

same city. Most of his work has connections to ' $p$ -adic fields', exotic extensions of the ordinary number system that are useful tools for studying prime numbers. On the  $p$ -adics, he has built fractal-like structures called perfectoid spaces, which have helped to solve problems across several fields of mathematics, including geometry and topology. In recent months, Scholze has been checking a gigantic proof of the  $abc$  conjecture, one of the biggest unsolved problems in number theory. In 2012, the enigmatic Japanese mathematician Shinichi Mochizuki posted a proof online, but no one has yet been able to say definitively whether it checks out. Now, Scholze and a colleague, Jacob Stix, are said to have found a significant gap in the proof.

Caucher Birkar, 40, has made breakthroughs in the classification of algebraic varieties — geometric objects that arise from polynomial equations, such as  $y=x^2$ . He was born in 1978 in a region of western Iran dominated by the Kurdish ethnic group. Birkar recalls his childhood in video profiles of the Fields medallists: "My parents are farmers, so I spent a huge amount of time actually doing farming," he says. "In many ways, it was not the ideal place for a kid to get interested in something like mathematics."

In 2000, after studying at the University of Tehran, Birkar moved to the United Kingdom, where he got refugee status and, eventually, UK citizenship. He is now a researcher at the University of Cambridge. Birkar said that he hopes that his Fields Medal will put "just a little smile on the lips" of the world's estimated 40 million Kurds.

His win made headlines for more than just his research: before the award ceremony was over, his briefcase was stolen, with his medal in it. The organizing committee of the congress presented him with a replacement medal in a special ceremony on 4 August.

Akshay Venkatesh, who is 36, works on, among other things, classical problems in number theory, including number systems that consist of fractions of whole numbers and roots such as  $\sqrt{2}$ . He is among the few mathematicians who have made substantial progress on a question formulated by mathematician Carl Friedrich Gauss in the nineteenth century. Venkatesh was born in New Delhi and raised in Australia, and is currently at the Institute for Advanced Study in Princeton, New Jersey.

Compared with the other three medallists, 34-year-old Alessio Figalli works in an area that is closer to the real world: optimal transport, which seeks the most efficient ways to distribute goods on a network. Figalli, who is Italian and works at the Swiss Federal Institute of Technology in Zurich, applies the field to partial differential equations, which have several variables and most often arise in physics. ■

## POLICY

# German science goes under a microscope

*Gigantic review of Helmholtz centres finds lack of diversity.*

BY QUIRIN SCHIERMEIER

Germany's largest research organization is funding top-notch science, but it needs to employ more foreign and female researchers — and it is failing to leverage 'big data', such as electronic medical records.

These are the conclusions emerging from a first-of-its-kind evaluation of the Helmholtz Association of German Research Centres, which employs some 30,000 scientists and technicians at 18 centres and has an annual budget of €4.5 billion (US\$5.3 billion).

Helmholtz showed *Nature* the results of the review, which individual centres will release over the next few weeks.

The results will serve as the basis for a strategic evaluation next year, which will be used to allocate research funding from 2021 to 2027. Other leading science organizations rarely, if ever, conduct such sweeping reviews, says neuroscientist Otmar Wiestler, president of the association.

## DISCIPLINED ANALYSIS

"We were very impressed by the quality of the science," says Andrew Harrison, chief executive of the Diamond Light Source at the Harwell Science and Innovation Campus in Didcot, UK. He was one of more than 600 independent scientists from 27 countries who, between October 2017 and April 2018, spent up to a full week in Germany assessing the strengths and weaknesses of the organization's national research centres.

"As everywhere, the gender balance could be much better — but Helmholtz is aware of this and committed to improve it," adds Harrison.

In many fields — including biomedical research, condensed-matter physics and

materials sciences — Helmholtz centres rank among the world's top institutes by quality of basic science and research infrastructures, reviewers concluded. Energy research and Earth and environmental sciences also received high marks.

In biomedical research, reviewers endorsed the organization's current focus on infectious diseases, diabetes, dementia and cancer. But specialized health-research centres in Munich, Braunschweig, Bonn and Heidelberg must make better use

of patient data to develop diagnostic tools and therapies, the review concludes. It also recommends that the centres establish more designated clinical-trial units, in collaboration with hospitals, to take discoveries from the bench to practice.

"Reviewers have clearly seen that Germany is lagging behind in digital medicine," says Wiestler. "It is absolutely vital for health research and health care in this country that we catch up."

## A CHALLENGE TO DO BETTER

Reviewers also urged the organization to boost diversity. Efforts to that effect are already under way, says Wiestler. A €5.4-million initiative to recruit more female scientists was launched last year. It aims to increase the proportion of women in senior positions, from the current level of 19% to 24% by 2020.

To attract more foreign scientists — the organization employs around 6,000 right now — Helmholtz plans to establish an international research school in astronomy, in partnership with the National University of ▶

**"Like almost everywhere in science, real equity may still be generations away."**



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This station in Antarctica is part of Helmholtz's Alfred Wegener Institute for Polar and Marine Research.

► General San Martín in Buenos Aires, and another in energy research, with five partner institutes in Israel. A prototype research school in cancer biology was recently launched in partnership with the Weizmann Institute of Science in Rehovot, Israel.

"I'm impressed by the seriousness of how Helmholtz is thinking about diversity and

gender equity," says reviewer Meigan Aronson, a condensed-matter physicist at Texas A&M University in College Station. "And yet, like almost everywhere in science, real equity may still be generations away."

Most Helmholtz centres also operate large research infrastructure, including light, ion and neutron sources; an experimental fusion

reactor; marine research vessels and aircraft; satellite systems; and Germany's Antarctic research station.

These facilities are Helmholtz's strongest asset, says Aronson, who spent a week last December helping to review neutron and nuclear research at the Helmholtz centre in Jülich.

Research time at these and other Helmholtz physics centres is in high demand. For example, an electron-positron collider called DESY, in Hamburg, and the synchrotron-radiation sources named BESSY in Berlin are used by scientists around the world to probe the structure of matter and experimental materials. Overall, almost 4,500 guest scientists spent time at Helmholtz centres in 2017. A €1.5-billion international accelerator facility for research with antiprotons and ions in Darmstadt, due to open around 2025, will add to Helmholtz's appeal, says Aronson.

The results of the extensive review will be analysed by the Helmholtz's leadership in the coming months. But already, says Harrison, the meticulously planned exercise has set a new standard for the evaluation of science.

"Reviewers are sometimes confronted with science organizations that don't completely engage with the process," he says. "Here, we went away with the feeling that every stone we could think of was turned over." ■