photo-realistic images in their latest paper, which was posted on the arXiv preprint server last November (A. Nguyen *et al.* Preprint at http://arxiv.org/abs/1612.00005; 2016).

ARTIFICIAL DATA

Generative AIs look promising for basic science, too, says Welling, who is helping to develop software for the Square Kilometre Array (SKA), a radio-astronomy observatory to be built in South Africa and Australia. The SKA will produce such vast amounts of data that its images will need to be compressed into low-noise but patchy data. Generative AI models will help to reconstruct and fill in blank parts of those data, producing the images of the sky that astronomers will examine.

A team led by Rachel Mandelbaum, an astrophysicist at Carnegie Mellon University, has been experimenting with both GANs and VAEs to simulate images of galaxies that look deformed because of gravitational lensing — when the gravity of objects in the foreground distorts space-time and warps light rays. Researchers are planning to survey huge numbers of galaxies to map gravitational lensing across the Universe's history. This could show how the distribution of the Universe's matter has changed over time, providing clues to the nature of the dark energy that is thought to have driven cosmic expansion. But to do this, astronomers need software that can reliably separate gravitational lensing from other effects. Synthetic images will improve the programs' accuracy, Mandelbaum says.

> ***"I have reached a point in my life where I'm kind of having reality vertigo."***

Many scientists hope that the latest AI neural nets will help them to discover patterns in huge, complex sets of data — but some are wary of trusting the interpretation of such 'black box' systems, whose inner workings are mysterious. Even if virtual neurons seem to give correct answers, they might have a mistaken understanding of the world. But adding a generative element to a neural net could help, Cranmer says. "If it can generate data that look just as real, then it's much more convincing that, whatever the black box is, it has actually learned the physics."

Clune worries about generative algorithms, too. For all their potential benefits, he's concerned about the social implications of having machines that will one day be able to produce fake but real-looking pictures or video — perhaps, say, of Donald Trump receiving bribes from Vladimir Putin. "I think that, increasingly, this is going to be an interesting challenge in society," he says. ■

PHYSICS

Hydrogen yet to prove it's metal

Doubts shroud claimed fulfilment of 80-year quest.

BY DAVIDE CASTELVECCHI

Two physicists say that they have crushed hydrogen under such immense pressures that the gas became a shiny metal — a feat that scientists have been trying to accomplish for more than 80 years.

But other researchers have serious doubts about the claim, the latest in a field with a long history of failed attempts. Ranga Dias and Isaac Silvera, both physicists at Harvard University in Cambridge, Massachusetts, first posted a report of their results on the arXiv preprint server last October[1], which attracted immediate criticism. A peer-reviewed version was published on 26 January in *Science*[2], but sceptics say that it includes little new information.

Five experts told *Nature*'s news team that they do not yet believe the claim, and need more evidence. "I don't think the paper is convincing at all," says Paul Loubeyre, a physicist at France's Atomic Energy Commission in Bruyères-le-Châtel.

Silvera and Dias say that they wanted to publish their first observation before making further tests on their fragile material.

METALLIC DREAM

Creating metallic hydrogen has been a dream in the high-pressure-physics world since 1935, when theorists predicted its existence[3]. Squeezed hard enough inside an anvil, hydrogen should be able to conduct electricity, the hallmark of a metallic state. Theorists say that the material could have other exotic properties, such as being a superconductor — able to conduct electricity without resistance — at room temperature.

By making metallic hydrogen, physicists might also be able to explore planetary science at their lab bench: gas-giant planets such as Jupiter are theorized to have metallic hydrogen in their cores, which would perhaps explain how they can sustain a magnetic field.

In recent years, physicists have crushed tiny samples of hydrogen between diamond anvils at pressures exceeding those at the centre of Earth. But no one has made metallic hydrogen. Dias and Silvera say that they were able to squeeze their hydrogen gas at pressures greater than those achieved by anyone else. To do so, they used an anvil that can fit inside a cryostat, enabling them to cool the hydrogen to just above absolute zero. They also say that they have found a better way to polish the tips of their diamonds, to remove irregularities that could break the gems. They then turned a screw to crank up the pressure to 495 billion pascals, or almost 5 million times higher than atmospheric pressure at sea level.

"Then, suddenly, it becomes a lustry, reflective sample, which you can only believe is a metal," Silvera says. Seen through a microscope, the sample appeared shiny, and it reflected light in the way metallic hydrogen should do, he says.

REDO THE MEASUREMENT

It's far from clear, however, that the shiny material the researchers see is actually hydrogen, says Alexander Goncharov, a geophysicist at the Carnegie Institution for Science in Washington DC. He suggests that the material could be alumina (aluminium oxide), which coats the tips of the diamonds in the anvil, and might behave differently under pressure.

Loubeyre and others think that Silvera and Dias are overestimating the pressure that they produced, by relying on an imprecise calibration between turns of the screw and pressure inside the anvil. Eugene Gregoryanz, a physicist at the University of Edinburgh, UK, adds that part of the problem is that the researchers took only a single detailed measurement of their sample at the highest pressure — making it hard to see how pressure shifted during the experiment.

"If they want to be convincing, they have to redo the measurement, really measuring the evolution of pressure," says Loubeyre. "Then they have to show that, in this pressure range, the alumina is not becoming metallic."

But Silvera says that he and Dias just wanted to get the news out before making confirmation tests, which could break their precious specimen. "We wanted to publish this breakthrough event on this sample," he says. To preserve the material, they have kept it in the cryostat; the lab has only two cryostats, and the other is in use for other experiments. "Now that the paper has been accepted," he says, "we're going to do further experiments. ■

1. Dias, R. & Silvera, I. F. Preprint at https://arxiv.org/abs/1610.01634 (2016).
2. Dias, R. P. & Silvera, I. F. *Science* http://dx.doi.org/10.1126/science.aal1579 (2017).
3. Wigner, E. & Huntington, H. B. *J. Chem. Phys.* **3,** 764–770 (1935).