Centro de Ciencia & Fe

Beauty in Science and Christianity

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Thank you for coming, and I would like to thank the University of Deusto for inviting me here this evening. Let me begin by stating my position. I am a scientist, and I am also a Christian. I spent a number of years working in the laboratory, both as a PhD student and a postdoctoral researcher in the field of genetics, including evolutionary biology. I have also spent the last ten years working in the field of science and religion, focusing on communicating the relationship between science and faith, mainly to a Christian audience, and also to the general public.

I believe that science and religion are not just compatible, but science can also *enhance* our experience of God. I find this when I talk to scientists who are also men and women of faith, and I experienced it myself in the lab. Today I will speak briefly about the complementarity of science and faith from my own perspective as a scientist and a Christian, using some of the ideas from the 'La Fe a Examen' project, and then I will speak about how science enhances faith. I will use beauty as an example, showing how beauty can raise questions that go beyond science, and for a Christian it can teach them something about God.

I know that there is a rich seam of teaching on beauty in the Catholic Church. I have drawn on some of this work in my own research, and I am very grateful for those who have stewarded this area so well while Protestant theologians such as Karl Barth were getting so nervous about natural theology – about arguments from nature to God. I speak primarily as a biologist and a member of the Protestant church who wants to move away from debates on evolution and suchlike, and focus on more positive conversations about science and faith, both among scientists and theologians, and anyone else who wishes to engage intellectually in the modern world. I have found that in focusing on the experiences of scientists themselves, we can have a far more interesting conversation. I should also emphasise that when I speak of science, I mean natural science, unless I refer to the social sciences specifically.

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[1] This is the text of the lecture delivered at Deusto Forum (University of Deusto, Bilbao) on May 20st of 2014, for the launch of the book *La fe a examen* (Fliedner Ediciones, Madrid, 2014; a translation of the book by Ruth Bancewicz *Test of Faith*, Patesnoster, Milton Keynes, 2009). A video of the lecture is also available https://www.youtube.com/watch?v=nBzU9qDgZOw

So - first, the relationship between science and faith. In recent years, historians have begun to recognise that religion played a positive role in the development of science. For example, Noah Efron, a historian of science at Bar-Ilan University in Israel has written that "one cannot recount the history of modern science without acknowledging the crucial importance of Christianity."

From the twelfth century onwards, when Arabic and Greek texts began to make their way to Europe and were translated into Latin, European scholars started to do 'natural philosophy' – which was the name for science until the nineteenth century. As this new wave of ancient learning was absorbed and modified by Christian thinkers in Europe, science began to emerge in a form that we would recognise today.

One example of the influence of Christian theology on science is the increasing importance of experiments. The mathematics that the Greek philosopher Plato taught was incredibly important for the growth of the physical sciences, but lacked an emphasis on experimentation. But the early natural philosophers in Europe reasoned that God wasn't limited by anything when he created, so it is impossible to predict what the material world will be like – you have to go out and study it for yourself. For Galileo, Isaac Newton, Robert Boyle and others like them, scientific experiments became a key to exploring God's creation.

Another example of how theology influenced scientific thinking is in the concept of scientific 'laws'. The idea of rules that describe the movement of objects, chemical processes, and so on, came initially from the Biblical idea of a God who creates everything in an orderly way. The Old Testament in particular has a strong emphasis on God sustaining the world in regular ways: day and night, cycles of the moon, birth and death, winter and summer. So the pioneering early scientists expected to find law-like behaviour in the world, and this step of faith was well rewarded. We now know that matter behaves in regular ways that can be described by laws and physical constants, which we can use to make predictions and develop technologies.

So these examples show that science and religion are entirely compatible, and the early scientists saw their work as an act of worship. For them, faith was something that affected the whole of their lives, and their scientific writings were often littered with theological reflections. I will give you just one example. The German astronomer Johannes Kepler, who is famous for his 'laws of planetary motion', had originally wanted to be a theologian, but he found himself a scientist instead, and realised that this was a worthy vocation for a Christian. At the end of his book *The Harmony of the World*, he dedicated his work to God, saying that "If I have been enticed into rashness by the wonderful beauty of thy works, or if I have loved my own glory

among men, while advancing in work destined for thy glory, gently and mercifully pardon me; and finally, deign graciously to cause that these demonstrations may lead to thy glory and to the salvation of souls, and nowhere be an obstacle to that."

