



OVERVIEW

Peter Harrison delivered a lecture entitled 'The Bible and the Emergence of Modern Science' on 24th May 2005 in the Howard Lecture Theatre in Downing College, Cambridge. A transcript of the lecture can be found at:

<http://www.st-edmunds.cam.ac.uk/cis>.

Subsequent to the lecture, a dinner/discussion with the speaker was held at St Edmunds College, Cambridge. An edited transcript of this discussion follows. It was chaired by Dr Denis Alexander (Babraham Institute) with introductory remarks from Dr. John Coffey, Reader in History, Leicester University. The other contributors are described at the end of the discussion.

Templeton Foundation Post-dinner Discussion

Peter Harrison – 24th May 2005

Denis Alexander: I'm going to ask John Coffey to give a short response to Peter's very helpful lecture this evening. As you'll see from the biographical note [at the end of the discussion text], John is a reader in History from Leicester University but was here as a Fellow at Churchill College until a few years ago and he's written quite a bit on this particular period of history.

John Coffey: First of all, let me say what a privilege it is to be able to respond to Peter's lecture. I first read his book "*The Bible, Protestantism and the Rise of Natural Science*" soon after it came out in 1998 and was struck by its originality, the lucidity of the argument and its boldness, and also by the fact that it was a very entertaining book. If you've not read it, it's worth reading for that reason.

It reminds us, for example, that the Royal Society commissioned Robert Hook to investigate whether Chinese was the language spoken by Adam and Eve in the Garden of Eden and it raises all kinds of interesting questions about research methodology, concluding perhaps rather sensibly, that it wasn't! The original language of mankind had been lost. Or we read about William Whiston's suggestions that hell would be sited on a comet – and as Peter reminds us, Whiston was comet-obsessed. So there are all kinds of fascinating incidental details in the book which don't necessarily come across in lecture format.

But there's also this very bold and ambitious argument which Peter presented to us today and I have to say I admire that as a historian, because historians tend to be rather timid creatures whom happily cultivate their own little allotments and don't dare to go across town, let alone to other centuries! So I think the boldness of the argument is something that helps us to engage with some big and important ideas, and Peter has done that very successfully.

It also, of course, opens you up to all kinds of criticism and I notice that at one point in the lecture you said you've joined that line of historians who have advanced the rather risky proposition that modern science, and indeed modernity in general, is in some way deeply indebted to Protestantism. I like that phrase about the "risky proposition" – risky for different reasons. One accusation that has been thrown against Peter from at least one reviewer is that this is reviving weak history, that it's "a glorification of modernity, Protestantism and the English". I suppose for some kind of postmodern historians, glorifying the English would be the worst possible thing you could do! The issue I wanted to point up for further discussion was exactly what's been claimed for the role of literal hermeneutics, and particularly for the role of Protestantism in this whole development you lay out, this hermeneutical revolution that you map out for us. Clearly you're not presenting us with a mono-causal explanation, you're not joining the Beatles and singing "All you need is Literalism". You make it quite clear there are other causes involved in the rise of modern science, so Protestant literalism is clearly not sufficient explanation for what's going on. But I wonder whether you'd say that Protestantism and Protestant literalism is a necessary cause of the scientific revolution, that's another way of putting the question. Or to put it differently and ask a counterfactual question, where would science be without Luther and Calvin?

I have to say I'm quite attracted to your idea that Protestantism does play a key role in this development, probably partly because my father was a Protestant pastor but I'm also somewhat sceptical about it, I suppose, for some of the reasons that were put forward earlier in the questions following the lecture: the emergence of more emphasis in the literal sense in the late Middle Ages and the crucial importance of humanism and the whole humanist movement behind Protestantism. At one point in the lecture you said Protestant reform, with some help from Renaissance humanists, sponsored a new approach to the biblical text and I wonder if that could be put almost the other way round, that Renaissance humanists, with some help from Protestant reformers, sponsored a new approach to the biblical text.

It seems to me that humanist exegesis, with its careful attention to the grammatical and historical meaning of the text, was not the exclusive property of Protestants but in some ways a common possession of early modern intellectuals. Also, of course, you don't say very much about early modern Catholicism. Galileo and Descartes and so on were mentioned, but no-one would deny that Catholics, particularly in Italy and France, were very heavily involved in the development of science, particularly in the sixteenth and early seventeenth centuries.

Now one could argue, I suppose, that early modern science is very much an ecumenical project, that England's natural philosophers were part of a wider republic of letters that crossed confessional boundaries and facilitated the exchange of ideas across Europe, so I'm wondering whether, in some ways, your argument on the importance of this hermeneutical revolution could be strengthened if you see it as a broader thing that is not so crucially dependent on Protestantism. I realise that there are all kinds of other questions that people might want to raise, but I thought this was something worth highlighting.

Denis Alexander: We are going to allow Peter to reflect and respond on some of those points in a moment, but I think it might be a good idea if those academically related to the questions that John has raised might wish to comment first. We'll then come back to Peter to give some thoughts on these points. Janet, would you like to say something?

Janet Soskice: I must admit that it sounds too good to be true in a way, but as a non-historian I was wondering similarly if one couldn't say that it was a humanist thing, that it was the humanists who were looking back at the text and wanting to go back *ad fontis*, that was a humanist movement. After all, Erasmus never left the old church and not all the reformers became Protestants, but there was definitely a movement amongst them to be rid of the gloss and to go back to the simplicity of the text and the original Hebrew and Greek. As you rightly pointed out, I think it is hooked up with a kind of a liberation of the spirit that allows people to dispense with traditions in other areas too.

