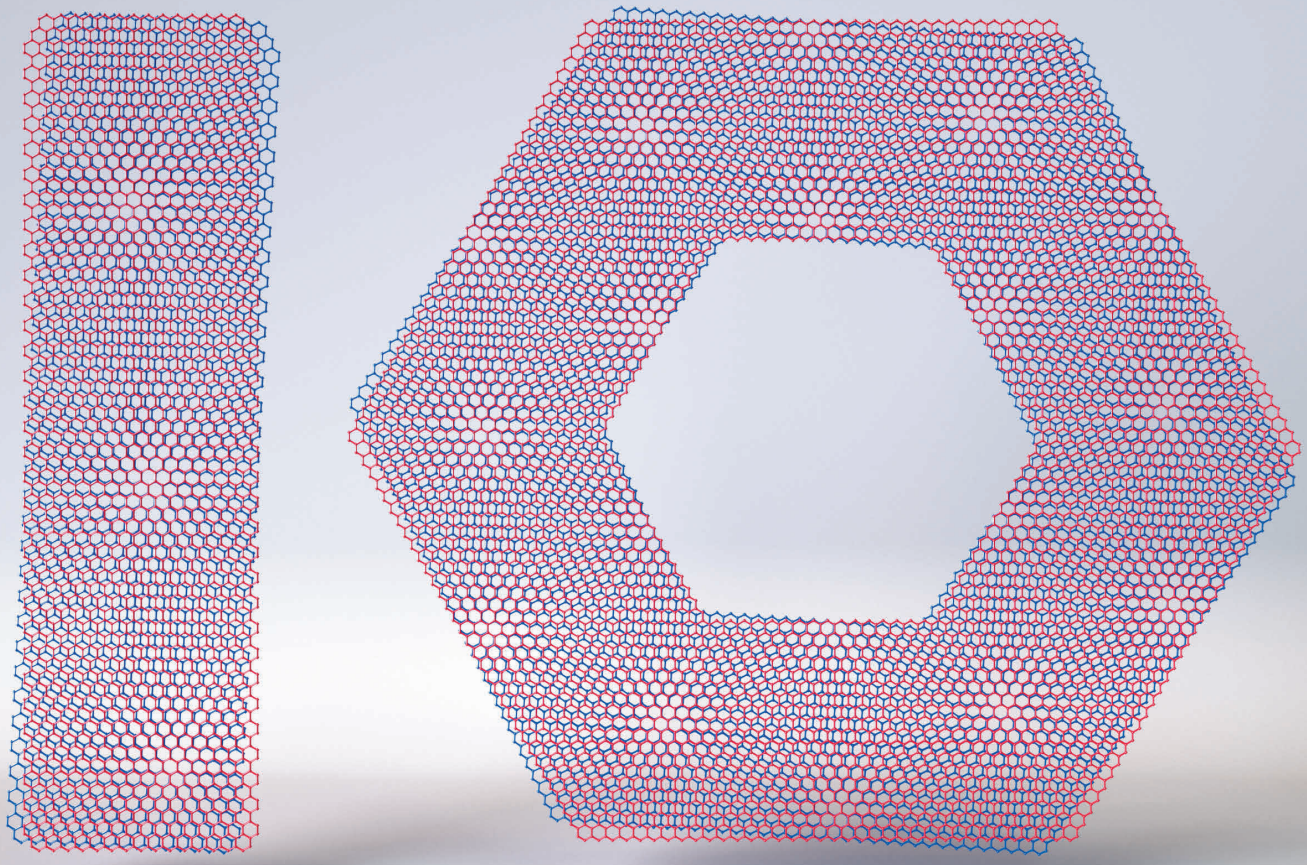
NATURE'S 10

Ten people who mattered this year

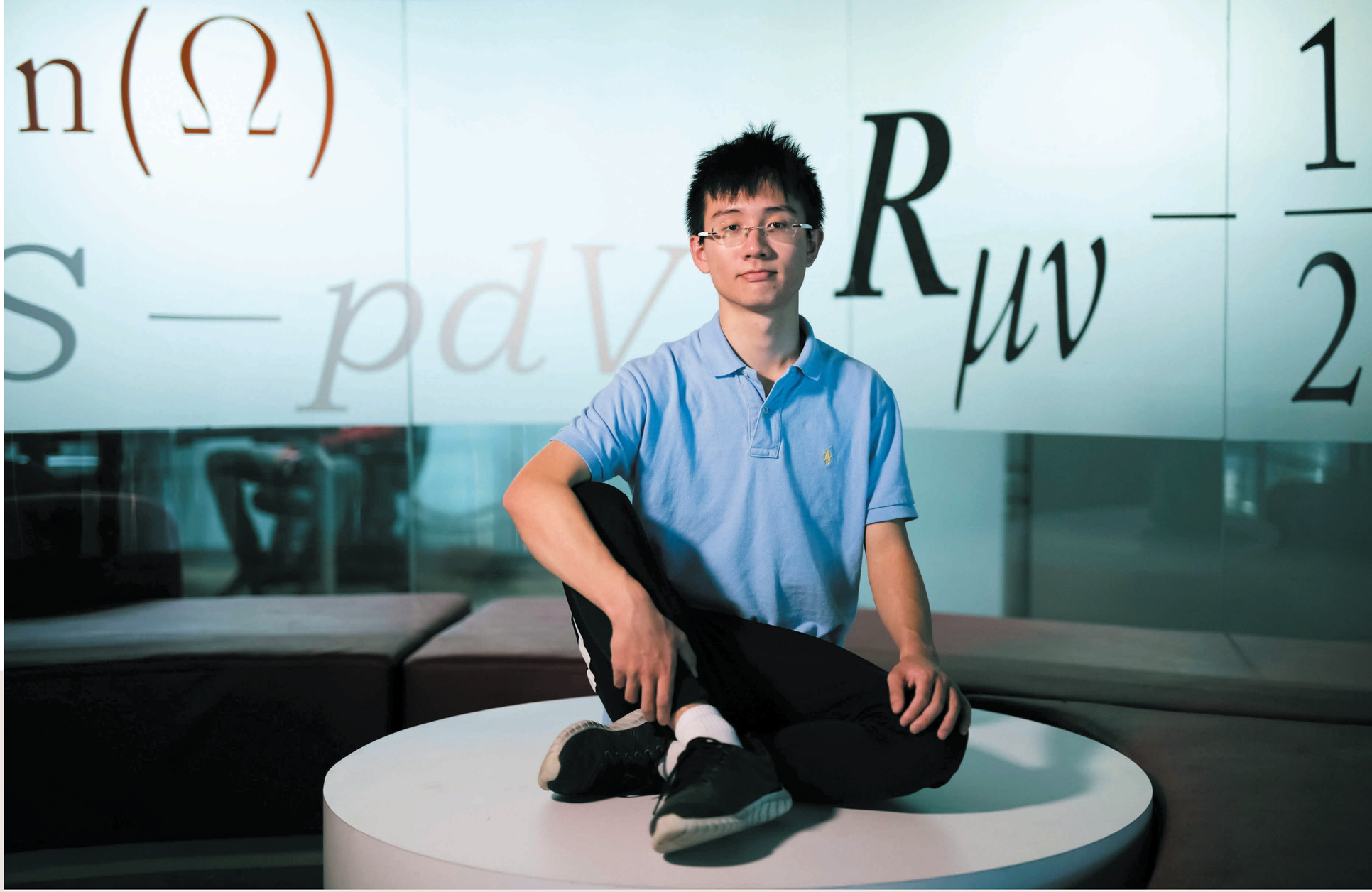


YUAN CAO / VIVIANE SLON / HE JIANKUI / JESS WADE
VALÉRIE MASSON-DELMOTTE / ANTHONY BROWN / BEE YIN YEO
BARBARA RAE-VENTER / ROBERT-JAN SMITS / MAKOTO YOSHIKAWA

About the image:
This design highlights advances in studies of atom-thick materials with unusual properties. The image represents two graphene sheets offset by a 'magic' angle, an arrangement that can behave as a superconductor in certain conditions. Image by JVG.

365 DAYS:
the year in science

YUAN CAO



CORINNA KERN FOR *NATURE*

GRAPHENE WRANGLER

A PhD student coaxed superconductivity from sheets of atom-thick carbon.

BY ELIZABETH GIBNEY

Yuan Cao's teenage years were hardly typical. By age 18, he had already graduated from high school, completed an undergraduate degree at the University of Science and Technology of China in Hefei, and travelled to the United States to begin his PhD. He hasn't slowed down since: this year, aged just 21, Cao had two papers published on strange behaviour in atom-thick layers of carbon that have spurred a new field of physics. Cao admits that his situation is unusual, but says he isn't special. After all, he did spend a full four years at university: "I just skipped some of the boring stuff in middle school."

Pablo Jarillo-Herrero's group at the Massachusetts Institute of Technology (MIT) in Cambridge was already layering and rotating sheets of carbon at different angles when Cao joined the lab in 2014. Cao's job was to investigate what happened in two-layer stacks when one graphene sheet was twisted only slightly with respect to the other, which one theory predicted would radically change the material's behaviour.