So while there are inevitably some issues to consider, on the whole, science is a natural home for a Christian. Science is simply a way of understanding the world that God made and learning to use its resources wisely. As you know here in this university, there is a rich tradition of reason and learning in the church that enables academics to flourish intellectually in a Christian context. And as demonstrated by the US-based organisation BioLogos, which was founded by Francis Collins, the former director of the Human Genome Project, even a conservative evangelical need not reject evolutionary biology on the grounds of incompatibility with Genesis.

A recent survey of both natural and social scientists in the US by the sociologist Elaine Howard Ecklund found that 61% identified themselves as Christians, compared to nearly 74% in the general population. Considering the aggressive nature of the science-faith debate in the US, those figures are extremely encouraging because they show that large numbers of Christians still recognise the compatibility of science and faith. Statistics are not available for the rest of Europe yet – that study is still ongoing - but as the discussion is far less polarised over here, I suspect the proportion of Christians in science would be the same as number in the general population. I won't go into Ecklund's work any further, but I do recommend it to you, because it shows that the claims about science and faith being at war are completely unfounded.

So when I talk to other Christians who work as scientists, they tend to focus on the fact that their research in the lab simply deepens and expands their picture of the world, and of God. They know that science and faith do not have to be kept in separate compartments for fear of one polluting the other. In his book *The Language of God*, Francis Collins speaks for many of these people when he says that it is "possible for the scientist-believer to be intellectually fulfilled and spiritually alive, both worshipping God and using the tools of science to uncover some of the awesome mysteries of his creation."

[SLIDE] And now for beauty. After exploring this area for some time, I can safely say that it appears to be a universal experience for a scientist to find beauty in the objects he or she studies. Marie Curie said that "I belong in the ranks of those who have cultivated the beauty that is the distinctive feature of scientific research". [SLIDE] And in *'La Fe a Examen'*, Dr Ard Louis from Oxford University descries how he sees beauty in the mathematics behind the

universe, using the discovery of antimatter as an example. [SLIDE] Francis Collins, in the introduction to his chapter about genetics, also talks about the beauty of DNA.
A cynical person might say that scientists see beauty in their work because the daily discipline of examining *anything* in enough detail helps us to appreciate its finer points – whether it is actually beautiful or not. Or maybe the process of choosing something to work on and then spending the greater part of your waking hours staring at it provokes something akin to the loyalty of a mother who thinks her child is beautiful, despite the large pimple on its nose.

But a scientist's experience of beauty seems to be more than just the fascination and devotion of the true professional. Before I can make my case I need to define 'beauty'. Definitions in different times and for different cultures have been varied and contradictory, and include symmetry, harmony, proportion, order, unity, a ratio of uniformity to variety, uselessness and usefulness. Plato and some of his contemporaries considered beauty to be a virtue, part of a trio with goodness and truth. Is beauty is in the eye of the beholder, or is it an objective value? Is beauty a rare quality - something that takes your breath away - or can it be found in an everyday object that is quite plain but simple and satisfying?

[SLIDE] When it comes to natural beauty, the biologist E.O. Wilson and a number of others have connected our ideas of beauty with evolutionary history. They say that we enjoy wide-open vistas, long stretches of clear water, hiding places and high lookout points because they would help us to survive in a wilderness situation. Other aspects of aesthetics are no doubt related to our culture, upbringing, or personal preference. I also wonder whether we enjoy nature and find it refreshing because it is so much more complex than anything we can make ourselves?

My own definition of beauty for the purposes of this lecture is 'something that is pleasing to the senses'. This can include more abstract qualities that appeal to the intellect as well as the emotions. So [SLIDE] a tree might be beautiful because it's covered in blossom, but also because it has an unusually symmetrical shape. A child might find her new bicycle beautiful because it's red and shiny, but someone else might think it is beautiful because it is well designed. I will assume that beauty is a matter of taste most of the time, but I will mention a few people who think it is an indicator of truth.

