HISTORY IN FLAMES

Since 2010, at least six sites relevant to Brazil's scientific history have caught fire. There has also been damage to other cultural sites.

2010 — **Butantan Institute, São Paulo** — An inferno destroyed almost 90% of the museum's snake bank, the largest in Latin America, and a small part of its arachnid collection. Buntantan has been able to replace only about one-third of its snake specimens.

2012 — **Comandante Ferraz Antarctic Station** — A fire that started in the machine room housing the power generators destroyed approximately 70% of the research station. Two people died.

2013 — **Museum of Natural Sciences, Belo Horizonte** — The museum, owned by the Pontifical Catholic University of Minas Gerais, went up in flames in January.

2015 — **Museum of the Portuguese Language, São Paulo** — In December, a major fire destroyed the museum building and killed one firefighter. The museum has since been rebuilt and was scheduled to open its doors in June 2020.

2018 — **National Museum, Rio de Janeiro** — In September, a blaze at the National Museum claimed many of the most prized records of the nation's past. Recovery and reconstruction efforts continue.

2020 — **Natural History Museum and Botanical Garden, Belo Horizonte** — A fire destroyed parts of the museum owned by the Federal University of Minas Gerais, affecting stored zoological and archaeological specimens. As yet, authorities have no estimate of the scope of the loss.

working at the museum in 1975, was devastated. He and his colleagues had amassed a collection of human remains from a range of periods, including some from the earliest known inhabitants of Brazil, as well as samples of cultivated and wild plant species. Prous had also seen part of his life's work disappear during the 2018 fire at the National Museum, when ancient skulls that he helped to collect in the 1970s were destroyed.

"The sadness is matched only by the fear that other, similar disasters will continue to destroy [Brazil's] scientific heritage," he says. Some stone artefacts, ceramics and documentation of the sites he has excavated survived the blaze.

Historic losses

Brazilian museums have faced a series of fires, often resulting in irreparable losses, says Carolina Vilas Boas, director of museum processes at the Brazilian Institute of Museums in Brasilia. At least 12 buildings of cultural or scientific significance have burnt in the country, many of them in the past 10 years (see 'History in flames'). But the full extent of the damage is hard to know, says Vilas Boas, because reporting is probably incomplete.

Brazil is not unique in losing heritage institutions to fire, she says, but the country does have a poor record in taking care of its museums. Often, fire-prevention systems are installed, but budgets are too thin to maintain them properly. "There are many actions being taken to mitigate this risk," she says, but recurring economic crises have hindered long-term planning.

"That lack of resources had no relation to the fire in the collection's storage rooms," says Ricardo Hallal Fakury, a structural engineer at the UFMG. He did not speculate as to the cause of the fire, because investigations are still under way. But he says that the building that burnt was equipped with smoke detectors, and was mostly built of non-flammable materials.

Federal pressure

The tragedy in Belo Horizonte has amplified a decades-long discussion among Brazilian scientists pushing for national and state-level policies to help protect research collections, says Luciane Marinoni, an entomologist at the Federal University of Paraná and president of the Brazilian Society of Zoology, both in Curitiba. "The community is upset because we have been trying to solve this problem with the federal government but without success."

Some protective policies already exist. In 2017, the southern state of Paraná established norms and guidelines for the recognition of biological collections, defining who has responsibility for them, and putting in place objectives and goals to expand them and provide maintenance. Last year, the policy helped researchers to convince the government of Paraná to allocate 2 million reais (US$370,000) for the state's collections over the next three years. It's not a lot of money, but it's a solid start, says Marinoni: "The collections are leaving the darkness."

Back in Belo Horizonte, scientists are cleaning up after the fire. This time, however, they have some guidance on how to move forward.

National Museum researchers have teamed up with Lacerda to advise on the recovery of items that might still be salvageable. They are sharing protocols they developed after the 2018 blaze with UFMG professors and students who have volunteered to help. "Unfortunately, we are now experts in this matter," says palaeontologist Alexander Kellner, director of the National Museum. "We went through it. We know the mistakes to avoid, we have a way to act, we have a methodology."

PHYSICISTS FIND BEST EVIDENCE YET FOR ELUSIVE 2D STRUCTURES

Strange quasiparticles called anyons could herald a way to build quantum computers.

