Science and Religion

Michaelmas Term, 2013

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Newton's Apple: Forbidden Fruit?

Science and Religion Introduction

13th October, 2013

Rev Dr Simon Perry

The word 'scientist' was first used here in Cambridge. It was here that Stephen Hawking first showed that the universe is expanding; that Watson and Crick solved the structure of DNA; that J.J. Thompson discovered the electron; and of course, that Isaac Newton discovered gravity. In fact, if you go to the botanical garden you can see a clone of the tree from which Newton's famous apple is said to have fallen. There are members of the university who, this week, are eating apples from Newton's tree.

Is it forbidden fruit? Newton's apple is dangerous: When Newton discovered gravity, it did not simply pull apples from trees, but sparked a revolution that pulled bishops from their seats and kings from their thrones and in the end, in the popular mind-set it pulled god down from heaven. The so-called scientific revolution of the seventeenth century has had massive repercussions in the modern west – and left us with a particular understanding of what science is – and that is what we are looking at during the Sunday evening services this term.

The popular understanding of science runs something like this: – is that it was born in ancient Greece, developed in ancient Rome, and continued to progress until Christianity became the dominant religion. The Christian God didn't think much of science – and wanted to see it abolished. Knowledge was forbidden, because God prefers people to be stupid and ignorant. The more that science expanded its territory, the more God himself was forced into retreat. The church of Christendom, seeing the threat and desperate to defend its divine fairy tale against those who were slowly but surely picking it to pieces, reacted violently. But … science was an unstoppable force that would march forwards through time, evicting God from the public sphere, forcing him to take up residence in ever-shrinking 'gaps' beyond either the reach or interest of science.

After three centuries in which the scientific empire enlarged its territory by wrestling truth out of the unknown, God himself had aged considerably and was forced to accept his weakened status. Having once been a powerful, malevolent dictator, he was now shuffled out of the world of public life, away into a celestial nursing home. From here, any claims he makes are heard as the toothless, meaningless and pointless ramblings of a being who has lost all connection with reality.

This popular story of the relationship between science and religion is mythological through and through – no matter how many scientists subscribe to it. Its credibility in the world of serious contemporary peer-reviewed historical scholarship is identical to the status of a seven-day creation or a literal worldwide flood. It is a persistent myth, nevertheless, passionately defended by those who believe that science and religion are mutually incompatible.

Science is simply a way of knowing, of making sense of our experience of the world. Traditionally we do that through the five senses – but where do we inherit the belief that there are only five? It is, in fact, Aristotle who taught that there are five senses: Through the early Middle Ages, Aristotle had been largely forgotten in the West, but Islamic scholars had long retained their interest in Aristotle, and after the crusades, he was eventually popularised in the west – where his writings gained near infallible status. Part of his legacy is the infallibility with which his thought is still treated, even unwittingly, even by some scientists.

Might it be possible that scientific perception is itself destined to remain severely limited, because there are other ways of knowing and experiencing the world that are currently viewed as ‘unscientific’ because they do not fit Aristotle’s model? Is it possible that there are major facets of the universe that simply do not register on the radar of human perception? To insist that everything in the universe gains its existence from revealing itself to the five senses identified by an ancient Mediterranean philosopher hardly sounds scientific. The infallibility Christendom bestowed upon Aristotle continues to assert itself through the secular arguments of science – proving that even in the sterilized sanctity of the lab, (as Julian Barnes famously wrote) “history just burps, and we taste again that raw-onion sandwich it swallowed centuries ago.”

Conclusion

Being scientific, after all, like being Christian, requires that we embrace what human life really is. A human being is an assembly of subatomic particles, which – for a tragically miniscule nano-fragment of time – have taken the form of carnal matter. We are comprised exclusively of shrapnel from the big bang, human wreckage, briefly animated corpses. The entire life span of our race, the greatest heights of our civilization and the profoundest depths of our love, occupy no more than a hideously insignificant splinter of history. And so we are left floating through a dark corner of time and space, through the unfathomable expanse of infinite void, until we are soon engulfed in the cold shadow of eternal silence.

How do we cope with this scientifically revealed reality? If you’re a card-carrying, bible-thumping Christian, surely you respond by closing your eyes, sticking your fingers in your ears, and singing “Jesus loves me this I know for the Bible tells me so.” If you’re a card-carrying dyed in the wool, secular modernist – surely you are compelled to cram your life full of something called “meaning,” hurrying to complete the 40 must-do tasks, visit the 40 must-see places, and read the 40 must-read books, before you die.

To be Christian, to be scientific, is to see the world as it really is:

If we gaze through a telescope, we are reminded that an eternal record of all activity is streaming live from every point in space and time. (Any being in the Andromeda Galaxy furnished with a powerful enough telescope, could point it at planet earth today and witness as live events, whatever was happening here 2.5 million years ago.) Hurtling across space at the speed of light is the unbroken everlasting imprint of every nanosecond we live. Every detail of every moment of every life will far outlast the lifespan of our planet, to survive at least as long as the universe itself. At least, that is what my son claimed when he was 7 years old. Our every action and experience is packed with cosmic significance, broadcast on waves of light rippling through the infinite reaches of space and time.

If we gaze through a microscope, we are reminded of the impenetrable depths of any object in our hand, the bottomless mystery of how it holds together as an object, and the cruel limitations of our human perception. The most powerful microscope in the world is currently the Large Hadron Collider (LHC) in Switzerland, a monument to humanity’s thirst for knowledge and phenomenal ability to understand the world around us. This feat of human knowledge is a worthy object of wonder in and of itself. And yet, even the LHC has a limited depth of sight. Growing numbers of physicists continuing to seek a Unified Theory of Everything concede that, “physics will not be complete until it can explain how space and time emerge from something more fundamental.”[1] The microscope reveals that the ground beneath our feat is a swirling vortex of entropy, like certain undergraduate rooms after the bop formerly known as Corruption.