The things scientists find beautiful are not always immediately attractive to the uninitiated beholder – though perhaps you can appreciate their enthusiasm. [SLIDE] As a biologist I am fascinated by the images of cells, protein structures, and weird and wonderful organisms that grace the covers of scientific journals. [SLIDE] I have spent whole weeks staring down a

microscope at the beautifully transparent bodies of developing fish embryos, and I never tired of looking at them.

[SLIDE] Jeff Hardin is Professor of Zoology at the University of Wisconsin-Madison. He and the members of his lab study a tiny transparent roundworm called *C. elegans,* which shares many of the most basic functions of our own bodies. [PLAY VIDEO] The life of this simple organism is completely determined by its biology: hatch, grow, moult four times, then mate. Most C. elegans adults are hermaphrodites, so they make some sperm, then switch to making eggs and fertilise themselves. One could find this cycle depressing, but that's not the take-home message for Hardin. "Knowing the steps in a complicated bit of ballroom dancing leads to greater appreciation for the skill of the dancers, and it is the same with *C. elegans*. Watching these tiny embryos in exquisite detail using powerful microscopes gives us a deep sense for the intricate cellular choreography that build their bodies."

So a scientist may find beauty in the objects they study – the data – whether that is a group of organisms, a diagnostic printout, or an aesthetically pleasing series of molecules. I've given some examples of this in biology, but I'm sure that researchers in most fields of science find at least some of their data beautiful.

[SLIDE] There is also the beauty of the cleverly devised experiment carried out with skill and patience. This is the sort of work that produces good clear results: the molecular biologist's sharp DNA bands on a gel, the organic chemist's high yield, or the physicist's precise measurements. When you focus hard on a technically demanding experiment and manage to complete it successfully, the outcome is a piece of work that is often very beautiful as well as useful. Colleagues gather round to admire your work, and requests begin to come in for you to teach others how to do the same techniques. Like most people, I didn't excel at every aspect of lab work but I managed to learn some techniques well, and I am still proud of a few nice pieces of data from my days as a PhD student. The best moment is when someone who has taught you says, "that's very nice!"

Another kind of beauty is introduced by the scientists themselves: perhaps some elegantly drawn graphs, or a carefully crafted presentation filled with photographs of microscopic organisms. [SLIDE] Among my favourites at the moment are the black and white telescope images that are coloured to distinguish between different wavelengths of light, producing the most stunning images of stars and galaxies. This process of adding beauty to one's work is extremely satisfying, particularly if it helps your colleagues, friends and family to appreciate why you spent all those days and nights in the lab.

Finally, there is a more abstract kind of beauty in science, and the first person to define this for me was a theologian. Jürgen Moltmann has been fascinated by science since he was a teenager, and he sees beauty as an important part of the human side of science. According to Moltmann, beauty in science is seen most clearly when systems are moving from chaos to order, or vice versa. He is convinced that scientific beauty is not worth seeking for its own sake, but can be a sign that you are nearer the truth. Beauty, says Moltmann, may be useless from a utilitarian point of view, but it is meaningful in itself.

Some of the best examples of this last type of beauty come from physics. [SLIDE] The theory – usually expressed as a mathematical equation – that gathers data into a coherent whole can have a beauty of its own that is both striking and satisfying. I find it hard to appreciate the beauty of equations, but when they show simplicity, symmetry and unity, physicists call them beautiful. If a theory can be used to make predictions for further experiments and explain other types of data, then that adds to its beauty.

A number of successful physicists have deliberately followed beauty in their search for truth, and Paul Dirac - winner of the Nobel Prize in 1933 - was one of these. He said that "It was a sort of act of faith with us that any equations which describe fundamental laws of Nature must have great mathematical beauty in them… It was a very profitable religion to hold and can be considered as the basis of much of our success."

