The outgoing centre-left coalition government, led by Paolo Gentiloni of the Democratic Party, has introduced some research initiatives, including a €1.5-billion (US$1.9-billion) research centre in Milan focused on genomics and personalized medicine, called the Human Technopole. The Democratic Party has some science-related policies in its manifesto that promise more money, research positions and institutional competition.

Pianta says that further reforms to the research system must be supported by increased budgets. But since the 2008 economic crisis, Italy's already low R&D spending has declined by 20% in real terms — equivalent to a hefty €1.2 billion. In 2016, it stood at €8.7 billion. The university budget has shrunk by about one-fifth — to €7 billion — as has the number of professors nationwide. Funding for public research institutes is no higher than it was in 2008, representing a 9% drop in real terms. And Italy's substantial deficit means the situation is unlikely to improve soon.

Even worse, more scientists have left the country since 2008 than have entered it, according to statistics from the Organisation for Economic Co-operation and Development. "It is not just that scientists are going to countries with strong bases in science," says Pianta. "There is also a net loss of scientists from Italy to countries like Spain."

Paradoxically, science is performing well overall. Since 2005, Italy has increased its contribution to the top 10% of the world's most cited scientific documents. And it produces more publications per unit of R&D expenditure than any other European Union country except the United Kingdom. "The happy paradox cannot sustain," says Pianta. "We are heading towards mediocrity."

The next government will have its work cut out. Polls suggest that the Five Star Movement, founded by comedian Beppe Grillo and led by Luigi Di Maio, will receive the highest number of votes. Di Maio has actively wooed academics, bringing some on board as advisers. But most researchers regard the movement with alarm. Some of its members have vociferously supported anti-science campaigns, including that against vaccination.

The movement is unlikely to take part in any governing coalition. So the most likely government to emerge will be a mix of centre-right parties led by Silvio Berlusconi's Forza Italia and including the regionalist League, which is expected to receive the second highest number of votes. But whatever the content of the next government, says Mattia Butta, an Italian engineer at the Czech Technical University in Prague, it is unlikely to fundamentally change the scientific culture. ■

NUCLEAR PHYSICS

Physicists plan first antimatter road trip

Elusive material will be used to probe radioactive nuclei.

BY ELIZABETH GIBNEY

Antimatter is notoriously volatile, but physicists have learned to control it so well that they are now starting to harness it as a tool for the first time. In a project that began last month, researchers will transport antimatter by truck and then use it to study the strange behaviour of rare radioactive nuclei. The work aims to provide a better understanding of fundamental processes inside atomic nuclei, and to help astrophysicists learn about the interiors of neutron stars, which contain the densest form of matter in the Universe.

"Antimatter has long been studied for itself, but now it is mastered well enough that people can start to use it as a probe for matter," says Alexandre Obertelli, a physicist at the Technical University of Darmstadt in Germany, who leads the project, known as PUMA (antiProton Unstable Matter Annihilation), which will take place at CERN, Europe's particle-physics laboratory near Geneva, Switzerland.

CERN's antimatter factory makes antiprotons — the rare mirror image of protons — by slamming a proton beam into a metal target, and then dramatically slowing the emerging antiparticles so that they can be used in experiments. Obertelli and his colleagues plan to use magnetic and electric fields to trap a cloud of antiprotons in a vacuum. They will then load this trap into a van and drive it a few hundred metres to the site of a neighbouring experiment, known as ISOLDE, which produces rare, radioactive atomic nuclei that decay too quickly to be transported anywhere themselves. "It's almost science fiction to be driving around antimatter in a truck," says Charles Horowitz, a theoretical nuclear physicist at Indiana University Bloomington. "It's a wonderful idea."

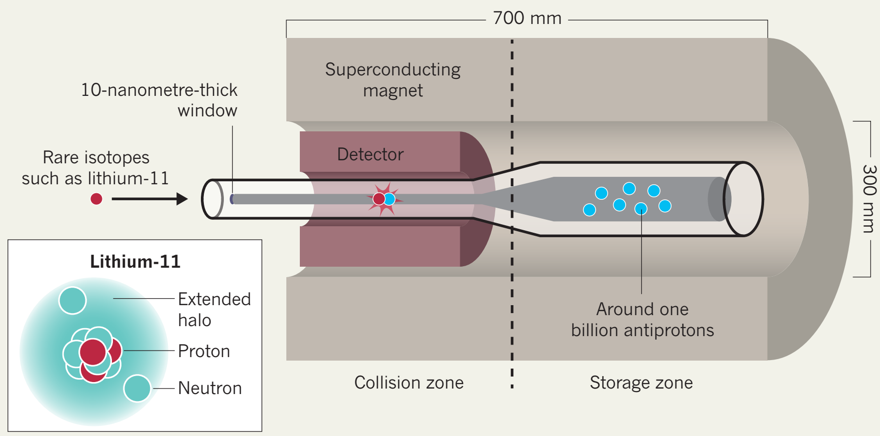
UNIQUE PROBE

Because antiprotons annihilate so readily, both with protons and with neutrons, they present a unique way to study the unusual configurations of radioactive nuclei. Whereas everyday atomic hearts host protons and neutrons in roughly equal measure, radioactive isotopes are stuffed with extra neutrons. This imbalance can give rise to exotic characteristics, including a surface 'skin' that is richer in neutrons than protons, or an extended halo in which neutrons orbit alone, as in lithium-11 (see 'Antimatter to go'). By observing how often antiprotons annihilate with a proton versus a neutron, the team will be able to understand the relative densities of these particles at the very edge of the nucleus. "It's a kind of test we haven't been able to do before on these new, more exotic nuclei, which may have very interesting structures," says Horowitz.

