a triangle, millions of kilometres apart, making the mission sensitive to much longer gravitational waves, such as the ripples produced by the collisions of even larger black holes.

The mission will bounce laser beams between the three LISA craft — or, more precisely, between test masses suspended in a vacuum inside each satellite. Taking advantage of the vibration-free conditions of space, it will measure tiny variations in the distances between the test masses that reveal the passage of space-warping gravitational waves.

LISA Pathfinder's goal was to show that such variations could be measured in zero gravity and with a precision of one picometre, or one-billionth of a millimetre. High-precision thrusters adjusted Pathfinder's route so that it would closely follow the gravitational free fall of two test masses inside the craft and not interfere with their orbit. At the same time, the probe bounced a laser beam between the two masses — a pair of 2-kilogram cubes made of a gold and platinum alloy — and measured fluctuations in their separation (see 'Gravity Laboratory').

The €400-million (US$447-million) probe was declared a success in February 2016, two weeks after LIGO announced its first detection. Pathfinder did not detect gravitational waves — which would not have appreciable effects over the short distance inside the probe — but it showed that it could detect motions 100 times smaller than the picometre requirement. Since then, the experiment's performance has improved by another order of magnitude (M. Armano *et al. Phys. Rev. Lett.* **118,** 171101; 2017).

By early June this year, LISA Pathfinder had almost run out of thruster fuel, and mission control used what was left to nudge the spacecraft out of its operating orbit and into its final orbit around the Sun. On 1 July, Pathfinder will stop collecting data, and the spacecraft will be put to sleep for good on 18 July.

Pathfinder was "a triumph", says William Klipstein, a physicist at NASA's Jet Propulsion Laboratory in Pasadena, California, who works on LISA development but was not involved in ESA's Pathfinder mission. Its performance "removes the last major technical barrier for proceeding with a long-planned ESA-led gravitational-wave mission", he says.

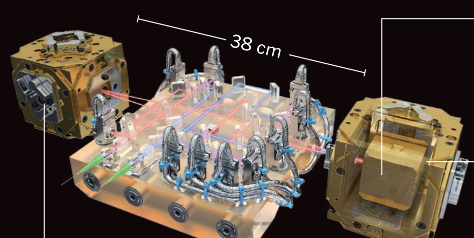
In a unanimous decision on 20 June, ESA's Science Programme Committee officially selected LISA as the third of the agency's large, or €1-billion-class, mission in its current science programme. The approval was long-awaited but had been in little doubt after Pathfinder's success and LIGO's gravitational-wave discoveries, says Karsten Danzmann, a director of the Max Planck Institute for Gravitational Physics in Hanover, Germany, and Pathfinder's co-principal investigator.

The decision is not final, but it means that industrial partners will now be involved in detailed design and cost projections. Once those are finished, ESA will decide whether to 'adopt' the mission and commit the funding to build it. The United States — which was an equal partner in the mission until 2011, when it reduced its participation to save costs — is expected to provide important components.

ESA has chosen two other large missions to go ahead before LISA — one to the moons of Jupiter, slated to launch in 2022, and an X-ray observatory for 2028. This puts LISA on schedule to be launched in 2034. But Pathfinder principal investigator Stefano Vitale, a physicist at the University of Trento in Italy, and others hope that its schedule can be accelerated. ESA's call for proposals to lead the gravitational-wave observatory — won by Vitale's team — was put out in late 2016, instead of late 2019 as the agency had planned. Vitale and other gravitational-wave researchers hope the agency will push the launch date forward so that LISA can start sending back data before too many of the current key researchers have retired. ■

GRAVITY LABORATORY

LISA Pathfinder showed that it could measure tiny variations in the distance between two free-falling cubes, paving the way for a full-scale experiment in which the falling masses will reside on different satellites, millions of kilometres apart.



PICTURE: ATG MEDIALAB/ESA

IMMIGRATION

Court revives US travel ban

Policy targets people from six majority-Muslim countries.

BY SARA REARDON

The US Supreme Court has reinstated a limited version of President Donald Trump's temporary order banning travellers from six majority-Muslim countries from entering the United States. The court will hear a legal challenge to the ban in October.

The court's decision, announced on 26 June, casts doubt on the fate of students and scientists from these countries who hope to study or work in the United States. It bars citizens of Iran, Libya, Somalia, Sudan, Syria and Yemen from travelling to the United States unless they have a "bona fide" connection with a person or entity in the country.