I was also saying to Peter over dinner that where it seems to me that the Protestant genius clicks in is maybe slightly later in a particular attitude to technology: in making things work and using them, not frittering your life away, but doing things with your life. These kinds of Protestant, and indeed Calvinist, ideas did seem particularly *very* influential in Scottish industrialism and when I look at that I always see that this wouldn't have been possible in the same way in a Catholic country – and I speak as a Catholic. Partly this great industry and technology comes out of a particular Protestant spirit.

Patrick Richmond: I greatly enjoyed the lecture and I haven't read the book, so I'm even more grateful!

I was reminded of my study of patristics as an undergraduate theologian and the fact that Philo of Alexandria (20 BC-50AD) was already drawing on Greek allegorical interpretations of Homer in his Biblical exegesis. There were originally two streams in Christian Biblical interpretation – the allegorical Alexandrians, but also the more literal Antiochians. I can't remember whether the Antiochians more heretical associations meant that they fell from favour and that is why Alexandrian allegory became the dominant approach. But both of them were, of course, drawing on an earlier tradition and were less 'literal' than many modern exponents of the historico-grammatical sense.

If I understood Professor Harrison rightly, there seemed to be some stress on the idea of *sola scriptura*, the idea that the Bible *alone* was necessary and sufficient for salvation. This stress goes beyond the widespread humanist methodology of going back "*ad fontes*", going back to the sources to study them according to their literal and historical meaning. If I have heard you rightly I think you are saying that the Protestants were stressing *sola scriptura*, (I'm interested in how that stress arose and was applied, as it didn't seem to be directly concerned with science or nature). If they were stressing that, then that might create pressure to 'desymbolise' the natural world and remove its sacred meanings. It thus does seem to me that if you can make the link between the *sola scriptura* hermeneutical approach to the Biblical text and the hermeneutical approach to nature, then you have shown how Protestantism, and not just humanism, helped modern science emerge.

As I understand it, and I am no expert, though the humanists were reading *texts*, that did not necessarily desymbolise *nature*. However, when you have realised that nature is encrusted with sacred symbolism, natural histories, morals and allegorical 'pelicans in the wilderness', and that that ought to be stripped away to allow Scripture its proper place as uniquely sufficient guide to salvation, then you have cleared the way for more modern scientific study of nature. If that is what you are arguing then it also goes some way to answering the point Janet Soskice made in questions about the way that allegory in fact helped harmonise science with the Bible. I think Janet's point is fair, but as I understand it, you are suggesting that Protestantism still allowed a great scientific leap forward, because medieval study of nature was encumbered by all of these multiple meanings. Allegory might alleviate the clash between science and biblical theology, but it hindered science from studying nature. Science might generate many more theological problems without allegory, but Protestants could still use the idea of divine accommodation. So, if my understanding of what you have said is correct, more attention needs to be given to the role of the Protestant principle of *sola scriptura*.

Peter Harrison: Let me first of all thank John Coffey for his kind words and thoughtful questions and for the further elaborations on some of his points by Janet Soskice and Patrick Richmond. There are perhaps four main issues in these questions and comments that I should respond to: the relative importance of the Protestant Reformation in the emergence of modern science; the role of Humanism; the importance of the principle *sola scriptura*; the Catholic contribution to early modern science. I'll take these more or less in order.

Was the Protestant Reformation a sufficient condition for the emergence of modern science? No. Was it necessary? Yes. And while historians tend to be reluctant to talk about counterfactuals I still think it's a sensible question to say why "science" arose at this

particular time in this particular culture, and I think the argument I have made is part of the answer to that question. Therefore I do think it is relevant to ask why, for example, science didn't happen in China, which had a wonderful technology, or to ask why the promise of Islamic science in the eleventh century wasn't fulfilled. I think Protestantism has something to do with it, and remember that Protestantism emerges out of the matrix of medieval Catholicism.

On the question of the humanists versus Protestants, I think that it is important to realise what an important influence Humanism had on the Protestant approach to texts. Calvin and Melancthon in particular were deeply influenced by humanist ideas. However, and this is where I agree with Patrick, the principle of *sola scriptura* makes a vital difference. On the one hand, the appeal to scripture is a specific application of the humanist cry of *ad fontes* (in essence, "back to the original sources"), as Janet reminds us. On the other hand, the Protestant elevation of the authority of scripture, understood in its literal sense, is unprecedented. And what makes this text different is that, like nature, it is authored by God. So it is the integrated interpretative framework in which both scripture and nature were interpreted together that comes apart with a Protestant insistence on the literal reading of this unique text.

