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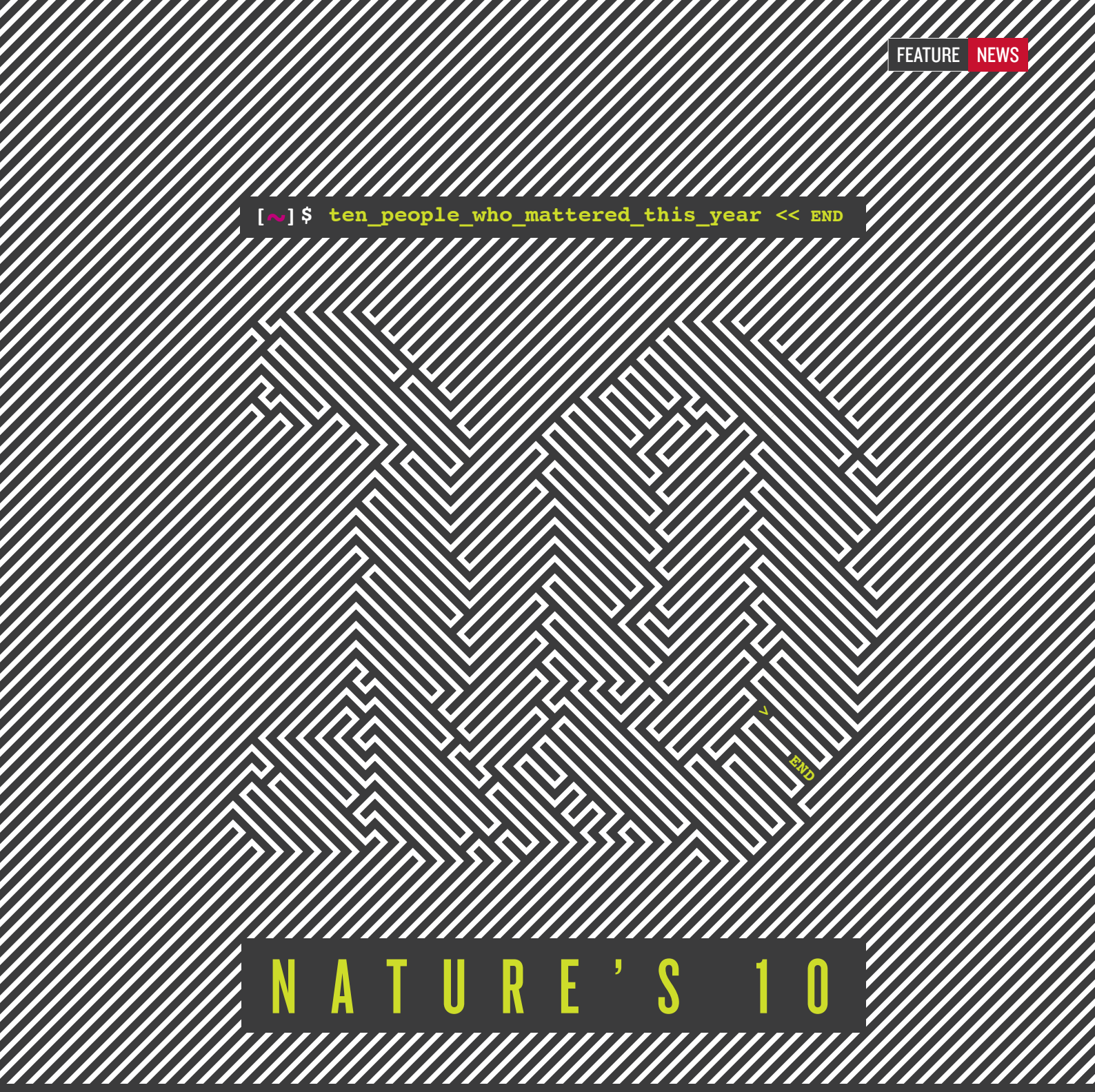


NATURE'S 10

DAVID LIU / MARICA BRANCHESI / EMILY WHITEHEAD / SCOTT PRUITT
PAN JIANWEI / JENNIFER BYRNE / LASSINA ZERBO / VÍCTOR CRUZ-ATIENZA
ANN OLIVARIUS / KHALED TOUKAN

[ABOUT THE IMAGE]
This design speaks to the increasingly important role of artificial intelligence in science and technology. The image was created in the style of a machine-learning algorithm designed to solve the travelling salesman problem, which asks for the optimum path between a given set of points. The '10' was created using a single line.
Image by Martin Krzywinski.

365 DAYS: *the year in science*

MARTIN ADOLFSSON

GENE CORRECTOR

A biologist developed gene-editing tools that are new to nature, and that could one day save lives.

