

Several people who have worked for Cooper — some of whom gave evidence to the investigation and include current members of his research group — have told *Nature* that he bullied them; several more say that they observed him bullying members of his team. Cooper has declined to comment on his suspension and on the bullying accusations at the present time.

Nic Rawlence, a former student of Cooper's

at ACAD, made a submission to the probe about being bullied by Cooper. Rawlence, now director of the Otago Palaeogenetics Laboratory at the University of Otago in Dunedin, New Zealand, was one of the few who spoke to *Nature* and agreed to be named. He sees Cooper's suspension as evidence that the university is taking the allegations and the evidence from the probe seriously. "I still think permanent change

for the better is needed," he says.

Cooper started ACAD in 2005, after he pioneered ancient-DNA extraction techniques and championed authentication processes in a field in which contamination of ancient samples with modern DNA was rife.

The university spokesperson confirmed that Cooper had been suspended, but said the institute would not be commenting further. ■

ASTRONOMY

Haul of mysterious cosmic bursts excites astronomers

Discovery of more 'repeater' fast radio bursts should help to reveal signals' origins.

BY ELIZABETH GIBNEY

Astronomers are edging closer to finding out what causes brief, powerful flashes in the sky known as fast radio bursts (FRBs), after a Canadian telescope discovered eight more of the most intriguing type of these blasts — those that repeat their signals.

FRBs are intensely energetic events that flare for just milliseconds, seemingly all over the sky and from outside the Galaxy. But their cause has remained a mystery since the first FRB was identified in 2007. Astronomers hope that studying bursts that repeat their flashes, rather than flare just once, can help to elucidate the origins of FRBs. That's because it's easier for high-resolution telescopes to make follow-up observations of 'repeaters' and trace their origins compared with one-off blasts.

"This is a pretty exciting result," says astronomer Laura Spitler at the Max Planck Institute for Radio Astronomy in Bonn, Germany. Astronomers' priority will be to search for the galaxy from which these repeat signals come, she says. Pinpointing the host galaxies is essential to cracking the mystery of what causes FRBs.

Of the roughly 75 FRBs seen before this month's discoveries, just 2 bursts were known to be repeaters. The first of these has been extensively studied, and the Canadian Hydrogen Intensity Mapping Experiment (CHIME) telescope discovered the second repeater earlier this year. CHIME's latest results, published on the arXiv preprint server on 9 August, now show that repeaters are far from rare (B. C. Andersen *et al.* Preprint at <https://arxiv.org/abs/1908.03507>; 2019). In the past few weeks, another telescope, the Australian Square Kilometre Array Pathfinder, also found a repeater, bringing the total so far to 11 — although researchers are yet to publish this result.



CHIME COLLABORATION

The CHIME telescope in Canada searches the sky for energetic cosmic events called fast radio bursts.

CHIME, which began hunting for FRBs in 2018, has also found hundreds of one-off FRBs, CHIME researcher Bryan Gaensler said on Twitter on 12 August. Members of the telescope collaboration are still analysing these events, said Gaensler, an astronomer at the University of Toronto, Canada. "In 25 years of astronomy research, this is unquestionably the most exciting project I've ever worked on," he said.

ELUSIVE ENVIRONMENTS

Sketching a picture of the environments in which the blasts are born will allow researchers to whittle down some of the dozens of possible explanations for FRBs. Astronomers suggest that the bursts could be emissions from young magnetars (dense star cores spinning in a magnetic field) or from vibrating cosmic strings.

The findings mean that there are now enough

repeaters to start comparing these with one-off blasts, to find out whether the two kinds of FRB are produced in similar environments, says Spitler. All FRBs could come from fundamentally similar environments, but perhaps repeat blasts avoided detection until now or their sources flare only under certain conditions. Or each type could be caused by different events — one that repeats and one that doesn't.

The CHIME team has already seen clues that could help to answer this question. The eight repeaters seem to be located in a similar range of distances to the one-off bursts. But repeater signals lasted longer on average, the collaboration reports. Spitler says that, if this trend holds, it could be a sign that two separate phenomena cause the different types of blast, because the duration of a blast reflects the underlying mechanism that produces it. ▶

► The latest data reveal differences in the environments from which repeaters emanate. A previously discovered burst, FRB 121102 — the only repeating signal for which the precise host galaxy has been identified — came from a highly magnetized environment. Like FRB 121102, the signal of one of the latest bursts is polarized with a spiral pattern that suggests it comes through a magnetic field. But the strength of the field for the new repeater is around 100 times weaker than that of FRB 121102.

Many, although not all, of the latest haul also

share a feature of the first two repeaters. Rather than being simple blasts with a narrow frequency range, the signals descend in frequency in a way that the team compares to a 'sad trombone' sound. "Such 'sad trombone' signals are actually rather unusual and complicated," says Spitler. Explaining them poses a challenge to theorists, she adds.

