Futures

Dead letter

Communication breakdown. **By William C. Armstrong & J. W. Armstrong**

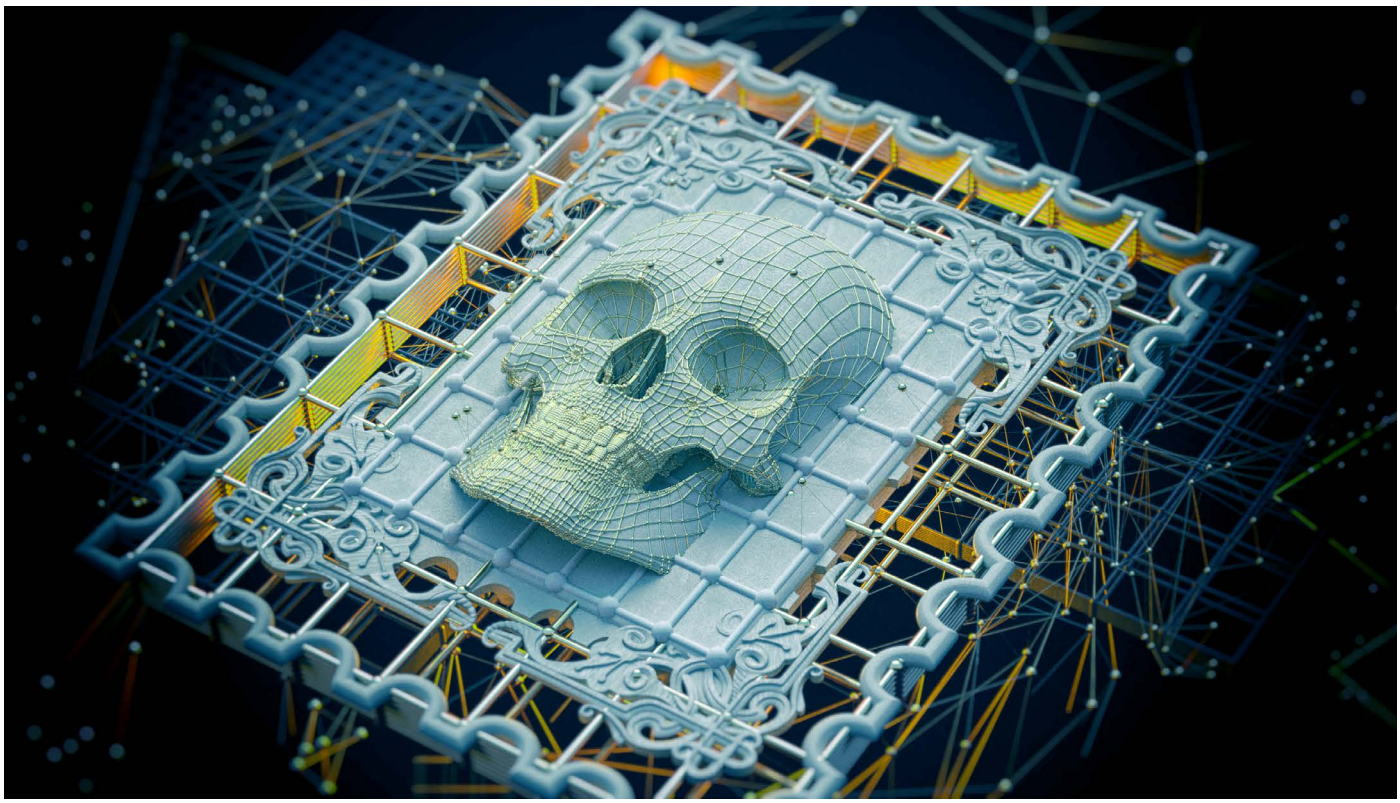

ILLUSTRATION BY JACEY

Astronomy Department holiday parties have some predictable aspects. Professor Witcher will be at the chessboard, analysing grandmaster problems and trouncing any newbie unwise enough to propose a game. Professor Hutton will be holding court with her postdocs. Professor Thaler, the quintessential introvert, will be nursing a beer in the corner and pretending to be fascinated with the books on the library shelf.

I tend towards introversion, too, but attendance is obligatory for graduate students. I planned to make a cameo appearance, chat briefly with the department chair, and then get back to the lab. My thesis is due soon and progress has been slow.

But I revised the plan when I saw Professor Sanders. I had been his teaching assistant three years ago and had learnt he's a candidate for the smartest guy in the room – any room. Social situation or not, this was an opportunity to get his thoughts on my thesis observations.

He was sitting alone, looking pensive. After superficial greetings, I tried to turn the conversation to my research but he interrupted. He pulled out a smartphone, poked it, and handed it to me. "What do you see?"

