Micrograph of yttrium barium copper oxide, a high-temperature superconductor.

they disagree on how to explain these patterns. One approach views electrons as strongly interacting particles[2,3], whereas the other treats them as wave-like and only weakly interacting.

To glean more information about these patterns, Kim's team designed neural networks — AI inspired by structures in the brain — that studied images of the pseudogap. Patterns in the images, taken with a scanning tunnelling microscope, often seem disordered to the human eye because of the material's naturally chaotic and fluctuating nature, and noise in the measurements. The advantage of machine learning in this situation is that algorithms can learn to recognize patterns that are invisible to people.

PATTERN RECOGNITION

To train the algorithms, the team fed neural networks examples of rippled patterns that corresponded to different theoretical predictions. Having learnt to recognize these examples, each algorithm applied this learning to real data from cuprates in the pseudogap. Over 81 iterations, the algorithms repeatedly identified one modulating pattern that corresponded to the particle-like description of electrons, which dates back to the 1990s.

The team's paper shows that the particle-like description is more appropriate in this case than is the conventional wave-like description, says André-Marie Tremblay, a physicist at the University of Sherbrooke in Canada, who was at Kim's talk in Beijing. Working out the nature of the patterns is crucial to interpreting what causes them, says Milan Allan, a physicist at Leiden University in the Netherlands.

The technique could eventually help physicists to understand high-temperature superconductivity, says Allan, although he cautions that the paper is far from definitive and that debate about what the pseudogap is will continue.

The work is an impressive, original application of machine-learning algorithms to this type of experimental data, says Tremblay. But the algorithm can only distinguish between the various hypotheses it is given, he says, rather than find entirely new patterns.

During her talk, Kim said that work is under way to apply the technique to rapidly make sense of data from the X-ray diffraction of quantum materials — a technique that uses the scattering of electromagnetic waves to reveal a material's 3D physical structure, but which creates patterns so rich that they can take months to unravel by conventional means. In this case, the AI must draw out similarities and classifications itself, rather than be given pre-labelled examples, by grouping features that it sees as similar. "This journey of using AI, or machine learning, for various aspects of our quest to understand quantum emergence has just begun," said Kim. ■

1. Zhang, Y. *et al.* Preprint at https://arxiv.org/abs/1808.00479 (2018).
2. Kivelson, S. A., Fradkin, E. & Emery, V. J. *Nature* **393**, 550–553 (1998).
3. Zaanen, J. *Science* **286**, 251–252 (1999).

GENDER BIAS

Peer review fails equity test

Analysis of submissions to eLife *reveals a gender gap in whom journals invite to do reviews.*

BY DALMEET SINGH CHAWLA

Women are inadequately represented as peer reviewers, journal editors and last authors of studies, according to an analysis of manuscript submissions to an influential biomedical journal.

The study looked at all submissions made to the open-access title *eLife* from its launch in 2012 to 2017 — nearly 24,000. It found that women worldwide, and researchers outside North America and Europe, were less likely to be peer reviewers, editors and last authors. The paper — which hasn't itself yet been peer-reviewed — was posted on the preprint server bioRxiv on 29 August (D. Murray *et al.* Preprint at BioRxiv https://doi.org/10.1101/400515; 2018).

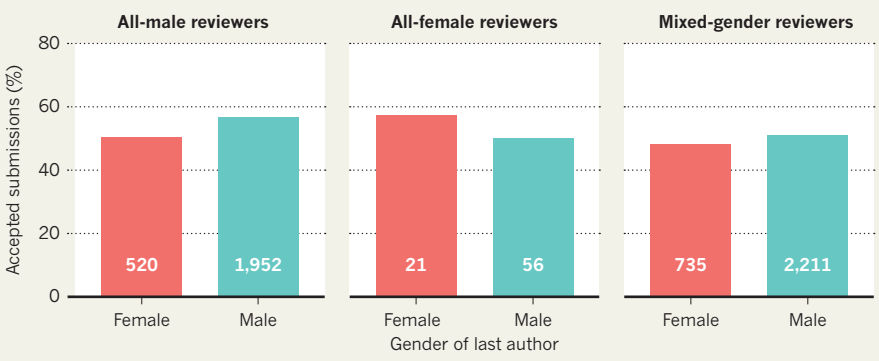
About 7,000 of the submitted studies went through the full submission process (at *eLife*, authors make a 'pre-submission query' before being invited by the journal to send a full paper — a relatively uncommon practice among journals). In all, the analysis covered the activity of about 7,000 referees, 890 reviewing editors and 57 senior editors.

The researchers found that women make up only 21% of peer reviewers, and around one in four reviewing editors. Most reviewing editors and peer reviewers were based in the United States — 62% and 56%, respectively ▶

SOURCE: D. MURRAY *ET AL.* PREPRINT AT BIORXIV HTTPS://DOI.ORG/10.1101/400515 (2018).

PEER-REVIEW PATTERNS

An analysis of thousands of submissions to the journal *eLife* — in which peer-review panels openly discuss submitted works — found that all-female reviewer groups accepted more manuscripts with female last authors than did all-male panels.



— followed by the United Kingdom and Germany in second and third place. Less than 2% of reviewers were in developing nations.