The findings are only a small preview of the "full awesomeness coming out of CHIME", said Gaensler. The telescope, which is near Penticton in British Columbia, was initially built to

study radio waves from the early Universe. But in 2013, astronomers realized that the half-pipe-shaped telescope, which every day sweeps almost the entire northern sky, could also spot FRBs. For the relatively low cost of US\$16 million, they turned CHIME into an FRB-hunter. Astronomers had only recently begun to take the telescope seriously, after initial observations seemed to be caused by interference or instrumental glitches.

"CHIME is definitely living up to its promise," says Spitler. ■

ORGANIC CHEMISTRY

Chemists make first ring of pure carbon

Molecule contains 18 atoms and is a semiconductor.

BY DAVIDE CASTELVECCHI

Long after most chemists had given up trying, a team of researchers has synthesized the first ring-shaped molecule of pure carbon — a circle of 18 atoms.

The chemists started with a triangular molecule of carbon and oxygen, which they manipulated with electric currents to create the carbon-18 ring. Initial studies of the properties of the molecule, called a cyclocarbon, suggest that it acts as a semiconductor, which could make similar straight carbon chains useful as molecular-scale electronic components.

It is an "absolutely stunning work" that opens up a new field of investigation, says Yoshito Tobe, a chemist at Osaka University in Japan. "Many scientists, including myself, have tried to capture cyclocarbons and determine their molecular structures, but in vain," Tobe says. The results were published in *Science* on 15 August (K. Kaiser *et al.* *Science* <http://doi.org/c9mq>; 2019).

Pure carbon comes in several different forms, including diamond, graphite and 'nanotubes'. Atoms of the element can form chemical bonds with themselves in various configurations: for example, each atom can bind to four neighbours in a pyramid-shaped pattern, as in diamond; or to three, as in the hexagonal patterns that make up the single-atom-thick sheets of graphene. (Such a three-bond pattern is also found in bulk graphite as well as in carbon nanotubes and in the globular molecules called fullerenes.)

But carbon can also form bonds with just two nearby atoms. Nobel-prizewinning chemist Roald Hoffmann at Cornell University in Ithaca, New York, and others have long theorized that this would lead to pure chains

of carbon atoms. Each atom might form either a double bond on each side — meaning the adjacent atoms share two electrons — or a triple bond on one side and a single bond on the other. Various teams have attempted to synthesize rings or chains based on this pattern.

But because this type of structure is more chemically reactive than graphene or diamond, it is less stable, especially when bent, says chemist Przemyslaw Gawel of the University

of Oxford, UK. Synthesizing stable chains and rings has usually required the inclusion of elements other than carbon. Some experiments have hinted at the creation of all-carbon rings in a gas cloud, but they have not been able to find conclusive proof.

ONE RING

Gawel and his collaborators have now created and imaged the long-sought ring molecule carbon-18 (see 'Full circle'). Using standard 'wet' chemistry, his collaborator Lorel Scriven, an Oxford chemist, first synthesized molecules that included four-carbon squares coming off the ring with oxygen atoms attached to squares. The team then sent its samples to IBM Research's laboratories in Zurich, Switzerland, where collaborators put the oxygen-carbon molecules on a layer of sodium chloride, inside a high-vacuum chamber. They manipulated the rings one at a time with electric currents (using an atomic-force microscope that can also act as a scanning-tunnelling microscope) to remove the extraneous, oxygen-containing parts. After much trial and error, micrograph scans revealed the 18-carbon structure. "I never thought I would see this," says Scriven.

The IBM researchers showed that the 18-carbon rings had alternating triple and single bonds. Theoretical results had disagreed over whether carbon-18 would have this kind of structure, or one made entirely of double bonds.

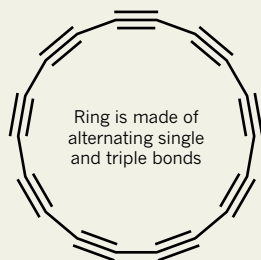
Alternating bond types are interesting because they are supposed to give carbon chains and rings the properties of semiconductors. The results suggest that long, straight carbon chains might be semiconductors, too, Gawel says, which could make them useful as components of future molecular-sized transistors.

For now, the researchers are going to study the basic properties of carbon-18, which they have been able to make only one molecule at a time. They are also going to keep trying alternative techniques that might yield greater quantities. "This is so far very fundamental research," Gawel says.

"The work is beautiful," says Hoffmann, although he adds that it remains to be seen whether carbon-18 is stable when lifted off the salt surface, and whether it can be synthesized more efficiently than one molecule at a time. ■

FULL CIRCLE

Chemists have created the first-ever ring molecule made purely of carbon, C₁₈, and imaged it with an atomic-force microscope.



SOURCE: K. KAISER ET AL., SCIENCE (2019); IBM RESEARCH