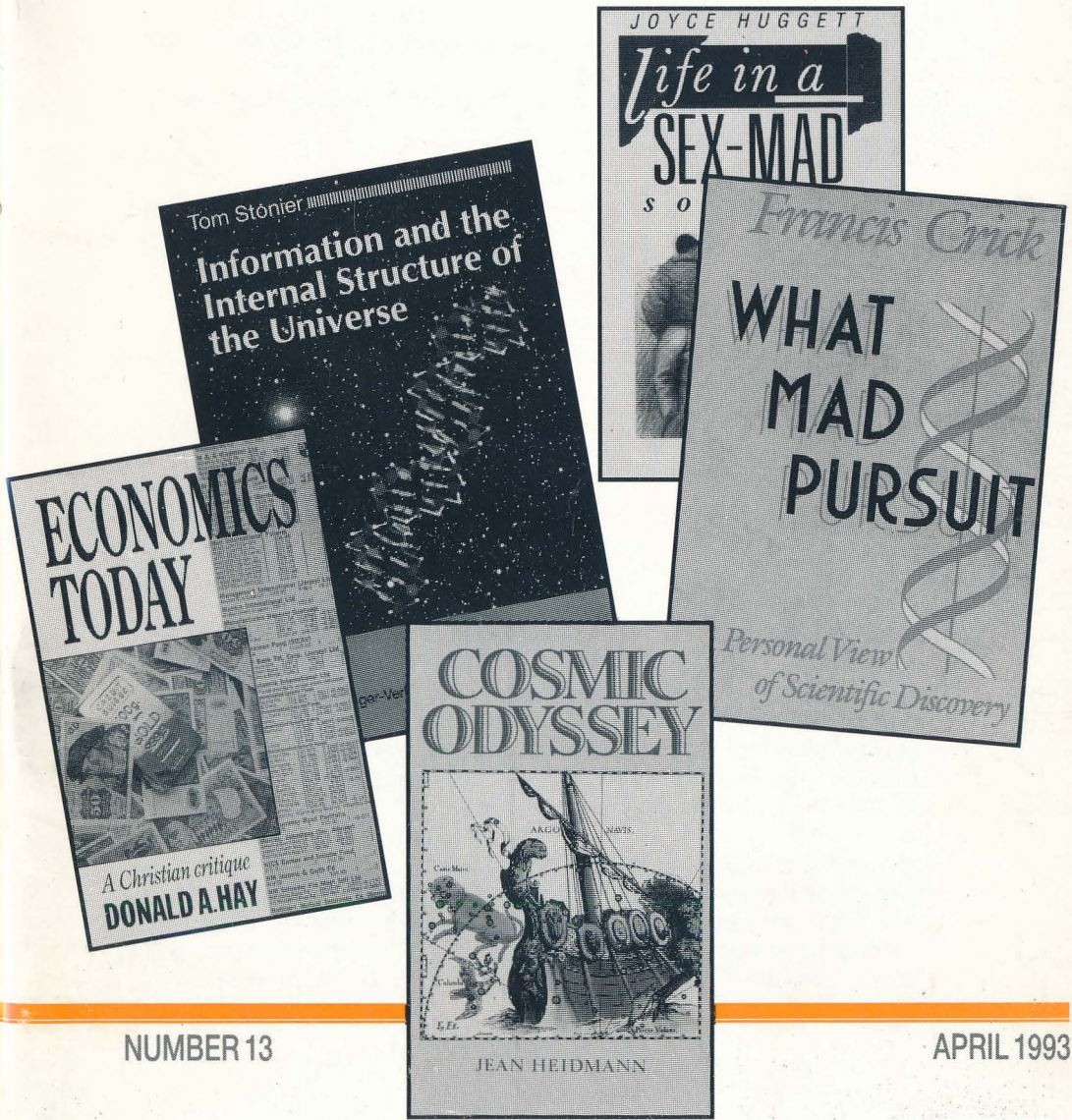
FAITH & THOUGHT

• BULLETIN •



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EDITORIAL

We are pleased to print in this issue a lecture given by the Reverend Dr John Polkinghorne, President of Queens' College, Cambridge to the Hockerill Educational Foundation on November 20, 1992. Information about the H.E.F. will be found at the end of the printed lecture, and we gratefully acknowledge permission to print this lecture in full.

No entry for the Essay Competition (Bulletin 11, April 1992) was deemed worthy of the award, and another competition will be advertised in due course.

The Annual General Meeting for 1993, of which readers may already be aware, will take place on Tuesday, May 11th. The speaker will be D. A. Hay, M.A., M. Phil., who will address the topic 'Can Economics be Trusted?' This promises to be a fascinating lecture.

We have received an offer to post back issues of Faith and Thought

to scientists overseas who would like them. If anybody is interested in this offer, please contact:–

G. S. Cansdale,
Dove Cottage,
Great Chesterford,
Saffron Walden,
Essex. CB10 1PL.

We thank George Cansdale for this kind offer.

NEW MEMBERS OF THE VICTORIA INSTITUTE

(*J*) indicates joint membership of the Victoria Institute and Christians in Science.

Mrs. J. Catherine Munnion	St Albans, Herts
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Mr. David Lorimer	Alresford, Hants *J*

ERRATUM

The Editor regrets the inclusion of two misprints in Bulletin Number 12, October 1992.

On page 2, two lines from the bottom of the page, 'An overall improvement in excess of £24,000' should replace '£2,400'.

On page 3, item 8, the date of AGM referred to should be '1991', not '1990'.

Apologies for any inconvenience caused by these errors.

