

RESEARCH INSTITUTES

Egypt science city in trouble

State support needed for project pioneered by Nobel laureate Ahmed Zewail.

BY PAKINAM AMER & MOHAMMED YAHIA

Questions are swirling over the future of Egypt's first science city, after the death of the Nobel laureate who made the project his legacy. The Zewail City of Science and Technology, a campus outside Cairo comprising a non-profit university and several research institutes, is named after the man who spearheaded it: Egyptian-born US chemist Ahmed Zewail, the first Arab to win a science Nobel prize.

But Zewail's death at the age of 70 on 2 August raises fresh doubts about the research hub's already precarious finances. The institute, which opened in 2011, had relied heavily on Zewail's star name and contacts to attract the support of scientific luminaries, as well as donations of 700 million Egyptian pounds (around US\$80 million). It is now running out of that money, and, despite a loan of 1 billion Egyptian pounds from the ministry of defence, it has not raised enough cash to support a planned move to a new \$450-million campus in 2019, says Sherif Fouad, a spokesman for the institute.

"Fundraising has always been a challenge, and I think it is likely to be affected by the loss of Dr Zewail in the short term," says Sherif El-Khamisy, a molecular biologist at the University of Sheffield, UK, who is also director of Zewail City's Center for Genomics. But he and others affiliated with the hub say they are hopeful that it will survive. In a speech on 6 August after Zewail's death, Egypt's president, Abdel Fattah el-Sisi, asked Egyptians to continue to donate to the city, but vowed that the nation's armed forces — whose engineers are building the new campus — would finish construction even if no more money comes through.

It is likely that Egypt's government will ultimately need to step in with support, says Salah Obayya, a physicist who is acting as chairman of Zewail City until a replacement for Zewail is elected. "The logistical support envisaged from the state is expected to override the initial fear or uncertainty," says El-Khamisy. ■

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George W. Bush had barriers erected along nearly 1,100 kilometres of frontier during his presidency.

ECOLOGY

Trump's border-wall pledge raises hackles

Ecologists fear plan to seal off the United States from Mexico would put wildlife at risk.

BY BRIAN OWENS

With Republican presidential candidate Donald Trump talking about walling off the United States from Mexico, ecologists fear for the future of the delicate and surprisingly diverse ecosystems that span Mexico's border with the southwestern United States.

"The southwestern US and northwestern Mexico share their weather, rivers and wildlife," says Sergio Avila-Villegas, a conservation scientist from the Arizona-Sonora Desert Museum in Tucson. "The infrastructure on the border cuts through all that and divides a shared landscape in two."

Trump's policies tend to be short on detail, but he has talked about sealing off the entire 3,200-kilometre border with a wall that would be 10–20 metres high. "We will build a wall," Trump says in a video on his campaign website. "It will be a great wall. It will do what it is supposed to do: keep illegal immigrants out."

Constructing a wall "would be a huge loss," says Clinton Epps, a wildlife biologist at Oregon State University in Corvallis. "We know how important the natural movement of wildlife is for the persistence of many species."

Far from being a barren wasteland, the US–Mexico borderlands have some of the highest diversity of mammals, birds and plants in the continental United States and northern Mexico — including many threatened species.

A wall could divide species that make a home in both nations. Bighorn sheep, for example, live in small groups and rely on cross-border connections to survive, says Epps. Other species, such as jaguars, ocelots and bears, are concentrated in Mexico but have smaller, genetically linked US populations.

"Black bears were extirpated in West Texas, and it was a big deal when they re-established in the 1990s," Epps says. Breaking their links with Mexican bears could put the animals at risk again. And birds that rarely fly, such as roadrunners, or those that swoop low to the ground, such as pygmy owls, could also have trouble surmounting the wall.

Such a physical barrier would worsen the habitat disruption caused by noise, bright lights and traffic near the border. And a wall would cut across rivers and streams that cross the border, severing a vital link. "When water crosses the border, it unites ecosystems," says Avila-Villegas. "If we block the water, it affects nature on a much more fundamental level."