BY HEIDI LEDFORD

When David Liu was an undergraduate student 25 years ago, he wrote a dissertation that his adviser remembers to this day. "It was absolutely word perfect," says Nobel-prizewinning chemist E. J. Corey, now an emeritus professor at Harvard University in Cambridge, Massachusetts. It needed no editing.

Liu is nevertheless obsessed with editing. For more than a decade, he has been in the vanguard of researchers tinkering with powerful gene-editing technologies, most recently with the much-hailed method known as CRISPR. For all the excitement about the ability to edit the genome deftly, however, the technique is not yet perfect. CRISPR won't reliably rewrite snippets of DNA in some cells, for example, and certain changes that scientists want to create in the genome pose problems.

In October, Liu's team at the Broad Institute in Cambridge, Massachusetts, published the results of a daring attempt to tweak the CRISPR system. They used an enzyme created in the laboratory to chemically convert pairings of the DNA bases adenine (A) and thymine (T) into guanine (G) and cytosine (C). No such enzyme exists in nature — and there was no guarantee that Liu and his team could make it.

But Liu's career has revolved around risk-taking. As a PhD student at the University of California, Berkeley, he developed a way to incorporate non-natural amino acids into proteins in living cells. "I remember well some respected senior graduate students advising me that it would be pretty crazy to take on that project," Liu says.

While Liu was in his fourth year of graduate studies, Corey invited him back to Harvard to give a seminar. Members of the chemistry faculty there were so impressed that they offered him a job as soon as he got his PhD. His group moved to the Broad in February 2017.

Liu's lab pioneered methods for developing new enzymes in the laboratory, and then added gene editing to its repertoire. In 2013, Liu joined a host of other luminaries in founding a company now called Editas Medicine, also in Cambridge, to develop treatments based on CRISPR technology.

Such clinical applications could be limited by the unpredictability of CRISPR–Cas9 gene editing, the most commonly used version of the tool. Although the Cas9 enzyme cuts DNA where directed, researchers must rely on the cells' own DNA-repair systems to fix the break. This can create a variety of different edits to the genome.

Liu's lab looked for ways to improve on that. In 2016, postdoc Alexis Komor and others on Liu's team reported its first base editor, which relied on naturally occurring enzymes and could convert a C to a T or a G to an A. For the first time, researchers had a reliable, predictable way to make a single-letter change in the genome of a living cell.

The approach has since been deployed in a range of organisms, from wheat to zebrafish and mice. And in September, researchers in China reported that they had used Liu's base editor to correct a single-letter mutation, or point mutation, for a blood disorder in human embryos. (The embryos were not allowed to develop further.)

Another postdoc in Liu's lab, Nicole Gaudelli, was eager to build on that work and create an enzyme that could convert As and Ts into Gs and Cs. Gaudelli was proposing to break a cardinal rule in the Liu lab: no one takes on a project if the first step is to create a new enzyme. The risk of lost time and failure is too high. Liu nevertheless encouraged her, and months of work yielded a protein that could, in theory, reverse about 48% of known disease-causing point mutations in humans. In October, the team reported that the new protein does so more reliably than the classical CRISPR–Cas9 system. Such tools could help in the future development of gene-therapy approaches.

"This will cover a good number of disease mutations," says Dana Carroll, a genome engineer at the University of Utah in Salt Lake City. "There will be significant impact." ■

MERGER MAKER

An astronomer helped scientists make the most of a historic gravitational-wave event.

BY DAVIDE CASTELVECCHI

For a few weeks starting on 17 August, it seemed as if every telescope on Earth and in space was looking in the same direction. Prompted by the latest detection of gravitational waves by facilities in Italy and the United States, some 70 teams of astronomers rushed to capture the first direct observations of the collision between two inspiralling neutron stars. What they saw solved several astrophysical mysteries at once, including the nature of certain γ-ray bursts and the origin of the Universe's heavier elements.

This effort was the result of years of preparation spearheaded by Marica Branchesi, a member of the Virgo collaboration, which operates the gravitational-wave detector near Pisa, Italy. Branchesi bridged the divide between observational astronomy and the physics-heavy realm of gravitational-wave research — fields that, until recently, had little reason to work together. "Marica has been the key communicator between astronomers and physicists," says Gabriela González, a physicist at Louisiana State University in Baton Rouge and the former spokesperson for Virgo's partner, the collaboration that runs the US-based Laser Interferometer Gravitational-Wave Observatory (LIGO).

Branchesi, an astronomer herself, joined Virgo in 2009 when she got a job at the University of Urbino, located in her Italian hometown. At the time, Virgo and LIGO were beginning to operate as one group, and it had become clear that they needed someone to act as an ambassador to the astronomy community. Gravitational waves, which are ripples in the fabric of space-time, reveal a side of the cosmos that ordinary telescopes cannot see. But in the case of a neutron-star merger, LIGO and Virgo would be able to detect only the final minutes leading up to it; much of the information about such collisions — and the elements produced in the process — would be accessible only by conventional telescopes.