Many physicists were sceptical about the idea. But when Cao set out to create the subtly twisted stacks, he spotted something strange. Exposed to a small electric field and cooled to 1.7 degrees above absolute zero, the graphene — which ordinarily conducts electricity — became an insulator (Y. Cao *et al. Nature* **556**, 80–84; 2018). That by itself was surprising. "We knew already that it would have a big impact on the community," says Cao. But the best was yet to come: with a slight tweak to the field, the twisted sheets became a superconductor, in which electricity flowed without resistance (Y. Cao *et al. Nature* **556**, 43–50; 2018). Seeing the effect in a second sample convinced the team that it was real.

The ability to coax atom-thick carbon into a complex electronic state through a simple rotation now has physicists clamouring to engineer exciting behaviour in other twisted 2D materials. Some even hope that graphene could shed light on how more-complex materials superconduct at much higher temperatures. "There are so many things we can do," says Cory Dean, a physicist at Columbia University in New York City. "The opportunities at hand now are almost overwhelming."

Hitting graphene's 'magic angle' — a rotation between parallel sheets of around 1.1° — involved some trial and error, but Cao was soon able to do it reliably. His experimental skill was crucial, says Jarillo-Herrero. Cao pioneered a method of tearing a single sheet of graphene so that he could create a stack composed of two layers with identical orientation, from which he could then fine-tune alignment. He also tweaked the cryogenic system to reach a temperature that allowed superconductivity to emerge more clearly.

Cao loves to take things apart and rebuild them. At heart, he is "a tinkerer", his supervisor says. On his own time, this means photographing the night sky using homemade cameras and telescopes — pieces of which usually lie strewn across Cao's office. "Every time I go in, it's a huge mess, with computers taken apart and pieces of telescope all over his desk," says Jarillo-Herrero.