It was the standard Astronomy 101 all-sky picture of the cosmic microwave background … the aftermath of the Big Bang, now observed 13.8 billion years later glowing as 3 kelvin microwaves. The image had been colour-coded to emphasize the minute CMB temperature fluctuations over the sky.

I asked Sanders if this was a trick question. He tapped the phone for a new image.

It was the abstract of a paper published two years ago. The authors had asked: if the Universe had a creator (they didn't say it *did* have a creator) and if the creator wanted to leave a message for the Universe's subsequent inhabitants, how might that be done? Their conclusion: a message could, in principle, have been encoded as tiny temperature fluctuations in the Big Bang. As the Universe expanded and cooled, the fluctuations – the presumed message – would remain imprinted in the cosmic background radiation and could be read, billions of years later, by intelligent beings when they developed the appropriate technology.

The paper had garnered little interest. (My officemates had called it "The big billboard in the sky". We generated the obligatory sophomoric speculations regarding message content: "42", "some assembly required", "this page intentionally left blank" and so on – graduate students are an irreverent lot.) It was a speculative intellectual exercise. I was surprised Sanders was interested.

Sanders took his phone back. "The authors estimate the information – the number of bits – that could be encoded in a CMB message. They conclude that a message of interesting length would have to be aimed towards a specific observer – a particular point in space and time in the subsequent Universe – for it to be understandable."

This was hitting me without context and I probably glazed. I mumbled something about violation of the Copernican principle and immediately regretted it; if you postulate a creator, the usual bets are off.

Sanders realized he had skipped some background and switched to professor-mode. "Immediately after the Big Bang the Universe was fully ionized and radiation scattered efficiently. As the Universe expanded and cooled, electrons and protons combined to form neutral atoms. The Universe abruptly became transparent; photons could propagate freely, encoding the tiny temperature differences at their last scattering. This is the CMB we see today."

I was regretting that I had engaged Sanders at all, but felt I needed to say something. "Ummm … so the point is that the distance to the last scattering is different for differently located observers? Everybody sees the CMB, everybody agrees on CMB statistics, but only a preferred observer – a special point in space-time – would see the specific CMB fluctuations encoding the message?" I was trying to show I was following the discussion but it sounded crazy.

Sanders drank from a glass of bourbon I hadn't realized he was holding – I thought he was a teetotaller – and nodded. "Absurd, of course. But it's good to check things. I sent the published CMB data to a friend, an expert in computational linguistics and … umm … she also breaks codes for a living. I asked her to run it through public-domain cryptology software just to look for the presence or absence of a message. Of course, she would find nothing and we'd be done."

Sanders face clouded, looking as if someone had just shot his dog. He took another drink, leant forward, and lowered his voice.

"Not quite. Apparently, using information-theoretic techniques she was able to show there *is* a signal – a message in the CMB! – but it's garbled. The message is plastered across the whole damn sky … and we can't read it."

There was an awkward silence. This was shocking, of course. I briefly wondered if Sanders was pulling my leg or had gone bonkers. But he seemed earnest and rational.

He also seemed depressed, which I didn't understand. I pointed out the obvious: this was the biggest discovery in human history. The existence of a message, even one humanity can't understand, implied an entity to produce it. Belief systems – maybe the meaning of human existence – would have to be rethought. Before I could continue Sanders waved dismissively.

"There's more. I computed the appearance of the CMB for different observers to understand the message distortion. The result: the message really was aimed at us – our Galaxy at least." Sanders drained his glass and stood, unsteadily.

"And would have been completely intelligible to the intended recipients – when it was delivered 5 billion years ago."

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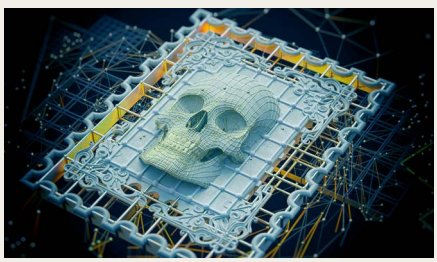
THE STORY BEHIND THE STORY

William C. Armstrong & J. W. Armstrong reveal the inspiration behind *Dead letter*.



The scientific paper alluded to in *Dead letter* is fictional. The idea that a message could be encoded in the CMB, however, came from two real papers: S. Hsu and A. Zee *Mod. Phys. Lett. A* **21**, 1495–1500 (2006), and D. Scott and J. P. Zibin Preprint at arXiv https://doi.org/hnmv (2005).

The story evolved over many drafts. The first part was written quickly and did not change much in subsequent iterations. The ending took longer. In some versions, the message was readable but the content was not revealed. (Two drafts had scientists successfully deciphering the message – still with message content not stated — and followed humanity's subsequent response.) Other endings had a minimal message readable throughout the Universe because it was short, per the above-referenced papers. We finally converged on an 'interesting length' (that is, longer-than-minimal) message aimed at a time pre-dating the origin of Earth, thus explicitly not intended for humanity.