There was a flaw in the Dirac's argument, however. Beauty can sometimes be an unreliable guide, and scientific revolutions have often involved a revolution in aesthetics. Einstein and a number of other physicists favoured continuity in their equations, so when quantum mechanics came along (a theory about the structure of the atom that involved electrons jumping from one energy level to another), it was difficult at first for the scientific community to accept it because they thought it was ugly. As the physicist Stephen Weinberg wrote, "our sense of beauty is sometimes a useful guide and sometimes not…"

This more abstract type of beauty is perhaps harder for a non-scientist to appreciate, but it is an important part of the scientific endeavour. [SLIDE] Each of these very different types of scientific beauty involve characteristics that are intrinsic to the natural world, but to see them requires observation, imagination and creativity on the part of the scientist. Through the work of scientists like Jeff Hardin, our eyes are continually being opened to new worlds of beauty.

So where does beauty take us? For some scientists, the beauty they see in their work points to a reality beyond science. In an in-depth survey of elite scientists, Elaine Howard Ecklund found

that 20% of them did not believe in God, but valued something beyond science that they chose to call spiritual. Some of these 'spiritual but not religious' scientists had a strong sense of awe and wonder at the natural world. There was a sense of mystery too - a belief that there is something beyond the material. Although my own convictions go further than this, I agree with these people that what can be seen in the lab points to something more than the measurements and pictures that make up the data.

The American cell biologist Ursula Goodenough wrote in her book *The Sacred Depths of Nature* that "the beauty of Nature [SLIDE] - sunsets, woodlands, fireflies - has elicited religious emotions through the ages. We are moved to awe and wonder at the grandeur, the poetry, the richness of natural beauty; it fills us with joy and thanksgiving." Although she rejects traditional religion, Goodenough gives time to thinking about what she calls 'ultimate questions' because, she writes, "the remarkable beauty of the cell, of everything that is, coupled with the improbability that life would have originated in the first place… continues to draw me to spiritual issues." Like some physicists and mathematicians, she also thinks that beauty is an indicator of truth, saying that "the creative scientist… has as his or her goal the eureka, the unifying principle, the recognition of something beautiful embedded in Nature."

Werner Heisenberg, a physicist who won the Nobel Prize for his work on quantum mechanics, saw the beauty of these unifying principles as a gift. In 1925, at the age of twenty-three, he published his ground breaking work on quantum mechanics. At the moment when everything came together and he was able to set out his theory, he felt such a high that he said it was like summiting a mountain. [SLIDE] Not a believer in God, he described the beauty he saw in philosophical terms, saying that "Not even Plato could have believed that it would be so beautiful. In fact these relations cannot have been invented: they have existed since the creation of the world."

Explaining his own experience of beauty in the lab, Jeff Hardin said, "I could talk about the theologian Rudolph Otto's 'sense of the numinous' - a spiritual feeling. But is there something more concrete than that? Is it, as the biblical scholar Tom Wright says, an 'echo of a voice'? I'd like to suggest to my colleagues that creation itself is calling out to us, saying something about its creator."

In saying that scientific beauty speaks of God, Hardin is drawing on a tradition that began over two thousand years ago. The Old Testament tells how the whole world speaks a message about the God who created everything. Psalm 19 says that "The heavens declare the glory of God; the skies proclaim the work of his hands", and in Psalm 29 we read that "…the God of

glory thunders, the Lord thunders over the mighty waters". The beauty of the land and everything in it is celebrated: mountains and trees, plants and animals, men and women.

The earliest Christian theologians, collectively known as the 'Church Fathers', often expressed their delight in the details of animal and plant life [SLIDE], and what we now understand as ecosystems. They were writing in the first to eighth centuries, but their lack of scientific knowledge didn't stop them enjoying what they saw. The Catholic theologian Jame Schaefer has surveyed the writings of the Church Fathers, and also some medieval scholars. Many of them thought that a careful study of God's creation was essential to the serious worship of God. Their writing expresses great thankfulness that they are able to "read God's book of nature", unlike the foolish ones – they say – who pass all these delights by.

One of my favourites among the people Schaefer studied is an unnamed Cistercian monk from the twelfth century, who wrote about the grounds of the abbey in Clairvaux where he lived, and the surrounding countryside. He was obviously very happy with his vocation, and had a good understanding of the interconnectedness of the different factors: water, weather and crops - an early ecology. He writes about the "friendly," "faithful" and "kindly stream" by the abbey and the different ways in which it serves the monks by providing for the fish, watering the plants and trees, helping things to grow in springtime and filling up the lake.