RELIGION IN AN AGE OF SCIENCE

I have spent most of my working life as a theoretical physicist and all of my consciously remembered life as part of the worshipping and believing community of the Church, so that I am someone who wants to take absolutely seriously the possibility of religious belief in a scientific age. If that belief is to be embraced with integrity, then I think two conditions must be fulfilled:

(1) We must take account of what science has to tell us about the pattern and history of the physical world in which we live. Of course, science itself can no more dictate to religion what it is to believe than religion can prescribe for science what the outcome of its inquiry is to be. The two disciplines are concerned with the exploration of different aspects of human experience: in the one case, our impersonal encounter with a physical world that we transcend; in the other, our personal encounter with the One who transcends us. They use different methods: in the one case, the experimental procedure of putting matters to the test; in the other, the commitment of trust which must underlie all personal encounter, whether between ourselves or with the reality of God. They ask different questions: in the one case, how things happen, by what process?; in the other, why things happen, to what purpose? Though these are two different questions, yet, the ways we answer them must bear some consonant relationship to each other. If I assure you that my purpose is to create a beautiful garden and then I tell you that how I am going to do so is by covering the ground with six inches of green concrete, you will rightly doubt the genuineness of my intentions. The fact that we now know that the universe did not spring into being ready made a few thousand years ago but that it has evolved over a period of fifteen billion years from its fiery origin in the Big Bang, does not abolish Christian talk of the world as God's creation, but it certainly modifies certain aspects of that discourse.
(2) We must understand that religious belief, just like scientific belief, is *motivated* understanding of the way things are. Of course, a religious stance involves faith, just as a scientific investigation starts by commitment to the interrogation of the physical world from a chosen point of view. But faith is not a question of shutting one's eyes, gritting one's teeth, and believing the impossible. It involves a leap, but a leap into the light rather than the dark. It is open to the possibility of correction, as God's ways and will become more clearly known.

Scientists do not ask 'Is that reasonable?', as if we knew beforehand what the world is going to be like. They know that when we move into regimes far away from everyday experience, all sorts of surprising things can happen. Common sense will not be the measure of all things. We are not clever enough to see very far ahead. Therefore, the scientific question is 'What makes you think this might be the

case?', a different question, you see, from 'Is that reasonable?'—a question that is open to the possibility of enlarging our understanding of how things are. Let me give you an example of the surprises that the physical world has proved to have in store for us. If I were to say to you, 'Bill is at home and he is either drunk or sober', you would expect either to find Bill at home drunk or to find him at home sober. It seems trivial and obvious; the learned would say that you have used the distributive law of logic. Oddly enough, the corresponding argument applied to a quantum entity like an electron does not work. The elusive, unpicturable quantum world is found to obey a different kind of logic. May the same not also be true of encounter with divine reality?

In explaining my Christian belief in the setting of an Age of Science, I know it has to be motivated belief, based on evidence that I can point to. The centre of my faith lies in my encounter with the figure of Jesus Christ, as I meet him in the gospels, in the witness of the Church and in the sacraments. Here is the heart of my Christian faith and hope. Yet, at a subsidiary but supportive level, there are also hints of God's presence which arise from our scientific knowledge. The actual way we answer the question 'How?', turns out to point us on to pressing also the question 'Why?', so that science by itself is found not to be sufficiently intellectually satisfying. I want to spend the rest of this lecture sketching these encouragements to religion that are available to us in our Age of Science.

A characteristic of scientific thought is the drive for synthesis. We want to have as unified an understanding as we possibly can. That is the drive behind the present activity in my old subject, particle physics, which is looking for a grand unified theory—a GUT, as we say in our acronymic way. So, it's the instinct of a scientist to seek as economic and as extensive an understanding as possible, a unified understanding of the world. I believe, actually, that the grandest unified theory that you could ever conceivably reach is a theological understanding of the world. Theology is the drive to find the most profound and most comprehensive understanding of our encounter with reality. Now, if we're going to look for such a total theory, there are basically two strategies that are possible, for if we are looking for a total explanation, we won't get it for nothing. Every explanation depends upon certain basic unexplained assumptions. *Ex nihilo nihil fit*, nothing comes from nothing. That's true intellectually, and, therefore any theory of the world will have to have its basic assumptions on which the rest of the understanding is built. There are basically two strategies corresponding to two different choices of

what you regard as fundamental (and so not to be explained.) Firstly, you can just take the brute fact of the physical world as your starting point. That's what somebody like David Hume would take; start with the brute fact of matter as your unexplained basis. Or secondly, you can take the brute fact (if that's the word to use) of God. In other words, one can appeal to the will of an Agent, the purpose of a Creator, as the basic unexplained starting point for understanding the world. The first approach is the strategy of atheism. The second approach is the strategy of theism. I want to defend the second strategy and to explain why I believe that, if we are driven by the desire to have as comprehensive and unified an understanding as possible, we shall find it in a scheme of things that has a place for belief in God.

If we were to start with the brute fact of the physical world, that world is described for us, at least in part, by the laws of science. Therefore, if that's going to be a satisfactory starting place for us, we would have to feel intellectually satisfied with those laws as being a comfortable intellectual resting place, the foundation on which to build the rest of our understanding. The first important point I want to make is to suggest that in fact if we take the laws of nature as discerned by science seriously, and if we look at them carefully, we will find that they are not sufficiently intellectually satisfying in themselves alone. They are not sufficiently self-explanatory to be comfortable resting places, or a natural given foundation for our belief. They seem to have a certain character, which I am going to describe, which actually points beyond themselves. In other words, out of the scientific understanding of the world arise questions which seem to direct us beyond science itself to a deeper level of intelligibility. Here are two examples.

The first example is a fact about the physical world which is very familiar to us, a fact indeed that makes science possible. Most of the time we take it simply for granted, but, if we stop to think about it, I think we'll see that it is not a fact that we should accept without further thought. It is simply this: that we can understand the physical world, that it is intelligible to us in its rational transparency. Not only is that so, but it is *mathematics* which is the key to the understanding of the basic structure of the physical world. It is an actual technique in theoretical physics, a technique that has proved its value time and again in the history of the subject, to look for theories which in their mathematical expression are economic and elegant. In other words, we seek theories which have about them that unmistakable character of mathematical beauty. It is our expectation that it is precisely those theories with that character of mathematical beauty which will prove

to be the ones that describe the structure of the world in which we live.