I should add to this that we need to think not merely in terms of Protestant conceptions and ideas, but how the Reformation changed material practices and how the political climate changed as a consequence of Protestantism. So changes to the prevailing authority structures, for example, made possible what we would call the flourishing of a scientific enterprise in a way that I believe wasn't possible under the conditions of mediaeval Catholicism where the authority structures were centralised and an Aristotelian view of things was endorsed. So when Galileo sets out ideas that run counter to the prevailing Aristotelianism, he is silenced. And whereas on the one hand Galileo may seem to be a counter example to my thesis, the story of Galileo is that essentially he retracted his views and he retracted them because they ran counter to what was the officially sanctioned view of a centralised ecclesiastical authority. Now Copernican views were openly discussed in England in the middle and later seventeenth century and my argument would be that that was because of the religious situation in England, where we don't have a centralised authority making determinations about matters of natural philosophy and where there was thus the opportunity to discuss these sorts of issues. So irrespective of even the intrinsic ideas of Protestantism, which was the predominant focus of the lecture, the environment that it creates in Protestant states where there is no papacy determining questions of doctrine and where the Aristotalean science is to be the prevailing science, makes an enormous difference. So it's not merely Protestant ideas as such, nor merely Protestant material practices which I think is important – how worship changes, how the whole material context of worship changes, for example – but the political situation in which individuals find themselves and their capacity to express views in a way that can be taken up as a social enterprise. Further to this, then, I do think that the religious climate of seventeenth-century England is a wonderful crucible for the development of a scientific culture. So on the question of being somewhat Whiggish and Anglocentric I plead guilty (but with extenuating circumstances).

Lastly, I'll mention the Catholic contribution to early modern science. While something of an industry has developed in the last ten to fifteen years that stresses the importance of Catholic science, I think that there is an element of an "every child gets a prize" version of history operating here. The Jesuits were very good on the mathematical sciences and that's partly because it could be done within an Aristotalean rubric and – to overstate the case somewhat – with instrumentalist conceptions of astronomy. A Jesuit scientist can run with Tycho's model, with the Copernican model, with the Ptolemaic model, and not have to decide between them. We find Jesuits in the Collegio Romano putting forward these three theories simultaneously and in certain respects – I haven't attempted to establish this, so this is somewhat speculative – this parallels the possibility of multiple

senses of scripture. So we also get multiple readings of the Book of Nature, all of which have something which can be said for them because these models, throughout the sixteenth and for much of the seventeenth century, are compatible to varying degrees with the observational data. Certainly Copernicism has major defects, so we can run these models under the prevailing Jesuit understanding where mathematical astronomy is regarded as saving the phenomena, but interestingly the Protestants, for the most part, want to argue for a realist conception and that necessitates a single reading of the Book of Nature.

Michael Hoskin: On the other hand, I think quite undue stress is being laid on the Galileo episode which I think was triggered by his own particular personality and the way he pushed himself and made enemies. I would have thought that the exact opposite case could be made to the one you have done, by taking Copernicus's *De revolutionibus*, where you have a Catholic canon who is proposing that the earth really is a planet; and then when the book is sent for publication, a Lutheran clergyman, without any authority, puts in an unsigned introduction bogusly asserting that this is an instrumentalist book only, a mathematical device unrelated to questions of truth. So I think there you get the exact opposite of what you've been arguing, the Catholic saying the earth really goes round and the Protestant clergyman saying no, it's purely instrumentalist.

Peter Harrison: This is the problem of having a historian astronomer in the audience! You are exactly right in terms of how you've constructed this episode and it's interesting that Copernicus seems to want to argue for a realist account. Galileo, who's a Catholic, is also wanting to argue for a realist account, and the Protestant Osiander, in his preface to Copernicus' *De revolutionibus*, is urging an instrumentalist reading. I suppose all I can say is they are historical facts, and as you've put them to us they seem to cut in exactly the opposite direction to the way in which I'm interpreting events. In defence of my claims, let me say that instrumentalism with regard to astronomy remained the official Catholic position, and Galileo was condemned partly for making realist claims. In short, he is not representative of Catholicism and this is the very reason his views are condemned as heretical. It is interesting that he was subsequently to become something of a hero in Protestant circles. Also if we compare, for example, the way in which astronomy is conducted in Jesuit institutions like the Collegio Romano with how it is carried out in a Calvinist institution like the University of Geneva in the seventeenth century, it does seem that we have a clear divide on the basis of an instrumental *versus* realist models. So I take your point about how Galileo, in certain respects, seems to count against my thesis, but I would claim he is the exception rather than the rule.

Denis Alexander: Are there other similar exceptions to the general thesis?

Michael Hoskin: I've got a broader problem. I have spent my career explaining the emergence of modern science without ever once introducing the explanation that you've so interestingly offered us and to which I listen with great interest. What you've said about Medieval symbolism is unquestionably true, and I recall one particular occasion when I was trying to impress it on students who were with me in my office in Free School Lane, Cambridge, and I looked out and there was the crest of Corpus Christi College with exactly what I wanted: the pelican feeding its young with its own flesh, as a symbol of Christ. But on the other hand, there was also in the fourteenth century, in Oxford, a school of mathematical physics (the only words I can give for it) for whom velocity was given by $v = \log (F/R)$ -- and this is not a modern formulation, this is absolutely what is there.

There's likewise the impetus theory of fourteenth century Paris where people are dealing with the problem of why arrows keep on moving even in the face of the gale and this is supposedly because there's some impetus which has been conferred on them. And then the question arises, in the light of this, do the proofs that the earth is at rest really hold water? Oresme says "No, they don't hold water". Then Copernicus challenges people by saying the earth really is moving, and one consequence is the attempt to understand moving bodies and what physical motion is, with Galileo and his rolling balls down an incline plane.

All this seems to me to be a perfectly coherent and intelligible account which has nothing to do with the accounts that you've given. I'm not criticising you in the slightest. Had I listened to your lecture many years back I would I'm sure have introduced what you have to say as a qualification, but I really don't see a justification for the enormous emphasis which you're putting on this one explanation.