Albert the Great lived a century later, and contributed to the early development of science. He wrote about how important it is to make observations and experiments, studying animals, plants, metals, and inorganic elements. He carried out field studies and, as Jame Schaefer wrote, "legitimised the study of the natural world as a science within the Christian tradition". For him, the appreciation of creation involved both deep thinking and emotional sensitivity.

Schaefer noticed that these early theologians appreciated the beauty of creation on a number of different levels, starting on the surface and moving to a deeper more intellectual understanding of both nature and God. Her classification is interesting because it reflects the different reactions of scientists to what they see in their work today.

First, there is a simple delight in what is seen: an emotional appreciation that doesn't require any great thought or deep study. I can enjoy a tree [SLIDE] just by looking at it, appreciating its colours and admiring the shape and pattern of its leaves and branches.

Second, comes a more in-depth study. I could walk right up to the tree and touch its trunk, feeling the texture of the bark and noticing that it is covered with patches of lichen. I could look up and see the leaves stretching out in every direction to catch the sunlight, providing me

with shade below. I could also find out what type of tree it is and learn some more details online. What sort of flowers or seeds does it have? How long will it live?

Third, is a more abstract type of appreciation. I could think about other trees, and how their different species have come and gone over the millennia. Every organism is interconnected in some way: sharing air and water, decaying and becoming part of another organism. Each part plays its unique role in a global network of living things.

Fourth, and carrying on those more abstract ways of thinking, there is a feeling of mystery and incomprehensibility. There is something in the scale and complexity of the universe that eludes human comprehension. I could be struck by the absolutely vast number of these trees that exist, the billions of seeds they scatter each year and the small fraction that survive to maturity. It's difficult to take in, especially when I think of how many other tree species there are, and what the world might look like if all their seedlings survived.

Finally, and coming to questions of religion, these theologians appreciated a quality of the world that could be called sacramental. For Christians, visible things can remind us of the invisible God's presence and character. I could think about the fact that the tree has stood on that spot for hundreds of years, and will probably continue to do so long after I have died, which might remind me of God's even greater strength and permanence.

So these early scholars believed that everyone should study creation and enjoy its beauty using their God-given intellect. Their detailed exploration of the wonders of the universe was fuelled by faith in a benevolent creator God, and their deep intellectual study led to heartfelt praise for the one who made it. This example I have given is quite a simple one, but others have given very complex forms of natural theological arguments, and I will explore the principles behind these in more detail later.

Professor Jeff Hardin is walking in the footsteps of these early scholars, because he also has a degree in theology. He described to me how his approach to life in the lab takes both science and faith into account. [SLIDE]

He said "There's the analogy of the 'two books', which comes from Psalm 19. There is the book of God's works in the world and there is also the book of God's word, which for Christians is the Bible. We need to take each of those books incredibly seriously. The regularity of heavenly bodies is the subject of discussion in Psalm 19, but there are other Psalms that talk about biological process, including predator-prey relationships. It's clear in these pieces of poetry that understanding those biological processes as well as you can is actually an exercise in

giving glory to the one who stands behind them. To me that's part and parcel of being a scientist."

Jeff went on to explain that "Christians, when they're doing science, are experiencing something that I call 'doxological fascination'. In other words they're locked in on a minute detail, as academics tend to do, and yet they're doing it for God's glory, in the same way that Johann Sebastian Bach wrote SDG, short for *Sola Deo Gloria* (glory to God alone), in all the margins of his manuscripts. They're trying to, as Johannes Kepler is reputed to have said, 'think God's thoughts after him'."

In a presentation to some Christian researchers, Jeff said that "We need to be excited about biology as an act of worship. So in that sense, bringing glory, doxology, and fascination means being really fired up about what we are studying and being motivated to try to unlock the secrets of our research… The creation is bubbling forth praise of the Creator. That needs to be the bedrock upon which we do our biology." He finished by saying that "What ever we ultimately choose to do… I think God wants us to… love doing our research. He wants it to seem like it's not fair that we should be paid to do it. I believe that's what he wants. The task for all of us is to ask the questions to help us get to that end point."