If you have a friend who is a theoretical physicist and you wish to upset him or her, you simply say to them, 'That latest theory of yours looks rather ugly and contrived to me'. They will be very upset, because you are saying to them 'It doesn't have that indispensable character of mathematical beauty'. When we use mathematics in that way, as a key to unlock the secrets of the universe, something very peculiar is happening. What is mathematics? Mathematics is the free exploration of the human mind. Our mathematical friends sit in their studies, and out of their heads they dream up the beautiful patterns of mathematics. If mathematics is not your subject, just think of mathematics as being a pattern-creating, pattern-analyzing subject. What I'm saying is that some of the most beautiful patterns thought up by the mathematicians are found actually to occur in the structure of the physical world around us. In other words, there is some deep-seated relationship between the reason within (the rationality of our minds—in this case mathematics) and the reason without (the rational order and structure of the physical world around us). The two fit together like a glove. If you stop to think about it, I think you'll see that is a rather significant fact about the world. It's a fact about the world that the mathematicians, in their very modest way of speaking, would describe as non-trivial. Non-trivial is a mathematical word meaning highly significant! Not only does it strike me as significant, but it also struck Einstein that way, which is perhaps more interesting. Einstein once said, 'The only incomprehensible thing about the universe is that it is comprehensible'. Why are our minds so perfectly shaped to understand the deep patterns of the world around us?

You have a choice in these matters. You can always just shrug your shoulders and say, 'Well, that's just the way it happens to be, and a bit of good luck for you chaps who are good at mathematics'. My instincts as a scientist, as someone who is searching for understanding, is not to be as intellectually lazy as that. I want to ask the question a famous theoretical physicist called Eugene Wigner once asked, 'Why is mathematics so unreasonably effective in understanding the physical world?'. You might reply, 'That's pretty easy—evolutionary biology will explain that for you'. If our minds didn't fit the world around us, we just wouldn't have survived in the struggle for existence. Now, that's obviously true, but it's only true up to a point. It's true about our experience of the everyday world of rocks and trees where we have to dodge the rocks and miss the trees, and it's true of our mathematical thinking of the world, which I suppose amounts to a little elementary arithmetic and a little elementary Euclidean geometry.

But, when I'm talking about the power of mathematics to illuminate and give understanding of the physical world, I'm not talking just about the everyday world. I'm talking, for example, about the counter-intuitive, unpicturable quantum world. That is a world that we can't visualize, but we can understand it, and, for its understanding we need very abstract mathematics, ultimately the mathematics of spontaneously broken, gauge-field theories—which I'm sure you'll agree is fairly abstract mathematics!

Paul Dirac invented something called quantum field theory which is fundamental to our understanding of the physical world. I can't believe Dirac's ability to invent that theory, or Einstein's ability to invent the general theory of relativity, is a sort of spin-off from our ancestors having to dodge sabre-toothed tigers. It seems to me that something much more profound, much more mysterious is going on. I would like to understand why the reason within and the reason without fit together at a deep level. Religious belief provides me with an entirely rational and entirely satisfying explanation of that fact. It says that the reason within and the reason without have a common origin in this deeper rationality which is the reason of the Creator, whose will is the ground both of my mental and my physical experience. That is for me an illustration of theology's power to answer a question, namely the intelligibility of the world, that arises from science but goes beyond science's unaided power to answer. Remember, science simply *assumes* the intelligibility of the world. Theology can take that striking fact and make it profoundly comprehensible.

You could summarize what I have said so far by saying that when we look at the rational order and transparent beauty of the physical world, revealed through physical science, we see a world shot through with signs of mind. And, to a religious believer it is the Mind of the Creator that is being discerned in that way. That's one example of how I think our thirst for understanding will take us beyond science and will make science itself, or the brute fact of the physical world, by itself an unsatisfactory intellectual resting place.

Let me give you another example, a scientific discovery of a more specific character that's been made in the last thirty or forty years. We thought a little earlier about the fact that we live in a universe that's had a very interesting history. It started about fifteen billion years ago and it started extremely simple. One of the reasons why cosmologists can talk with great confidence about the very early universe is that the very early universe is so simple, just an expanding ball of energy. Yet, the world that started so simple has become very rich and complex through its evolving history, with you and me as the

most interesting consequences of that history known to us. We are the most complicated physical systems that we have ever encountered in our explorations of the world. So, the history of the universe has been astonishingly fruitful, and we understand many steps in that evolving, fruitful process. When we think about those steps and our understanding of them, we reach a very surprising conclusion.

Scientists can play intellectual games, and they play those games with a serious intent. The sort of game they play is this: when we think of the universe we live in, it is characterized by certain types of scientific laws and certain types of basic forces that go with those laws. For example, we live in a universe which has gravity in it, not just any old gravity, but gravity of a particular type and a particular strength. There is an intrinsic strength to the force of gravity built into the fabric of our universe, into the specification of what sort of world we live in. In fact, it's a very weak force, which might surprise you if you have ever walked out of a second floor window, but the force of gravity is intrinsically very weak. Now we can play intellectual games and say, 'I wonder what the universe would be like, and what its history would have been like, if gravity had been a bit different—if it had been much stronger, or even a little bit weaker than it is'. And we can play similar games with all the other fundamental forces of nature. We can take electromagnetism, the force that hold matter together. You can sit on your chairs because electromagnetism holds them together, and it hold you together as well! We can again say, 'What would the universe be like if electromagnetism were weaker, or if it were stronger?' and so on. We can play these intellectual games and, when we do that, a very surprising conclusion follows. Unless the fundamental physical laws were more or less precisely what they actually are, the universe would have had a very boring and sterile history. In other words, it's only a very special universe, a finely-tuned universe, a universe in a trillion, you might say, which is capable of having had the amazingly fruitful history that has turned a ball of energy into a world containing you and me. This insight is called the anthropic principle: a world capable of producing *anthrópoi*, (complicated consequences comparable to men and women) is a very special finely-tuned universe. It's a very surprising discovery!