Despite his youth and shy manner, colleagues say that Cao's maturity shines through in his persistence. Having missed out by a whisker on a place in MIT's physics graduate programme, for example, Cao found a way to pursue the subject by joining Jarillo-Herrero's team through the electrical-engineering department. Cao also shrugged off a disappointing start to his PhD, after realizing that seemingly exciting data that he had spent six months trying to understand were due to a quirk of the experimental set-up. "He wasn't happy, but he just rolled up his sleeves and continued working," Jarillo-Herrero says.

Cao, now 22, doesn't yet know where he'd like his career to lead. "On magic-angle graphene, we still have a lot of things to do," he says. But universities around the world are already eyeing him for not only postdoctorate jobs, but also faculty positions, says physicist Changgan Zeng, Cao's undergraduate supervisor and mentor at the University of Science and Technology of China. "Among condensed-matter physicists in China, everybody knows his name," Zeng says. The university would gladly have him back, but Zeng expects that Cao will stay in the United States for now. "There, it's easier to see the stars." ■

HUMANITY'S HISTORIAN

A palaeogeneticist discovered a remarkable ancient hybrid hominin: half Neanderthal, half Denisovan.

BY EWEN CALLAWAY

Viviane Slon was sure she had made a mistake three years ago, when DNA tests on an ancient bone fragment pointed to a union of two extinct human groups. Half of the genome looked like a Neanderthal's; the other half matched sequences from Denisovans — a group once found throughout Asia.

"I was very much of the mindset that this cannot be," says Slon, a palaeogeneticist at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. Slon told no one for several days, and wondered whether she had made some mistake.

When she couldn't find an error, Slon shared the results with her colleagues and began to ponder what they might mean. Further tests determined that the individual — a young adult female affectionately named Denny by colleagues — was the daughter of a female Neanderthal and a male Denisovan who lived roughly 90,000 years ago.

Neanderthal and Denisovan genomes point to past interbreeding, but a direct product of such an encounter had never been found.

The discovery, reported in August, reverberated with other scientists and the public, triggering hundreds of news articles and thousands of tweets. "It's probably the most fascinating person who's ever had their genome sequenced," one geneticist said at the time.

"It was fun to see people who are not at all in this field and do not think about Neanderthals in their everyday life, how this caught their attention," says Slon, a postdoctoral fellow working with palaeogeneticist Svante Pääbo.

Slon's perspective is unique among her peers, says Israel Hershkovitz, a palaeoanthropologist at the University of Tel Aviv, Israel. He supervised some of Slon's graduate-degree research, which spanned archaeology, anthropology, pathology and anatomy; she even supported herself by working in a cadaver lab. "She was not born in a sterile DNA lab," says Hershkovitz. "When she speaks about the Neanderthal, she sees the Neanderthal. She sees its physiology, its anatomy, not just its genes."

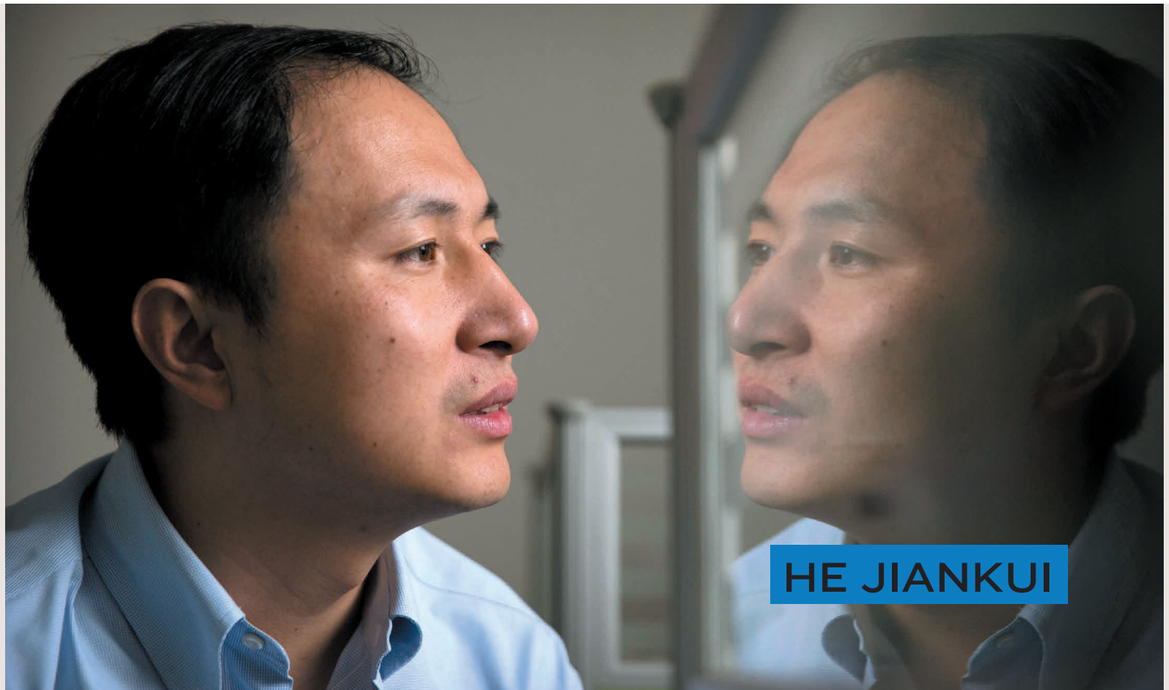
Slon says she is drawn to using genetics and other scientific approaches to study prehistory because of the lack of written records. "Everything you can infer is from what people left behind," she says. "It's almost like solving a riddle."

Much of her palaeogenetics research has centred around material from Denisova Cave, the vast cavern in southern Siberia that gave its name to the Denisovans, a cousin group to Neanderthals.

