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WSU Researchers to Probe Physics of Anti-Matter

by John Armstrong

Presidential elections are not the only things decided by a small margin. Take, for instance, our very existence.

The Big Bang created a universe with nearly equal quantities of matter and anti-matter. When matter and anti-matter interact, the mass of each particle is converted to energy. Lucky for us, matter tallied a few more votes than anti-matter, and in the resulting mutual annihilation, matter—the stuff we're made of—dominated our universe.

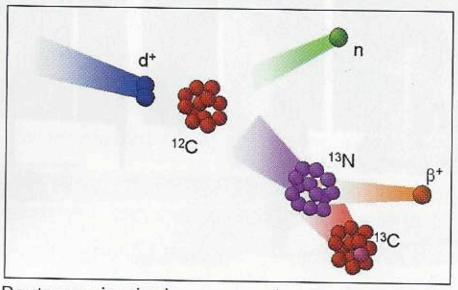
Thanks to a recent $1.1 million grant from the W. M. Keck foundation of Los Angles, researchers at Washington State University are building a state-of-the-art positron beam to make some anti-matter of their own.

Positrons are the anti-matter analogue of electrons—they have a positive instead of a negative charge.

"Anti-matter research in the past has been severely limited by the positron beam intensity," says Kelvin Lynn, professor of physics and mechanical and materials engineering at WSU. "There are no facilities that provide beams with up to 1 billion positrons per second."

"WSU will break the 100 million positron-per-second beam and then boost that power up to nearly 1 billion," says Lynn.

The Keck anti-matter research laboratory, and the accelerator itself, will be housed on campus in the Engineering Teaching and Research Laboratory Building. Along with Lynn, the group comprises David Cassidy, Alan Hunt, Marc Weber, and undergraduate Russ Tjossen.



Deuterons impinging on a carbon target create a neutron and ^{13}N, which decays to ^{13}C, a neutrino (not shown), and a positron (the anti-matter version of an electron). WSU researchers are working to construct such a source of positrons to probe the fundamental physics of anti-matter. Source: Kelvin Lynn

One of the conventional sources of positrons makes use of ^{22}Na isotopes. The new accelerator, however, will produce positrons in a reaction where atomic nuclei called deuterons, containing one proton and one neutron, are accelerated and impact a diamond matrix.

The science objectives for the accelerator beam include aspects of material science as well as pure research in anti-matter physics. The positrons are used to probe impurities and defects in semiconductors, something of interest to industry. "There is a tremendous need here," says Lynn, and detailed analysis of semiconductors can lead to faster and better computer components.

According to Cassidy, industry may be further interested because the Keck accelerator will not be hampered by the persistent radioactive background inherent in the sodium source design.

Once the accelerator-based system is turned off, the radiation decays within minutes, in contrast to the conventional sodium source, in which the radioactivity has a half-life of 2.7 years.

The beam may have more esoteric applications. According to Lynn, for the first time scientists will be manufacturing a relatively large amount of anti-matter. Over the course of one day, the billion positron-per-second beam could accumulate 10^{14} positrons. According to Lynn, this amount is "interesting."

"Positron-electron annihilation is 1,000 times more efficient than nuclear fusion of hydrogen," says Lynn, "and we know we can generate [anti-matter]. But can we store it?"

If anti-matter could be stored, 10^{14} positrons would produce about 10 joules of energy, or one tenth of the amount of energy produced by a 100-Watt bulb in one second. To operate the accelerator for one day, however, requires two billion joules of energy.

"I do not see any realistic scenario in which anti-matter could be a source of energy," says Cassidy—at least for now. ■

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