Let me illustrate why we think that's so. If you are to have a fruitful universe, one of the things you've got to have in it are stars. And, you've got to have stars of the right sort. The stars have two jobs that are absolutely indispensable to the fruitful history of the universe. One is, they have to act as long-term, steady energy sources. Essentially all our energy here on earth comes from the sun, either directly or indirectly through fossil fuels. The sun has been burning

steadily for about five billion years and it will continue to burn steadily for about another five billion years more. You need that for the development of life. You must have long-term energy sources, because it takes billions of years for life to develop, and you must have steady energy sources, because stars that flared up or died down would either burn life to a frazzle or freeze it to death. So you must have what we call main sequence stars which are steadily-burning, long-lived stars. Now, we understand what makes them burn in that sort of way. Basically, it's the balance between the force of gravity and the electromagnetic forces. If you were to alter either of those forces, you would put the stars out of kilter. You'd have stars that either burned up very rapidly, that lived just for millions of years rather than billions of years, or you'd have stars that were very turbulent and unstable and flared up and died down, and that would be disastrous. No life could develop in a universe of that character. So you see how difficult it is to design a fruitful universe. You've got to get the right balance between gravity and electromagnetism to make the stars act as acceptable energy sources for life. But that's only part of the story, because the stars have another tremendously important thing to do. The nuclear furnaces that burn inside the stars are the source of the chemical elements which are the raw materials of life. The early universe is very simple, and because the early universe is very simple it only produces very simple consequences. In fact, the very early universe can only make the two simplest chemical elements, namely hydrogen and helium. And they are just not rich enough in their chemistry to make life possible. For life you need a much more complicated chemistry than hydrogen and helium by themselves could sustain. In particular, you need the chemistry of carbon, which has the ability to make those immensely complicated macro-molecules which are the basis of the possibility of life. Every atom of carbon inside your body was once inside a star; we are all made from the ashes of dead stars. The only place you can make those heavier elements which are indispensable as the constituents of life is inside the right sort of stars, and it's pretty difficult to make the stars do that. What you have to do is first to make carbon by making three helium nuclei stick together. That's actually quite hard to do and it depends upon very delicate aspects of the nuclear forces. Now, suppose you've figured out how to do that. You can't sit back and feel satisfied, because carbon in not enough. You've got to make lots more elements. You've got to make oxygen for example. That means making another helium atom stick to the carbon you already made and turn the carbon into oxygen. You've got to do that, but you must not overdo it. You mustn't turn all the carbon into oxygen otherwise

you've lost the carbon. So, you've got to get all these balances right, and so on, and so on, up to iron. If you can just tune the nuclear forces right, you can make all the elements up to iron inside the stars, but iron is the most stable of all the nuclear species and you can't get beyond iron inside the stars. So, you've still got two problems left that you've got to solve. You'll need to make some of the heavier elements beyond iron, some way or another, and you also have to make accessible for life the elements you've already made. It's no good making carbon, oxygen, and all that, and leaving them locked up, useless, inside the cooling core of a dying star. You'll have made the elements, but they won't be of any use to bring about life. You've got to make sure that your stars are such that when they come to the end of their natural life, which is about ten billion years, some of them will explode as supernovae and so will scatter out into the environment those chemical elements that they've made. If you're made from stardust, there's got to be some dust from stars around for you to be made of. You've got to have stellar explosions. And, if you're very clever, you can arrange in the explosion that the neutrinos, as they blow-off the outer layer of the star, then make those heavier elements like lead and so on that you couldn't make inside the star itself. The details don't matter very much, but I hope I've given some feeling that making elements is a very complicated process, which depends for its fruitfulness on a very delicate, fine-tuned balance between the nuclear forces that control these processes. If those nuclear forces were in any way slightly different from the way they actually are, the stars would be incapable of making the elements of which you and I are composed. That gives you some idea how difficult it is to make a fruitful universe. There are many, many other considerations of that kind.

I'll move on to ask the question, 'What do we make of the fact that the world we live in is only fruitful because it's given basic scientific constitution is of a very special, very finely-tuned character?' Once again, you can shrug your shoulders and say, 'Well, that's just the way it happens to be. We're here because we're here and that's it'. That doesn't seem to me to be a very rational approach to the issue. I have a friend, John Leslie, who is a philosopher at Guelf University in Canada, and he writes about these questions. He has written far and away the best book about the anthropic principle, called *Universes*.* He's a beguiling philosopher because he does his philosophy by telling stories, which is a very accessible way for those of us who are not professionally trained in philosophy to understand it. He tells the

* reviewed on p. 20.

following story. You are about to be executed. Your eyes are bandaged and you are tied to the stake. Twelve highly-trained sharp shooters have their rifles levelled at your heart. They pull the trigger, the shots ring-out—you've survived! What do you do? Do you shrug your shoulders and say, 'Well, that's the way it is. No need to seek an explanation of this. That's just the way it is'. Leslie rightly says that's surely not a rational response to what's going on. He suggests that there are only two rational explanations of that amazing incident. One is this. Many, many, many executions are taking place today and just by luck you happen to be the one in which they all miss. That's a rational explanation. The other explanation, is, of course, that the sharp shooters are on your side and they missed by choice. In other words there was a purpose at work of which you were unaware.

You see how that parable translates into thinking about a finely-tuned and fruitful universe. One possibility is that maybe there are lots and lots of different universes, all with different given physical laws and circumstances. If there were lots and lots of them (and there would really have to be rather a lot) then just by chance, in one of them, the laws and circumstances will be such as to permit the development of carbon-based life. But, of course, that's the one in which we live, because we couldn't appear anywhere else. It's a possible explanation that's called the many-universes interpretation. The other possibility is that there is more going on than has met the eye and the sharp shooters are on our side. That translates into the idea that this is not just any old universe. Rather it is a universe which is a creation which has been endowed by its Creator with just those finely-tuned given laws and circumstances that will make its history fruitful. It is the fulfilment of a purpose.

Leslie says in relation to the anthropic principle that there is an even-handed choice between those two possibilities. By itself, I think that is correct. Let me emphasize that both are metaphysical explanations. We have no adequate, scientific motivation for thinking of any other universe but the universe of our direct experience. So the speculation that there are many, many other universes is a metaphysical speculation. I'm not against metaphysics. In fact, you can't live without it, but the many-universes interpretation is a metaphysical speculation just as the existence of a Creator is a metaphysical speculation. Of course, if you think there are other reasons, as indeed I do, for believing that there is a God whose will and purpose lies behind the universe, then that second explanation, that the world is fruitful because it is a creation, becomes the more economic and persuasive explanation. That, of course, is the one to which I myself adhere.