Radioactive nuclei act as microcosms for learning about neutron stars, objects that squash more mass than is contained in the Sun into the size of a city, and which are key to understanding how the Universe's heavy elements form. The cores of these

ANTIMATTER TO GO

To reveal the surface structure of atomic nuclei, physicists send ions of rare isotopes into a bottle 700 millimetres long — where they annihilate with antiprotons stored in the trap.



SOURCE: PUMA

super-dense stars remain a mystery, but their structure is dictated by the same little-understood interaction that creates bizarre phenomena in neutron-rich nuclei. "One of the reasons understanding neutron skins and halos is so important is to make the most of astrophysical observations," says Panagiota Papakonstantinou, a nuclear physicist at the Institute for Basic Science in Daejeon, South Korea.

Obertelli and his collaborators hope to create a trap that can store a record 1 billion antiprotons — more than 100 times as many as can be stored in any existing experiment. Another difficulty will be keeping the particles for weeks at a time, something that has so far been achieved for no more than a few dozen antiparticles at once. This will mean storing them at 4 degrees above absolute zero, and in a vacuum comparable with that of intergalactic space. "It's a challenging project," says Chloé Malbrunot, an antimatter physicist at CERN. "But I do think it is feasible."

Developing and testing technology for the portable trap will take around four years, with the first measurements scheduled for 2022. If the method works, physicists could transport antimatter much farther afield, allowing other scientists who aren't involved in the six experiments huddled at CERN's antiproton source to study and use the elusive matter.

"As soon as they can demonstrate one billion protons and keep them for several weeks, then many more experiments will join, and people with new ideas will come," says Malbrunot. "I think it will really open up the field." ■

OCEANOGRAPHY

Sensor array provides new look at global ocean current

Findings hint at the complexity of North Atlantic currents that drive the world's weather.

BY JEFF TOLLEFSON

The North Atlantic Ocean is a major driver of the global currents that regulate Earth's climate, mix the oceans and sequester carbon from the atmosphere — but researchers haven't been able to get a good look at its inner workings until now. The first results from an array of sensors strung across this region reveal that things are much more complicated than scientists previously believed.

Some research suggests that climate change is slowing currents in this area, which could affect weather and oceans around the world. Scientists with the Overturning in the Subpolar North Atlantic Program (OSNAP) are closer to pinning this down now. With data collected from 2014 to 2016, researchers have found that the strength of the Atlantic meridional overturning circulation — which pumps warm surface water north and returns colder water at depth — varies with the winds and the seasons, transporting an average of about 15.3 million cubic metres of water per second. The team presented its findings last week at an ocean-sciences meeting in Portland, Oregon.

The measurements are similar in magnitude to those from an array called RAPID, which has been operating between Florida and the Canary Islands since 2004. But scientists say they were surprised by how much the currents measured by the OSNAP array varied over the course of two years.

"We're delighted with the data," says Susan Lozier, an oceanographer at Duke University in Durham, North Carolina who is coordinating OSNAP. "We always find more complexity and more variability, but perhaps that shouldn't be surprising given how undersampled the ocean is."

MATHILDE JUTRAS

The research vessel *Polarstern* makes its way through sea ice off eastern Greenland.

OSNAP includes 53 moorings festooned with instruments that measure water conditions including temperature, salinity and current speeds. The network extends from southern Labrador in Canada to the southern tip of Greenland and on to the Rockall Trough off the west coast of Scotland (see 'Sea sensors'). And it's positioned where surface waters travelling north begin to cool and sink into the deep sea before turning south towards the Equator.

The array was designed to help answer fundamental questions about what drives this overturning circulation, which transports heat from the tropics to the poles. Climate models suggest that the formation of cold, deep water in the north might slow down as the climate warms. This would affect weather patterns in northern Europe and beyond, and some research suggests that this process could already be under way (S. Rahmstorf *et al. Nature Clim. Change* **5**, 475–480; 2015).

The RAPID array has registered a decline in the strength of this overturning circulation since 2008, including a 30% drop ▶

CORRECTION

In saying that everyday atomic hearts have equal protons and neutrons, the News story 'Physicists plan first antimatter road trip' (*Nature* **554,** 412–413; 2018) didn't take account of the fact that some elements, such as hydrogen and lithium, have uneven numbers of protons in their most abundant form.