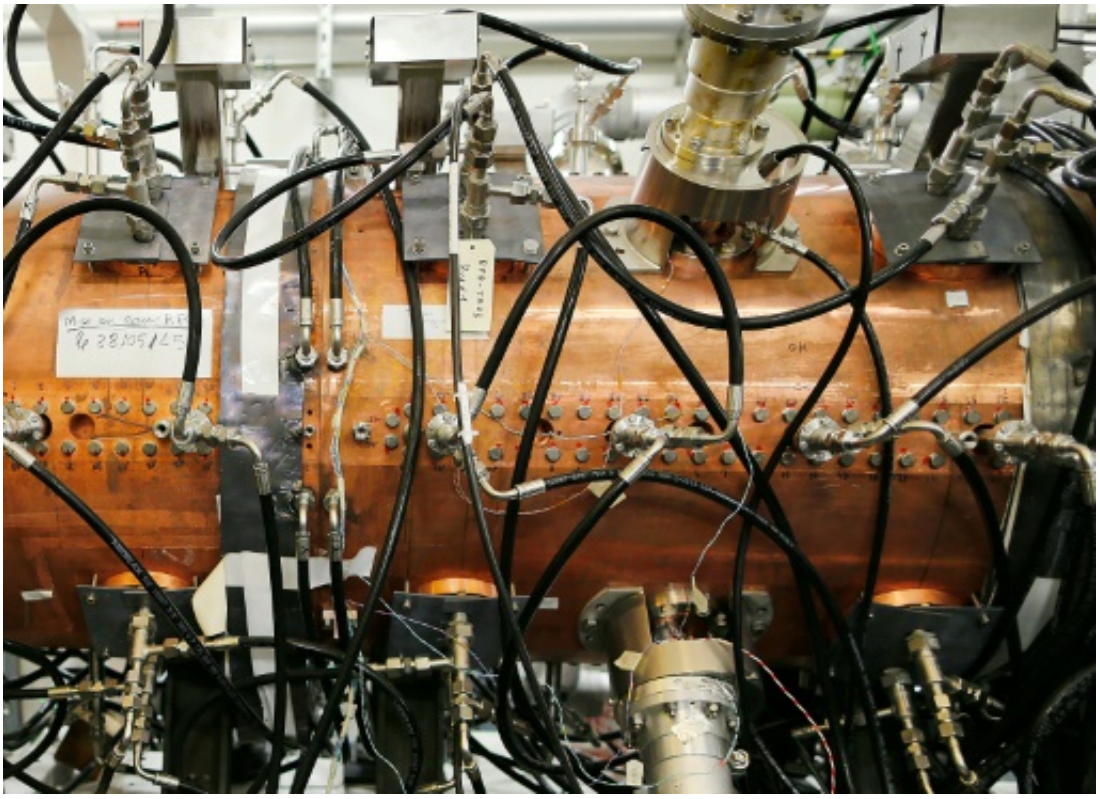
French particle accelerator to embark on 'exotic' quest

November 2 2016, by Laurence Coustal



A part of the SPIRAL2 particle accelerator in Caen, nortwestern France

Long thought to be the smallest building blocks of all matter, we now know atoms are themselves composed of electrons spinning around a nucleus made of protons and neutrons.

But where do nuclei come from? How are they forged? Which forces

govern their behaviour? These are questions for a new particle accelerator dubbed SPIRAL2 to be inaugurated in Caen, northwest France, on Thursday.

The atom nucleus was discovered in 1911, and its constituent parts about two decades later.

Yet scientists still know very little about nuclei, which are about 10,000 times smaller than the atoms they sit in.

To study them, the 138 million-euro ($153-million) project will synthesise and examine so-called "exotic" nuclei, usually forged in the cores of stars and not found on Earth.

"We want to understand how these matter-building elements are produced under the extreme heat conditions found in stars," said Jean-Charles Thomas, a researcher at France's CNRS science institute.

To create such particles, scientists will shoot dense beams of ions—atoms stripped of some of their electrons—over a 40-metre (131-foot) tunnel some 10 metres underground.

"We will recreate what happens inside stars in the laboratory," Thomas told AFP.

A scientist speaks in front of the SPIRAL2 particle accelerator in Caen, nortwestern France

The beams will explode against a target surface, disintegrating into subatomic particles including nuclei, many of whom would never have been seen on Earth.

Scientists hope the experiment will help explain why different nuclei have different proton to neutron ratios. The ratio is what determines the charge of an atom and the chemical element to which it belongs.