When Branchesi began, she found that she had to encourage physicists to send out alerts about potential events, even when they were not completely sure they were genuine. She also had to persuade astronomers that it would be worth listening. Many were sceptical that LIGO and Virgo, which had already run for years without a single detection, would find anything. "It was my job to convince astronomers that it was a promising field," says Branchesi, who moved to Italy's Gran Sasso Science Institute in L'Aquila this year. Branchesi says she began to see attitudes change around 2013, as significant upgrades to the detectors neared completion; these would boost the odds of discovery a thousandfold. Soon dozens of astronomy teams had signed up to receive detection notices from LIGO and Virgo. (In exchange, they must keep their findings confidential until the gravitational-wave teams are ready to announce the detection.)

Branchesi's diplomatic skills also came in handy when it was time to write up the results of the neutron-star discovery. Of the dozens of papers released on 16 October, one was a summary paper that boasted more than 3,500 authors (B. P. Abbott *et al. Astrophys. J. Lett.* **848,** L12; 2017). Branchesi helped to corral the large group of contributors and ensure that the findings were synthesized fairly. "She played an important role in making sure that all the important results were represented," says co-author Eleonora Troja, an astronomer at NASA Goddard Space Flight Center in Greenbelt, Maryland.

Like many others, Branchesi says she looks forward to making further discoveries. But this year might be hard to beat. When physicists set out to build LIGO and Virgo, the detection of neutron-star collisions topped the wish list. The Universe delivered, and sooner than expected: "It was everything I ever hoped for," she says. ■

T. J. KIRKPATRICK/REDUX/EYEVINE

LIVING TESTIMONIAL

A young girl's battle against leukaemia inspired a new generation of cancer therapy.

BY ELIE DOLGIN

The simplest gestures can be the most powerful. At a US Food and Drug Administration meeting in July, 12-year-old Emily Whitehead rose from the audience and walked up to the man presenting at the lectern. Without a word, she grasped the back of his arm.

"I just thought it would help him if I stood by him," recalls Emily, who five years earlier was the first child in the world to receive an experimental treatment called CAR-T therapy.

The man speaking was her father, Tom. He was urging the panel to approve the therapy, in which a patient's immune cells are genetically reprogrammed to recognize and attack cancer cells. When he saw his daughter approach, Tom began to cry. The advisory panel got choked up, too. "We were touched, obviously," says paediatric oncologist Timothy Cripe, a panellist from Nationwide Children's Hospital in Columbus, Ohio. "She's a physical, living testimonial."

The panel voted unanimously to approve the therapy — the first of its kind — for children and young adults with acute lymphoblastic leukaemia; the FDA agreed. Within a few months, another CAR-T therapy got the green light, this time for non-Hodgkin's lymphoma, making 2017 a historic year for this class of cancer therapeutic.

"It's a watershed," says Crystal Mackall, a cancer immunotherapy researcher at Stanford University School of Medicine in California. But, she says, these first two approved therapies are rudimentary examples of what CAR-T could do.

Dozens of academic teams and biotech companies are working on CAR-T therapies, striving to make existing treatments safer and more controllable, and producing off-the-shelf versions that don't require tailoring to each patient.

Yet despite the progress being made, "the border between success and failure can be really, really thin", says Stephan Grupp, the paediatric oncologist who treated Emily at Children's Hospital of Philadelphia in Pennsylvania. A few days after Emily's CAR-T infusion, she had a severe immune reaction known as cytokine-release syndrome. Had Grupp not acted quickly and treated her — with an intervention that at the time was also unproven — it is almost certain she would have died, he says.

Such a tragedy would not only have devastated Emily's family, it could also have derailed the development of CAR-T therapies.

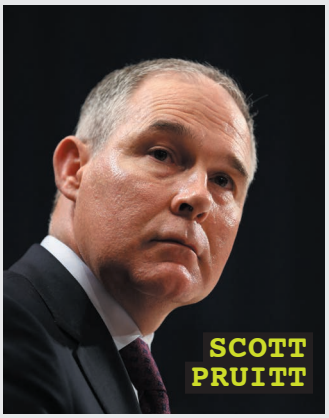
Emily made a full recovery and has embraced her role as the poster child for a cancer revolution. "It feels great," Emily says. "All of these people like to look up to me, and that's really special." ■

JIM WATSON/AFP/GETTY

AGENCY DISMANTLER

A political appointee chipped away at the US Environmental Protection Agency — and science — with ruthless efficiency.