Stephen Orchard: I wonder if we're trapped a bit in our own meanings of Protestant and Catholic and whether it would help to see them in inverted commas so far as the sixteenth century is concerned. For one thing Protestants are just about recognised as Protestants at that time and they would probably call their opponents Papists rather than Catholics. They saw themselves as Catholic Christians. We are looking at two different views of authority, so there's that bit of adjustment.

The other thing I am still fascinated by is the humanist bit because that is the link across these different discourses. When Erasmus established and published a *Greek New Testament* in Cambridge, this was an enormous release of energy, the Rutherford Laboratory stuff of the day. This transformed the intellectual climate because people were confronted with new language and a new artefact. Now, that was neither Protestant nor Catholic, as Janet has remarked. It was a shifting of the plates, people had to think differently. You contrast a Greek page with that illustration you had in the lecture of the Vulgate with all the commentary around, and that's the contrast that people were working with. Yes, I think the broad brush gives you a strong correspondence with Protestantism but I'd be very surprised if it was a thesis you could drive home in every case, for the very reason that denominations were not so defined in the sixteenth century; they were more like trends and tendencies. I think that's why we've set up this competition, to try and make the Catholic side as well as the Protestant. It wasn't like that in the sixteenth century.

Ard Louis: I wonder whether what you are seeing is correlation or causation. If causation, then one expects to see a similar flowering of science in protestant countries like Holland. So far most of your examples have been about the UK.

Denis Alexander: We'll collect one more counter-example before letting Peter reply: it's much more fun collecting counter examples!

Jason Rampelt: Yes, I'd just like to add something along the lines of what Michael was saying. I have a question on what you were speaking about – and if I'm drawing from the book as well, I apologise. This is a question about method in two respects. The first is a question of fact about early modern methods of investigation, and the second on your own historiographical method. Your thesis suggests that there was a new method in natural philosophy based on the sort of biblical hermeneutics that we find with the Protestant reformers. Herein, you show a parallel between the observation of the text (among the reformers), and the observation of nature (among the new natural philosophers). In both cases, one's own observation is given a new priority over existing authorities.

As a counterexample, if you are going to do a history of modern science and want to tell that story, there is a long and thorough tradition of observation that stands well outside of Protestantism and even Christianity. Typically, in this narrative of modern science as it's usually told, astronomy figures quite prominently. As Michael suggested earlier, there's a very long, strong, thorough tradition of observation of planetary motions of the stars. On the book table I think there was David Lindberg's "History of Western Science" and right on the front there was a perfect illustration of what I'm talking about. The picture shows what is probably an Arab philosopher standing there with an astrolabe, looking at this perfectly painted picture of the stars. It's very clear what he was doing there, and this was all of course mathematicised as well, and very elaborately worked out. There were detailed reference tables and also, remembering Ptolemy, instruments. In the early modern period we had improvements of these instrumental and mathematical technologies, and even new theories, but the method of observation is something that's continuous between ancient, medieval and early modern periods. The second level of method is of course why are we

choosing to make the sharp distinction between these two periods, when there is this very strong continuity.

Denis Alexander: I think, Peter, you've got two streams of thought coming in here and plenty to get on with!

Peter Harrison: David Lindberg is a good friend and he's an excellent historian, so I hesitate to contradict any claims he might be making. One general issue in these responses is the question of continuity *versus* discontinuity in the history of science. Over the past few decades there has been a quite proper correction of an overemphasis on the discontinuity between medieval and modern natural philosophy. Dave Lindberg's work on medieval science has made a vital contribution here, and he has changed the way we think about medieval science. We also have the kinds of examples that Michael Hoskin had provided of a sophisticated medieval mathematical physics. That said, I would still want to argue for important discontinuities, including for example the conception of what counts as observation. Thus Aristotelianism was undeniably empirically based, but tended to make generalisations on the basis of our commonsense observations – “heavy objects fall faster than lighter ones”, for example – which is to say that nature was read uncritically and taken to be more or less as it presents itself to us. This is in stark contrast to seventeenth century English “experimental philosophy”, which interrogates nature and examines it time and time again under what are essentially “unnatural” or artificial conditions. So what we find people like Boyle advocating is that we manipulate the natural world, that under special conditions we observe what's going on, and it's only under these contrived conditions that we actually see, or get insight into, the various processes. This involves communal observation, it involves accumulation of all sorts of observations under different conditions. Eventually, we come to some conditional conclusions on the basis of this long complicated experimental process. This is a radically new approach to observation. Now this argument was not part of the lecture I gave today – it will be the major theme of my next book – but there is a fundamental difference between the Aristotelian assumption that our sensory and cognitive apparatus are designed in such a way that they'll give us a veridical account of nature, and a Calvinist view that says our cognitive apparatus and our faculties of observation are fallen, imperfect, that they give us the wrong knowledge, they persistently mislead us, and that the natural world itself is in a fallen condition and deceives us. An implication of Calvinist theological anthropology, I believe, was that we have to augment our natural faculties with instruments like telescopes and microscopes, and manipulate the natural world experimentally because it's inherently deceitful. We need to do all these things to guard against the easy assumption that our faculties give us a reliable account of the natural world.