Of the full submissions, the study found that 1,549 (22%) had a female last author — a position that indicates seniority — and 5,127 had a male last author. About 53% of manuscripts with male last authors were accepted, compared with around 50% of those with female last authors.

Fifty-seven per cent of fully submitted papers with a male last author were accepted when the review panel was all male (see 'Peer-review patterns'), whereas mixed-gender teams accepted 51% of male-last-author papers. And submissions that had been edited or reviewed by someone in the same country as the corresponding author were more likely to be accepted than those with a country mismatch.

The trends are likely to be a result of implicit biases, says study co-author Cassidy Sugimoto, an information scientist at Indiana University Bloomington. The study did not seek to reveal how the disparities arose, say the authors. But because the gender make-up of senior authors and gatekeepers closely matches disparities found broadly in science, there is no evidence that *eLife* is making such disparities worse.

The research was prompted by *eLife*, which approached Sugimoto and her colleagues with the data; two study authors are *eLife* employees. The journal's reviewing process is unorthodox in that referees know each other's identities, which allows them to discuss any differences of opinion on manuscripts.

BODY OF EVIDENCE

The study is robust, says Jevin West, an information scientist at the University of Washington in Seattle. And it is concerning that women and authors in developing countries seem to be marginalized in peer review, he says. "It's very important that we have diverse voices represented and that those voices are treated equitably."

"It's important that we have diverse voices represented and that those voices are treated equitably."

The results echo previous findings about peer review. This month, a global survey by Publons — a site that allows academics to record their peer-review activity — found that researchers in developing countries are under-represented as reviewers, yet are more likely than scientists in richer countries to accept review requests, and complete reviews faster.

And last year, an analysis of American Geophysical Union (AGU) journals found that women are invited to review less often than expected, but that the editors' gender has no influence on acceptance rates (J. Lerback and B. Hanson *Nature* **541**, 455–457; 2017).

Sugimoto says that journal policies should aim to ensure diversity on review panels, for example, by inviting a greater proportion of women and researchers in developing nations to do reviews. "This is one of the simplest policy changes we can make," she says, "without high risks, and potentially high benefits."

Andrew Collings, *eLife*'s executive editor and a study co-author who is based in Cambridge, UK, says that the team is communicating its results to the editorial board, so that editors can consider the findings as they assess submissions and select reviewers. "We are particularly keen to see editors using diverse groups of reviewers whenever possible."

To weed out the effect of implicit biases on acceptance rates, it is tempting to see blinding as a solution, West says. But, he adds, double-blind peer review — in which neither authors nor reviewers know each others' identities — often works poorly, because some fields are so small that reviewers can guess who wrote a paper.

Sugimoto says that more data are needed to determine the effectiveness of techniques such as blinding or open peer review, in which reviews are published and authors and reviewers might know each other's identities.

She hopes that more journals and publishers will release data on peer review for analysis. "Then, we can inform it with evidence rather than with anecdote." ■

ECOLOGY

Hidden lives of deep-sea animals

Cameras record behaviours long cloaked in darkness.

BY AMY MAXMEN

Advances in video cameras and low-light sensors are revealing animal behaviours in the deep sea that researchers have never recorded before.

The behaviours include a worm-like predator shooting off rings of blue light, and an animal anchored to the sea floor sending flashes of light dancing along its body, creating the illusion of a tiny creature swimming upwards.

Steven Haddock, a marine biologist at the Monterey Bay Aquarium Research Institute (MBARI) in California, showcased videos of these phenomena and more for the first time on 13 September at the Deep Sea Biology Symposium in Monterey. He is one of a handful of researchers around the world who are using extremely high-resolution cameras and ultra-sensitive sensors to capture unprecedented footage of marine organisms in the wild.

"We can see natural behaviour in a way that we've never been able to before," says Haddock.

COMING INTO FOCUS

Until recently, researchers needed to use bright lights to capture footage of animals living in the deep dark ocean. The lights scared many creatures away, and when scientists tried filming under low-light conditions, poor camera resolution made it difficult to pick out fine details such as a small ring of light.

In 2016, Haddock's team attached a 4K camera, which has four times as many pixels per image as a high-definition (HD) camera, to one of MBARI's remotely operated vehicles (ROVs). On one of Haddock's first voyages with the camera, he recorded a 2.5-centimetre-long animal called an arrow worm emitting a trail of doughnut-shaped rings of blue light. Haddock speculates that the creature uses the display to distract predators as it escapes. "Our HD camera wouldn't have captured this at all," he says.

In mid-August, another research team deployed an 8K camera in the deep sea for the first time to explore hydrothermal vents in the Okinawa Trough near Japan. The 8K camera's resolution nearly matches that of the human eye, and it enabled Dhugal Lindsay, a marine biologist at the Japan Agency for Marine-Earth Science and Technology in Yokosuka, to film near-microscopic plankton in enough detail to identify their species.

SEEING IN THE DARK

Other marine biologists are fine-tuning the latest low-light camera sensors that also reduce noise from scattered, indirect light. This allows researchers to use a lot less illumination to record ocean life, decreasing the chances of their ROVs scaring off animals.

The sensors also allow scientists to pick up phenomena such as bioluminescence — the production of light by an organism — and to