BY SARA REARDON



MARTIN H. SIMON/REDUX/EYEVINE

When thousands of people took to the streets in April's March for Science, many protesters brandished signs attacking Scott Pruitt, the outspoken climate-change sceptic who had recently taken over as administrator of the US Environmental Protection Agency (EPA).

Pruitt was one of the EPA's fiercest critics before President Donald Trump tapped him to head the agency. As attorney-general of Oklahoma, he sued the EPA at least 14 times. "To have him as head of EPA is frightening," says Deborah Swackhamer, an environmental chemist at the University of Minnesota in St Paul who chaired the agency's Board of Scientific Counselors until Pruitt's administration demoted her in November. "Pruitt has all the expertise needed to really do damage."

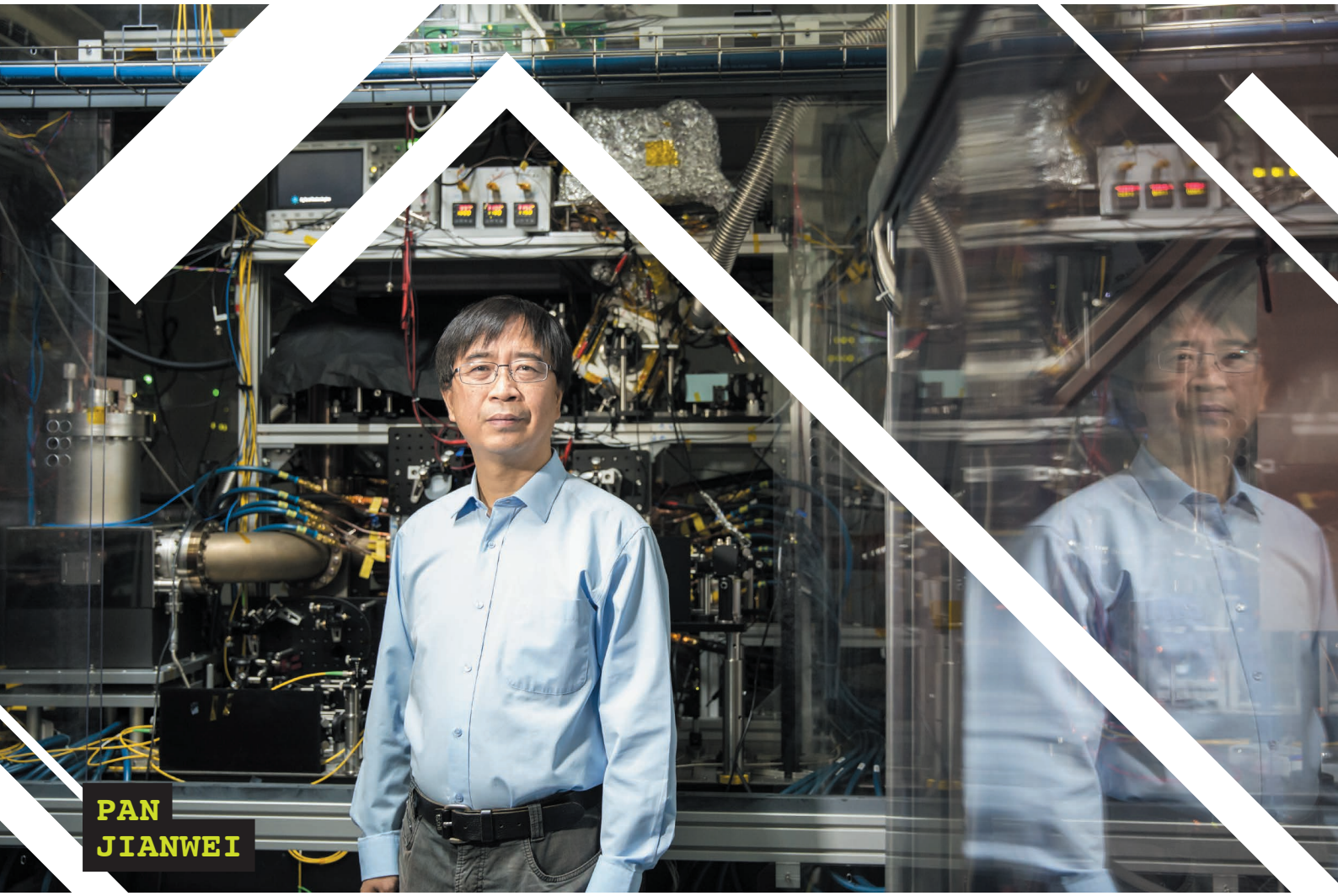
After taking office in February, he immediately set to work blocking or repealing dozens of environmental rules, including regulations on emissions, mining and hazardous waste. The fossil-fuel and chemical industries cheered his appointment. "He does what he thinks is right, and doesn't seem to be unnecessarily concerned about the criticism he might get from interest groups," says Jeffrey Holmstead, an attorney at the legal firm Bracewell in Washington DC, who represents companies in the energy industry. The EPA did not respond to multiple requests from *Nature* for an interview with Pruitt.

