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Scientists Lay a Magnetic Trap to Get Antimatter to Stick Around

Scientists trap antimatter with magnets to keep it from vaporizing.

MILWAUKEE, Wis.—A common plot in science fiction novels is that the bad guys get hold of antimatter and threaten the good guys with widespread destruction. The existence of antimatter, though, is not science fiction—it actually exists and can be made in a laboratory (by good guys and gals!).

All fundamental particles making up matter have antimatter twins—a proton has an antiproton, a neutron has an antineutron, and an electron has an antielectron that is called a positron.

One reason antimatter is exciting is that if it comes into contact with its matter partner, the two particles annihilate and vaporize into raw energy. This is an example of Einstein's famous formula $E=mc^2$; the mass of the particles turns into energy when the matter and antimatter meet.

This is great for science fiction novels, as it offers a high-tech way to threaten the good guys. It can also be good for medicine—*positron-emission tomography* (or a PET scan) is used to help doctors find cancer in patients. But the annihilation of antimatter by matter can be bad for science, because if antimatter runs into matter, it vaporizes before it can be studied.

Antimatter can, however, be held in traps using strong magnetic fields. Now, physicist Matt Stoneking at Lawrence University in Wisconsin and his collaborators in the APEX (A Positron-Electron EXperiment) project are trying to put large amounts of antimatter in a magnetic trap and combine it with regular matter for long enough to study it (Figure 1).

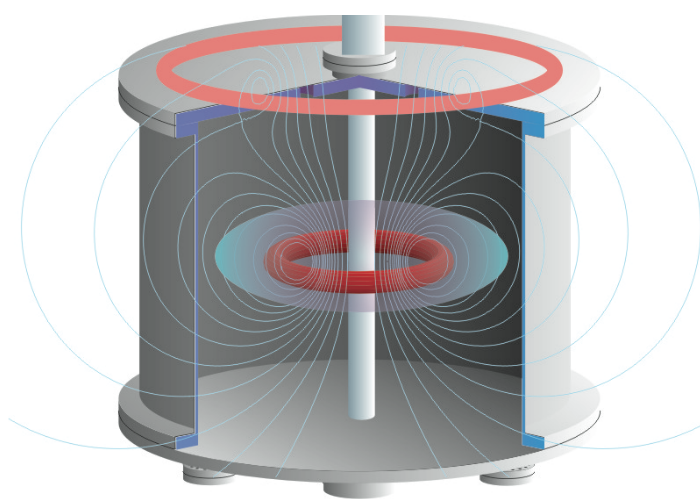

Figure 1: A drawing of the vacuum chamber with magnetic field lines, magnetic coils (red) and positron-electron plasma (blue) in the APEX experiment.

The APEX project, located in Germany, recently achieved a significant milestone. Using an intense source of positrons from a nuclear reactor, they moved almost all the positrons into the trap without them getting annihilated along the way.

“To keep antimatter from annihilating with matter, we trap the particles using strong magnetic fields in a chamber with all the air removed,” says Stoneking. “Our magnetic field is shaped like Earth’s, and when we put matter into the trap with antimatter, it will take a long time for the pairs to find each other and vaporize.”

“We are very excited about this development,” says Stoneking.

In the next experiments, he and his colleagues will make a magnetic trap using a magnetically levitated ring of superconducting material that must be kept at a temperature near absolute zero to have no resistance to the flow of electricity. By trapping the particles without them vaporizing, they can study a hot gas of electrons and positrons, called a plasma.

In addition to electron-positron plasmas being an interesting curiosity, scientists believe that they occurred in the early universe during the Big Bang and may occur in distant regions of the universe today. When a star explodes in a supernova, the core of the star that is left over is very small and spins very fast. Magnetic fields in the star are thought to be strong enough to create an electron-positron plasma coming from the energy in the magnetic fields. So, the atmospheres of some of these remnants are thought to be electron-positron plasmas. Scientists will soon be able to study this exotic plasma in a laboratory.

Plasma in experiments and in nature are usually very hard to contain; they are often turbulent like the white-water rapids of a river. Electron-positron plasmas, on the other hand, should be much easier to contain. The APEX project will test this and other predictions about electron-positron plasmas.

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Abstract

UI3.00002	Progress toward magnetic confinement of a positron-electron plasma: nearly 100\% positron injection efficiency into a dipole trap
Session	UI3: Complex Plasmas and Reconnection 2:00 PM–5:00 PM, Thursday, October 26, 2017 Room: 103ABC