So, in the intelligibility of the world and the finely-tuned fruitfulness

of the world, we see insights arising from science, but calling for some explanation and understanding which, by its very nature will go beyond what science itself can provide. And that shows to me, at any rate, the insufficiency of a merely scientific view of the world. In fact, I think we're living in an age where there is a great revival of natural theology taking place. Natural theology is the attempt to learn something about God by the general use of reason and by inspection of the world. That revival of natural theology is taking place, not on the whole among the theologians, who have rather lost their nerve in that area, but among the scientists. And not just among pious scientists like myself, who would be rather inclined to think that way, but among scientists who have no particular time for, or understanding of, conventional religion, but who, nevertheless, feel that the rational beauty and the finely-tuned fruitfulness of the world suggest that there is some intelligence or purpose behind the universe which is more than has met the scientific eye. That revived natural theology is also *revised* in the sense that it is more modest in its ambitions. Unlike either the natural theology of the late middle ages or the eighteenth century, it doesn't claim to talk about *proofs* of God. We're in an area of discourse, of the search for understanding, where knock-down argument or proof is not available to anyone. But we are in an area where we're looking for insights which are intellectually satisfying. I wouldn't want to say that atheists are stupid, but I would want to say that atheism is less intellectually satisfying and less comprehensive in the understanding it provides, than is a theistic view of the world.

That's part of the story and these are gifts that theology gives to science. It offers science a deeper, more comprehensive understanding than would be obtained from itself alone. But there is traffic across the border in both directions and I'll spend a few moments talking about what I think are the gifts that science gives to theology in this Scientific Age. That kind of gift is rather different—for it is to tell theology what the physical world is actually like in its structure and in its history. That raises issues to which theology has to address itself.

Let me begin by saying just a word about what many people think is the classic interaction between science and theology, namely the question of origins. How did things begin? Actually I don't think that's a very important subject, and that people are mistaken if they think it is. They are in error because they wrongly think that the theological doctrine of creation is concerned with how things began. Who lit the blue touch paper of the big bang? The doctrine of creation isn't about that. It's not concerned with temporal origin, but with ontological origin. It answers the question, why do things exist at all? God is as much the Creator today as he was fifteen billion years ago. Thus

though big bang cosmology is very interesting scientifically, theologically it is insignificant. Therefore, if my friend and former colleague, Steven Hawking comes along, as he does in his book, *A Brief History of Time*, and says that if you think about quantum cosmology and how quantum mechanics fuzzed out the very early universe, then, though the universe has a finite age, it has no dateable beginning, that's a very interesting scientific speculation, but there's no particular theological mileage in it. Hawking writes, 'If there is no beginning, what place then for a Creator?'. It is theologically naive to answer other than by 'Every place, as the Sustainer of the universe in Being'. God is not a God of the edges, with a vested interest in beginnings. God is the God of all times and all places. So I think the question of origins is not terribly important theologically, though it is certainly interesting scientifically.

Much more interesting is the question of the process of the world. How does the world history unfold? It is in sustaining the fruitful process of the world that God is at work as the Creator, as much today as he was fifteen billion years ago. When we think about the process of the world, we get two insights that come to us from science which we have to take seriously and to think about. I've talked about that very fertile process which turned a ball of energy into a world containing you and me, and I've said that it could only happen in a very special, finely-tuned sort of universe. Let's now go on to ask the question: Given we've got a universe with fine-tuning (given we've got the right ground rules) how does it actually come about that the world makes itself? How does it realize its in-built fruitfulness, its in-built potentiality? We understand many bits of that process quite well. All those bits we do understand seem to realize that fruitfulness through an interplay between two opposing tendencies which, in a sort of slogan-way, we could describe as 'chance' and 'necessity'. Those are slippery words and I have to explain what I mean by them. By 'chance', I mean simply happenstance—just the way things happen to be. When the universe was about a billion years old, there just happened to be a little bit more matter here than there. That was chance—happenstance—getting things going. That happenstance produced something lasting through the operation of 'necessity', that is to say, lawful regularity, because, if there is a little bit more matter here than there, then that matter exerts a little bit stronger gravitational pull, and it draws more matter to itself in a sort of snowballing process. That's how we picture the universe, which started so uniform, began to get a bit grainy and lumpy, an essential step in its fruitful history. You've got to have the stars and you've got to have the galaxies that contain the stars. A fruitful universe has to

become lumpy at some stage. That begins through chance, happenstance, and develops through necessity, snowballing through the attractive force of gravity. And, it seems that the interplay between those two tendencies, chance as the origin of novelty, and necessity as the sifter and preserver of the novelty thus produced, is the prime way in which the fruitfulness of the universe is realized. A much more familiar example is provided by biological evolution. Mutations occur through happenstance. That produces some new possibility for life, which is then sifted and preserved in the lawfully regular environment which is necessary for the operation of natural selection. In every stage of the fruitful history of the universe there is an interplay between chance and necessity. Now, the question is, 'What do we make of that?'.

A very great French biochemist called Jacques Monod wrote a famous book in the early 1970s whose English translation is called *Chance and Necessity*. And in that book, Monod says, with passionate Gallic rhetoric, 'Pure chance, absolutely free but *blind*, lies at the basis of this stupendous edifice of evolution'. Of course the word where Monod puts in the knife is the word 'blind'. For Monod, the role of chance, of happenstance, in the evolving history of the universe subverts the religious claim that there is a purpose at work in the world. For Monod, the role of chance means that ultimately the universe is a tale told by an idiot. That's how he sees it.

Here is a serious challenge which we have to address. I would approach it this way. There is no unique way of going from physics to metaphysics, from science to a deeper view. I will take the same scientific picture of the interplay between happenstance and regularity, but offer an alternative interpretation of it and, I would venture to say, a more evenhanded interpretation, which lays as much emphasis on the necessary half as upon the chance half of the process. I respectfully suggest that when God came to create the world he was faced with a dilemma. The Christian God is a God of love and the gift of love is always the gift of independence, the genuine otherness of the beloved. Parents know that. There comes a time when Johnny has to be allowed to ride his bicycle into dangerous traffic on his own. The gift of love is a gift of a true independence. So, a God who is loving will endow his creation with its own due freedom, its own due independence. But, independence by itself can easily degenerate into simply licence and chaos. However God is not only loving, he is faithful. And the god who is faithful will surely endow his creation also with the gift of reliability. Yet reliability by itself can easily rigidify into a merely mechanical world. I believe that the Christian God, who is both loving and faithful,

has given to his creation the twin gifts of independence and reliability, which find their reflection in the fruitful process of the universe through the interplay between happenstance and regularity, between chance and necessity. That would be my re-interpretation of this insight into the fruitful physical process.