Part of the privilege of being at Cambridge, is being immersed in the sheer diversity of different ways of seeing the world as it really is. By the sciences in particular, we are invited to see the world differently, to see new dimensions, and to see new discoveries – all of which highlights the wonder of what our universe is. From a Christian perspective, we join the scientists in their wonder – allowing them to show us ever more fully the world and the life which we receive as a gift. This gift will be celebrated in different ways throughout the coming term, as we hear from a variety of scientists and theologians here at Robinson College.

Newton's apple is not forbidden fruit. The approach of these Sunday evenings, will simply be to say grace before we taste Newton's apple.

[1] Merali, Zeeya, "Theoretical Physics: The origins of space and time," in Nature, 28 Aug 2013.

Making Sense? Neuroscience and Behaviour

Dr Brian McCabe

20th October, 2013

Good evening. My name is Brian McCabe. I first set foot in this chapel before many of you were born and have distinct memories of events here going back decades. I spend much of my time trying to understand how I'm able to store information and recall it after all these years. The ability to remember things is easily taken for granted but is nevertheless truly remarkable. It is imperfectly understood; and there is every reason to suppose that a scientific approach, the tried, tested and self-correcting way of discovering things about the natural world, will deepen our understanding.

It's always a good idea to try to say why one is doing something. As far as I'm concerned, curiosity is a strong motivation. Moreover, I am as fond of a challenge as the next person. There is also a widespread feeling, which I share, that it is important to understand how the brain works: after all, it's an organ that distinguishes our species and which has been the determinant of human achievement. So, 'How does the brain work?' is a big question. It has been the experience of many scientists, that having such big questions in mind is a good thing, even though one may at first have no idea whatsoever how to answer them. Because then, if the opportunity arises, one may at least be in a position to recognise important data that could lead to a major discovery. Study of the brain also has practical importance. Some of the cruellest diseases are those affecting the nervous system. Moreover, these diseases can be very difficult to treat. Attempts to cure neurological disorders are not going to be particularly successful unless we have a better understanding of how nervous systems work. Despite all of these considerations, one should recognise that science can be double-edged: increased knowledge of how the brain works may make it easier to do bad things as well as good. I believe that the benefits outweigh the risks, but I'd be the first to admit that this is an act of faith.

In order to make headway, one needs to choose the right object of study. I work mainly on the domestic chick which, as well as being in plentiful supply, learns rapidly, particularly through imprinting. Imprinting is a process whereby the young animal learns the characteristics of its mother and demonstrates this by following her in preference to other individuals. Chicks can become imprinted to all sorts of things in the laboratory, including me for example, so we have a very powerful and experimentally tractable form of learning, which resembles processes seen in many animals, including humans. In fact, the chick has a large number of advantages for studying learning and memory. One of these is that its previous experience is very limited, so that any change that is specifically related to learning is more likely to stand out. What we learn during this service will undoubtedly be encoded as changes in our brains but these are likely to be tiny in comparison with all the changes that have accumulated from experiences throughout our lives. A newly-hatched chick, in contrast, has had very little previous experience of anything and therefore learning-related changes in its brain are likely to be easier to detect.

It's useful, as a working hypothesis, to think of the brain as a machine that can remember things. Without going into too much detail, my colleagues and I have found a region in the brain of the chick that has the properties of a memory system. Various biochemical changes were found in this region, which appeared to occur only when learning had occurred (we could measure this behaviourally). The change was not found with the same behaviour and

sensory processes in the absence of learning. I'll describe one way in which we followed up these findings. There is a brain region suspected of storing information. If it is doing so, one might predict that nerve cells in this region would change from being relatively unresponsive to a stimulus in the naive animal to a relatively responsive state after the animal has become imprinted to that same stimulus. So one does an experiment. Taking care not to hurt the animal, under anaesthetic, one implants tiny electrodes - fine wires - to record the electrical activity of individual nerve cells (a procedure, incidentally, licensed and very tightly controlled by the Home Office in the interests of animal welfare). The chick is then allowed to recover from the anaesthetic and one determines whether the nerve cells respond to one or more stimuli (we use various sorts of flashing lights). Typically, the nerve cells show little interest in the stimuli before the chick becomes imprinted. The chick is then exposed to one of the stimuli, the imprinting stimulus, for two hours. This is plenty of time to become strongly imprinted. We again measure the nerve cells' response to the stimuli. Typically, it's just the response to the imprinting stimulus that is changed: the cells become 'tuned' to that, by now familiar, stimulus. One can also label nerve cells that have been active over the previous hour or so. In this case one finds that, just in the brain region in question, the greater the strength of learning, the more cells become labelled. With this technique, it is also possible to determine whether the effect occurs in cells having a particular chemical signature. So we now have more evidence that we are dealing with a memory system and have come to know a good deal about how it behaves.

Science is very useful to us and it might not be terribly surprising if something similar has encouraged the evolution of at least some organisms. A life scientist need never be idle (this is your Director of Studies speaking) because we are always carrying around a laboratory - namely ourselves. What is more, we don't even need ethical approval. Could it be that something similar to the scientific method is employed by our nervous systems? When attempting a complex action for the first time, say throwing a dart at a dartboard, the result is likely to be pretty poor. But with practice it gets better until it seems relatively effortless and quite accurate. The first time, our motor system evidently uses some sort of hypothesis to plan and execute an action; call that action an experiment. During and after execution of the action, we receive sensory information about our environment, the results of the action and how accurate the action was: information from vision, skin sense organs, stretch receptors in muscle, little strain gages in tendons and so on; call that data. These data, presumably, are used to modify the hypothesis because the next time we try the action it is usually more accurate. And so on, until our action is as good as it is going to get. Our hypothesis has been modified by information about the world and the consequences of our actions. This information is limited by the quality of the sensory processes that have mediated it. Get a better pair of spectacles and the hypothesis can be refined according to the improved information that is now being received. The hypothesis may depend on a crude, highly censored representation of the world but is perfectly good enough for very complex behaviour. There are, I think, several interesting aspects of this process. First, it happens automatically, at least ultimately when we can perform the action relatively effortlessly. Second, information representing the outside world is encoded in what I suspect is quite an economical way. An enormous amount of data comes in at any one time and this is likely to be quite drastically filtered, extracting only those pieces of information that are useful. Finally, actions such as the one I described, in the general run of things, are useful in their own right, but at the same time may also be considered as experiments. This is a very efficient use of resources, from which we might learn something useful about how to organise systems that we employ to do things for us, such as robotic systems, for example.