By Davide Castelvecchi

Physicists have reported what could be the first incontrovertible evidence for the existence of unusual particle-like objects called anyons, which were first proposed more than 40 years ago. Anyons are the latest addition to a growing family of phenomena called quasiparticles, which are not elementary particles, but are instead collective excitations of many electrons in solid devices. Their discovery — made using a 2D electronic device — could represent the first steps towards making anyons the basis of future quantum computers.

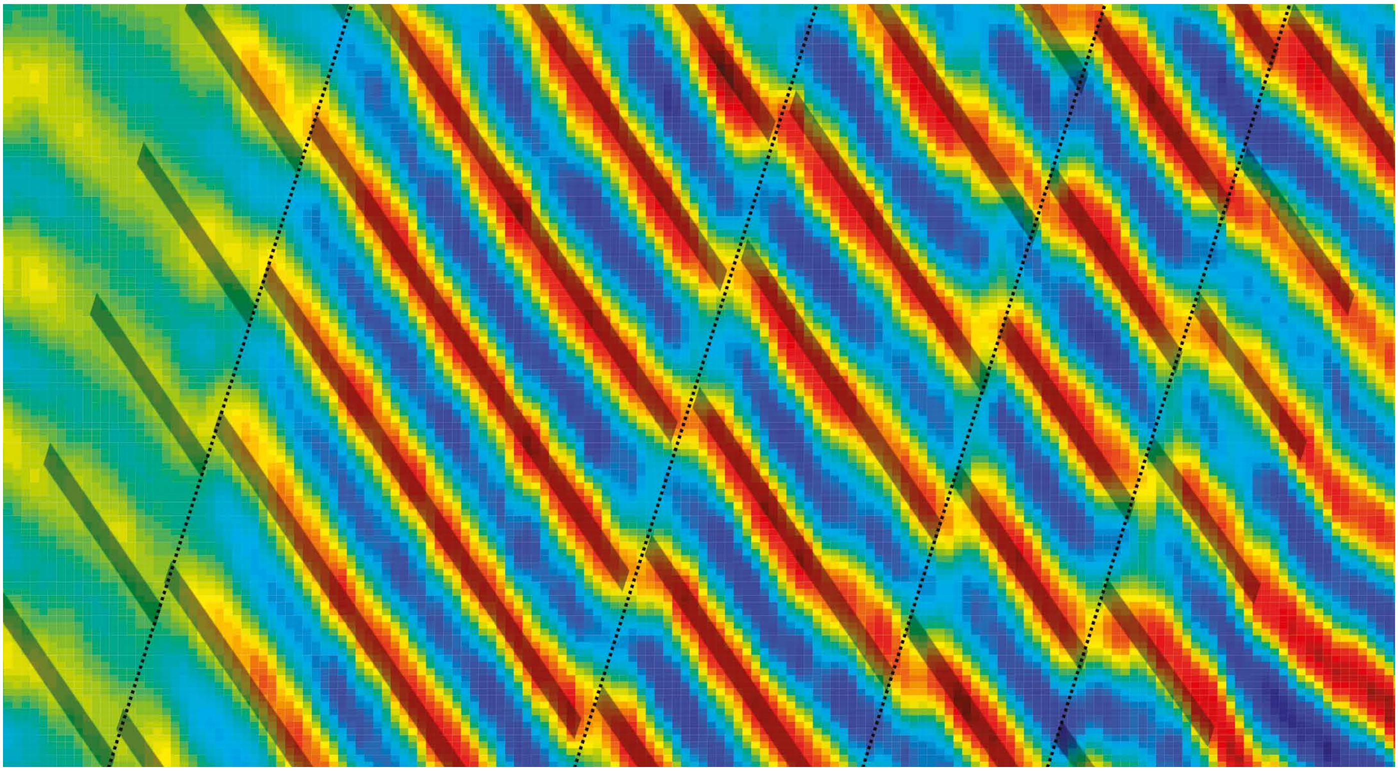
"This does look like a very big deal," says Steven Simon, a theoretical physicist at the University of Oxford, UK. The results, which have not yet been peer-reviewed, were posted on the arXiv preprint server last week[1].

Known quasiparticles display a range of exotic behaviours. For example, magnetic monopole quasiparticles have only one magnetic pole — unlike all ordinary magnets, which always have a north and a south. Another example is Majorana quasiparticles, which are their own antiparticles.

