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NEWS RELEASE

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ANTIMATTER AND MATTER MAY HAVE DIFFERENT PROPERTIES, CONTRARY TO PREDICTIONS OF CURRENT PHYSICS

BLOOMINGTON, Ind. -- Antimatter and matter may have different properties if a new theory holds true.

"Finding a matter-antimatter asymmetry of this type would be a startling result, because currently accepted theories of physics simply do not predict it at all," said Alan Kostelecky, professor and chair of physics at Indiana University.

Scientists now believe that antimatter and ordinary matter have equivalent properties, verified to high precision in numerous experiments. However, new theoretical work by Kostelecky and his group shows that tiny but significant differences could exist between the spectra of the hydrogen atom and its twin, the anti-hydrogen atom. Current theories require that the spectra be identical.

In addition, according to the new theory, differences between the spectra of hydrogen and anti-hydrogen would provide further evidence for violation of time-reversal symmetry in nature.

The group's report, co-authored with Kostelecky by Robert Bluhm of Colby College and IU graduate student Neil Russell, is scheduled for publication in the March 15 issue of the physics journal *Physical Review Letters*. It points out particular portions of the spectrum of anti-hydrogen where tiny deviations from the ordinary hydrogen spectrum might be found.

"If they do indeed occur, these deviations would represent fingerprints of matter-antimatter asymmetry," Kostelecky said.

Their work follows about 10 years of efforts to produce a viable theory to describe possible differences between the properties of matter and antimatter. The new theory identifies effects that could be detectable in various experiments.

Comparing the properties of matter and antimatter involves three transformations: a change in the sign of electrical charge (C), a mirror reflection (P), and a reversal of the direction of time (T). If all three of these changes could be made, scientists currently believe the resulting laws of physics would be the same as they are now, which implies complete symmetry between the properties of matter and antimatter.

"This result, called the CPT theorem, has been a sturdy and respected edifice of physics since its proof in 1954," Kostelecky said.

(MORE--antimatt)

Two further experiments at CERN, named ATRAP and ATHENA, are planned that will test CPT symmetry of the spectra of hydrogen and anti-hydrogen, he added. Unlike hydrogen, which is the most abundant element in the universe, anti-hydrogen is extremely hard to obtain. The giant CERN particle collider on the France-Switzerland border was able to produce just 11 anti-hydrogen atoms in 1996 (*New York Times*, Jan. 5, 1996). The Fermilab particle collider near Chicago produced a similar number a few months after that. Later this year, a new machine at CERN will begin operation that eventually will allow the production of enough anti-hydrogen to enable ATRAP and ATHENA physicists to look for matter-antimatter asymmetries of this type.

According to the new theory, differences between the spectra of hydrogen and anti-hydrogen also would provide further evidence for time-reversal violation. Two experiments, KTeV at Fermilab and CPLEAR at CERN, recently proved that nature is not symmetric when time is reversed (*New York Times*, Dec. 22, 1998) by careful observations of the decays of the short-lived kaon particle and its anti-particle.

Precision data from experiments on kaons and anti-kaons also could be used to uncover other kinds of effects suggested by the new CPT-violating theory. In a paper published in *Physical Review Letters* on March 2, 1998, Kostelecky showed that if an asymmetry between kaons and anti-kaons indeed exists, then the size of the asymmetry could vary cyclically as Earth rotates. The KTeV experiment will perform an analysis to test this idea within a few months.

Another effect suggested by the new theory is a minuscule difference between the electron and the positron (the anti-electron). An analysis of precision measurements of the electron's magnetic properties that constrains this possible effect has recently been performed in the laboratory of Nobel laureate Hans Dehmelt at the University of Washington in Seattle.

At present, Kostelecky and his group are studying the implications of the theory for several other experiments.

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