So let me explore the theology a little more. What would a theology of beauty look like? First, there is an aesthetics of theology itself. Karl Barth was a leading Protestant theologian of the last century, and he wrote that "theology…is the most beautiful of all the sciences. To find the sciences distasteful is the mark of the Philistine. It is an extreme form of Philistinism to find… theology distasteful."

Moving to the person of God himself, there is a strong Christian tradition of studying what creation reveals about God. "[F]rom the beauty of the visible things let us form an idea of Him who is more than beautiful", said Basil of Caesarea, one of the Church Fathers.

Christians have generally approached natural theology in two ways, and one is more helpful than the other. In the first, the beauty experienced in nature is just for starters - we must rise above it in order to reach God who is the perfect source of beauty. The beauty of creation is a pale, imperfect shadow of the beauty of God, so we mustn't dwell on it too much. This ascent from earthly to spiritual beauty is an idea from the Greek philosopher Plato that was adopted by some Christian theologians early in the history of the church.

The second way to view nature is that it is somehow transparent, so we can see God through it. In other words, we will see the imprint of God's character in creation if we can only

interpret it properly. This second, more horizontal concept has a more solid basis in the biblical idea of creation revealing God's glory. For example Psalm 19 says that "The heavens declare the glory of God", Jesus uses nature parables to describe God, and the beginning of the book of Romans suggests that we can see something of God in creation.

The second way of seeing creation is also more challenging, because it requires discernment. There are several dangers that Christians need to be aware of when trying to learn about God from what he has made. As the theologian and former biophysicist Alister McGrath has said, "If the heavens really are 'telling the glory of God', this implies that something of God can be known through them… But it does not automatically follow from this that *human beings*, situated as we are within nature, are capable unaided, or indeed capable under any conditions, of perceiving the divine through the natural order."

First, creation is not God, so it does not fully reveal his character or purposes – for that we need to look at the person of Jesus. Second, because creation is not God it is not to be worshipped or idolised in itself. Third, we are not perfect, so we need to be aware that we might deceive ourselves and say things about God's character that might be false. Finally, creation is described as 'groaning' (in Romans 8). The world we live in is not perfect either, and will only reveal God's character fully when it is renewed at the end of time, as described in Revelation 21.

For these reasons, some theologians – including Karl Barth – have rejected natural theology entirely. Others have decided that, rather than throw the baby out with the bathwater, we should learn to discern what we can of God's attributes from creation. God created the universe, so it bears marks of his character – however dimly perceived.

Alister McGrath put it this way: "The Christian doctrine of creation provides an intellectual framework for seeing God *through* nature". He goes on to say that the birth of Jesus allows us to see God's physical presence in nature: a culmination of everything he has made. I think this second approach is helpful. Many Christians intuitively experience the natural world as an important point of contact with God, so we should tap into that tendency and learn to use it well.

So what *does* the beauty of creation reveal about God? When I get to this point, I often start to struggle. How can we even begin to describe the creator of the universe? I found one theologian, Karl Rahner, helpful on this point. He said that studying God is a balancing act. At times the theologian has to hold their breath, as it were, and suspend their sense of the sacred

in order to understand deep truths. But they should also keep their connection with spiritual experience. This is "theology on its knees" in worship. Emotion, beauty and art are all important to help keep this balance.

I feel the same as Rahner about conversations on science and theology. It's fascinating to look at examples of how the universe looks 'finely tuned' for life – which is another lecture entirely - because perhaps this is a pointer to the existence of God. Logical analysis of the physical constants involved requires a good deal of spiritual breath-holding, but it's possible – at least for a time – to remain focused on the physics. It's when I look at what the natural world reveals of God's character that I begin to find it difficult to keep my calmly rational demeanour – but I will hold my breath for now.