So whereas it's true to say that Aristotelian science is empirical and observational, it is in a radically different way to what we see happening in seventeenth century experimental philosophy as epitomised in the sort of things going on in the Royal Society, in Boyle and the whole Baconian approach to natural philosophy which is, I think, radically different from anything that came before. Now I must say, this development is not related to hermeneutics *per se*. It's related to what I think is the important contribution of Protestant theological anthropology to the emergence of modern experimentalism. In a sense, I've given you an answer to a question that isn't related to the subject matter of the lecture but that's what I think is going on. Perhaps to answer Jason Rampelt's question more directly, *natural history* in the Middle Ages and Renaissance is undoubtedly a bookish and scholarly endeavour, although it can be conceded that the contents of the sources were originally based on observation, and were added to on the basis of contemporary observations. *Natural philosophy* was perhaps less so, but still was taught in the universities, for example, from the texts of Aristotle and from commentaries on those texts.

To get back to Ard Louis's question about Holland and Switzerland and Sweden and so on, I think these are very interesting places where there is a lot of scientific activity worth looking at. I'm not going to be the one to do this, however, because, basically I'm a specialist on what's happening in England! So I'm not wanting to deny that interesting things are going

on there and someone should do those sorts of studies, I agree (it might yet be me!). One thing that would certainly be worth exploring further is whether there are differences between Lutheran and Calvinist approaches to nature during this period, and whether there was something unique about English Protestantism. Again, the Netherlands is a particularly interesting case and there has been important work done recently on, for example, the Calvinist Copernicans in the seventeenth century.

With regard to Stephen Orchard's point about Erasmus and the Greek texts and the Vulgate. Yes, I agree that the production of a Greek text of the New Testament was a vital stimulus for biblical study and that this work has nothing to do with Protestantism *per se*. But it is the Reformers who appropriate the text and use it. As for Catholicism, unless the ecclesiastical authorities sanction the use of this text – and they don't, because they continue to insist that the Latin Vulgate is the official text of Scripture – this important humanist scholarship is not going to have the same impact. So humanism is a crucial part of the equation – don't get me wrong here. But it is the new intellectual polity generated by Protestantism that makes it possible to utilise those resources in a way that can actually change things.

Finally, to return to Michael Hoskin's very interesting point about the "modern" features of some aspects of medieval science. One possible response would be to retreat from making a strong claim about what all this means for natural philosophy and mathematical astronomy, and to focus on natural history. Certainly, I think that the example of John Ray and others shows how changes to hermeneutics made a clear difference in the realm of natural history. Perhaps one of the limitations of my original statement of thesis in the book was that I did not sufficiently distinguish between natural history and the other disciplines that we now classify amongst the natural sciences. Having said this, I think I can also make the case for significant change in the spheres of mathematical astronomy and natural philosophy, but perhaps relying less on the hermeneutical changes that I've been focusing on here. One of the important issues here is the role of mathematics in Aristotelian natural philosophy. In essence, Aristotle wanted to keep mathematics distinct from natural philosophy – the mathematical treatment of nature was relegated to the so-called "subordinate sciences". One of the distinguishing features of early modern natural philosophy is that it becomes mathematical, and in my view this constitutes a clear break with the Aristotelian arrangement. My point is that we can identify a significant discontinuity between medieval and early modern uses of mathematics. Whether this shift can be said to be related to changes in hermeneutics requires further work. Certainly, it is true that Descartes, who was a Catholic, was an important figure in this transition.

Peter Head: I wonder if you can help me because I heard you making in your lecture a strong statement, *i.e.* that the anti-allegorical hermeneutical shift which you regarded as intrinsic to the reformation was the key feature that led to the scientific revolution. Now we've heard about a range of other factors too, the political situation in Protestant countries and so on, and especially just now the different attitude towards natural theology (the optimism of Aquinas compared to the pessimism of Calvin—influenced by Romans 1.20: the natural revelation is real, but suppressed by sinful humanity). So I wonder what is the strong thesis that you're making, is it just that this hermeneutical shift is one among a range of factors that lead to the emergence of modern science or are you still trying to press the strong thesis, because I hear you sometimes backing off a bit.

Janet Soskice: Perhaps I can say from the remarks you've just made that some of the points are about Protestantism and some are specifically Calvinist. I think that Peter's point as well is terribly important, this ability to say "well we won't think that's great just because it's tradition", you can say that's more globally Protestant. But the whole question, this interrogation, this having to go behind deceitful appearances that you emphasise, that's more acutely Calvinist. Is it perhaps partly because the English church was Calvinistic in that period, that you see it more acutely in Britain than, say, in Sweden which was more Lutheran. It would seem that there's a sub-thesis about Calvinism in this.

John Coffey: I do think there's a danger of polarising Catholic and Protestant theologies too much, at least at the basic level; for example, both are deeply indebted to Augustine in quite a few ways and he is fairly pessimistic. Some historians would argue that there is a quite pervasive attitude in sixteenth and seventeenth century Europe for a bleak view of human capacities, of human depravity. It's not just a uniquely Calvinist attitude.

Peter Harrison: John is right to make this point. We need to be careful about reifying these notions "Protestantism" and "Catholicism". This is also what Stephen Orchard was saying earlier. After all, all the first generation of Reformers were raised and educated as Catholics, and the confessional boundaries imposed on Europe by the relevant treaties – Augsburg and Westphalia – are not going to map directly onto individuals' personal religious commitments. And I can't emphasize strongly enough how much I agree with John's observation that Augustinianism was a pervasive feature of early modern intellectual culture. Jansenism is a good example.