A final consideration is the question of models. Scientists build models all the time. This is quite challenging in the case of many biological systems because of their complexity and the paucity of information available to identify the model that fits the data best. Nevertheless, as I speak there are supercomputers around the world chuntering away to make models of the brain. It should be said that there is considerable scepticism as to whether they will be successful. Who knows? It seems likely to me, anyway, that they will be of some use in revealing hitherto undiscovered aspects of nervous systems. But if a satisfactory model is to be devised, there is a major problem in finding the level of organisation at which such a model can be understood. With 100 billion nerve cells in the human brain (give or take), many with over 10,000 inputs, that, to put it mildly, is a challenge. Which brings me to issues at the heart of all scientific endeavours. Our ideas about the natural world are formulated in terms of the information we are able to collect. From these ideas arise models which, provided they are testable, can be proxies for the real thing until more suitable models turn up. It seems obvious but it may be worth saying that, if you are going to construct a model, stick like glue to the data. And for heaven’s sake, keep it simple.

References for those who are interested

Book

Ramachandran, VS (2003) The Emerging Mind: The BBC Reith Lectures 2003, Profile Books, ISBN-10: 1861973039, ISBN-13: 978-1861973030.

Video

http://www.cam.ac.uk/research/news/the-man-with-the-golden-brain

If it can't be measured, surely it doesn't exist?

Dr Melinda Duer

27th October 2013

Science can explain everything, can't it? If not now, then with a bit more work, surely it can. Actually, I'm not so sure. I think there are some things that Science as it is presently operates, will not be able to explain or indeed shed much light on at all. Why do I think that? Because Science explains phenomena by measuring or calculating things and before you can measure or calculate something, you have to know what it is, or at least what kind of thing it is. So, we can measure electrical currents with an oscilloscope, because we know about electrical currents, we know that they are basically a stream of charged particles, and so we can design a piece of kit to measure things about a stream of charged particles, be it in an electrical circuit in a television, or down a nerve in an animal. But until we know what substance something is made up of, or what kind of force causes a phenomenon, we can't even begin to design an experiment to measure or calculate anything about it.

I work on the boundaries between chemistry, physics, materials science, biology and medicine. I'm trained as a physical chemist. When I first started to look at human medicine, what struck me was just how little we know about the human body. Of course, medical and biological science has advanced hugely in the last two centuries. We know now how to cure cancers that only ten years ago killed without fail and how to replace defective hearts and livers, all amazing things. But although we know that our tissues are largely made up of a protein called collagen and although that same collagen protein is used to plump up wrinkles in ageing actresses, we don't actually know what its structure is. Imagine that, the most abundant protein in our bodies, the molecule that is key in the tissue which forms all our organs, our kidneys, our heart, our blood vessels, bones, teeth and skin, and we don't know how its atoms are arranged. And because we don't know how its atoms are arranged, we don't know really how it works. In truth, there is more in our tissues than just collagen protein. There is a whole host of interacting molecules, that change with time and age and a whole load of other factors we still don't know about. And that's what I work on – trying to deduce the structure of all those molecules, including collagen, and understand how they interact with each other to produce the amazing biological and mechanical functions of a tissue.

The reason that Science does not yet know the atomic structure of our tissues is, quite simply, that they are just so complicated. The techniques that can tell us what the atomic structure of a silicon chip or a man-made polymer is simply don't work on a tissue. But at least we know that a tissue is basically made up of arrangements of atoms, so we can design experiments to begin to glean information about them. With the clues given by a whole host of experiments and modelling what structures could fit in with the results from them, we can begin to uncover the molecular structures. In time, I am confident we will understand the molecular structure of tissues, and how and why they are altered by disease, how the molecules in a tissue are altered to allow cancer cells to grow there, for instance, why tissues age and skin wrinkles. In fact, we're more than halfway there on some of those aspects already but what I have learnt most in the last ten years is that you have to be incredibly broad minded and prepared to overturn long-held beliefs when you are the first person to ever see something. When what is in a tissue has only ever previously been examined indirectly, by pulling a tissue apart and analysing the fragments of molecules that you are able to extract from it, the chances are that things will have been missed, sometimes, even rather big things. And remember, we can only measure what we know about. So, scientists know there are proteins in tissues, so they analyse proteins. Scientists haven't analysed much at all for other polymers or other types of molecule in tissues. No one has seriously analysed tissues for (extracellular) DNA, for instance. Scientists only look for DNA inside cells because all the research that has been done tells us without any doubt that DNA is in cells and we understand its job there; it's a job that can only be done inside a cell. Over the years scientists have implicitly made the assumption that DNA has only one function, and that function being inside a cell means that DNA only exists in any functional role inside a cell.