One of the main theologians to deal with beauty in recent decades was the Catholic scholar Hans Urs von Balthasar. He was upset that aesthetics had been established as its own academic field, because separating beauty from logic (truth) and ethics (goodness) meant that art was then seen as a product to be consumed, and no longer useful for the life of the mind. He redressed the balance with his multivolume work *The Glory of the Lord*, which focused on theological aesthetics. Balthasar has almost singlehandedly reinstated beauty as a subject that theologians – both Protestant and Catholic – should be discussing. From the work of Balthasar and a number of other theologians, I have gleaned three main ways in which beauty can show us something about God's character.

[SLIDE] First, the beauty of the world is a reflection of the beauty of God. Psalm 27 contains a very moving expression of this: "One thing I ask from the Lord, this only do I seek: that I may dwell in the house of the Lord all the days of my life, to gaze on the beauty of the Lord and to seek him in his temple." The beauty of God is expressed in his holiness and majesty, his deep love for people, his justice, forgiveness and generosity – and the list could go on for a long time. What does the beauty of God mean? Perhaps the best descriptor is 'glory', a word whose definition includes grandeur, greatness, splendour, magnificence, majesty, brilliance.

This aspect of natural theology was important for the fourth and fifth-century theologian Augustine of Hippo. He was a grown man before he began to appreciate the beauty of his surroundings, and wanted to find the source of that beauty. Through his search he found God. In his book *Confessions,* he wrote that his love for the beauty of the world now reflected his love for God. Later in life, he wrote that every part of creation helped him to appreciate Gods beauty, saying that "If I were to take each one of them individually, and unwrap them, as it

were, and examine them, along with all the rich blessings contained within them, how long it would take!"

Writing nearly one and a half thousand years later, Barth thought beauty was an absolutely essential part of God's glory, but he didn't want people to focus on it because he was worried about nature-worship. Balthasar was less cautious, and said that the beauty of creation reflects God's glory, because that is its purpose. "For the glory of God the world was created", said Balthasar, and that has implications for the life of a Christian. "...only the person who is touched by a ray of this glory… can learn to see the presence of [God] in Jesus Christ."

The second way in which science shows something of God, is the order and interconnectedness of the world. This was an important point for many of the early theologians, who saw God's power, wisdom and goodness in creation. The medieval scholar Thomas Aquinas wrote that "Each creature manifests God in some way, but the best manifestation of God is the beautifully ordered universe of all creatures functioning in relation to one another as God intended." Basil of Caesarea put it more poetically, saying that, "The world is a work of art, set before all for contemplation, so that through it the wisdom of Him who created it should be known."

[SLIDE] The grand picture of the world painted by science today is even more dynamic and interconnected than these early theologians could have imagined: many animals, plants and microbes interacting together; an environment where seismic events and thermal cycles combine to create varied ecological niches; a planet with lunar and solar systems that provide tides and seasons, and a universe where immense physical forces create the stability needed for that planet to exist. God endowed things with properties that enable them to 'create themselves', and the highly complex and highly ordered world that resulted from that process does indeed demonstrate God's great power and wisdom.

Finally, and entering the realm of the physicists, the beauty of the world also shows something of God at a more abstract level. In the Bible, the first chapter of Genesis, and the first chapter of John describe a God who creates order out of chaos. The symmetry, pattern, and intricate detail we see in nature are the result of finely balanced physical properties. [SLIDE] A snowflake is symmetrical because the laws underlying its formation are symmetrical. The evidence for order and fine-tuning that we see in the universe still prompt some astronomers to ask questions about God.

The physicist Subrahmanyan Chandrasekhar has put forward the idea that scientists who are more aesthetically aware are more likely to do great work. In a more recent paper Tracee Hackel, a pastor and theologian, has suggested that Christians are necessarily more aware of the beauty of God, so more likely to notice the beauty of creation. Or – the third option - would people who are more attuned to the beauty of creation be more likely to recognise the beauty of God? I'm not sure which applies, but Augustine's quest for beauty shows that what we see in nature can lead some people to God, no matter how circuitous the route.

Jeff Hardin put it this way: "Science for a Christian is, in some very real sense, an exercise in art appreciation, and art historians must take works of art on their own terms and try to understand them. Balthasar has written a good deal about aesthetics, and how it feeds into epistemology (a study of how we know what we know), and even to metaphysics [which describes the fundamental nature of things – including philosophy and religion]... For me", said Jeff, "being a Christian means that I need to take the world as it is and understand it as well as I can, in the same way that someone who is studying a work of art must take it as it is and try to understand it for its own sake, as well as he or she can."