Atomic nuclei on Earth vary from the lightest, hydrogen, with a single proton, to the heaviest, uranium, which has 92.

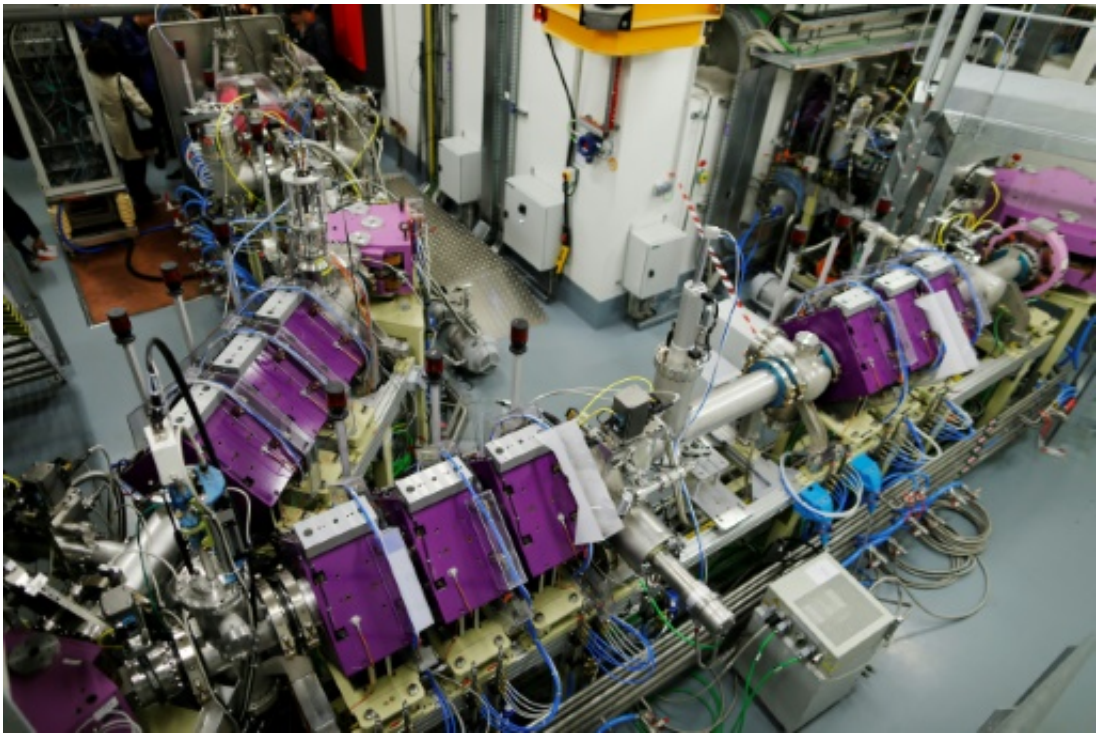
Nuclei are about 10,000 times smaller than their atoms, but contain 99.9 percent of the mass.

"SPIRAL2 will give access to a whole range of experiments on exotic nuclei, which have been impossible up to now," said a statement on the project website.

"In particular, it will provide intense beams of neutron-rich exotic nuclei whose properties are little explored at present."

The beams, 10 to 100 times more atom-dense than those used at any other particle accelerators today, will create vast quantities of exotic nuclei for further experimentation, the team expects.

Scientists believe there are nearly 8,000 types of exotic nuclei, of which we have observed some 2,900 so far.



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Medicine and energy

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"We hope to produce radioactive nuclei which... will give off very strong but localised radiation" for tumour treatment, said Herve Savajols, the project's scientific coordinator.

These super-tiny particles could be injected into cancer patients to give off their radiation only when they reach the targeted tumours, thus without damaging any non-cancerous tissue, as existing treatments do.

The research may also help design a safer, greener and more efficient method of generating energy from nuclear fission, a process which involves splitting atoms with neutron beams.

SPIRAL2, will form part of the GANIL heavy ion accelerator in Caen—a project of France's Atomic Energy Commission (CEA) and the CNRS, with backing from the European Union.

Similar projects are also being developed in other countries, including Canada and at the European Organisation for Nuclear Research (CERN) in Switzerland.

Citation: French particle accelerator to embark on 'exotic' quest (2016, November 2) retrieved 17 July 2024 from https://phys.org/news/2016-11-french-particle-embark-exotic-quest.html