Slon's first project on remains from the cave was to sequence the DNA in a tooth from the fourth Denisovan individual found there. She also co-led a team that found Denisovan DNA in excavated dirt, an approach that could transform palaeogenetics — because it doesn't rely on finding rare hominin bones. Slon's colleagues had to screen more than 2,300 unidentified bone fragments to find Denny.

Slon is still working on material from Denisova Cave, which she got to visit for the first time earlier this year. And she will continue to work on extracting hominin DNA from sediments. She doesn't expect to happen on another once-in-a-lifetime find like Denny, but she is eager to plumb ancient genomes for all sorts of personal insights, such as family relationships between ancient humans or how living conditions influenced the individuals' health. She also hopes to examine the lives of hominins who lived beyond Eurasian sites. "There's a whole world that can still be explored," she says. ■

STEFANIE LOOS FOR *NATURE*



MARK SCHIEFELBEIN/AP/REX/SHUTTERSTOCK

CRISPR ROGUE

A scientist's claim to have created gene-edited babies generated international furore.

BY DAVID CYRANOSKI

He Jiankui knew he was crossing a new bioethical boundary, when he revealed in November that he had altered the genomes of two infants — in a way that would be passed on to future generations. "I understand my work will be controversial, but I believe families need this technology and I'm willing to take the criticism for them," he said in a video announcing the births of twin girls whose genomes he had edited using CRISPR, ostensibly to protect them from HIV infection.

The reaction to the news was stronger than He had expected. He was widely criticized for ignoring important ethical considerations and exposing the girls to unknown risks for an uncertain benefit. The Southern University of Science and Technology in Shenzhen, China, where He works, distanced itself. The Chinese science ministry forbade him from continuing research. And the health ministry launched an investigation. He, who is now not speaking to the press, disappeared from the world stage as quickly as he had emerged.

He came to gene editing as an outsider. The first publication listed on his website, from a decade ago, is related to quantum physics. In 2010, he had publications on economics, evolution and the nature of curious repeated sections of DNA in bacterial genomes. He won some acclaim for his work in genome sequencing. A company he founded, Direct Genomics in Shenzhen, targeted the clinical-sequencing market and pulled in hundreds of millions of dollars in investments.

But He wanted to get into gene editing. He visited Feng Zhang, a CRISPR pioneer, at his laboratory at MIT, who warned him against editing human embryos for reproduction. Mark DeWitt, a geneticist at the University of California, Berkeley, says that he advised the same. Jennifer Doudna at Berkeley, another CRISPR pioneer, refused He's request for a visit because she thought he wasn't doing anything related to this technology. Now, she wonders whether He was "trying to leave a trail" of reputable contacts so he could say that he had broad support.

He will leave a complicated legacy. Scientists worry that the field of gene editing might now struggle to secure funding, regulatory approval or support from the public. And although the technology could lead to new insights into human development and potentially some ways of preventing deadly genetic disorders, few would argue that He's approach has helped. "I think he will be judged harshly," says DeWitt. ■

Additional reporting by Ewen Callaway

GRAEME ROBERTSON/*GUARDIAN*/EYEVINE

DIVERSITY CHAMPION

A physicist wrote hundreds of Wikipedia pages to boost the profiles of scientists from under-represented groups.

BY NISHA GAIND

When Jess Wade started writing a Wikipedia page every day, she didn't expect her efforts to earn her global attention. She was simply trying to correct the online encyclopaedia's under-representation of women and people of colour in science. But in July, when she tweeted about a trollish comment she'd received about the work, it prompted an outpouring of support and a big boost for her quest. "That wouldn't have happened without that one mean comment," she says.

Wade, a polymer physicist at Imperial College London, has tackled many science-outreach projects aimed at fostering diversity. She took up her page-a-day habit after learning that 90% of Wikipedia editors are men and only about 18% of people profiled on the site are women.

She has now created about 400 pages and works with organizations to host regular 'edit-a-thons' — in which people create and edit Wikipedia content with an eye to inclusivity. These have inspired similar events around the world, including some focused on other professions.

The visibility and momentum that Wade's project created is important, says Lenna Cumberbatch, who studies diversity at the University of St Andrews, UK. Although Wikipedia entries won't fix science's inclusivity problems, efforts such as Wade's help to change people's expectations. "She's redressing an imbalance that's existed for aeons," says Cumberbatch. "When you're literally writing history — that's kind of cool."

Wade's Wikipedia campaign isn't the only thing that thrust her into the spotlight this year. In September, she spoke about her engagement work at a conference on gender at CERN, Europe's particle-physics lab near Geneva, Switzerland. On the same day, physicist Alessandro Strumia from the University of Pisa in Italy delivered a presentation questioning women's ability in physics and attacking policies that encourage diversity. "His presentation was totally inappropriate," Wade says, "telling a room of mainly young woman scientists that they'd only ever achieve success in physics due to affirmative action".

Wade once again used social media to highlight the comments, and they were widely condemned. Strumia has been suspended from his work with CERN while an investigation is ongoing.

Wade expects to press on with her outreach, including stocking school libraries with the book *Inferior* by Angela Saini, which explores the harm caused by gender stereotypes. "I think diverse teams do better science," she says. "Doing all this stuff definitely makes sure that the academic community is more robust, resilient and creative." ■

EARTH MONITOR

A climatologist was a driving force behind the IPCC's stark report on global warming.

BY JEFF TOLLEFSON

In October, Valérie Masson-Delmotte and her colleagues presented the world with alarming news about its future. Within as little as a dozen years, Earth's average temperature could reach 1.5 °C above what it was in the mid-nineteenth century, triggering a wave of changes that would transform ecosystems and kill off most of the world's coral reefs, among many other impacts.

