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).

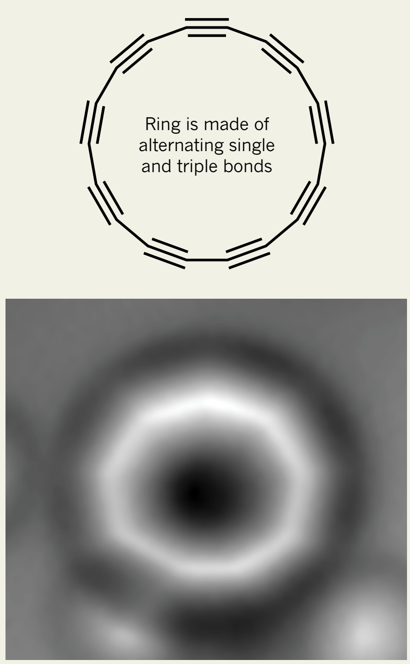
Pure carbon comes in several different forms, including diamond, graphite and 'nanotubes'. Atoms of the element can form chemical bonds with themselves in various configurations: for example, each atom can bind to four neighbours in a pyramid-shaped pattern, as in diamond; or to three, as in the hexagonal 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 able to find conclusive proof.

FULL CIRCLE

Chemists have created the first-ever ring molecule made purely of carbon, C_{18}, and imaged it with an atomic-force microscope.



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

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. ■