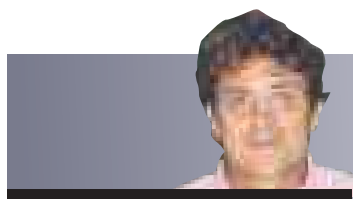
Time warp, Santa-style



CHARLES LINEWEAVER

How could Santa deliver toys to every child in the world in one night? It sounds like a crazy idea. But imagine Santa at the speed of light, and the story gets even stranger.

One of the main reasons I became a physicist was because physicists had come up with the weirdest ideas I had ever heard. Some of the weirdest are about time.

Let's suppose there are good children on a planet orbiting a star that is 20 light years away. If Santa's sleigh travels at almost the speed of light to the planet, where he delivers iPods and candy canes, and then turns around and comes back to Earth at the same speed, he will have aged only a few days (or less, depending on how fast he went) while we will be 40 years older (or dead depending on how many dumplings we've eaten during those 40 Christmases on Earth that Santa missed).

This weird effect is real and is known as the Twin Paradox, because if you replace Santa with your twin brother, after his trip, you will be 40 years older than your twin.

If you send your mother instead of your twin, after her trip, you will be older than she is. That would be weird.

The closer to the speed of light Santa goes, the less time goes by for him. Both his watch and his biological clock tick more slowly than our watches and biological clocks. If Santa Claus were a photon, he would travel at the speed of light and cross the universe in no time at all, delivering presents to all the good children in the observable universe.

If Santa were a photon, time would stop for him and all the distances in our vast universe would shrink to zero. For a Santa travelling at the speed of light, all those good children could be stuffed into a very small stocking. If Santa were a photon, there would be no time or space for him. Our universe would not exist for him. That's a bit of a table-turning mind-bender for Santa-sceptics.

It's not only fast speeds that make weird things happen to our space-travelling Santa. Gravitation will have weird effects too. When Santa is on the roof (where the Earth's gravity is slightly weaker) his watch runs slightly faster. When he goes down the chimney, his watch slows down.

Gravity slows time down. Near a black hole – where gravity is very strong – these time-warping effects can jeopardise the whole holiday season. For example, suppose Rudolf loses his way and gets caught in the in-spiralling accretion disk of the 3.6 million solar mass black hole at the centre of our galaxy. Santa, Rudolf and all the other reindeer would fall towards the black hole.

Santa might say, ''Dash it all,'' and threaten to attach a GPS unit to Rudolf's red nose. Then, as Santa and his reindeer fell through the surface of the black hole, approaching the singularity at the centre, gravity would pull so hard that jolly St Nick and all his reindeer would be tidally stretched. They would become long strings of Santa and reindeer spaghetti.

From our point of view, however, Santa and his reindeer would never be spaghetti-fied. They would appear to fall towards the black hole but never fall completely into it. They would become frozen at the surface – the event horizon – and slowly fade away. From our point of view, Rudolf's nose would get redder and redder as the light escaping from his nasal beacon gets gravitationally red-shifted.

This schizophrenic dual version of reality is not a joke or a made up story. This isn't some embellished imitation of a pagan winter solstice festival. This isn't Mithras's birthday or a Saturnalia. This isn't a nativity scene. It is a General Relativity Scene. This is what Einstein's theory of general relativity predicts for a Santa waylayed by a black hole.

The wonder of physics is that weird stuff is on offer not only at Christmas, but all year long.

So if Santa doesn't come by your house this Christmas, it may not be because you have been so bad. Blame Rudolf and Einstein.

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Answers

1. The galaxy we live in is called the Milky Way. It is shaped approximately like a) a round ball b) a doughnut c) a pretzel or d) a flat spiral

2. What is the most dangerous animal in the world (excluding humans)?

3. In what field of science will you find WIMPs and MACHOs: a) biology, b) chemistry, c) physics or d) geology?

4. From what species was the first animal to have its entire genome sequenced?

5. What is irrigated agriculture?

Answers: 1. d) The Milky Way has four spiral arms radiating out from a central cluster of stars or "nucleus". Our solar system is located on one of the spiral arms, 27,000 light years from the centre. **2.** a) The most dangerous animal in the world is the mosquito. More than two million deaths per year result from malaria infection caused by mosquito bites. They also transfer diseases to more than 70 million people each year. **3.** c) physics. WIMP is an acronym for weakly interacting massive particle and MACHO is an acronym for massive (astrophysical) compact halo object. **4.** *Caenorhabditis elegans*, more commonly known as a roundworm. **5.** Irrigated agriculture uses water pumped or piped onto land to grow crops or pastures. In an average year irrigated agriculture uses 14,000 gigalitres of water, about 65 per cent of all water use in Australia.

NYSSA SKILTON

BYTE SIZE

Some like it hot, while others – such as the damselfish on Australia's Great Barrier Reef – can get rather cranky as temperatures rise. Studies on two species of young damselfish have found the coral reef fish can undergo a major personality change in warmer water, suggesting climate change may make some species more aggressive. Researchers from the University of NSW showed just a one- or two-degree lift can have little effect on some fish, but can transform the behaviour of others. Some can become up to 30 times more bold, active and aggressive, the researchers found. The scientists, led by Peter Biro, said these changes in behaviour could affect food acquisition, encounter rates with predators and even the likelihood of an individual being captured by sampling or harvesting equipment. The research is published in the journal, *Proceedings of the Royal Society B*.

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The idea that a strong cup of coffee has sobering powers may be a myth. A study published in *Behavioural Neuroscience* suggests caffeine does not neutralise alcohol intoxication, but instead may make it harder for someone to realise they are drunk. Researchers from Temple University in Philadelphia, Pennsylvania, studied the effect of caffeine and alcohol on mice in the laboratory. They observed the caffeine made the mice more alert but did not reverse the learning problems caused by alcohol, including their ability to avoid things they should have known could hurt them. The researchers say popular caffeinated "alcohol-energy" drinks may lead to people thinking they are able to handle dangerous situations, such as driving while intoxicated.

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The Australian Government must develop cyber security measures in line with its national broadband network, according to an Australian Strategic Policy Institute report. The report, by high-tech crime specialist Alistair MacGibbon, details the widening gap between the cyber security problem and Australia's ability to deal with it, and offers a range of steps to improve the situation. One such step involves establishing an internet crime-reporting and analysis centre. The centre would adopt an internet "shop front" approach for homes and businesses to report matters and seek advice. The report, titled *Cyber security: threats and responses in the information age*, is available at www.aspi.org.au

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Australia plays centre stage in heated arguments about human evolution and early human environmental impacts, according to a world-leading palaeo-analyst. The assistant director of UNESCO's International Centre for Theoretical Physics in Trieste, Italy, Dr Claudio Tuniz, will speak in Canberra on Wednesday about the facts and myths surrounding the first human arrival in Australia. Tuniz will also describe recent developments in dating and refining the time frame for human evolution and dispersal as well as how scientists read the past in matter such as bones, eggshell and pollen. The free public lecture will take place from 6.30 until 7.30pm at the Australian National University Finkel Theatre in the John Curtin School of Medical Research, building 131, Garran Road.