The warning came courtesy of a special report from the Intergovernmental Panel on Climate Change (IPCC), in which Masson-Delmotte played a primary part. A climatologist at the Laboratory for Sciences of Climate and Environment in Gif-sur-Yvette, France, and co-chair of the IPCC working group that assesses the physical science of climate change, Masson-Delmotte helped to gather the report's authors, coordinate their work and, ultimately, get the report approved by governments.

The IPCC normally takes the better part of a decade to produce its massive assessments, but the 1.5 °C report came together quickly, incorporating research published just weeks before the final draft was submitted for government review. "I'm really proud," Masson-Delmotte says. "We had a horribly stringent timeline, but I think we managed to build trust and ownership of the report by the authors."

The report makes clear that limiting warming to 1.5 °C would have huge benefits compared with allowing temperatures to surge to the 2 °C level. But keeping to 1.5 °C would require aggressive action to curb greenhouse-gas emissions. And even if nations could somehow achieve that, the world would look very different: entire ecosystems could be destroyed across more than 6% of the planet's terrestrial surface, and 70–90% of coral reefs would probably disappear.

"This report will be a hard one to ignore," says co-author Ove Hoegh-Guldberg, who is director of the Global Change Institute at the University of Queensland in St Lucia, Australia.

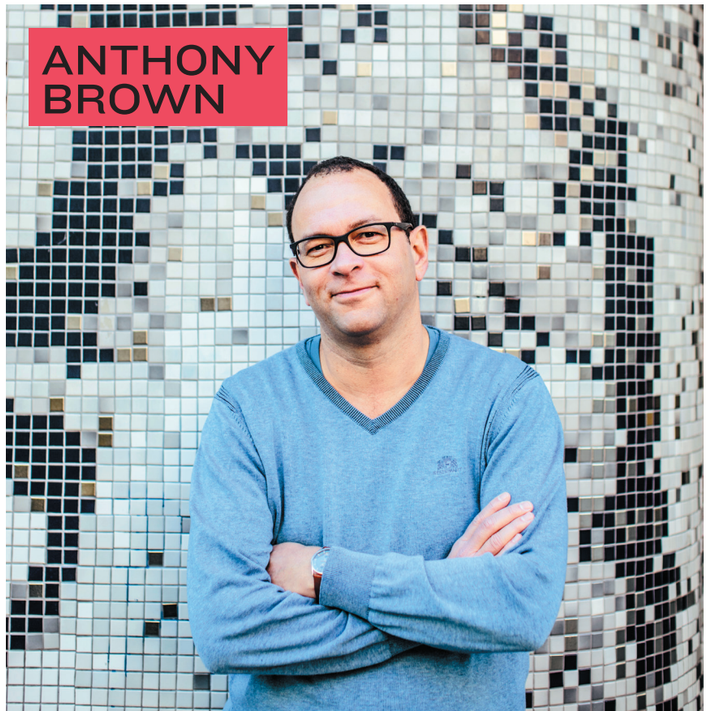
Diana Liverman, a geographer at the University of Arizona in Tucson, singles out Masson-Delmotte's work to improve diversity and representation in the IPCC. Women made up just 22% of the author team on the last assessment, completed in 2014; in this report, they comprised an unprecedented 40%. Masson-Delmotte also worked to elevate the role of early-career scientists and researchers from the global south. And for the next full climate assessment, due out in 2021, she has introduced procedures to promote engagement by all authors — including an online participation tool for scientists who are uncomfortable speaking up during meetings.

In an attempt to break down scientific silos, researchers from various disciplines worked together on every chapter. The result, Masson-Delmotte says, was an analysis that focused less on emissions scenarios and more on social, technological and governmental policies that could foster change — without exacerbating poverty and inequality around the world.

Masson-Delmotte spent ten days talking about the report and the wider IPCC process with delegates at the United Nations climate summit in late 2018. Now, she and the other co-chairs are pushing forward with two more reports — one on terrestrial biomes, the other on oceans and polar regions, slated for release in August and September 2019, respectively.

Similar to the IPCC itself — participation in which is a voluntary affair — Masson-Delmotte says that she is stretched to the limit. Her own research has been relegated to occasional nights, weekends and train rides, and she doesn't see as much of her two daughters and husband as she used to. "It's frustrating," she says. "But at the same time, it's awfully stimulating." ■

LAURENCE GEAI FOR *NATURE*



STAR MAPPER

Working behind the scenes, an astronomer coordinated the release of Gaia's long-awaited bounty of Milky Way data.

BY RACHEL COURTLAND

For many astronomers, Christmas this year came on 25 April at precisely 10:00 Coordinated Universal Time. That was when scientists with the European Space Agency's Gaia mission published its first major data set: a 551-gigabyte catalogue detailing the positions and movements of more than 1.3 billion stars.

Researchers around the world were eager to dive into the data. But Anthony Brown, an astronomer at Leiden Observatory in the Netherlands, had a different feeling when the catalogue finally rolled out: "Tired," he says.

Brown had good reason. He leads the Gaia project's Data Processing and Analysis Consortium, a group of more than 400 researchers that had been crunching the numbers for years. The Gaia spacecraft, which launched in 2013, spins to scan the sky and records the starlight that streaks across the camera. Boiling the craft's data down into precise information on stellar positions, motion and other properties requires sophisticated processing on the ground.

To researchers who are more interested in using Gaia to explore the mysteries of the Milky Way, Brown's job might seem less than glamorous. A calm and measured character, Brown has worked as the data-processing consortium's chair since 2012. His day-to-day job is intensively administrative: much of his time involves coordinating with and meeting consortium teams to make sure that the mission's data-crunching pipeline, which fans out from an operations centre near Madrid, works smoothly.

