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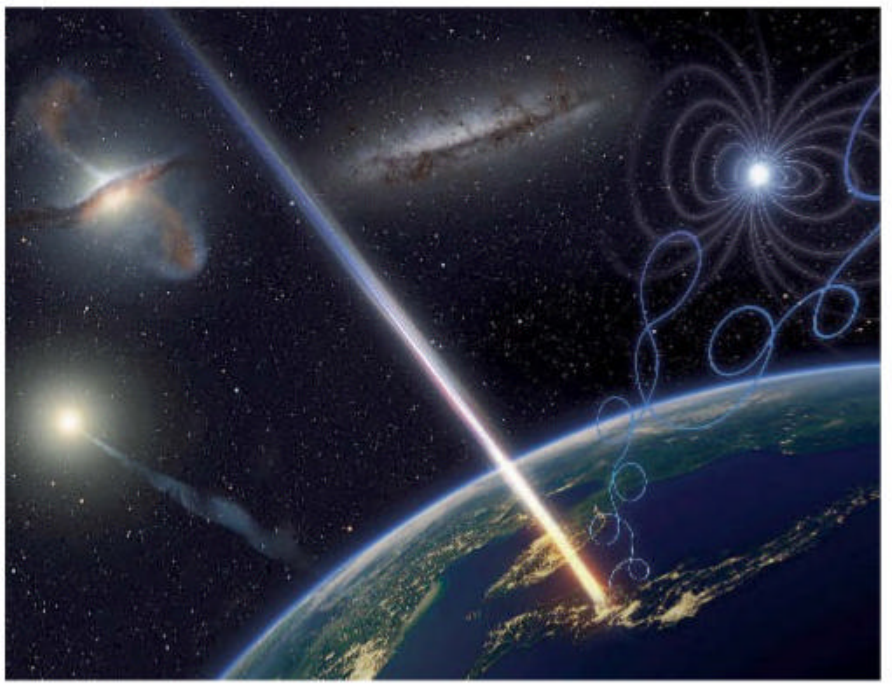
Physics

Mysterious high-energy cosmic ray smashes into Earth

Alex Wilkins



OCU/L-INSIGHT, KYOTO UNIVERSITY/RYUUNOSUKE TAKESHIGE

Illustration of an ultra-high-energy cosmic ray hitting our planet

ASTRONOMERS have detected the second most powerful cosmic ray ever recorded, but it seems to have come from an empty region of the universe known as a cosmic void, where there is nothing obvious it could have originated from.

This mysterious cosmic ray, which is probably a charged particle nucleus of some variety, such as of carbon or oxygen, has been dubbed Amaterasu after the Japanese sun goddess.

Possible explanations for it include magnetic fields steering the particle off course, an invisible source in another galaxy or a novel particle.

"The first time I saw the result, I thought that it should be some mistake," says Toshihiro Fujii at Osaka Metropolitan University in Japan. "I thought it was a bit unlucky as it had no source, but actually it is lucky, because we found a new mystery."

Fujii and his colleagues spotted the event using the Telescope Array in Utah, which has more than 500 sensors that can detect showers of particles raining down from extremely energetic particle collisions with Earth's atmosphere. By working back from detections using particle physics models, researchers can reconstruct the energy and direction of an incoming particle.

On 27 May 2021, a group of the sensors lit up with signals that implied a particle had exploded above them with an energy of about 244 exaelectronvolts (EeV), equivalent to the energy of a tennis ball moving at nearly

244

The energy of the strange particle in exaelectronvolts

100 kilometres per hour, squeezed into an atomic-sized object (*Science*, doi.org/k579).

Events at this energy are rare, with only four recorded above 200 EeV. The most energetic one, a 320 EeV particle called the "Oh-My-God particle", still isn't fully explained.

Ultra-high-energy cosmic rays are thought to be produced in exotic astrophysical events, such as in supermassive black holes or gamma ray bursts. But when Fujii and his colleagues examined the part of the sky the particle had come from, they could see no obvious source.

It is possible the cosmic ray came from somewhere else and veered off course because of the effect of an object's magnetic fields, but with the particle still having such a high energy on arrival, this change of direction can only have been minimal, unless our models of extragalactic magnetic fields are incorrect, says Fujii.

The higher the charge of the particle nucleus, the bigger the deflection, but even the maximum deflection, which would come from a highly charged iron nucleus, doesn't provide a change in trajectory that leads to a possible source.

Higher-energy particles lose energy when interacting with the cosmic microwave background (CMB), radiation left over from the big bang. This limits how far the rays can travel, but if the charged particle is a more exotic phenomenon that doesn't interact with the CMB, it could have come from much more distant galaxies that we can't detect, says Fujii.

It is puzzling, says Justin Bray at the University of Manchester, UK, partly because we have few examples of high-energy cosmic rays and they have been detected in different ways. This makes it hard to analyse them as a group. Although differentiating between possible sources for Amaterasu is tricky, says Bray, claims of a new particle would require extraordinary evidence. "It is a fairly out-there possibility, but, of course, very exciting if true." ▮

Medicine

Lack of sleep before surgery may mean a painful recovery

Grace Wade

NOT getting enough sleep prior to having surgery may increase postoperative pain. This suggests that improvements in recovery time may require good sleep before, as well as after, going under the knife.

Maíra Bicca at Johns Hopkins University in Maryland and her colleagues have studied mice to see how sleep affects the healing process. They used distractions to stop six mice from falling asleep for 9 hours, then gave them an anaesthetic and made an incision in the rodents' hind paws before stitching the wound closed.

For the next two weeks, the team measured each mouse's pain daily by stroking nylon fibres against the wound, seeing how much force was needed before the animal retracted its paw.

Five days after surgery, mice that had been sleep deprived showed greater sensitivity to pain than an equal number of animals who slept sufficiently. For instance, two weeks post-operation, 50 per cent more pressure was needed to make the well-rested animals retract their paws than was needed to make the sleep-deprived mice do so, Bicca told a recent meeting of the Society for Neuroscience in Washington DC.

The sleep-deprived mice also had more inflammatory cells at the site of their incision. This suggests that lack of sleep impairs the immune system's ability to resolve inflammation, which is our body's first line of defence against injury or illness, says Bicca.

Whether the findings will apply to humans is unclear, says Jianguo Cheng at Cleveland Clinic in Ohio. It is possible, though, given known links between sleep, inflammation and pain in us, he says.

To improve surgical outcomes, it might be helpful for healthcare facilities to minimise sleep disruptions, such as noise and light, before surgery, says Cheng. ▮