I tell you this because some years ago, we started looking for the molecule that makes tissues calcify. Our bone tissues calcify, that is, they acquire crystals of calcium phosphate. That's what makes bones strong and structural – and why your mother made you drink milk and eat your greens when you were kids. But arteries also calcify – that's the so-called hardening of the arteries; kidneys calcify causing kidney stones and ultimately, chronic renal failure. The main technique we use in my lab, something called solid-state nuclear magnetic resonance spectroscopy, sees everything that is in a tissue, providing it's there in reasonable concentration – and providing you have the patience for the months of data analysis. So using this technique, we see the proteins in a tissue – and everything else. So we worked out that the molecules that trigger calcification of tissues is the same in all cases – in bones, in arteries and in kidneys - and that in contrast to popular hypothesis, they are not a proteins, but sugars. Everyone thought it must be protein, because they had only ever looked at the proteins – they'd simply never measured anything else. Why not? Because they didn't know what else was there. Because the technology to look at anything else either didn't exist or was too complicated or expensive to use. So, using what is a pretty new technique for biology, our nuclear magnetic resonance spectroscopy, we worked out that sugars were the culprit in calcification, but we knew very little else about it. We didn't know what sorts of sugars they are, what their structures are or how they're linked to the rest of the tissue. All we knew was that there were others things bonded to the sugar moelcules. That was seven years ago. Finally, in the last six months, we have worked out the identity of the sugars. And guess what? They're fragments of DNA and a sugar-based polymer that biochemists know to be a repairer of damaged DNA. They are so not what we, or anyone else, was expecting. Where do they come from? From dead cells – ones programmed to die in the case of calcifying bone; ones killed because of chronic inflammation and fatty deposits in the case of arteries and kidneys. And it makes sense. Nature is rarely wasteful – that's what several million years of evolution does for you. So why would Nature go to all the trouble of evolving a whole new molecule when there's already one there that can do the job? But DNA can't be in tissues, someone told me confidently, only in cells. Really? Why not? Because we couldn't detect it in tissues before now. Just because we can't measure it, doesn't mean it doesn't exist.

All in all, I'm pretty confident that given time and a substantial amount of effort from me and many others the world over, we, the scientific community, can explain a huge amount about the atomic structure of tissues and how they work. But there is one thing in my research that I am equally confident that I will not be able to explain, no matter how much effort I put in.

Let me give you a little background here before I tell you what it is. I work with biologists, physicists, medics, even engineers, a very interdisciplinary team. The best days I have, without the shadow of a doubt, are those when we all meet up and chew over the latest results, because when that team gets together, something that I can only describe as magic happens. Ideas come out that none of us alone would have dreamt of. We as a team become more than the sum of our parts. Something very special happens when human beings interact and that is what I cannot explain. Sometimes in our research group, the ideas start to flow before any of my colleagues have even opened their mouths, so it's not the verbal exchange of ideas. There is, I am quite certain, some sort of communication or link between human beings that doesn't use sight or sound or smell or even touch. I call it our humanness.

It's the same sense, I think, that allows us to know when a loved one is in trouble. For some part of my childhood, I was the main carer for my little brother (I still call him my little brother even though he's now 43 and a good 6'6'' tall) . As a child, I always knew when he'd fallen down and cut himself, long before I heard the screams or saw the blood. I suspect it's something of the same humanness that makes a complete stranger stop to help someone in distress. When you think about it, stopping to help a spiritually or physically injured person defies logic. At the very least, it makes you late for work. In evolutionary terms, it ensures there is another mouth to feed and one we surely can't imagine will help us. Yet we all know that feeling that sometimes there is something that is so much more important than being on time for work or even than our own wellbeing, that we just have to stop and help whatever the consequences. We might call it empathy or sympathy, but what are those things? Science can do experiments that show which part of the brain lights up when we help someone. It can measure all sorts of responses that demonstrate the existence of something, but none of those experiments explain what this humanness is. They can't. We don't fundamentally know what it is, what it consists of, so we don't know how to measure it. We can guess at what it might be and set up experiments on that basis. But if those experiments show nothing, it does not mean that our humanness does not exist, only that we don't know how to measure it.

There's one other aspect of our humanness that I want to mention, because it's relevant here: that part which gives us an innate sense of right and wrong. I'm not talking of our conscious debate about moral rectitude – as adults we are aware of a huge grey area that is the stuff of debates and politicians' careers. I'm talking about that deep down feeling when we just know, without being able to explain, that something is right or wrong. In the recent Westgate Shopping Mall massacre in Kenya, it was a four-year old boy, a four year old, who saved his mother from a gunman by shouting at him,

"You're a very bad man! Leave us!" Because a four year old boy knew what somehow that grown man had managed to eradicate – that killing a mother in cold blood is wrong.

That massacre, like others before it and others inevitably to come, was ostensibly done in the name of religion. You don't need me to tell you that no true religion, including Islam, advocates murder. Rather, it seems to me that religions like Islam and Christianity are, at least at some level, doing for our humanness what science seeks to do for our physical world: provide a framework on which we can understand it. And like science, there is a very honourable intention behind the endeavour which I can best describe as trying to make our lives better in some shape or form – healthier, perhaps. Because as soon as we begin to understand something, we accept it. If we have some sense of understanding our humanness, we will accept it, we will honour it, not try to fly against it as the gunmen in Kenya and murders everywhere have.

There are other aspects similar in both science and religion. Terrible things are done in the name of religion. Terrible things are done in the name of science too. It seems to me that we cannot go against our basic humanness, against what we know is fundamentally right and wrong, without ascribing our motive to some higher force. In that context, both science and religion all too easily become the culprits. But at their best, both science and religion give us confidence, confidence that we can understand the world around us in all the aspects that matter to us right now. If they are to serve us well though, we must keep questioning and both science and religion must allow us to question, because we don't know, we cannot yet know, how we will need to understand our world next year or in the next century.

But always remember, just because you can't measure it, see it, smell it , hear it or touch it, doesn't mean it doesn't exist.