But Brown's care and expertise have been crucial to the success of Gaia's data set, which has already been cited in more than 700 research papers. His efforts have helped to steer the collaboration through myriad snags, including a systematic error in the telescope's parallax data — measures of angles to stars that enable astronomers to work out distances. The team decided to characterize the problem carefully and explain it in the release, rather than delay for more than a year to collect more data to reduce the error, says Amina Helmi, an astronomer at the Kapteyn Astronomical Institute in Groningen, the Netherlands, and a member of the consortium. Brown has an impressive ability to motivate researchers who would rather be working on science, Helmi says. "I don't know how he does it," she says. "We all respect him. There is really this feeling that we all share that wants to make Gaia a success."

Brown and his colleagues have had little time to catch their breath. They are already preparing the next data release, which will probably be ready some time in the first half of 2021. Another is planned after that, and more could follow: in November, the mission was extended to at least the end of 2020. Brown, who has been involved with Gaia since 1997, is in no rush to see it end: "Having worked on this mission more than 20 years now, it's definitely part of who I am." ■

TIMOTHY ARCHIBALD FOR *NATURE*

VINCENT PAUL YONG

FORCE FOR THE ENVIRONMENT

Malaysia's new science and environment minister became a strong voice against plastic pollution.

BY YAO-HUA LAW

Bee Yin Yeo began to question the future of the world — and her own career — while evaluating oil wells in the deserts of Turkmenistan. The new university graduate decided that humanity would eventually move away from fossil fuels, so she decided to find another profession that would serve the well-being of the world.

A few years later, in 2010, she returned home to Malaysia, armed with a master's degree in advanced chemical engineering from the University of Cambridge, UK. She joined politics and won a seat in a state legislative assembly in 2013. Then, a political tsunami hit Malaysia: on 9 May 2018, voters ousted the coalition that had held uninterrupted power since the country's founding in 1963. The new government brought in its own cabinet members, including Yeo, who was appointed Minister of Energy, Science, Technology, Environment and Climate Change.

Yeo was "shocked" when she first heard of her appointment. "It was unimaginable," said the 35-year-old, who grew up in a small town amid oil-palm and rubber-tree estates in southern Malaysia. Yeo had spent the previous 5 years attacking national policies, and now she could change them.

Since taking office on 2 July, Yeo has made several bold steps in reforming how Malaysia manages its environment and research. She announced goals to increase renewable energy from 2% to 20% of total energy generation by 2030, to reform the electricity market and to ramp up energy efficiency. She also went to battle against plastics pollution — which plagues southeast Asia. She criticized the influx of plastic waste into Malaysia, and helped to set a nationwide ban on its import. On 31 October, Yeo launched a 12-year roadmap and legal framework towards eliminating single-use plastic in Malaysia by 2030, which also calls for research and commercialization of eco-friendly alternatives, such as biodegradable plastics.

Yeo's efforts parallel an escalating global concern over single-use plastics. In October, the European parliament voted to ban their use in products such as straws and cutlery. And a growing number of other nations have issued similar bans.

Julian Hyde, general manager of the environmental organization Reef Check Malaysia in Kuala Lumpur, praises Yeo's efforts and roadmap. "The most important thing about it is that it's over a realistic timescale."

But the Malaysian Plastics Manufacturers Association (MPMA) sees problems ahead. Ching Yun Wee, who chairs the MPMA's sustainability subcommittee, says that local manufacturers can now produce biodegradable plastics, but that the material cannot yet decompose as quickly or completely as is needed to solve the problem of plastic pollution.

Wee says, however, that compared to her predecessors, Yeo has given the MPMA more opportunities to voice its opinion.

Yeo says that by funding local research and adopting foreign techniques, Malaysia can develop the technology for biodegradable plastic. "Some people think of problems to solutions, and not solutions to the problem," she says. "When business as usual is not possible, you find another solution." ■

DNA DETECTIVE

A genealogist helped to identify a serial killer and paved the way for DNA to play a larger part in solving crimes.

BY BRENDAN MAHER

In February 2017, Barbara Rae-Venter got a call from an investigator looking for help with a criminal case. "I said, 'Sure,'" says Rae-Venter, a retired patent attorney in northern California, unaware that she was signing up to try and catch one of the most notorious serial killers and rapists in US history. This year, Rae-Venter's work not only led to the killer's arrest, but also demonstrated a powerful — if controversial — approach for identifying criminals through genetic genealogy.

"She opened the door for others who wanted to do this, but had reservations," says CeCe Moore, who heads a forensic-genealogy unit at the company Parabon Nanolabs in Reston, Virginia.

Rae-Venter first trained in genetic genealogy — which uses DNA to fill out family trees — to explore her own ancestry. Eventually, she started using the tools to aid others, such as people who had been adopted as children, which drew the attention of Paul Holes, an investigator with the Contra Costa county district attorney's office in California.

Holes was on the trail of a man who had terrorized California during the 1970s and 1980s. With 12 murders, 45 rapes and 120 burglaries attributed to him, the elusive perpetrator had become known as the East Area Rapist, the Original Night Stalker and the Golden State Killer. Holes reasoned that if Rae-Venter could piece together the killer's family history, it could help to find his true name.

Rae-Venter uploaded a profile made from crime-scene DNA into GEDmatch, a public database used by genealogists. Although not nearly as large as commercial genealogy websites, GEDmatch's terms of service didn't expressly prohibit law enforcement from doing searches.