There is a second thing I want to say, and it's this: many people have a picture of the physical world which is very outdated. The great triumphs of the science in the eighteenth century, and the further discoveries of the nineteenth century, encouraged a view of the physical world as if it were in some sense mechanical, a rather rigid and deterministic world. Actually, we've always known that can't be right, because we've always known as an absolutely basic fact of human nature that we have the experience of choice and responsibility. In the twentieth century we have made further scientific gains and twentieth-century science has seen the death of a merely mechanical view of the world. In part, that is due to the cloudy fitfulness of quantum theory lurking at the atomic and sub-atomic roots of the world. But I think, more importantly still, it is also due to another unexpected insight of science gained in the last thirty–forty years. Even the physics of the everyday world, even the physics of Newton, is not as mechanical as Sir Isaac and his followers would have thought it to be. That's a very surprising discovery. Those of us who learned classical physics, learned the subject by thinking about certain tame, predictable systems, like a steadily ticking pendulum. That's a very simple robust system. If you take a pendulum and slightly disturb it, or you are slightly ignorant about how it is moving, the slight disturbance only produces slight consequences, the slight ignorance only produces slight errors in your estimation of how it will behave. We thought the everyday physical world was all like that. It was tame, it was predictable, it was controllable—in a word, it was mechanical. Now, we've discovered that, in fact, almost all the everyday physical world is not like that at all. Almost all of the everyday physical world is so exquisitely sensitive that the smallest disturbance produces quite uncontrollable and unpredictable consequences. There are very many more clouds than clocks around. This is the insight that is rather ineptly named chaotic dynamics, and it came as a very great surprise to us. It is not altogether astonishing that the discovery was first made in relation to attempts to make models of the earth's weather systems. In the trade it is sometimes called the butterfly effect: that the great weather systems of the earth are so sensitive to individual circumstance that a butterfly stirring the air with its wings in Beijing today will have consequences for the storm systems over London in a month's time. Now, that world—that exquisitely sensitive

world—is an intrinsically unpredictable world. We can't know about all those butterflies in Beijing. So, we've learned that the physical world, whatever it is, it certainly isn't mechanical, even at the everyday level. It is something more subtle and more supple than that. To do justice to the full development of the argument, I'd need to say a good many more things, but I think already one can see the beginnings of a picture of the physical world that is unpredictable in detail and open to the future. That is a gain for *science*. Science begins to describe a world which is sufficiently flexible in its developments, a world of true becoming, of which we can consider ourselves as inhabitants. The future is genuinely new, not just a rearrangement of what was there in the past. In such a world of true becoming, with its open future, we can begin to understand our own powers of agency, our own powers to act and bring things about. I would want to say also that such a physical world is one which, in my view, is capable also of being open to God's providential interaction and his agency in the world. So that whole picture of the physical world has been loosened up. It is much more hospitable to the presence of both humanity and divine providence than would have seemed conceivable a hundred years ago.

It is time for me to come to an end. I'd like to finish with a quotation which in many ways summarizes for me what I'm trying to do in my own intellectual exploration as someone who is both a physicist and a priest. You see, I want to hold these two parts of me together, not without puzzles, of course, but I hope, without dishonesty, and without compartmentalism. I don't want to be a priest on Sundays and a physicist on Mondays. I've tried this evening to show one or two examples of how science and theology interact positively to help each other, how religious belief is possible with integrity in an Age of Science. So let me end with one of my favourite quotations from a great Thomist thinker of this century, Bernard Lonergan. He once said this: 'God is the all-sufficient explanation, the eternal rapture glimpsed in every Archimedean cry of 'eureka'. I like that very much. The search for understanding, which is so natural to a scientist is, in the end, the search for God. That is how religion will continue to flourish in this Age of Science.

J. C. POLKINGHORNE

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REASON AND FAITH: A RESPONSE

The April *Faith and Thought* carried a 'review' by Melvin Tinker of the book *Reason and Faith* (Monarch 1989) by Roger Forster and myself. What is actually contained was an extended attack on the 'Arminian' position of our work. Now our book is 480 pages long, and our 'Arminian' viewpoint directly affects our comments on pages 206, 232–4 and 406, and indirectly affects our comments on Donald MacKay on pages 187–8 and 410–411. Outside these pages it has little, if any, relevance. His review, then, focuses on less than 2% of our book. In view, moreover, of the tone of his review, it seems ironical that he accuses us of 'rather patronizing treatment of other people's work with which they disagree'—a charge which we would dispute.

In view of this, I would like to make some points of clarification to our fellow members of the Victoria Institute.

Dr. Tinker is 'seriously unhappy' on two counts with our book. Firstly, the late Professor D. M. MacKay was a Christian thinker of great integrity whom we respected greatly but with whom on certain points we did not agree. Dr. Tinker accuses us of having 'balefully misunderstood and misrepresented' him. Since my dictionary renders baleful (not a word I much use) as 'evil' or mischievous I am shocked at this accusation. All thinkers, of course, may have elements of individuality in their thinking, but our classification of MacKay as a Christian Perspectivalist is paralleled by Mary Stewart Van Leeuwen in *The Person in Psychology* (p. 90), who also uses the term 'perspectives' to which Tinker objects. Has she too 'balefully misrepresented' MacKay? In actual fact, Tinker interprets Mackay as saying: 'mental activity determines brain activity' (p. 21); MacKay himself said: 'it is misleading and dangerous to discuss the relation between mental activity and the corresponding brain activity as one of cause and effect.' (*Christianity in a Mechanistic Universe* p. 61). The reader may judge. We recognize that of the two great Christian viewpoints on mind Professor MacKay took one (Perspectivalism) and we take the other (Dualistic-interactionism). We remain convinced that his attempt to allow insanity as a grounds of non-responsibility is inconsistent in his terms, since there is as much reason to assume that logical indeterminacy applies to the insane as to the sane. The reader must, however, decide for him/herself from MacKay's works and our comments. Finally, we do not believe Professor MacKay, for all his profundity of thought, could ever answer from his premises our question as to why God would wish to 'create and sustain a world in which human wills were causally determined to sin'. Dr. Tinker also seems to have no answer. After picking unconvincingly at our terminology, he retreats into divine inscrutability where he is, of course, unassailable.