In October, Pruitt announced that scientists who hold EPA grants would no longer be allowed to serve on the agency's independent advisory committees, owing to what he called a conflict of interest. As a result, the agency dismissed half the members of several scientific-advisory boards.

Most of the positions have since been filled with current industry employees and scientists who have industry ties.

But many scientists feel sidelined, and EPA employees, in particular, worry about their future. The Trump administration has proposed a 40% budget cut to the agency's research and development office, which would mostly eliminate staff-scientist jobs.

"We knew that he would not be a science-supporting administrator there, but I've been impressed with the many creative ways he's found to undermine science and scientists at the agency," says Gretchen Goldman, an analyst with the advocacy group Union of Concerned Scientists in Washington DC. ■



ERIC MICHAEL JOHNSON

FATHER OF QUANTUM

A physicist took quantum communication to space and back.

BY ELIZABETH GIBNEY

In China, some call him *Liàngzǐ zhī fù*: 'Father of Quantum'. It's an apt name for Pan Jianwei, widely hailed for leading China to the forefront of long-distance quantum communication: harnessing quantum laws to transmit information securely. After training in Europe, Pan returned full-time to China in 2008, and has since lit a fire under the country's efforts in quantum technology. "It seems like a couple of times a year I'm shocked when I read about what they're doing," says Christopher Monroe, a quantum physicist at the University of Maryland in College Park.

In July, Pan and his team at the University of Science and Technology of China in Hefei reported that they had smashed the record for quantum teleportation, transmitting the quantum state of a photon on Earth 1,400 kilometres to a photon on an orbiting satellite. And in September, the team used that satellite to beam photons to Beijing and Vienna, generating quantum encryption keys that allowed teams in these cities to video-chat with complete security. Because detecting the photons disturbs their quantum states, would-be hackers cannot intercept the keys without their activities being noticed.

The demonstration was a "historic event", says Anton Zeilinger, Pan's former PhD adviser and his current collaborator at the University of Vienna. Pan's group, he says, is surging ahead in the development of a quantum internet: a network of satellites and ground-based equipment that could share quantum information across the globe.

This would allow unbreakable worldwide encryption, as well as new experiments that harness long-distance quantum connections, such as combining light from detectors across the planet to create a super-resolution telescope. For now, Pan's team has plans to launch a second satellite, and is running another quantum experiment in space aboard China's Tiangong-2 space station. In the next five years, Pan says, "Many wonderful results will come. It's really a new era."

Although he leads a group of 50 scientists spanning multiple disciplines — including quantum simulation, computation and optics — Pan is the "essential brain" behind the work, says Zeilinger, bringing to it a combination of vision, organization and a flair for experiment.

Known as an optimist with unending enthusiasm, Pan also has a gift for persuading funders. And he is quietly confident that the Chinese government will support his next big plan: a US$2-billion, 5-year initiative focused on quantum communication, metrology and computation, which mirrors a $1.2-billion European flagship initiative announced in 2016.

Pan's skill lies in picking the right problem and taking risks, says Monroe. "China is very lucky to have him." ■

ERROR SLEUTH

A researcher on a mission to expose flawed papers helped build a tool to detect them.

BY NICKY PHILLIPS

By day, Jennifer Byrne studies the genetics of cancer. But by night, she hunts for errors in genetics research papers. As her children and husband watch action movies, Byrne has spent countless evenings over the past two years on her laptop trawling the literature for flawed — and potentially fraudulent — articles. "I was doing PubMed searches hoping nobody was noticing that I wasn't on the couch," she says.

Byrne, who works at the Children's Hospital at Westmead in Sydney, Australia, has so far spotted dozens of papers with DNA-sequence errors. Most of them have other suspicious features, such as poor-quality graphics and chunks of text that overlap with other manuscripts. Byrne suspects misconduct is involved in some cases, although that hasn't been proven.

Her tenacious work is now making waves. Journals have retracted nine papers as a result of Byrne's work — seven this year. And in October, she and French computer scientist Cyril Labbé released an online program called Seek & Blastn to help automatically detect similar problems. "When I'm on my deathbed, I'll look back and be really proud of this work," she says.

Byrne first discovered the patterns of errors in five papers that all mentioned a rare gene that she had studied. They all claimed to observe the effects of inactivating the gene in cancer cells, but Byrne saw that they reported the wrong DNA sequences for the experiments they claimed to conduct. Four of the papers have been retracted; neither Byrne nor *Nature* has heard from the editor or authors of the fifth.

