Science Week in Parishes 2019

An outreach of Science Week at The Cathedral

In an increasingly global and secular scientific culture, saturated with technology and the market, the science–faith conversation is at the cutting edge of Christian engagement.

Module #1: The wonders of the GPS

Hairdressers, students, science and God

"I believe in science, so I couldn't be religious."

Marion, an older member of the 8 am congregation at St Paul's Cathedral recounts the story of chatting to her hairdresser about attending church. "God! I don't believe any of that," the young hairdresser exclaimed. "There is no evidence for God." Marion felt awful and lost for words; she wanted to say something but could think of nothing to say.

Years at church had not equipped Marion or David for such moments.

Meanwhile, David, a science student who is keen to share his Christian faith, is faced with the same predicament when his friends typically respond, "I believe in science so I couldn't be religious."

Despite their good intentions, years at church had not equipped Marion or David for such moments.

Science Week in Parishes

Marion and David's stories locate the science–faith conversation in everyday places. The stories also show the practical importance of introducing as many people as possible to this conversation.

The material on the following pages is one of a number of 'modules' designed to promote helpful conversation in parishes about science and Christian faith.

- The modules are easy to use, designed for a minister or lay person to coordinate.
- We want this module to help people become more confident in answering your own questions about the science-faith conversation.
- The modules will help people be ready for moments such as Marion and David faced.

Some ideas …

- Do you have a lay person in your parish who could lead a small group using modules such as this one?
- Do you have a scientist in your congregation? Why not invite them to speak about their work and their faith?
- Would you like a visiting preacher or speaker or discussion facilitator? We can help.

Science Week in Parishes *is an outreach of Science Week at the Cathedral, run every year around National Science Week in August. It offers ways for your parish to open this important conversation through activities at the Cathedral and by organising events, groups or speakers in the parish.* ***Further details:*** *Stephen Ames (sames@unimelb.edu.au), Chris Mulherin (ChrisMulherin@ISCAST.org), John Pilbrow (jpilbrow@bigpond.net.au).*

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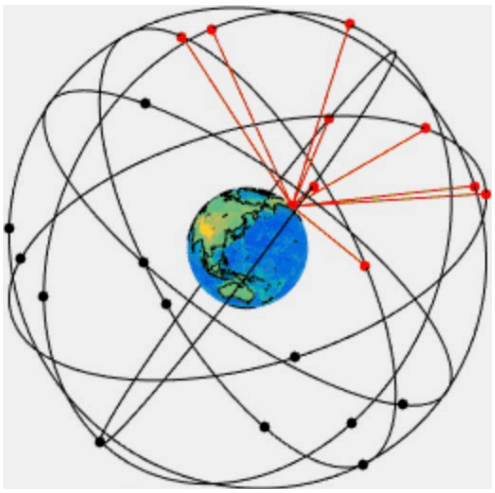
In an increasingly global and secular scientific culture, saturated with technology and the market, the science–faith conversation is at the cutting edge of Christian engagement.

What's your position? The GPS: A familiar example of science at work



Since the dawn of SatNav and TomTom, and now on our mobile phones and fitness devices, we map our journeys and receive instructions along the way. These ingenious devices work by accessing the Global Positioning System (GPS) of 24 satellites, each orbiting the earth every 12 hours or so. The satellites are positioned so that we always have access to at least four of them.

Information from four satellites is needed to fix position and to correct the clock error on GPS devices. What error? you might ask. Yes, the system only works if the time is constantly 'corrected' using Albert Einstein's theory of relativity. (See the box below for details.)

We should be grateful that even the most difficult of scientific ideas can impact in surprising ways on our everyday lives. And grateful for Einstein's equations and those who understand them so as to provide the necessary accurate corrections.[1]

The faith and science connection

The GPS incorporates extraordinary insights from science about this world, especially about time, space and gravity. It is mind-bending, awesome and often surprising. In the words of the Psalmist,

This world has been created by the living God, and, from what science shows us about God's world, we see a hint that God too is 'mind-bending, awesome, and often surprising.' In the words of the Psalmist,

> *When I consider your heavens, the work of your fingers, the moon and the stars, which you have set in place … Lord, our Lord, how majestic is your name in all the earth! (From Psalm 8)*

The more we find out about the world through science and technology the more of these hints we can expect to find.