Right away, she found someone who seemed to be a third or fourth cousin to the killer. With the help of the FBI and local law officials, she worked to triangulate a common ancestor and then build the family tree. She eventually zeroed in on Joseph DeAngelo, a former police officer living in Sacramento. A direct test of his DNA proved the match.

Many in the genealogy community knew that this approach was possible and there had been ongoing debates over whether it constituted an invasion of privacy. Moore says that she had been approached in the past to help in this way, but declined because of the debate and because most people who used GEDmatch were unaware that it could be done. DeAngelo's highly publicized arrest changed that: the genealogy community, by and large, embraced this use of data, at least for finding violent criminals.

Curtis Rogers, a co-founder of GEDmatch, has amended the database's rules to make it clearer that law enforcement might use the information. He hasn't seen a mass exodus from his site, he says.

The floodgates have now opened for these kinds of cases. Under Moore's direction, Parabon Nanolabs has uploaded about 200 perpetrator profiles to GEDmatch, resulting in at least 22 identifications and nearly as many arrests.

Rae-Venter says that she has been approached for help in more than 70 cases. Quiet and private, she is nevertheless excited to get more involved. After all, her new calling seems to run in the family. In her own research, she identified a great uncle who was a detective inspector with the London Metropolitan Police during the time of Jack the Ripper. "I would love to find out which cases he worked on," she says. ■

BRIAN L. FRANK/NYT/REDUX/EYEVINE

ONES TO WATCH

2019

JEAN-JACQUES MUYEMBE-TAMFUM

Director-general of the Democratic Republic of the Congo National Institute for Biomedical Research

As his nation battles a worsening Ebola outbreak, this veteran virologist is spearheading the deployment of experimental therapies and a new vaccine.

JULIA OLSON

Co-counsel for the plaintiffs in *Juliana v. United States*

This lawyer is suing the US government on behalf of people who claim that the country has violated their rights by not preventing climate change.

MUTHAYYA VANITHA

Project director of India's Chandrayaan-2 Moon mission

A big moment for this engineer could come in early 2019, as India plans to land a rover near the lunar south pole and explore that region for the first time.

MAURA MCLAUGHLIN

Chair of management team at the North American Nanohertz Observatory for Gravitational Waves

This astronomer and her colleagues monitor neutron stars, and could soon detect gravitational waves created by supermassive black holes for the first time.

SANDRA DÍAZ

Co-leader of the Global Assessment of Biodiversity and Ecosystem Services

Díaz and researchers from more than 50 countries will release a major biodiversity report as part of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

OPEN-ACCESS LEADER

A bureaucrat launched a drive to transform science publishing.

BY HOLLY ELSE

The architect of this year's bold push to get rid of paywalls in science publishing says he got his ideas from an unlikely source: the publishers themselves.

In March, Robert-Jan Smits was tasked by the European Union's research commissioner, Carlos Moedas, with a special one-year mission: to get more research papers published outside journal paywalls, and fast. A veteran science-policy bureaucrat, Smits decided to go to the source: he asked big publishers how he could do it. They told him that if the organizations that pay for research insisted the findings had to be published openly, journals would have to adapt.

So that's what Smits set out to persuade research funders to do — in a plan launched in September that has sent shock waves through science publishing.

Smits has spent decades pulling the science-policy strings at the European Commission, and, until his current assignment, had served eight years as the director-general of research. He was ideally connected to begin rallying Europe's agencies with the idea, dubbed Plan S for 'science, speed, solution, shock', as he puts it. As *Nature* went to press, 16 funders had signed the plan; they require that the results of work they support be made freely available at the time of publication, starting in 2020.

Publishers have been dictating how research is published for decades, Smits says. "Now it is the funders calling the shots, and we will do things differently."

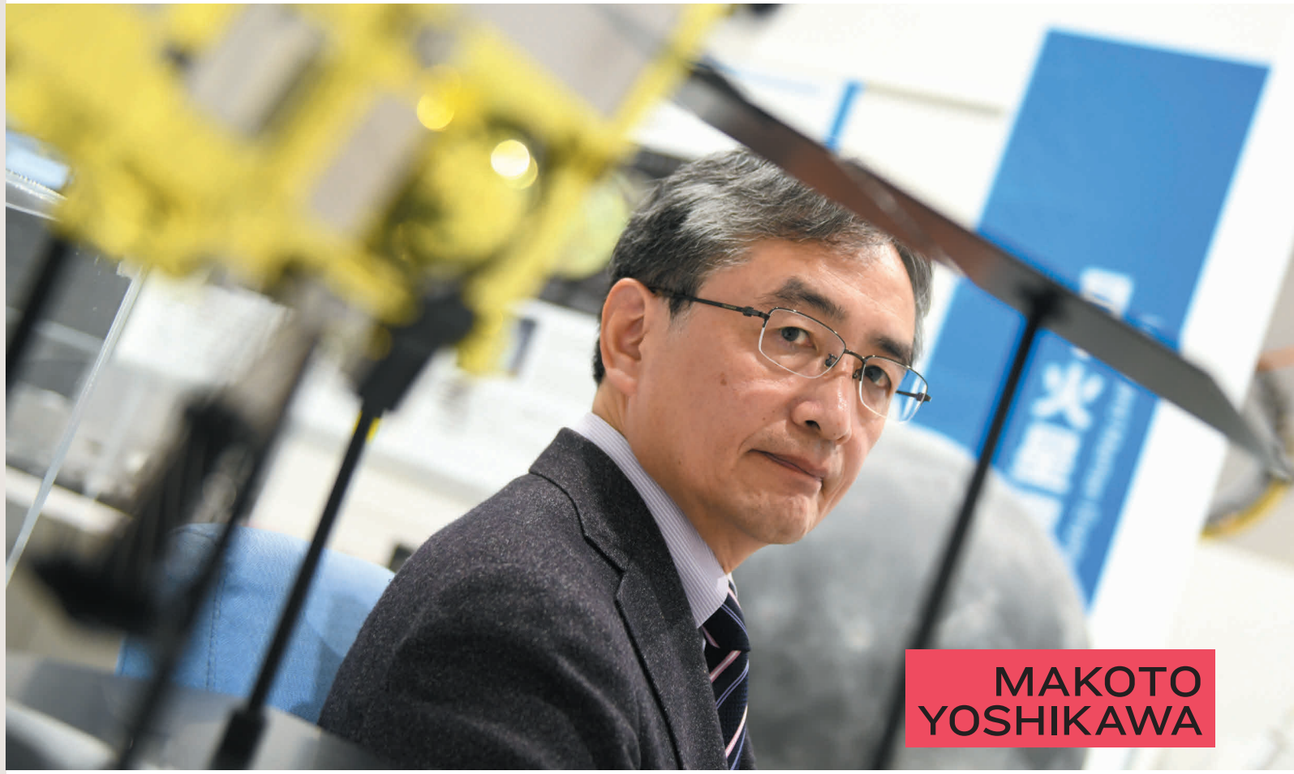
It's too early to know what the ultimate impact of Plan S on research publishing will be. Its details are open for consultation, and much might depend on how many other funders adopt the idea — but it will at least improve access to research, says Peter Suber, director of the Harvard Open Access Project and the Harvard Office for Scholarly Communication in Cambridge, Massachusetts. Smits has been overwhelmed with messages of support. But the initiative has also met with resistance: several publishers have said it could put them out of business, and some researchers have said that they don't want their choice of where to publish to be restricted.