The Philanthropic Principle

The Rt Reverend David Thomson, Bishop of Huntingdon

Commemoration of Benefactors, 3rd November, 2013

This is the day when each year we remember and give thanks for the vision and generosity of Sir David Robinson, the founding benefactor of this college, and all those who with and after him have blessed it with their gifts. I want, therefore, to take philanthropy as my theme; to show how it is at the heart of our Christian understanding of God and of the good human life; and - given the Science and Religion theme of your chapel addresses this term - to also and more boldly claim that it offers a powerful insight into how those two great disciplines of our approach to truth can act as complements not competitors.

I hardly need to remind a congregation like this that philanthropy as a word derives from the Greek for the love of humankind. It is used for those times when one human being shows altruistic generosity and kindness to others, especially to society as a whole and with few if any strings attached. But - and here is my first major point - isn't that exactly how the Bible describes God, the God who so loved the world that he sent his only Son that we might not perish but have eternal life; the God whose love for us defines what love is, prior to any love of our own. When we speak of grace in Christian theology we mean precisely the loving, gifting, unmerited and unconditional acts of God towards humankind: philanthropy.

We can in fact claim this not just as an action of God but as the essence of his being. For him, if we dare so speculate, to be is to give, to give away his life and his love and all that is good for and into the creation that by nature he will always be calling into being. He does this profligately and unconditionally in that creation; he does it personally and sacrificially in the life and death of his Son Jesus Christ, his other self; he does it in the heart of our own being as humans through the giving of the Spirit.

And this leads to my second key claim: that all that is given to us in creation, in redemption, in the sanctification of the Spirit, is given to us so that we, sharing in the character of Christ, can in our own turn give it away - knowing and trusting that the more we give the more we will in our own turn receive from the inexhaustible riches of God. Philanthropy is not an optional extra in the Christian life, something we can do or not do: it is the natural and essential expression of that life, to the point where stinginess of spirit can call into question just how much of that life is there anyway.

Because this is just going with the flow of God's life and love you could call it LILO theology, after the make of air bed that was around in my youth. Just as GIGO means garbage in - garbage out in information technology, so LILO here means love in - love out. If we go with the flow there are blessings all round. If we don't, then things go off. Like the time when our children had been playing in our caravan in the autumn, and we forgot to check the fridge when we locked it up for the winter. When we opened it up in the spring, the milk walked out... Even good things go off if they are left locked in our fridges and not put to use.

Two points down, and now I want to boldly go for a Star Trek of a third, and suggest that this philanthropic principle - and science and religion specialists are allowed to groan at the pun - has something important to say about how those two great disciplines relate. Our scientific understanding of the cosmos mirrors in many ways the profligate potentiality I have been attributing to God. It speaks of a singularity beyond our measuring generating all that we observe; of particles emerging unbidden from fields of potential; of a universe one the one hand just right for life like ours to emerge and on the other open to the emergence of life in amazing abundance.

Science observes the 'what' of this, but by definition is not in business to speculate as to its 'why'. It can note an anthropic principle, weakly conceived, that as a matter of fact the constants of the universe as we know it are finely balanced in such a way as to allow life to be possible. It may well resile from the stronger position that they are so balanced in order for life to emerge, just as I would caution care in speaking of species adapting in order to survive, not just surviving because they proved well-adapted.

So - that final point - I want to propose that what science demonstrably observes in terms of potentiality, of the values of constants consistent with the emergence of the complex and ordered systems we call life, of the consciousness and culture that reflects on life and starts to shape it: that all that asks anthropic questions of us that only philanthropic answers can satisfy. Within the domain of theology and philosophy, and within the practice of religion if I may dare say so, we can talk properly, and with some rigour, together about what it means to find ourselves living in such a world, what these crucial but scientifically soft categories such as love and compassion, sacrifice and generosity, our personal identities and our purposes all mean; and we can talk too about what we should then do about them.

And if you want a challenge as to what that "do about them" might be, look no further than the challenging words of Christ at the end of our Gospel reading tonight:

"But I say to you that listen, Love your enemies, do good to those who hate you, bless those who curse you, pray for those who abuse you. If anyone strikes you on the cheek, offer the other also; and from anyone who takes away your coat do not withhold even your shirt. Give to everyone who begs from you; and if anyone takes away your goods, do not ask for them again. Do to others as you would have them do to you."

Limits to deductive science

Prof. L.M. Brown

10 November 2013

Let me start by recounting some of the advances in science which have occurred since my birth. First, recognition of the scale of the universe outside our solar system: our galaxy only one among many thousands of millions in a population of galaxies about twelve thousand million years old, embedded in a space ever expanding but originating from a mysterious cosmic event, the zero of space and time. Second, release of almost unlimited energy, whether beneficial or harmful, from the atomic nucleus. I remember very clearly – I was nine years old – the headlines in the Windsor Star in Ontario proclaiming the destruction of Hiroshima by an atom bomb. Third, the picture of an active earth, about one third the age of the universe, now heated by radioactivity, with its crustal continents floating on a slowly churning mantle: volcanoes and earthquakes seen as shudders in a steady process of division, and collision. Fourth, the discovery of the molecular processes underlying human inheritance and evolution, resulting in an increasingly certain picture of the history of homo sapiens. We – humankind - originated in the Great Lakes region of Africa perhaps three hundred thousand years ago, but with ships and migrations gradually populated and exploited the rest of the world. Fifth, the development of antibiotics and the increase in human lifespan by at least ten years. Sixth, the observation of the nanoworld, including viruses and transistors, vital components of the silicon chips which now underlie our civilisation. Before I was born, no human had observed anything smaller than a wavelength of light; now the direct observation of atoms, ten thousand times smaller than that, is commonplace. It is a new world. I am very proud to have taken part in the voyage of discovery.

The novel vistas opened up are very real: the age of the universe is measured in our years, even though our solar system did not exist for most of the time; the magnitude of atoms is measured using the same metric as our height and weight. Instruments are the key to these advances, so when I say 'see' I refer to lenses, spectrometers, electric currents, and so forth: but, although always contingent upon further observation and debate, I see no reason to dispute the reality of the pictures I've described.