Questions for discussion

- How do you understand the relationship between science and Christian faith?
- Can you remember a conversation about science and faith that you have had?
- How do you think people outside the church see the wonders of creation?

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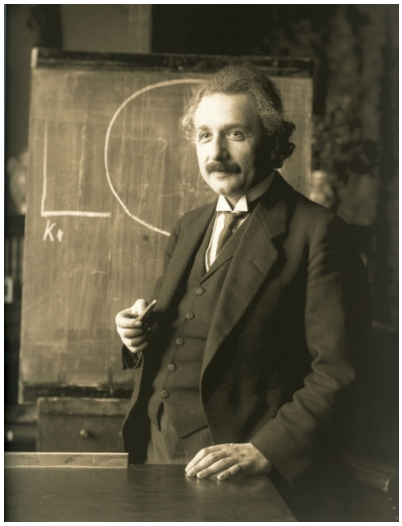
[1] Sources: http://www.astronomy.ohio-state.edu/~pogge/Ast162/Unit5/gps.html; https://www.webpages.uidaho.edu/nrgis/secure/pdf_slides/lesson4.pdf; Ian Stewart, *Calculating the Cosmos: How Mathematics Unveils the Universe*, London: Profile, 2016. pp. 3–4.

The Amazing Physics of the GPS

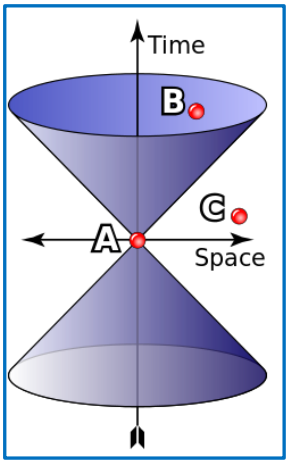
For those who like the details …



Albert Einstein,[2] one of the iconic figures in 20th-century science, is best known for his theories of Special and General Relativity, introduced more than 100 years ago. Relativity and Einstein's concept of four-dimensional spacetime have changed the way we must think about how the world behaves. General Relativity is a theory of gravity that can account for the expansion of the universe in Big Bang cosmology.

For most everyday situations, we use Newton's Law where gravity is described as a force between bodies. Newton's Law is a limiting case of General Relativity for small masses. In Newton's Law, the force between two point masses (or spheres) is an 'inverse square law' such that if the distance between them is doubled, the gravitational force between them is reduced by 75%.

While good enough get people on the moon, surprisingly Newton's Law doesn't help with regard to corrections to GPS positioning.



General Relativity and the idea of the warping of space-time must be employed when considering objects near massive stars or black holes. However, it also turns out that such an esoteric set of ideas is important for GPS navigation.

In the world of four-dimensional space-time, Special Relativity predicts that moving clocks will run slow. In General Relativity, where gravity is manifest as the warping of space-time, the closer a clock is to a large body, the slower it will become. As a consequence, there are important corrections required from both Special and General Relativity to work out by how much the satellite clocks need to be slowed down so that positional accuracy on the ground is not compromised.

Now to the correction from Special Relativity. What does this mean for the 24 GPS satellites? Since they are in orbit about 20,000 kms above earth and travelling at about 4 km/sec, they would lose 7 millionths of a second (or 7 microseconds) every 24 hours compared with an earth-bound clock.

The second correction, from General Relativity, results from the fact that clocks on the earth will be slower than clocks on GPS satellites in orbit. Therefore, satellite clocks will gain 45 millionths of a second (or 45 microseconds) over 24 hours over an earth bound clock!

If left uncorrected, GPS location errors would accumulate by about 10 km per day.

Combining these two effects, satellite clocks will gain overall (45-7=) 38 microseconds per day over earth-bound clocks. If left uncorrected, GPS location errors would accumulate by about 10 kilometres per day! To overcome this problem, the atomic clocks on the satellites are slowed down by 38 microseconds per day so that they will report the same time as a ground based clock or device. This to ensure positional accuracy on the ground to within 5-10 metres.

Had Special and General Relativity not been around when GPS systems were first introduced, the accumulating errors would have been immediately obvious and would have required urgent correction. But since Relativity shows us how to calculate the time errors precisely, guesswork has been removed!

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[2] Photo by Ferdinand Schmutzer (public domain). Image on this page by Sakurambo (public domain).