Denis Alexander: Can you un-package Jansenism for those scientists round the table who are not into Jansenism? We just need a little translation.

Peter Harrison: Jansenism was a predominantly French seventeenth-century Catholic movement that explicitly sought to revive elements of Augustinianism. In certain respects, but not all, they resembled the Calvinists and were frequently accused by the Jesuits of being crypto-Calvinists. John's point is an excellent one in that wherever you look in the seventeenth century you can find versions of Augustinianism. However, these different versions can often be opposed to each other.

There's a classic statement by B.B. Warfield, the Princeton theologian, who said that the Reformation can be understood in terms of a conflict between Augustine's doctrine of grace and Augustine's doctrine of the church, so you've got all sorts of varieties of Augustinianism. I think that's right – but that doesn't mean that they can't compete with each other. For example, Blaise Pascal was a Jansenist and he's a good example for my thesis because he's an advocate of experiments and he doesn't like Descartes, who is a Jesuit-educated Catholic. So you do have a divide within Catholicism between varieties of Augustinianism, but Jansenism stresses in a similar way to Calvinism the depravity of the human condition and it takes the Augustinian doctrine of grace very seriously. The Jansenists were very much opposed to the Jesuits so you've got a polarisation between these two groups in seventeenth century France. There is a strong version of an Augustinian concept of human nature and an Augustinian view of grace in Jansenism, so you've got this within Catholicism which complicates the situation. But in a sense this is helpful for my thesis, because what you find is that in certain respects the Jansenists are like the Calvinists, and Pascal is into experiment in a way that Descartes is not, although it must be said that Descartes' putative aversion to experiments is considerably exaggerated. Descartes is doing experiments too but in a different way to the English experimentalists.

I think also the divides within Protestantism are important. Janet is right to say that sometimes I'm talking about Calvinism and sometimes I'm talking about Protestantism more generally. These developments are quite complicated because, for example, in the Lutheran universities in Germany, owing to the influence of Melancthon, there was a reversion to certain features of Aristotelianism that was less pronounced in Calvinist institutions, and particularly in England. So we can't talk about "Protestantism" or "Catholicism" without significant qualifications. In other words the issue is that it's more nuanced than I've presented it. But I don't think there's anything in this that's going to count against the main claim.

To address Peter Head's point, let me just backtrack a little bit. What I was talking about in this lecture was biblical hermeneutics and early modern science. That's part of a much bigger story and I haven't pretended to tell that whole story, although I can try and give you little bits of it that are relevant to a thesis that links the Reformation with the rise of science. Let me say again it's not merely Protestant conceptions, Protestant ideas,

Protestant doctrines. What the Reformation does to Europe is also crucial and that need not have anything to do with the intrinsic values or ideas of Protestantism. It makes all sorts of things possible, and that's a key thing. The event of the Reformation, that's one thing, and the ideology of the Protestant groups, that's another thing – they're both important.

Bob White: Opening up that same theme but going back two steps further: why didn't science get going in China or the Middle or Far East? We've been talking about minutiae of different Christian viewpoints – is there a case to be made that actually the Christian viewpoint *per se* is what enabled science to get going?

Peter Harrison: My own view is that the answer to this question is absolutely yes. But as I've said earlier, historians tend to be wary about these counterfactual hypotheses. Why didn't it happen in China? I think that this is an interesting question to reflect on. We know what really happened, so it's easy to read back into the history some sort of causal necessity, as opposed to accepting that it might have been a sheer fluke that science arose here and nowhere else, which is one possibility I suppose.

Part of what I'm trying to say is that it's not merely a range of people coming up with a few different ideas, like Copernicus and Galileo, Descartes and ultimately Newton. What I think is crucial is the sort of social matrix that makes science possible as a cumulative enterprise, where the study of nature is valued. It seems to me this is an ideology that was unique to the seventeenth-century West, to a large extent because of theological factors.

Often the history of science is told as individuals having great ideas, which are quickly accepted. But in fact when you look at the history of science, it's often people having great ideas, and the majority of their contemporaries saying "Well, no, you're wrong". So the additional question we need to ask is about what makes possible the acceptance and flourishing of certain ideas. So what makes science possible? It's not isolated individuals having great ideas – although that's a necessary but insufficient condition. What's going to make it possible is a culture in which these are ideas encouraged and enabled to flourish, along with the social structures and organizations that make possible concerted collective endeavours. Again I don't want to be Whiggish and Anglocentric, but seventeenth century England was a wonderful environment for these sorts of things to flourish and to take root. I do not want to stress the importance of England to the exclusion of everywhere else, but rather to say that this is the field, period and geographical region I know and what I can say is here's a wonderfully fertile environment for which these ideas are encouraged and made possible. Francis Bacon and Baconianism are a crucial part of that, in addition to the social structures that become possible with the Royal Society and so on. Now the Royal Society is paralleled in other places, with similar societies in Italy and France of course, but in certain respects I think the Royal Society is unique. If we're going to ask the question about why does science emerge here and what makes it possible, it's not merely people having good ideas but it's the cultural context that encourages those ideas and builds on them.

Further, I think that the notion that nature is intelligible and governed by mathematical laws is firmly grounded in theological conceptions – ones common to both Catholic and Protestant versions of Christianity – and that these theological notions, which in the seventeenth century are often explicitly set in opposition to Aristotelian ideas, play a crucial role in establishing the foundations of modern science.