On the very grand scale, and on the very minute scale, science has opened our eyes, enlarged our world in space and time. However, we are still unable to predict with any reliability the incidence of specific earthquakes, or the weather a week from now.

In September 2011 seven men, four scientists, two engineers, and a government official, went on trial in Italy, charged with criminal manslaughter for the deaths of some of the three hundred and nine people killed in a big earthquake in the city of L'Aquila in central Italy. Although the citizens had detected earth tremors, and were starting to panic, to sleep in the streets and to leave the city, the scientists correctly explained that the chance of a big earthquake was very small, negligible, although specifically whether one would occur in the immediate future is an question they could not answer. As a result, several citizens remained in their houses and were killed when the earthquake struck. It seems that the Judge scarcely listened to the case put by the scientists, but blamed them for not communicating the risk properly, and therefore guilty of manslaughter. There is an excellent account of this important case in the Times Higher Education Supplement of October 2013.

The unpredictability of earthquakes is easily grasped. In a simple hour-glass egg timer, the individual avalanches in the growing cone of sand at the bottom of the glass cannot be predicted, even with the most powerful computers: there are too many variables. The trajectory of each grain is indeterminate: one cannot ascertain where each will end up, although you might know where they are located just before turning the hour glass over and starting the avalanche processes. Yet the sand falls regularly enough so that you can accurately time the boiling of an egg to make it either soft boiled, or hard boiled: the timing is an ‘emergent property’ of the egg timer, yet the detailed fall, bounce, and slide of the grains of sand cannot be foretold. You can imagine yourself living on a grain of sand. You know that your life is precarious, and you know where are the danger zones, but you cannot know whether you will survive the next few seconds or not. Avalanches on ski runs are of course the same, and so is the weather: the famous ‘butterfly effect’ renders a range of predictions impossible. Of course, bigger computers greatly improve the forecasting, so that recently the hurricane which struck England last week was predicted a few days in advance, although its exact trajectory could not be foretold until a few hours before it struck. The prediction undoubtedly prevented much damage, and saved many lives: but not those upon whom the trees fell and the floods washed away.

What is the moral of this story? I think it is to encourage scientists to be humble, not to claim too much, and to respect those who trust other ways of coping with the uncertainties of life. Surely it is also for others not to expect too much of scientists, but also to recognise the ambition and success of the scientific endeavour. The enemy which leads to tragedy is self-righteousness: smugness and the reluctance to listen to other points of view. I believe that the sending to prison of seven conscientious scientists is a tragedy, not only for them, but for the public understanding of science.

If I could adopt an image from the late, great, Joseph Needham, formerly a Trustee of the nascent Robinson College: one imagines a troika drawn by three horses: the first is religion, by which I mean recognition of the spiritual side of life, capable of comprehending our fragility in the face of uncontrollable and irresistable forces; the second is science, capable of widening our horizons to reveal more and more of the world we inhabit, and capable also of improving our material lot; the third is politics, participation in our society, with its law courts and parliaments, and whatever other insitutions there may be. Religion is for the spirit, science for the body and mind, and politics for hope for the future of our children and grandchildren.

A troika cannot reverse. It can make wide circles and return along a former route if required, but it cannot travel backwards.

But who or what holds the reins? Who keeps the team of horses balanced and peaceful? I would like to think it is charity. Charity in its old-fashioned meaning: that ability to empathise with others, to puncture the armour of self-righteousness by human contact, to listen and to try to understand, to forgive. This is close to what my father used to call ‘Judgement’ – not to be carried away by self-involvement and self-deception, not to proselitise, but still to try to communicate to your fellows what you truly understand.

Knowing Very Little

Dr Rachel Oliver

17th November, 2013

•Knowing very little

•Chaplain suggested title

•Apt because

–I work on very little (small) things (nanotechnology)

–I often feel I know very little about those little things

–I know even less about speaking in chapel

•Hence – forgive my incompentence!

•What do I actually do?

•LEDs for lighting

•Tungsten filament bulb – 5% efficiency

•Light emitting diodes 5 to 10 times better

•20% of electricity generated in UK is used for lighting

•Changing to LED light bulbs would allow us to shut 5 – 10 medium sized power stations.

•? LED toys / hand-cranked generator here?

•Why are LEDs so efficient?

•Tungsten filament light bulbs – basically make heat

–Light as a bi-product – incandescence

–Useful in cold countries if buildings are well-insulated?

–Not so great otherwise…

•LEDs generate light directly

–Semiconductor materials

–Recombination of positive and negative current carriers

–No need for heat – although there is likely to be some due to imperfections in the material and limitations of device design

•Where do the very small things come in?

•"Active region" of LED

–Bit that the light actually comes from

–Made up of flat layers which are a few nm thick

–Structure in the plane of the layer is also very important to light generation mechanism

•Not going to go into detail…. But…

–Light generation mechanism in blue (and white) LEDs not well understood

–Technology outstrips science

–We really do "know very little"

•If we know very little – how do we learn more?

•In my case, often by using microscopes

–Not familiar light microscopes (?magnifying glasses)

–Either electron microscopes or scanning probe microscopes

•Electron microscopes – a lot like light microscopes, but use a beam of electrons instead of light, and electromagnets as lenses

•Scanning probe microscopes – briefly describe AF using record player analogy

•Both offer atomic resolution – allow us to learn in detail about material structure and to relate this to device properties

•"Seeing" atoms

•Not really seeing (!)

•Almost routine in some of the nanotech projects I have worked on

•Should be amazing!

•Scientists (?all of us?) need to make sure we don't lose our sense of wonder.

•Huge privilege to have the opportunity to learn about the world in such detail.

•Seeing atoms – but knowing very little…

•Despite amazing microscopes and experiments – still don't understand the basics of our device.