Trump is not the first US politician to hit upon the idea of sealing the southern border. In 2006, President George W. Bush authorized the construction of a 1,126-kilometre border wall, of which nearly 1,100 kilometres were completed. The existing barriers are a mixture of 6-metre-high steel walls, 'bollard fences' made of steel pipes set upright in the ground about 5 centimetres apart, and lower vehicle barriers that Avila-Villegas says resemble the

CHARLES O'MANNEY/GETTY REPORTAGE

tank traps set on the beaches of Normandy during the Second World War.

Few studies have explored these barriers' effects on animal populations, and there are not even any reliable baseline data on conditions before the barriers were built. Avila-Villegas has seen photos taken by border patrols of mountain lions running alongside the barriers or trying to climb over them, so he knows that the walls are causing the animals stress. But he has no real way of measuring it. A 2014 study found that the fencing in Arizona seemed to harm native wildlife, but had little impact on human movement (J. W. McCallum *et al.* *PLoS ONE* 9, e93679; 2014).

In 2009, Epps published a paper setting out some of the potential threats to animal populations posed by Bush's wall, but he lacked the money to follow up with field studies (A. D. Flesch *et al.* *Conserv. Biol.* 24, 171–181; 2009). Now he is not sure such research would be possible, even with sufficient funds. "The border is not a friendly place any more," Epps says. "I would be hesitant to send a grad student there."

Avila-Villegas has first-hand experience of the difficulties that researchers face there. Ten years ago, he tried to collect some baseline data before Bush's barriers were built, but gave up for his own safety. "It's easy to ask why the research hasn't been done, but that ignores the fact that the border is a war zone," he says. "I had to stop my field work because of law enforcement and the Minutemen" — groups of armed private citizens who have taken it upon themselves to 'defend' the border against illegal crossings.

And it has not got any easier. "Every time I — a Hispanic male with dark skin and long hair — am in the field, I get patrols, helicopters and ATVs [all-terrain vehicles] coming to check on what I'm doing," Avila-Villegas says. He spends much of his time trying to promote conservation issues that affect Mexico and the United States by forging links between researchers and policymakers in both countries. But his dedication to an open border has also prompted him to take a more personal stand. After a dozen years in the United States, Avila-Villegas has finally applied for citizenship — so that, come November, he can vote against Trump and his wall. ■

PHYSICS

Neutrino clue to Universe riddle

Hint that elusive particles behave differently in matter and antimatter forms might explain matter's predominance.

BY ELIZABETH GIBNEY

It is one of physics' greatest mysteries: why the Universe is filled with matter, rather than antimatter. An experiment in Japan now hints at a possible explanation: subatomic particles called neutrinos might behave differently in their matter and antimatter forms.

The disparity, announced at the International Conference on High Energy Physics (ICHEP) in Chicago, Illinois, on 6 August, may yet turn out not to be real: more data will need to be gathered to be sure. "You would probably bet that this difference exists in neutrinos, but it would be premature to state that we can see it," says André de Gouvêa, a theoretical physicist at Northwestern University in Evanston, Illinois.

Even so, the announcement is likely to increase excitement over studies of neutrinos, the abundant but elusive particles that seem increasingly key to solving all kinds of puzzles in physics.

In the 1990s, neutrinos were found to defy the predictions of physics' standard model — a successful, but incomplete, description of nature — by virtue of possessing mass, rather than being entirely massless (Y. Fukuda *et al.* *Phys. Rev. Lett.* 81, 1562; 1998). Since then, neutrino experiments have sprouted up around the world, and researchers are realizing that they should look to these particles for new explanations in physics, says Keith Matera, a physicist on a US-based neutrino experiment called NOvA at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois.

"For the timescales of particle physics, this is changing really, really quickly."

"They are the crack in the standard model," he says.

If matter and antimatter were produced in equal quantities after the Big Bang, they would have annihilated each other, leaving nothing but radiation. Physicists have observed differences in the behaviour of some matter particles and antimatter particles, such as kaons and B mesons — but not enough to explain the dominance of matter in the Universe.

AN ODD ABUNDANCE

One answer might be that super-heavy particles decayed in the early Universe in an asymmetrical fashion and produced more matter than antimatter. Some physicists think that a heavyweight relative of the neutrino could be the culprit. Under this theory, if neutrinos and antineutrinos behave differently today, then a similar imbalance in their ancient counterparts could explain the overabundance of matter.