Brian Heap: You've said on several occasions that this was something that happened here in the UK, so what about all the science that developed much earlier both in China and in Central Asia and a number of other countries. Are you not calling it 'science'?

My second point is that I've been waiting for you to use the phrase that has been the Royal Society's motto "*nullius in verba*". In the history of UK science the idea that you must know for yourself by experimentation became critical compared with your emphasis on words alone.

Denis Alexander: Can I just interpose something on China based on Needham? I think it was Needham's point that science did not emerge in China because it did not have a world-view which encouraged the idea of the rationality of God that we have in the medieval European culture, coupled with the idea of God as law-giver. Perhaps, Peter, in your next comments, you could also pick up that Needham thread?

Peter Harrison: Look, it's a good question. We can give different definitions of science I think and this is something historians of science get themselves tied up in all the time. When they are talking to each other, historians no longer talk about early modern science. Instead, they talk about early modern natural philosophy, natural history, anatomy, medicine, astronomy and so on. Strictly speaking, I would say that modern science really only begins in the nineteenth century when we have the first professional organisations devoted to the pursuit of various sciences, and when the sciences come to assume a central place in the university curriculum. Before then we had natural philosophy and natural history both of which, some historians have argued, differ from modern science in being theological in orientation.

As for China, one not entirely satisfactory answer is to say that in China we've got knowledge of nature, we've got technology, but we don't really have a cumulative enterprise that looks anything like modern science. I don't have a problem with saying the sorts of things that are going on in the Royal Society in the seventeenth century are part of the genealogy of the enterprise that's taking place in the institutions of modern science in the twentieth and twenty-first centuries. I don't think there's anything happening in medieval China that looks anything like that – perhaps in Astronomy, but I must confess my ignorance on this in part as I haven't looked at this. I think you can say the same about Babylonian astronomy or medieval astronomy, which is to say that there is an impressive body of observational data, and in the case of astronomy, a capacity to predict what will happen, but the theorising about the causal mechanisms doesn't look much like what we would regard as science. Again, of course, this will depend on what you mean by "science", so you're right to suggest that by definition alone we can deny certain activities the status of science.

I should also comment on Brian Heap's earlier point about the motto of the Royal Society, "*Nullius in Verba*" because I think Brian is right about this being important. It's actually part of a quote from Horace – "*Nullius addictus jurare in verba magister*" – and while the shorter version of the motto looks as if it is saying something like "nothing in words", which would set up the kind of opposition between the treatment of words and things that framed the lecture, the meaning of the full quotation means something like: "I am not bound by allegiance to the doctrines of any master". My feeling is that it is the sentiment of full quotation that the founding fellows of the Royal Society wished to capture. Their commitment then was to find out things for themselves and not simply to accept the view of the received authorities. I think that this is an important and different commitment, and it is one that is paralleled in the religious sphere with the Protestant emphasis on what was called "experimental religion" in the seventeenth and eighteenth centuries. During this period the term "experimental" occurs as much if not more in a religious context than a scientific one, and by that term was then meant "direct experience". Hence, "It's important for me to experience this for myself". This view of "experimental religion" was opposed to a Catholic doctrine of implicit faith where the contents of belief were not explicitly known or acknowledged. Implicit faith was faith that the doctrines promulgated by the ecclesiastical authorities were true. It was, as critics such as Calvin expressed it, faith in the Church, not explicit belief. Luther and Calvin were to argue that it was important for us to come to know these religious truths for ourselves. Now this has clear parallels with the notion of experimental science or experimental philosophy as coming to know for ourselves, through experience, truths about the natural world, as opposed to relying on authorities and traditions. The story of the link between experimental religion and experimental science has yet to be told. I hope when the next two books are finished that I'll get round to this.

To get to Denis's question, I do think the concept of laws of nature is a crucial part of what is distinctive about the science of the modern West, and perhaps you'll be relieved to discover that I'm not going to argue that this is a peculiarly Protestant thing. Descartes is a crucial figure in the development of this new notion of laws of nature, a development that relates to the question that Janet Soskice asked in the lecture: what happens in the early modern period to Aristotalean *entelechy* or the idea that natural objects have within them a particular drive to fulfil an inner *telos* or to find their proper "place"? There is a connection here with the thesis that I outlined in the lecture, because over the course of the sixteenth and seventeenth centuries natural objects are evacuated not only of their inherent symbolic meanings with the collapse of allegory, but they're also emptied of their inner causal efficacy. All of the Aristotalean causes – and Aristotle has four: the efficient cause, the material cause, the formal cause and the final cause – are taken away from natural objects. So whereas a complete explanation of a natural phenomenon once invoked these four causes, three of which inhered in natural objects, the new explanations had recourse to the idea of laws of nature. These laws were externally imposed, and were equated for the most part with God's commands or volitions. We find an extreme version of this in Descartes, who wants to say God not only promulgates the laws of motion, but that he invents the laws of mathematics so that if He said two plus two equals five that's how it would be, so that there are no necessary truths until God instantiates them.