Anyons are even more strange. All elementary particles fall into one of two possible categories — fermions and bosons. Anyons are neither. The defining property of fermions (which include electrons) is Fermi statistics: when two identical fermions switch spatial positions, their quantum-mechanical wave — the wavefunction — is rotated by 180°. When bosons exchange places, their wavefunction doesn't change. Switching two anyons should produce a rotation by some intermediate angle. This effect, which is called fractional statistics, cannot occur in 3D space, but only as collective states of electrons confined to move in two dimensions.

Fractional statistics

Fractional statistics is the defining property of anyons, and the latest work — led by Michael Manfra, an experimental physicist at Purdue University in West Lafayette, Indiana — is the


JAMES NAKAMURA & MICHAEL MANFRA

The 'pyjama stripe' interference pattern denotes the presence of anyons in an electronic system.

first time it has been measured so conclusively.

The quasiparticles' unusual behaviour when switching places means that if one particle moves in a full circle around another – equivalent to the two particles switching positions twice – it will retain a memory of that motion in its quantum state. That memory is one of the telltale signs of fractional statistics that experimentalists have been looking for.

Manfra and his team manufactured a structure consisting of thin layers of gallium arsenide and aluminium gallium arsenide. This confines electrons to move in two dimensions, while shielding them from stray electric charges in the rest of the device. The researchers then cooled it to 10,000ths of a degree above absolute zero and added a strong magnetic field. This produced a state of matter in the device called a fractional quantum Hall (FQH) insulator, which has the peculiarity that no electric current can run in the interior of the 2D device, but can run along the edge. FQH insulators can host quasiparticles whose electric charge is not a multiple of the electron charge, but is instead one-third of it: these quasiparticles have long been suspected to be anyons.

To prove that they had indeed detected anyons, the researchers etched the device so that it could carry currents from one electrode to another along two possible edge paths. The team tweaked the conditions by varying the magnetic field and adding an electric field. These tweaks were expected to create or destroy anyon states stuck in the interior, and also to produce anyons running between the electrodes. Because moving anyons had two possible paths, each producing a different twist in their quantum-mechanical waves, when the anyons reached the end point, their wavefunctions produced an interference pattern called pyjama stripes.

This pattern shows how the relative amount of rotation between the two paths varies in response to changes in the voltage and the magnetic-field strength. But the interference also displayed jumps, which were the smoking gun[2] for the appearance or disappearance of anyons in the bulk of the material.

"As far as I can tell, it is an extremely solid observation of anyons – directly observing their defining property: that they accumulate a fractional phase when one anyon travels around another," Simon says.

It is not the first time that researchers have reported evidence of fractional statistics. Robert Willett, a physicist at Nokia Bell Labs in Murray Hill, New Jersey, says that his team saw "strong evidence" for fractional statistics in 2013 (ref. 3).

Quantum computing

But some theoretical physicists say that the evidence in these and other experiments, although striking, was not conclusive. "In many cases, there are several ways of explaining an experiment," says Bernd Rosenow, a condensed-matter theorist at the University of Leipzig in Germany. But the evidence reported by Manfra's team, if confirmed, is unequivocal, Rosenow says. "I'm not aware of an explanation of this experiment which is plausible and does not involve fractional statistics."

The results potentially lay the groundwork for applications for anyons. Simon and others have developed elaborate theories for how anyons could be used as the platform for quantum computers. Pairs of the quasiparticles could encode information in their memory of how they have circled around one another. And because the fractional statistics is 'topological' – it depends on the number of times one anyon went around another, and not on slight changes to its path – it is unaffected by tiny perturbations. This robustness could make topological quantum computers easier to scale up than are current quantum-computing technologies, which are error-prone.

Topological quantum computing will require more-sophisticated anyons than those Manfra and colleagues have demonstrated; his team is now redesigning its device to achieve that. Still, anyon applications are some way off, researchers warn. "Even with this new result, it is very hard to see [fractional quantum-Hall] anyons as a strong contender for quantum computing," Simon says.

But the quasiparticles' unique physics is worth exploring: "To me, as a condensed-matter theorist, they are at least as fascinating and exotic as the Higgs particle," says Rosenow.

1. Nakamura, J., Liang, S., Gardner, G. C. & Manfra, M. J. Preprint at https://arxiv.org/abs/2006.14115 (2020).
2. Rosenow, B. & Stern, A. *Phys. Rev. Lett.* **124**, 106805 (2020).
3. Willett, R. L. *et al. Phys. Rev. Lett.* **111**, 186401 (2013).