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New Laser Technique Produces Bevy of Antimatter

Eric Bland

Blasting a gold target with high-powered lasers creates huge amounts of antimatter, reported scientists from the Lawrence Livermore National Laboratory at a conference last week.

A steady supply of the antimatter particles, known as positrons, is a big step towards solving some fundamental mysteries, such as why more matter than antimatter survived the Big Bang at the start of the universe. A supply of antimatter could also be used in creating a new generation of tools for fields as diverse as astrophysics and medicine.

Hui Chen of Lawrence Livermore National Laboratory is shown adjusting the Titan laser. Chen's team used the Titan laser to produce large amounts of antimatter.

"This is the first substantial source of antimatter using lasers," said Hui Chen of Lawrence
Livermore National Laboratory.

Substantial indeed. The California researchers estimate that with every shot of their laser, which fires every 30 minutes, they create about 10 billion positrons, also called anti-electrons. That's several orders of magnitude more than the other two existing sources of positrons: natural radioactive decay and large linear accelerators.

The LLNL scientists created the positrons by shooting the lab's high-powered Titan laser onto a one-millimeter-thick piece of gold. The laser excites the electrons, causing them to "wiggle," as Peter Beiersdorfer, a LLNL physicist on the project explains.

As they move close to the gold nucleus, the electrons each break apart into a lower-energy electron and its anti-matter opposite, a positron. The high-energy electrons would naturally break down into matter and anti-matter pairs; the gold simply speeds up the transformation.

The negative electrons and positive positrons then fly out in a cone-shaped "jet" and into a magnetic field, which separates the two because of their opposite charges and tracks the particles. The combined laser, gold and detectors together are about the size of a small house, said Chen.

A split second later the positrons and electrons annihilate each other on contact in a flash of pure energy, called a gamma ray. Scientists are working on ways to store the antimatter for longer periods of time so they can build up even higher numbers of positrons.

Now that scientists can create large numbers of positrons on demand, the next question is what to do with them.

"The first step was to show that you can make enough positrons," said David Meyerhoffer, a professor of physics and astronomy at the University of Rochester. "The next step in the research is to come up with an interesting experiment, and that's even more challenging."

"There are a ton of ways to use positrons, and now people will start to use them because they are available," said Beiersdorfer. "Within the next three years we will see a lot of development in this area."

Each researcher Discovery News spoke to had different, sometimes overlapping ideas of what the new positions could be used for.

Scott Wilkes, another LLNL scientist, thinks that on-demand positrons could be used to eventually create a gamma laser which could theoretically be used to destroy incoming missiles, as well as for medical treatments. But one has never been built.

Chen thinks that the positrons could be used to improve resolutions in large particle accelerators like the Large Hadron Collider under Geneva, Switzerland. The positrons would act like a kind of strobe light to take more accurate pictures of subatomic particles as they are produced.

Matter and antimatter are produced in equal amounts. Yet the majority of the universe is made of matter, explains Beiersdorfer. By observing matter and anti-matter interactions, astrophysicists can gain a better understanding of why antimatter vanished after the Big Bang.

Meyerhoffer thinks that the technique could eventually produce a positron-electon plasma similar to what physicists think lies at the center of the universe's brightest objects -- splitsecond- long gamma ray bursts.

The next set of experiments could help with all of those uses. The University of

Rochester recently installed a new high-energy laser, the Omega EP, which carries about 20 times the power of the Titan laser. Scientists expect the Omega laser will produce even more positrons than the Titan laser starting next year.

Wherever they are produced, the positrons won't be dangerous. In the upcoming film "Angels and Demons," based on the best-selling Dan Brown book, a gram of stolen antimatter, or about 10 with 26 zeros after it, threatens to blow up the Vatican. Right now the physicists can only produce about 10 with nine zeros after it. An antimatter bomb a la Dan Brown, says Chen, is "unrealistic."

"We want people to be interested and understand that we are not creating anything harmful," said Chen. "There are so many fundamental parts of nature that we can now study with this new research."