To test this, researchers on the Tokai to Kamioka (T2K) experiment in Japan looked for differences in the way that matter and antimatter neutrinos oscillate between three types, or 'flavours', as they travel. They shot beams of neutrinos of one flavour — muon neutrinos — from the Japan Proton Accelerator Research Complex in the seaside village of Tokaimura to the Super-Kamiokande detector, an underground steel tank more than 295 kilometres away and filled with 50,000 tonnes of water. The team counted how many electron neutrinos appeared — a sign that the muon neutrinos had morphed into a different flavour along the journey. They then repeated the experiment with a beam of muon antineutrinos. ▶



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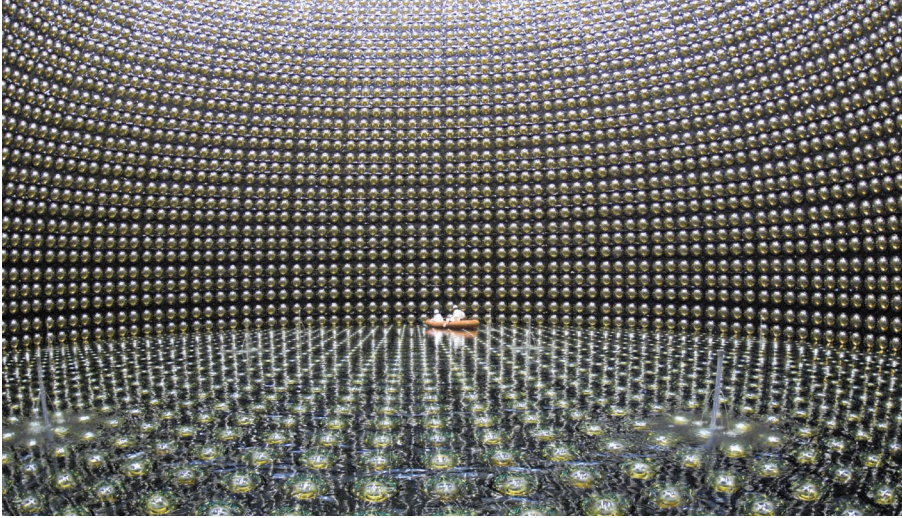
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Japan's Super-Kamiokande detector near Hida is analysing matter and antimatter neutrinos.

► The two beams behaved slightly differently, said Konosuke Iwamoto, a physicist at the University of Rochester, New York, during his presentation at ICHEP.

The team expected that if there were no difference between matter and antimatter, their detector would have, after almost 6 years of experiments, seen 24 electron neutrinos and — because antimatter is harder to produce and detect — 7 electron antineutrinos. Instead,

they saw 32 neutrinos and 4 antineutrinos arrive in their detector. “Without getting into complicated mathematics, this suggests that matter and antimatter do not oscillate in the same way,” says Chang Kee Jung, a physicist at Stony Brook University in New York and a member of the T2K experiment.

Preliminary findings from the T2K and NOvA experiments had hinted at the same idea. But the observations so far could be

chance fluctuations; there is a 1 in 20 chance (or in statistical terms, about 2 sigma) of seeing these results if neutrinos and antineutrinos behave identically, says Jung. By the end of its current run in 2021, the T2K experiment should have five times more data than it has today. But the team will need 13 times more data to push statistical confidence in the finding to 3 sigma, a statistical threshold beyond which most physicists would accept the data as reasonable — but not completely convincing — evidence of the asymmetry.

The T2K team has proposed extending its experiment to 2025 to gather the necessary data. But it is trying to speed up data-gathering by combining results with those from NOvA, which sends a neutrino beam 810 kilometres from Fermilab to a mine in northern Minnesota. NOvA has been shooting neutrino beams; it will switch to antineutrino beams in 2017. The two groups have agreed to produce a joint analysis and could together reach 3 sigma by around 2020, says Jung. Reaching the statistical certainty needed for a formal discovery, 5 sigma, might require a new generation of neutrino experiments, which are already being planned around the world.

Physicists are racking up discoveries about neutrinos on an almost annual basis, says de Gouvêa. “For the timescales of particle physics, this is changing really, really quickly.” ■