Dr. Tinker's 'next major concern' with our book is actually the only other one he addresses. He ascribes our rejection of the distinctive views of original sin which were invented by Augustine and adopted (admittedly with modifications) by Luther and Calvin, to some obscure German figure in whom neither of us are interested. It was actually based on an extensive reading of the works of Augustine and other early Fathers, and the Manichaean background, and was addressed in more detail in our earlier work *God's Strategy in Human History*. Dr. Tinker's claim that in Psalm 51.3 the 'theological and existential referent is *beyond doubt*' (my italics) is extraordinarily dogmatic, and he makes no reference to our point that Psalm 51.4 is never used in

this kind of way. The slur of our being perilously close' to Pelagianism is a nonsense. It illustrates the unfortunate tendency of some British Calvinists to try to equate Evangelicalism with Calvinism— an odd approach in view of John Wesley's place in the Evangelical movement. *Reason and Faith* itself is not about the theology of sin and salvation, but both Roger and myself have written other books which make our Evangelical orthodoxy on such issues very clear. Of course we recognize that Paul speaks of a 'sin principle' at work, but we find no Biblical evidence, in Romans 5–8 or anywhere else, that people are considered as sinners for any reason other than that they have committed sin. Intransigent Calvinists sometimes found John Wesley's theology 'disquieting' (review, last para) and Wesley also suffered absurd accusations of Pelagianism', but we little expected such things in the pages of *Faith and Thought*.

The really sad thing is that, with all Dr. Tinker's comments directed at less than 2% of our book's content, the reader is given little real idea of the book's contents: it is not about the Arminian/Calvinist debate but about the relationship between objective thought and Christianity. As committed Fundamentalist/Evangelicals (in the true sense of these often misused terms!) Roger and I share the passion of the great Fundamentalist and Evangelical figures of the past to 'give reasons for the faith that is within us'. The Victoria Institute itself has, indeed, been a prime meeting place for those with exactly just such a concern. The writings of one such, the late Professor F. F. Bruce, were a great encouragement to me as a young Christian student in a hostile secular environment, and it was a thrill to me for him to write in the foreword to our book: '*I have great pleasure in recommending this work to all who have an interest in the relation between reason and faith*'. Our desire, like his, is to challenge the uncommitted and encourage Christians, and to 'demolish arguments and every pretension that sets itself up against the knowledge of God, and take captive every thought to make it obedient to Christ . . .' In pursuing this aim we acknowledge debts to many Christians (such as D. M. MacKay) with whom we do not agree on all points. Readers of our own book, which is 480 pages long and attempts a summary and analysis across a whole range of 'reason and faith' issues, are almost certain to find *some* point somewhere in it with which *they* cannot fully agree. But out hope is that they *will* find much in it which may stimulate them as they develop their own understanding of the issues. Our further hope is that Evangelicals in our own generation may carry on the work on reason and faith for which the Victoria Institute stands, and if we can play some small part in this we will be satisfied.

V. PAUL. MARSTON

LETTERS

Dear Sir,

Interesting and thought-provoking though I found Clifford Rivington's recent article 'Neighbours Unborn', I must take issue with him that the Second Coming of Christ has already taken place. True, it has a superficial attractiveness in overcoming the difficulties associated with Jesus' prophecy that 'there are some standing here who will not taste death before they see the Son of Man coming in his kingdom' (Matthew 16:28) and similar passages. It is also true that Peter tied in the phenomena associated with Pentecost with the apocalyptic prophecy of Joel concerning the Day of the Lord. Nevertheless, angels told the disciples clearly after the Ascension that 'this Jesus, who was taken up from you into heaven, will come in the same way as you saw him go into heaven' (Acts 1:11), and this certainly did not happen at Pentecost!

The teaching of the Apostles after Pentecost had happened is clear, e.g. Paul: 'Now concerning the coming of our Lord Jesus Christ . . . we beg you, brethen, not to be quickly shaken in mind or excited, either by spirit or by word, or by letter purporting to be from us, to the effect that the day of the Lord has come. Let no one deceive you in any way; for that day will not come, unless the rebellion comes first . . .' Peter was also clear that at Pentecost, Jesus Christ had poured out the Holy Spirit whom He had received from the Father (Acts 2:33). I fear in the words of the Athanasian Creed that Clifford Rivington is 'confounding the Persons of the Trinity'.

Yours sincerely

DR. STEPHEN WALLEY

BOOK REVIEWS

John Leslie *Universes*, Routledge 1989; 229 pp, Hardback, £35

This book contains an excellent and authoritative review of the present status of the 'design argument' for the existence of God; the argument that the natural universe is so amazing that its existence requires a purposeful designer. The claim that, given enough time, together with the evolutionary force of natural selection, anything that *can* happen *will* happen seriously undermined this argument. However, increased scientific understanding has reinstated it by revealing that in order for something as complex as life even to be

possible, there has to be a remarkable series of apparent 'accidents' which surely require some explanation.

The only alternative to an explanation requiring a designer, is that there is a sufficiently large number of sufficiently different 'universes', so that it would be reasonable to suppose that in at least one of them these accidents would occur and that conditions would be right for life to evolve.

After a useful opening chapter in which all the relevant issues are summarised, the book has four chapters which are devoted to showing why there really is something requiring explanation. Two of these give detailed discussions of the fine-tuning required for the fundamental constants of nature and the 'initial conditions' of the universe; one elaborates on why 'life' is sufficiently remarkable that its existence in the universe should be regarded as significant, and the other deals with the Anthropic Principle, showing in particular that this cannot provide the complete explanation.

Chapter five is devoted to a discussion of how different universes may occur. They may, for example, exist at different times; the universe may undergo successive periods of expansion and contraction to some sort of 'singularity' from which it bounces with new, perhaps randomly selected, physical properties. Alternatively they may somehow coexist, as for example in the many-worlds interpretation of quantum theory. Much of the discussion here is close to the edge of our present understanding of physics. In particular, it seems to be a necessary aspect of the argument that very different forms of physics—perhaps different laws, certainly different constants—are possible. Thus a *unique* 'theory of everything' would not be acceptable.