Such a relationship should be formal and documented, the court said. Examples include a person with an offer of admission from a US university or someone who has accepted a job offer from a US company or organization.

But that wording leaves room for interpretation, says Brendan Delaney, an immigration lawyer at Leavy, Frank & Delaney in Bethesda, Maryland. "If I were a research scientist affected by this, I would be reticent right now" about making job or travel decisions, he says.

All US visas are granted at the discretion of immigration officials, who will now have to determine whether applicants from the six travel-ban countries have a "bona fide" relationship to the United States. Delaney notes that a person with a valid US visa is not guaranteed entry to the country. "We're back into a wait-and-see pattern" until US immigration officials explain how they will interpret the Supreme Court decision, Delaney says.

But regardless of the eventual outcome of the ongoing legal case, many researchers worry that uncertainty over US immigration policy, and perceptions that the country is unwelcoming, may have already driven away some international students and scientists.

"This is a big worry and concern, not just for the individual nations that have been specified [in the ban], but a broader concern that I certainly have heard from people all over the world," says Katharine Donato, a sociologist at Georgetown University in Washington DC. She is beginning a research project that she hopes will quantify the policy's impact on international students' enrolment in US universities. According to a 31 March white paper from the Institute of International Education in New York City, more than 15,000 university students — mostly in graduate programmes — and 2,100 scholars currently in the United States are from the 6 countries named in Trump's executive order.

Trump said on 14 June that the travel ban would take effect within 72 hours if the Supreme Court lifted injunctions on its enforcement that had been put in place by lower courts.

The president signed his first attempt at a travel ban into law on 27 January. It blocked citizens of the 6 countries affected by today's ruling, plus Iraq, from entering the United States for 90 days. It also barred all refugees for 120 days, and Syrian refugees indefinitely. After several federal courts blocked Trump's order, the president issued a revised ban on 6 March. That policy is the subject of the legal case now before the Supreme Court. It prevented people from the 6 countries from entering the United States for 90 days, with exemptions for permanent residents and current visa holders. The order also imposed a 120-day ban on refugees from Syria.

Universities have played a key part in fighting both versions of the ban. Washington state, which sued the administration over the original policy, cited the cases of several students and "medicine and science interns" who had planned to spend time at two state universities but were blocked from entering the country. And Hawaii, which challenged the revised ban, argued that the policy would harm the state by barring students who had been admitted to the University of Hawaii.

The president hailed the court's ruling this week, calling the decision "a clear victory for our national security". ■

MAHATHIR MOHD YASIN/EYEEM/GETTY

In dry conditions, leaves might lose more water through their outer surfaces than scientists suspected.

PLANT PHYSIOLOGY

Water loss in plants mismeasured

Issue could throw off estimates of photosynthesis.

BY HEIDI LEDFORD

Errors in how scientists account for water loss from leaves may be skewing estimates of how much energy plants make through photosynthesis, according to the latest research. This in turn could jeopardize models of how individual leaves function and even of the global climate. The errors are particularly pronounced when a plant's water supply is limited — a condition of increasing interest as plant breeders and climate scientists grapple with the effects of global warming.

"If you're trying to understand why a crop you're growing or a particular plant is able to survive and do better under drier conditions, you may misinterpret that," says plant physiologist David Hanson of the University of New Mexico in Albuquerque. Hanson presented his findings at the annual meeting of the American Society of Plant Biologists in Honolulu, Hawaii, on 25 June.

Researchers have long assumed that the main way that plants lose water is through leaf pores called stomata. When water is abundant, the stomata open wide to let carbon dioxide flow in — maximizing photosynthesis, but allowing water to exit. Plants also lose moisture through a leaf's waxy outer surface, or cuticle, but this effect has been considered negligible.

This understanding, in turn, has shaped how scientists extrapolate the flow of CO_2 into a leaf. Measuring CO_2 inside a leaf requires cumbersome, custom-made equipment, so researchers in the field often use measures of water loss and other factors to calculate the concentration of CO_2 inside. Once they have estimated the internal CO_2 concentration, researchers can calculate how efficiently the plant is converting the gas into food — a component of primary productivity, a measure that is an important factor in some climate models. ▶