Kepler is more platonic and says that geometrical relations are co-eternal with God and God instantiates them in the natural world. When we get to Newton's conception of gravity, Newton will famously say that he feigns no hypotheses about the cause of gravity. However, Richard Bentley's reading of Newton, popularized in Bentley's Boyle Lectures, is that God himself moves things directly. So God is gravity. Descartes' understanding of motion, at least on one influential interpretation, is similarly that motion takes place when God recreates objects in successive but proximate physical locations. In Nicholas Malebranche we have an explicit statement of the doctrine of occasionalism – the view there are no genuine causes in nature, there is only divine causation, and collisions and so on are the occasions of divine action. So whereas on one view modern science is gradually removing God from the equation, the reality is that God becomes an immediate causal force in a way that was never true under the Aristotalean system, where all sorts of internal *teleoi* are driving things and mediating between God and the natural world. This development, then, is a crucial part of what then makes it possible for us to explain the world in terms of laws of nature which, for Descartes and indeed for people like Newton and Isaac Barrow, are nothing less than God directly moving things in the world according to mathematical, regular principles. (Isaac Barrow was the first Lucasian chair of mathematics, Newton the second.) Barrow said on one occasion that we can have confidence in our inductive reasonings because God is regular and constant and is the author of all the motions in the universe. That's why we can be certain that experimental results obtained on repeated occasions will hold true. To take another example, Descartes says we have a law of conservation of motion. Why? –because of the immutability of God. So, in short, the early modern idea of laws of nature is grounded in a particular conception of divine activity. So this is an idea peculiar to the West, which arose in the late medieval period (although there are some precedents in Islamic theology) and became a dominant view in the seventeenth century.

Of course, this becomes secularised and God eventually disappears out of the picture partly, I think, because it's a very short step between saying God does everything and God does nothing. Then the laws God imposes on nature become simply law intrinsic to nature. Nonetheless the theological conception of laws of nature is a crucial phase and that's perhaps what's distinctive about this theological conception, which is a vital one in the seventeenth century.

Denis Alexander: We've got about two minutes left. Russell wanted to come in – do you have a quick question?

Russell Manning: I had an earlier question but I'll leave that aside to pick up on the very last thing that you said there. To a certain extent it seems to me that however one understands the influence of Protestantism on the development of science, I wonder if maybe the notion of a Protestant spirit might be a better way of phrasing it? In a sense what Peter has been talking about is descriptive of a particular moment in the development of 'Protestant science', in which the initially co-existent, and indeed mutually supportive, relationship between Protestantism and early-modern science dissolves. It seems to me that this is more a question of the secularisation of science than its 'Protestantisation', as it were; and that it is this movement that needs explaining. I wonder what your story has to say about that?

Denis Alexander: This is going to be your final word, Peter, and this is going to be your wrapping up of everything you've said – just to warn you!

Peter Harrison: Well, Russell, what I was going to say was that I'm a seventeenth century historian and that stuff happens in the eighteenth century! But where I think Weber got it right was to see in Protestantism, or certain features or consequences of it, intrinsically secularizing tendencies. On my account, Protestantism does disenchant nature, it disenchant it because it tends to relocate the active principles of nature into God. Its approach to texts and symbols, moreover, has the consequence of stripping the natural world of its symbolic significance and its intrinsic theological meanings. And this in turn leaves nature open to material exploitation and disinterested investigation. As for the process I've just been describing in response to Denis's question, if God seems to be no longer a plausible hypothesis then somehow we're left with this system that just happens to be the way it is, and it's clear that what happens in the nineteenth century is that what were previously divine laws imposed *on* nature become laws *of* nature. And in time, laws of nature become laws of science. The credit then shifts from the Deity to the professional class that discovered them – with apologies to the scientists. And what is interesting about this transition is that the remarkable features of the universe are no longer credited to the Deity but now rather reflect on the scientific enterprise as the institution that has managed to uncover the workings of nature. The laws tend to be seen as testimony to human ingenuity as opposed to the workings of a designing Deity.

As for the notion of a Protestant spirit or Protestant "ethic", to use Max Weber's expression, this is perhaps a helpful way to negotiate some of the difficulties that we've encountered this evening in relation to the question of the problematic identities of "Protestantism" and "Catholicism". After all, while the notion of "Protestant ethic" must be correlated in some fashion with the positive historical manifestations of Protestantism, there is no reason that it would necessarily be restricted to those who specifically identify themselves as Protestants. And speaking of Weber, we should also bear in mind his caveat that the Protestant ethic and its consequences were in all likelihood completely unintended consequences of Protestant teaching. That's probably not an entirely satisfactory answer to your question, but it's not a bad note on which to finish and at this stage of the evening that's all I've got!

Denis Alexander: I think we've had a great discussion and we want to thank Peter very much indeed – we've worked him very hard and we should show our appreciation and thank you all very much for coming and contributing in such a useful way.

WHO'S WHO

Prof. Peter Harrison is Professor of History and Philosophy at Bond University, Australia. His publications include *The Bible, Protestantism and the Rise of Natural Science* (CUP, 1998) and 'Religion' and the Religions in the English Enlightenment (CUP, 1990). He is currently a member of the Institute of Advanced Study, Princeton, where he is completing a book on the influence of theological ideas on the development of experimental science in the early modern period.

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Jason Rampelt, recently completed a PhD thesis in the Department of History and Philosophy of Science entitled, 'Distinctions of Reason and Reasonable Distinctions: The Academic Life of John Wallis (1616-1703)'; interested in the confluence of early modern natural philosophy and Reformation and Post-reformation Protestant theology.

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This discussion was sponsored by the Templeton Foundation.

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