Realizing that more faulty papers were out there, Byrne teamed up in 2016 with Labbé, a researcher at the University of Grenoble Alpes, France, who has experience developing software to identify junk manuscripts. The two hope that journal editors and publishers could use a refined version of the program they released this year to check manuscripts in advance of publication.

A lot of scientists despair over sloppy or fraudulent manuscripts polluting the literature, says Nick Enfield, a linguist at the University of Sydney. "But few people go to the lengths that Jenny has gone to expose them," he says. Enfield has given Byrne research funding to hire a research assistant to help check errors in some papers. "She's motivated by her belief that truthful publication of data is paramount," adds gene therapist Belinda Kramer, Byrne's colleague at the Westmead hospital's Kids Research Institute.

Byrne says her detective work has made her realize the extent to which research is built on trust. "I used to think that science ran on brains and money. Trust is the component that's easy to forget and take for granted," she says. ■

WOLTER PEETERS/*THE SYDNEY MORNING HERALD*

TEST-BAN TRACKER

In the face of destabilizing threats, a geophysicist fights for nuclear non-proliferation.

BY DAVIDE CASTELVECCHI

Lassina Zerbo's phone rang less than 30 minutes after North Korea conducted its sixth nuclear test, on Sunday 3 September. It was just before 6 a.m. in Vienna, and seismic data suggested that this was by far the most powerful bomb the country had ever detonated, shaking the Earth with a force close to that of a 6.1-magnitude earthquake. "It was frightening," says Zerbo, who heads the Comprehensive

QUAKE CHASER

When a 7.1-magnitude earthquake hit Mexico City in September, a seismologist's predictions came true.

BY ALEXANDRA WITZE

OSWALDO RUIZ

Víctor Cruz-Atienza was 11 years old when his house started shaking around him. It was 19 September 1985, and a magnitude-8.0 earthquake on Mexico's Pacific coast had just sent a burst of seismic energy racing across the country. Cruz-Atienza lived with his parents and brother south of Mexico City, in a two-storey house built atop hard rock. That was a lucky location. Much of Mexico City rests on soft sediments that shook like a vast bowl of jelly. Hundreds of buildings collapsed. Thousands of people died.

That day marked Cruz-Atienza for life. "The experience of feeling the ground moving has always awakened something instinctive in me," he says. He found himself drawn to geophysics as an undergraduate at the National Autonomous University of Mexico (UNAM) in Mexico City, and went on to study in France and the United States, focusing on the physics of how faults rupture.

By 2016, as head of the seismology department at UNAM's Institute of Geophysics, he had turned his talents back to his home town. In a prescient paper, he described how seismic energy from a quake would reverberate around the ancient lake basin in which the city sits. His simulations showed which parts would shake most strongly and for the longest time.

On 19 September this year, Cruz-Atienza was at a conference in Portland, Maine, when he heard news of a magnitude-7.1 quake that had struck about 120 kilometres from Mexico City. He scrambled to find a flight home, and got there the following day. His predictions turned out to be right: owing to the structure of the basin, the soft sediments were able to sustain shaking for longer the farther one got into them.

Thanks to stricter building codes put in place after the 1985 quake, and the relatively short duration of this year's quake, the death toll was much lower. But Cruz-Atienza urges diligence.

"Increasing the awareness of people is crucial for him," says Jean Virieux, a seismologist at the University of Grenoble Alpes in France and Cruz-Atienza's PhD adviser.

In 2013, Cruz-Atienza published a popular book, *Los Sismos: Una Amenaza Cotidiana* (La Caja de Cerillos Ediciones), about the 'daily threat' that earthquakes pose. And he continues to look ahead. Last month, working with Japanese collaborators, he led a research cruise to explore another seismic risk off Mexico's west coast, where two plates of Earth's crust are colliding and building up stress. The scientists installed seismic and geodetic instruments on the sea floor, aiming to predict the next great quake.

"Each earthquake is a different animal," Cruz-Atienza says. "Each one has its own story and memories." ■

Nuclear-Test-Ban Treaty Organization (CTBTO), which monitors nuclear tests worldwide. Before long, he had finished calls with the Japanese and South Korean ambassadors to Austria and was preparing for an onslaught of media requests to help make sense of this latest nuclear provocation.

It has been a challenging year for Zerbo and other advocates of non-proliferation. North Korea's leader, Kim Jong-un, and US President Donald Trump have traded increasingly aggressive threats, and uncertainty has grown about the United States' commitment to its allies.