•Compare to Higgs Boson

–Sometimes called the "God particle"

–"explains why other particles have mass, why things hold together, why you and I are able to exist"

–Good proof of it's existence from LHC – some physicists now think that we completely understand the Unviverse.

•Aside – "God particle"

•Name invented by Leon Lederman

–(who won the Nobel Prize for Physics in 1988 for contributions in particle physics)

–Name for a pop science book in which Lederman wrote: "Why God Particle? Two reasons. One, the publisher wouldn't let us call it the Goddamn Particle, given its villainous nature and the expense it is causing. And two, there is a connection, of sorts, to another book, a much older one. . . ." The Higgs is a concept of almost Biblical proportions."

•Back to physics and thinking we know everything

•I trained as an engineer – not a physicist

•Doing my degree, my friends in physics were studying the “Grand Unified Theory of Matter” which purported to explain nearly everything…

•And I was learning that if you stick a heavy weight on the end of a thick wooden beam, it’s very difficult to say exactly how much it will bend

–Factor of two safety margin needed for building projects

•So we can explain nearly everything – but can’t figure out the simplest things?

•Knowing nearly everything?

•At the end of the 19th century many scientists believed they had discovered everything there was to discover and all universal phenomena could by explained through one of the three branches of the sciences: classical mechanics, electromagnetism and thermodynamics.

•In the early 20th century…

–Einstein’s theory of relativity, development of quantum mechanics

–Completely new picture of the universe

•I suspect we still know very little!

Summing up…

•Perhaps realising that we “know very little” is a good starting point for all scientists

•If I had two pieces of advice to give to someone starting out in science it would be to remember that – and to never lose sense of wonder.

•Lastly – even if we know more than we realise, all we really have is a set of laws for the Universe.

–Newton’s laws, laws of quantum mechanics…

–They work in their correct sphere, but where did they come from…?

•God as lawgiver?

•Isaiah 33:22For the Lord is our judge, the Lord is our lawgiver, the Lord is our king; it is he who will save us.

•I know that this actually refers to the 10 Commandments given on Mount Sinai and the rest of the Jewish Law (Torah)…

•However, part of my concept of God (to the extent that I have one) is as the giver of the laws of physics that control the Universe… a different sort of lawgiver?

•Leave that as final thought….

Professor Morna Hooker

24th November, 2013

Creation

This term, we have listened to some of the scientists who are Fellows in this College speaking about their different disciplines and their approaches to them. I am not a scientist, and you may be wondering – as am I – what I am doing rounding off the series. I have two explanations. One is that the chaplain ran out of volunteers, and so fell back on his usual stop-gap. The other, which I prefer, is that he thought it appropriate to conclude with some sort of theological comment. The series is, after all, entitled 'Science and Religion'. So far we have heard a great deal about science, not much about religion. So where does religion fit in?

The specific topic he has given me is the creation narrative in Genesis, which is hardly surprising, since any discussion of the relationship between science and religion is bound, sooner or later, to focus on the question of creation. As we heard earlier, the Genesis account tells of God creating the world in 6 days – a task so arduous that God decided it was necessary to take a day off on the seventh. Even though the Psalmist tells us that a thousand years are a mere day in the sight of God, this is clearly a very different story from that told us by astronomers and geologists, who describe creation in terms of billions of years. And this, of course, is the point, for it is not just a different story but a very different kind of story.

Last week, I was talking with some of our graduate scientists and engineers. One of them expressed surprise at the title of this term's series of addresses. Surely it is case of science or religion, he said, not science and religion. I thought that we had abandoned that battle in the nineteenth century, but clearly many have not heard that an armistice has been agreed. And indeed, the chaplain spoke at the beginning of term of those who still believe that science and religion are mutually incompatible. They are encouraged by the fact that in certain places, some Christians attempt to maintain the literal truth of the biblical narrative. Just how they manage to do so while living in the modern world I do not understand. Do they still adhere to the nineteenth-century notion that God created fossils and placed them in the geological strata in order to confuse the scientists? These so-called creationists muddy the issue, providing easy Aunt Sallys for Richard Dawkins to attack, and leading millions to assume that scientists and Christians must be in opposition. You will have noticed that there has been no hint, in any of the addresses we have heard this term, that this is so.

Last week, many of us heard Rachel Oliver talking about her work in nanotechnology – a world of very little things in which, though she clearly knew a great deal, she felt she knew a very little. And in contrast, she spoke about attitudes at the end of the nineteenth century, when many scientists believed they had discovered everything there was to discover and could explain everything. And then Einstein developed his theory of relativity, and quantum mechanics were born. 'I suspect', she commented, 'that we still know very little'. As with all true scholars, she was aware that the more she knew, the more there was to know. The universe, we are told, is expanding. And so is knowledge.

The common theme that runs through all the talks we have heard this term is that of humility. We are clearly fortunate, for not all scientists are so humble. And neither are all theologians! The temptation to tie up all the ends, to produce an over-arching theory, is always present. We must never, said Rachel, lose our sense of wonder. We must always be prepared to confess that we do not know. It was a confession made by the author of the book of Job, centuries ago, as he imagines God addressing Job:

Where were you when I laid the earth's foundations?

Tell me, if you know and understand.

Who fixed its dimensions? Surely you know!

Who stretched a measuring line over it? . . .

Have you comprehended the vast expanse of the world?

Tell me all this, if you know. . . .

Can you bind the cluster of the Pleiades

or loose Orion' belt?

Can you bring out the signs of the zodiac in their season . . . ?

Did you proclaim the rules that govern the heavens

or determine the laws of nature on the earth?[i]

But doesn't the story in Genesis 1 claim to tell us just how God laid the earth's foundations? Not in any way that a scientist would recognize, since it does not claim to present a 'scientific' explanation. Did you notice that light is created at the very beginning, and that three days and nights then elapse before the sun and moon are formed? No, the Genesis narrative is, as I said earlier, not simply a different story but a different kind of story – a story about our role in a world made by God. Religion, suggested Melinda Duer, seeks to do for 'humanness' what science seeks to do for our physical world: provide a framework in which we can understand it. So what does it mean to be human?