I agree with Jeff, and with Augustine when he says that beauty points to God, but I take Augustine's argument in a more general way. In fact, I would say it even more cautiously - that beauty hints at God's presence. The following passage from Augustine's commentary on Psalm 26 is a wonderful example of his writing on this subject. It speaks of how beauty is the first step in wondering where that beauty comes from – and how, for a Christian, it can remind them very strongly of God.

[SLIDE] "Let your mind roam through the whole creation; everywhere the created world will cry out to you: 'God made me'. Whatever pleases you in a work of art brings to your mind the artist who wrought it; much more, when you survey the universe, does the consideration of it evoke praise for its Maker. You look on the heavens; they are God's great work. You behold the earth; God made its numbers of seeds, its varieties of plants, its multitudes of animals. Go round the heavens again and back to the earth, leave out nothing; on all sides everything cries out to you of its Author; nay the very forms of created things are as it were the voices with which they praise their creator."

So to conclude, scientists enjoy beauty in the same way that we enjoy the serenity of a garden or [SLIDE] carefully tended olive grove on a summer's day. Bringing order from chaos, watching things develop and become chaotic again and bringing order once more using reason, creativity and imagination, is one of the most fulfilling experiences in life. The startling

elegance of the mathematical solution, or the model that makes sense of what seemed to be a muddle of data is the beauty of 'shalom' (a Hebrew word whose definition includes peace, contentment, welfare and completeness). Not only is the prospect attractive, but it is also deeply satisfying, ordered and harmonious.

To achieve that state the scientist, gardener or farmer has expended time and energy. The process can be protracted, complicated, expensive and at times painful, but somehow we have the drive to do it over and over again. The Christian teaching that God has made us 'in his image', and often uses long and complex processes in order to work out his plans in the world, makes sense of that experience.

So my response to the beauty I see in nature is to enjoy it, to be grateful for it, and to allow it to remind me of God. The great cathedrals are a human expression of the beauty of nature, with pillars, colourful windows and tiny details in stone, designed to remind us of God's greatness and creative power. I appreciate these wonderful spaces, but I prefer to see the original – I'd rather be in a forest.

To appreciate creation to the full, Schaefer suggests seeking out information about what we are looking at – which a scientist will need no encouragement to do – and being open to new experiences, reflecting those back to God. Opening ourselves up to surprise, fascination and curiosity helps to foster an awareness of the bigger reality that includes both ourselves and the rest of creation. For scientists like Jeff Hardin and myself, the beauty we see in creation reminds us of God and moves us to both wonder and worship.

I will finish with a story about a theologian and a telescope. The theologian is a colleague from another department in Cambridge, and the telescope belonged to some friends of his. As we talked over lunch one day my colleague mentioned that he and his family had visited his friends the previous evening. It had been a clear night, so they spent some time looking at the stars. [SLIDE] My colleague had been an avid amateur astronomer as a teenager, but over the years he lost his love for science. He had been involved in debates about science and religion for so long that he had forgotten that the experience of science itself can foster awe, wonder and worship. His recent experience with the telescope reminded him how beautiful and fascinating the universe is. He rediscovered his love for science. For me, this is a useful reminder that while discussions about science-faith issues are important, one has to keep the debate in perspective. We have to remember what science is, and how the experience of doing science can raise deeper questions about the meaning of the universe and the God who made it.

Thank you for listening, and I wonder if anyone has any questions or comments about what I have said.

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After reading Genetics at *Aberdeen University* (UK), she completed a PhD at *Edinburgh University* (UK), based at the *MRC Human Genetics Unit*, working on gene-environment interactions during vertebrate development.

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Ruth Bancewicz has been researching on the positive interaction between science and faith. After developing the *Test of FAITH* resources project, she is currently working on other projects for outreaching projects on science and faith relations. In fact, this lecture is based on one of the chapters of his future book G*od in the Laboratory: How Science Enhances Faith*.