Although North Korea is the only nation to have conducted a nuclear test in nearly 20 years and most countries continue to favour non-proliferation, the ground seems to be shifting. In April, Zerbo was taken aback to hear university students in Nagasaki, Japan — a city that has been vocal in denouncing nuclear weapons in the wake of the US bombings during the Second World War — question their country's anti-nuclear stance. "The younger generations ask: 'Why shouldn't we ourselves be in the position where we have a deterrent?'" he says.

Born in Burkina Faso in 1963, Zerbo moved to France to earn a doctorate in geophysics and worked in the minerals industry before joining the CTBTO in 2004.

One of his first initiatives there was to set up a system to share information collected by the organization's monitoring stations with the broader scientific community. (It turns out that the troves of data gathered by the hydroacoustic, infrasound, seismic and radionuclide sensors are useful for many other purposes, including tsunami detection and whale-migration tracking.)

Zerbo became executive secretary of the CTBTO in 2013 and now spends much of his time travelling the world working towards the completion of the organization's network of monitoring stations. More importantly, he advocates for the ratification of the 1996 Comprehensive Nuclear Test-Ban Treaty, which created the CTBTO but has never been put into force. Key hold-outs include China and the United States. Siegfried Hecker, a nuclear-policy expert at Stanford University in California, calls Zerbo a "tireless and effective promoter" of the ban.

Despite the challenges, Zerbo says there is nothing as gratifying as working at the nexus of science and diplomacy. He often recommends young researchers consider a similar move: "Science has to be married with policy for the world to be a better place." ■

HEINZ-PETER BADER/REUTERS

LEGAL CHAMPION

As sexual-harassment cases surged, a lawyer worked to hold academic institutions accountable.

BY ALEXANDRA WITZE

Ann Olivarius had to add 20% more staff to her firm just to handle the phone calls. Women were ringing her law practice in Maidenhead, UK, in droves this year, asking for help with their #MeToo stories of sexual harassment.

For decades, Olivarius has dealt with high-profile cases of sexual misconduct and assault at academic institutions. But the astonishing developments of 2017 — with powerful men in science, entertainment, journalism and other industries losing their jobs over sexual misconduct — have created a tipping point even for her.

"I think now we've recognized the problem," she says. "Once society recognizes it, we have a better chance of trying to cure it."

Olivarius has been working on that cure since the 1970s. As an undergraduate at Yale University in New Haven, Connecticut, she was furious to learn that male professors were harassing and even raping students. She and several other plaintiffs sued Yale under the federal law Title IX, which requires gender equality on campus. They lost their individual cases, but won a broader victory: the court acknowledged that sexual harassment at universities was indeed sex discrimination in education. The landmark decision established the legal framework for battling sexual harassment on US campuses.

After Yale, Olivarius worked in law and finance at corporate giants including Goldman Sachs. Then, having made enough money to do as she wished, she took on challenging projects such as co-founding a law firm to fight sexual abuse of children. In 1996 she set up McAllister Olivarius, which she now runs with her husband, former journalist Jef McAllister. They represent plaintiffs in some of the most prominent cases of sexual harassment in academia, including at Yale, the University of Rochester in New York and the University of Oxford, UK.

ALISTAIR HILTON

"She is a very, very strong voice," says Elissa Newport, a cognitive psychologist at Georgetown University in Washington DC, who is a complainant in the Rochester case, which involves alleged sexual harassment of graduate students and retaliation against faculty members who reported it. "She's thoughtful and considerate with victims — and really ferocious in our defence," Newport says.

For Olivarius, the question now is how to transform all the attention on sexual-harassment issues into lasting legal change. One idea she supports is to impose financial penalties on institutions found to have violated Title IX.

Now, Olivarius says she is driven to improve working conditions for other women so that they, too, have a chance at career success. "Every day, I've got to get out there and make it possible for other people to break through and to be treated fairly." ■

[ONES TO WATCH]

2018

SHAUGHNESSY NAUGHTON
> PRESIDENT, 314 ACTION

This researcher turned political activist will be leading efforts to get scientists elected during the contentious US mid-term elections in November.

MARK WALPORT
> CHIEF EXECUTIVE, UK RESEARCH AND INNOVATION

Walport must unite the United Kingdom's nine research-funding bodies into a £6-billion (US$8-billion) super agency, and shape science as Brexit looms.