Many cultures have stories about 'how things began'. Often these are not so much accounts of what happened in the past as explanations of why the world is as it is now – and the story of how things went wrong when Adam sinned in Genesis 3 is one such attempt to explain why things are wrong with the world today. But Genesis 1 seems to be attempting something more. It seems to describe, not so much what the world is like now – did you notice that all the animals were apparently created vegetarians? – as what it should be. Men and women were created in the image of God – created to be like God. But are they? Is Genesis 1 perhaps trying to fathom the purpose of creation? And what does it mean to be 'in the image of God'?

The author of Colossians 1 had no doubts about that. It meant, he claims, to be like Christ, who is himself the image of God. And the description that follows is what we might well expect to find in a description of God – a description of one in or by whom all things have been created; and by 'all things', he explains, he means everything in heaven and on earth, things visible and invisible, both earthly rulers and the unknown forces that control the universe; the whole universe, he claims, has been created through him and for him. He exists before all things, and all things are held together in him. That is the kind of theological language you might expect a hymn-writer (which is what the author of this passage is) to use in describing God.

But – and here is the surprise – the author is describing, not God himself, but Christ! And that, you will agree, is some claim to make about someone who lived and died as a human being a few years earlier. How can he possibly do so? Because, he believes, Christ is the image of God, the reflection of God's character. In him, he says, God chose to dwell in all his fullness, and through Christ, God reconciled all things to himself, making peace through his death on the cross. Look beyond the theological jargon, and you will see that what our author is claiming is that the true character of God is revealed in the life and death of Christ – in an integrity that was prepared to die for the truth, and a love that was prepared to die for others. Nor were these just one-offs. They are, he says, the underlying principle of creation, the thing that makes the universe tick, that holds everything together. We see this principle embodied, claims the author of Colossians, in Christ, who is the image of God. So here is the pattern for the lives of men and women, who are, according to Genesis, created in God's image. Live in this way, and the whole of creation will be brought together in harmony.

What intrigues me about this is the fact that the vision presented in Colossians chimes in with something Mick Brown said in his talk. Now Professor Brown refuses to use the word 'God'. To him, he tells me, that word has no meaning, and it would be dishonest for him to use it. But he spoke of a troika drawn by three horses – religion, science, and politics – and asked: who or what holds the reins? His answer was that he would like to think it is charity. He preferred 'charity' to love, he told me, because in the modern world 'love' has lost its real meaning. Most of us abandoned the word 'charity' for precisely the same reason! But whatever word you choose to use, we seem to be talking about the same thing: namely a concern for others, an empathy which puts their well-being first. What holds the reins, he suggested, is what he terms 'charity', and what I call 'love'. Rachel Oliver spoke of God as a law-giver – giver of the laws of physics that control the Universe – and the biblical vision is that the fundamental law is to love God and to love one's fellow men and women. Science and religion may use different languages, and adopt different approaches, but clearly they can converge.

At the end of his book The Selfish Gene,[ii] Richard Dawkins concludes that we human beings 'have the power to defy the selfish genes of our birth' and 'can even discuss ways of . . . cultivating . . . pure, disinterested altruism'. But if we do, he suggests, this is to defy our nature. The biblical narrative tells a very different story. It suggests that pure disinterested altruism is not a defiance of our nature, but part of the divine plan. And that, to use Melinda Duer's term, is the biblical understanding of our 'humanness'. Live in that way, and creation itself will be brought into harmony, for underlying the many little things and the immensities of our universe there is a pattern that makes sense and gives purpose to our lives.

[i] Job 38.

[ii] Richard Dawkins, The Selfish Gene, OUP 1976, p. 215.

Christmas Reflection

Advent Carol Service, 1st December 2013

Simon Perry

An unchurched teenager in London heard the Christmas story for the first time in a Religious Studies lesson – and appreciating the story, quietly asked the teacher at the end of the lesson, "why did they give the baby a swear-word for a name?"

That teenager was probably much closer to the truth of Christmas than most theologians. The incarnation is the belief that the God of heaven and earth becomes human, the Word became flesh. But what kind of flesh? The fact is that the director general of the multiverse became a "chav", the Almighty Lord of time and space – became "trailer trash," the underprivileged outsider from a feral underclass. That is who this Jesus is, and according to scripture – God points at him and says, "that's exactly who I am."

Most Christians tend to miss the radical implications of God becoming so intolerably fragile. The majority assume that an All-Powerful God is not so much revealed as concealed in the person of Christ: The omnipotent God, we are told, does not show himself, but disguises himself as a weak and vulnerable peasant; the monarch of heaven does not express his power, but suppresses it in order to become human; Jesus is not the 'Word become flesh', he is only 'veiled in flesh.'

The life of Jesus becomes an act of divine espionage, in which God becomes something other than he really is in order to infiltrate the ranks of humanity. No The true story of Christmas is that the powerless, self-giving, political love embodied in this fragile Christ – is precisely how God runs the universe. This is a god whose fragile beauty reveals itself as ultimately more powerful than any cosmic tyrant could hope to be.

This term we have looked at the relationship between Science and Religion – and at Christmas – Christians celebrate the belief that the mechanics of the universe, the substructure of cosmos, are somehow revealed in who this child is and how he lived: this baby would drastically redefine what it means to be powerful, and great, and majestic and what it means to govern well. So it's little wonder he defied expectations, and it's little wonder he sparked a revolution, and it's little wonder that within a generation of his own death his name had become a term of contempt.

That London teenager was onto something important – because only as we grapple with why Jesus became a swear-word, do we begin to get a true glimpse at what Christmas really is.