Two chapters are given to discussing the alternative, theistic, explanation for the amazing properties of our world; one describes the modern version of the design argument and the other the nature of the God it suggests. The final chapter, entitled 'Conclusions', does not argue for either choice; rather it emphasises the main claim of the book: 'God is real and/or there exist vastly many, very varied universes'.

John Leslie has written a book which is well balanced, free of extravagant claims and enjoyable to read. I liked his use of simple analogues to illustrate the more subtle arguments and I never felt that I was reading the work of yet another philosopher who failed to understand physics. The discussion of many-worlds quantum theory given in the book is, in my opinion, incomplete, and I was disappointed to see that the idea of consciousness was not con-

sidered relevant (the word is not in the index). The fact that there is purpose in the universe (I know this because I experience it) is surely important.

E. J. SQUIRES

Professor of Mathematical Sciences, University of Durham, U.K.

L. Tomatis and others (Editors) *Cancer: Causes, Occurence and Control* International Agency for Research on Cancer. IARC Scientific Publication no.100. Oxford University Press 1990; 352 pp, £24.

This compendium on the present knowledge on cancer incidence is exactly what its title suggests. That is, there is no information on treatment, cure or genetic factors, and this is spelled out by the editors at the start. However, this is a very detailed report on the situation at the time of publication, and very well referenced (up to 1989) for further study. It seemed to this reviewer that the book could be read by any lay-person unfamiliar with the field, and the editors are to be congratulated in making the book uniform in style. The Introductory chapter, though only 8 pages long, covers the whole area of cancer incidence and therapy in a very readable way, and although it is only a summary, I am sure that any reader would get the feel of the whole breadth of what is known at this time from this alone. Thereafter, following chapters deal with occurence, epidemiology by site, causation by a great variety of agents, dietary factors, detection and screening, etc. Methods of control figure largely, prevention and early detection being paramount here. All these chapters contain a breakdown by sites in the body. An appendix covers the incidence of cancer by site in the countries of the world, and there is a good index. References abound at the end of each chapter. My only criticism would be that there are a few errata which need to be watched, e.g. in two places pages have been reversed and in another place a sentence needs to be corrected. One hopes that other similar mistakes have not escaped the editors' proof-reading.

A. B. ROBINS

Editor of Faith & Thought Bulletin, formerly in Cancer Research.

Charles P. Henderson, Jr. *God and Science: the Death and Rebirth of Theism* Atlanta: John Knox Press, 1986; 186 pp, S.C.M. (UK). Paperback, £10.00.

The author of this book has undertaken an ambitious task. He sets out to develop a case in favour of belief in God by turning on their heads

several of the traditional arguments used against religion. His method is to consider the contributions of Darwin, Marx, Freud, Einstein, Tillich and de Chardin, along with the ideas of Capra and Zukav, evaluating and developing them from a Christian stance.

The degree of success is not uniform. The author's scientific qualifications are not stated (he is pastor of the Central Presbyterian Church in New York and Assistant Dean of Chapel at Princeton), but his theological knowledge seems stronger than his science in several areas. It is unfortunate that he accepts unquestioningly the thesis of the conflict between science and religion, despite the evidence that this was always exaggerated, and deliberately fostered by T. H. Huxley and his associates.

The chapter on Marxism has been overtaken by recent events in eastern Europe and elsewhere; to read that 'more than half the world's peoples live under . . . Marxism' is a reminder of how rapid change has been. It is more surprising that in the disussion of modern physics there is no mention of 'chaos' theory, the anthropological principle or Stephen Hawking. An extended discussion of the implications of quantum theory is undertaken without any reference to the disagreements about its interpretation.

There is also doubt about what constitutes science. While stating explicitly of Marx that 'his social theories were dogmatic rather than scientific', there is no such qualification about Freud, for whom the author seems to have a totally uncritical admiration: 'His insights have been invaluable in the treatment of mental disease of all kinds; his methods represent the single most important contribution to mental health in this century'. The fact that for many scientists Freud's ideas would not qualify as science is not mentioned.

The description of Darwin's work is more balanced, with considerable reference to the ideas of Stephen Jay Gould as an opponent of Christianity. However it nowhere emerges that the 'conflict' between evolution and creation is mis-conceived because they are addressing different types of question. Teilhard de Chardin is clearly highly regarded by Henderson, who seems not to recognise any theological or scientific limitations in his thinking. He also makes a surprisingly positive assessment of Paul Tillich: 'he put forward such a persuasive case for Christianity that it surpasses all the old proofs put together'.

While being heavily critical of Fritjof Capra and Gary Zukav, and pointing out that Biblical religion has many of the characteristics they attribute to 'eastern' religions, it is curious that the author consistently refers to Judaism and Christianity as 'western' religions, which is to say the least misleading.

In many sections of the book the argument is in very general terms,

and for that reason lacks sharpness. In the final chapter the author attempts to show that the classical proofs for the existence of God can be replaced by new ones based upon the ideas of science he has discussed earlier. Here he certainly overstates his case, something he is inclined to do throughout the book: 'If we can coordinate the very best we have received in our faith with the very best we have achieved in our science, then we will have provided the world with an incontrovertible new proof for the reality of God'. At this point presumably faith becomes superfluous.

There are certainly serious weaknesses in this book, although much of it provides interesting commentary from a Christian perspective on the thinkers considered. Probably the original aim was over-ambitious. Had the author limited himself to demonstrating the various ways in which modern science gives a picture which is not inconsistent with belief in God, and is in some ways suggestive of a creator, he might have produced a more effective book.

JOHN BAUSOR

Secretary of Christians in Science Education: formerly senior science inspector of the ILEA and now an educational consultant.

The *Faith & Thought Bulletin* first appeared in 1985 under the title *Faith & Thought Newsletter.*

The new title reflects a wider coverage, since it will contain some short articles, notes and book reviews, in addition to the news items hitherto, which would not fall within the purview of the journal.

It is published by The Victoria Institute and mailed free to all Institute members, along with *Science and Christian Belief.*

The journal *Science and Christian Belief* is published jointly for VI and CIS. It replaces the CIS (previously RSCF) *Newsletter* and the VI journal *Faith & Thought,* the final number of which was volume 114 No 2 October 1988.

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