New way to produce antimatter-containing atom discovered

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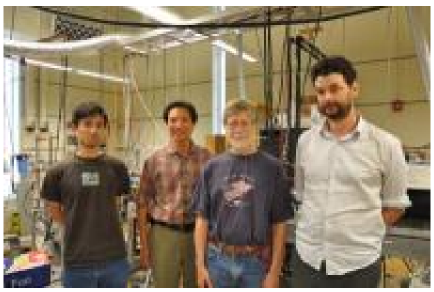

Researchers Tomu H. Hisakado, Harry Tom, Allen Mills and David Cassidy have found a new way to produce positronium. Credit: M. Kelley, UCR Strategic Communications

(PhysOrg.com) -- Physicists at the University of California, Riverside report that they have discovered a new way to create positronium, an exotic and short-lived atom that could help answer what happened to antimatter in the universe, why nature favored matter over antimatter at the universe's creation.

Positronium is made up of an electron and its antimatter twin, the positron. It has applications in developing more accurate Positron Emission Tomography or PET scans and in fundamental physics research.

Recently, antimatter made headlines when scientists at CERN, the European Organisation for Nuclear Research, trapped antihydrogen atoms for more than 15 minutes. Until then, the presence of antiatoms was recorded for only fractions of a second.

In the lab at UC Riverside, the physicists first irradiated samples of silicon with laser light. Next they implanted positrons on the surface of the silicon. They found that the laser light frees up silicon electrons that then bind with the positrons to make positronium.

"With this method, a substantial amount of positronium can be produced in a wide temperature range and in a very controllable way," said David Cassidy, an assistant project scientist in the Department of Physics and Astronomy, who performed the research along with colleagues. "Other methods of producing positronium from surfaces require heating the samples to very high temperatures. Our method, on the other hand, works at almost any temperature – including very low temperatures."

Cassidy explained that when positrons are implanted into materials, they can sometimes get stuck on the surface, where they will quickly find electrons and annihilate.

"In this work, we show that irradiating the surface with a laser just before the positrons arrive produces electrons that, ironically, help the positrons to leave the surface and avoid annihilation," said Allen Mills, a professor of physics and astronomy, in whose lab Cassidy works. "They do this by forming positronium, which is spontaneously emitted from the surface. The free positronium lives more than 200 times longer than the surface positrons, so it is easy to detect."

Study results appear in the July 15 issue of *Physical Review Letters*.

The researchers chose silicon in their experiments because it has wide application in electronics, is robust, cheap and works efficiently.

"Indeed, at very low temperatures, silicon may be the best thing there is for producing positronium, at least in short bursts," Cassidy said.

The researchers' eventual goal is to perform precision measurements on positronium in order to better understand antimatter and its properties, as well as how it might be isolated for longer periods of time.

Cassidy and Mills were joined in the research by Harry Tom, a professor and the chair of physics and astronomy, and Tomu H. Hisakado, a graduate student in Mills's lab.

In the near future, this research team hopes to cool the positronium down to lower energy emission levels for other experimental uses, and create also a "Bose-Einstein condensate" for positronium – a collection of positronium atoms that are in the same quantum state.

"The creation of a Bose-Einstein condensate of positronium would really push the boundaries of what is possible in terms of real precision measurements," Cassidy said. "Such measurements would shed more light on the properties of antimatter and may help us probe further into why there is asymmetry between matter and antimatter in the universe."

Provided by University of California - Riverside

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