KATE CRAWFORD
> CO-FOUNDER & DIRECTOR OF RESEARCH, AI NOW INSTITUTE

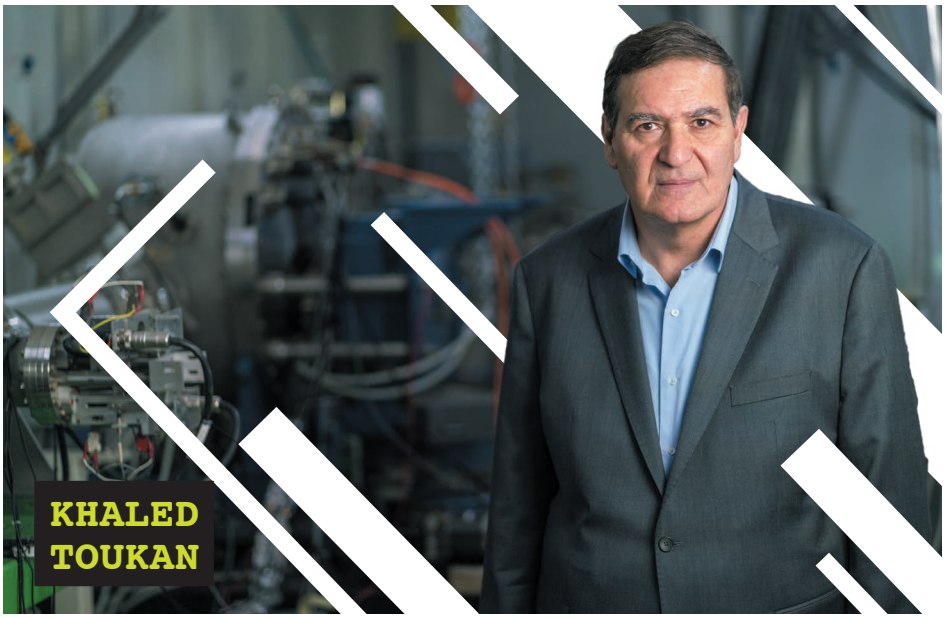
Artificial intelligence is on the rise — and Crawford is leading a critical examination of its effects on labour, health, social inequality and ethics.

JOHN MARTINIS
> TEAM LEADER, GOOGLE'S QUANTUM-COMPUTING EFFORTS

This year, Martinis's goal was to construct a computing chip with 50 quantum bits of processing power. Next year, his team will try to prove that such a system can outperform standard computers.

PATRICIA ESPINOSA
> EXECUTIVE SECRETARY, UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

This Mexican diplomat could have a key role in December 2018 at the United Nations climate conference in Poland, where countries will assess progress on the 2015 Paris climate agreement.



CHRISTOPHER HERWIG FOR *NATURE*

OPENING SESAME

Through twists, turns and setbacks, a physicist kept the Middle East's first synchrotron light source on track.

BY ELIZABETH GIBNEY

In May 2010, a planning meeting for the Middle East's first synchrotron was well under way when news broke that the Israeli navy had stormed a Turkish ship, part of a flotilla carrying aid to Gaza. The polarizing event could have scuppered the synchrotron project, which is supported by an unlikely combination of partners: Israel, Turkey and the Palestinian Authority as well as Cyprus, Egypt, Iran, Jordan and Pakistan. That the project survived the crisis was in large part thanks to Khaled Toukan, its founding director, who spoke to each delegation and calmed the situation. "This type of talent was absolutely crucial," says Maciej Nałęcz, a biochemist at the Polish Academy of Sciences in Warsaw.

The Synchrotron-light for Experimental Science and Applications in the Middle East, or SESAME, opened this year after 20 years of development. It is the first major international research centre of its kind in the Middle East, and puts the region on the world science map.

Throughout, Toukan, a venerated physicist, former university president and three-time government minister, has been a steady shepherd. He was one of a handful of people crucial to the project, says Christopher Llewellyn Smith, a physicist at the University of Oxford, UK, who chaired the project's governing council from 2008 to 2017: "Without him, SESAME wouldn't have happened."

The US$110-million facility, based outside Amman, Jordan, circulates high-energy electrons around a 133-metre ring. This creates intense radiation that can be used to image molecules, artefacts and myriad other objects. But the machine is not only a photon source, Toukan says: "It's light in a sea of conflict."

Over the years, Toukan soothed political tensions between SESAME's partners. And he helped ensure the project's financial survival when member states' contributions fell short. "We often had to plan month by month," Toukan says. He recently persuaded the Jordanian government to use European Union funds to build a $7-million solar power plant for SESAME. It will halve running costs that might otherwise cripple the project, says Llewellyn Smith.

Since 2003, Toukan has worked for SESAME around other jobs and without pay. But he always made time for the project, says Nałęcz, who headed the division at UNESCO that oversaw SESAME's formation. "When I called, he always answered," Nałęcz says. "For a minister, this is unbelievable." And this year has been particularly busy. In his current role as chair of Jordan's Atomic Energy Commission, Toukan supervised the start-up of a second historic project — the country's first nuclear reactor for research.

Toukan hopes that the success of SESAME will lead to more facilities, and collaboration with more countries. Some were sceptical the project would succeed, he says. "But now there is momentum. SESAME is real." ■