Smits is no stranger to disrupting the status quo in European science. In 2007, he was instrumental in setting up the excellence-focused European Research Council (ERC) funding agency — when, he says, very few member states wanted it. "We had to go country by country to convince people that we needed it," he says.

Those who have worked with Smits are not surprised by his ability to get consensus on controversial policies. "Robert-Jan has a fantastic memory, of people, events, documents, policies. His networking capacity is spectacular," says Helga Nowotny, a former president of the ERC.

Smits' short tenure as open-access tsar is almost over. Next year, he will leave to become chair of the Eindhoven University of Technology in his native Netherlands. "It's time for me to leave the commission at what I consider my height," he says. ■

ARTUR ERANOSIAN/EUROPEAN COMMISSION



NORIKO HAYASHI FOR *NATURE*

ASTEROID HUNTER

An astronomer led a daring mission to collect samples from a rock in space.

BY DAVIDE CASTELVECCHI

In June 2018, astronomer Makoto Yoshikawa stayed up around the clock as the space mission he was leading zeroed in on its quarry — a dumpling-shaped rock called Ryugu. In a delicate manoeuvre after a journey of more than three years, the Hayabusa2 spacecraft fired its thrusters so that it moved in synchrony with the 1-kilometre-wide asteroid as they orbited the Sun together.

That task achieved, Yoshikawa and his team at the Japan Aerospace Exploration Agency (JAXA) moved on to the exploration phase. By early October, the craft had successfully dropped three small rovers onto Ryugu — providing the first close-ups of the asteroid.

Hayabusa2 faces a bigger test next year, when it will gently touch down on Ryugu and collect a sample. Any navigational imprecision could send it crashing against a boulder. In an even more daring manoeuvre, the craft will then shoot a projectile at the asteroid and analyse the material that gets kicked up. The probe is due to come back to Earth in 2020, carrying specimens that could shed light on the early stages of the Solar System's evolution.

Yoshikawa has been through nail-biters before. As a JAXA astronomer, he helped to mastermind two of the most spectacular rescue operations in the history of uncrewed space exploration.

The first mission to collect a sample from an asteroid, the original Hayabusa, touched down on asteroid Itokawa in 2005. Soon afterwards, mission control lost touch with the craft. The team managed to restore communications and piloted Hayabusa back to Earth, despite having lost its main engine. The speeding craft burnt up during its re-entry, but its sample-return capsule was eventually recovered.

Then, in 2010, another JAXA probe, Akatsuki, had an engine malfunction as it tried to decelerate to enter into orbit around Venus. Akatsuki drifted away and went many times around the Sun until 2015, when it passed Venus again and the team managed to put it into orbit.

Some mishaps were inevitable, Yoshikawa says, given that Japan's space programme does not have a long tradition of deep-space exploration. "We need experience," he says. But Hayabusa2 has, so far, provided some redress for JAXA's historic ill-fortune.

Stephan Ulamec, a geophysicist at the German Aerospace Center in Cologne who had a leading role in developing one of the Hayabusa2 landers, MASCOT, says that risk-taking and the ability to learn from failures set Japanese space endeavours apart from more-cautious — and better-funded — agencies in the West. "They have a tendency to do bold missions, to take risks NASA would not," he says.

Yoshikawa has the rare ability to lead a collaboration of many different laboratories without having a big ego, and that has been key to the success of these missions, says Aurélie Moussi, an astrophysicist at the French space agency CNES in Toulouse and a co-project manager for MASCOT. "He is the kindest scientist I've ever worked with," she says.

Yoshikawa has had an interest in asteroids ever since he was a child and read *The Little Prince* — a 1943 novella that features a boy who lives on an asteroid and visits Earth. Asteroids are potential menaces that need to be kept track of — but they also hold the secrets to the Solar System, and are a possible source of materials to mine for future space exploration, Yoshikawa says.

"Asteroids are very small objects in the Universe — but very important for the future life of humans." ■