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ALPHA Collaboration once again charges up antimatter research

(Vancouver, BC) – In a paper published today in the journal *Nature Communications*, the ALPHA collaboration reports on their latest measurement of a fundamental property of antihydrogen, the ephemeral antimatter twin to normal hydrogen. Working at the CERN laboratory in Geneva, the collaboration determined the electric charge of antihydrogen with an accuracy one million times greater than before, finding it to be compatible with zero to eight decimal places. Although not surprising, since hydrogen atoms are electrically neutral, it is the first time that the charge of an antiatom has been measured to high precision, yielding an improved measurement of the antielectron's (positron) charge. The result was spearheaded by collaborators at Berkeley, California, with important contributions from ALPHA-Canada scientists.

"This is the first time we have been able to study antihydrogen with some precision," said ALPHA Collaboration spokesperson Jeffrey Hangst. "We are optimistic that ALPHA's trapping technique will yield many such insights in the future. We look forward to the restart of our program in August, so that we can continue to study antihydrogen with ever increasing accuracy." Makoto Fujiwara, TRIUMF Research Scientist, University of Calgary adjunct professor and spokesperson for the ALPHA-Canada team, added "This is one of the measurements I've wanted to do for many years. Our measurement improves the knowledge of the charge of the positron by a factor of two, with the possibility of significant improvement in the future."

Current theory predicts that antimatter should be identical to normal matter except for the sign of their electric charge. So while the hydrogen atom is made up of a proton with charge +1 and an electron with charge -1, the antihydrogen atom consists of a charge -1 antiproton and a charge +1 positron. However, it is known that matter and antimatter are not exact opposites – mysteriously nature seems to have a one-part in 10 billion preference for matter over antimatter, so it is important to measure the properties of antimatter to great precision. ALPHA achieves this by using a complex system of sophisticated "magnetic traps" that allow antihydrogen atoms to be produced and stored for long enough periods to be studied in detail. Understanding the so-called "matter antimatter asymmetry" is one of the greatest challenges in physics today. Any detectable difference between matter and antimatter could help solve the mystery and open a window to new physics.

To measure the charge of antihydrogen, the ALPHA experiment studied the trajectories of antihydrogen atoms released from the trap in the presence of an electric field. If the antihydrogen atoms had an electric charge, the field would deflect them, whereas if they were neutral, it would not. The result, based on 386 recorded events, gives a value of the antihydrogen electric charge as $(-1.3\pm1.1\pm0.4) \times 10^{-8}$, the plus or minus numbers representing statistical and systematic uncertainties on the measurement, respectively. York University graduate student Andrea Capra and supervisor Prof. Scott Menary, with TRIUMF Research Scientist Art Olin, provided key analysis details of possible systematic effects arising from the silicon detector subsystem. Capra remarked that "it was painstaking work making sure that everything performed as we expected, so its extremely gratifying that our efforts paid off with this important result."

ALPHA's antimatter research program is set to resume in 2014 with the restart of CERN's accelerator complex getting underway. The main goal of the "ALPHA-2" upgrade is to perform precision laser and microwave spectroscopy of the atomic structure of antihydrogen, in order to compare it to the extremely well-known structure of normal hydrogen.

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About TRIUMF: TRIUMF is Canada's national laboratory for particle and nuclear physics. Located on the south campus of the University of British Columbia, TRIUMF is owned and operated as a joint venture by a consortium of the following Canadian universities, via a contribution through the National Research Council Canada and building capital funds from the Government of British Columbia: University of Alberta, University of British Columbia, University of Calgary, Carleton University, University of Guelph, University of Manitoba, McGill University, McMaster University, Université de Montréal, University of Northern British Columbia, Queen's University, University of Regina, Saint Mary's University, Simon Fraser University, University of Toronto, University of Victoria, University of Winnipeg, York University. See http://www.triumf.ca.

About ALPHA-Canada: ALPHA is a collaboration of about 41 physicists from 15 institutions from Canada, Brazil, Denmark, Israel, Japan, Sweden, UK, and the USA. ALPHA-Canada currently consists of 7 senior scientists, graduate students, and several professional staff from 5 Canadian institutions. ALPHA-Canada constitutes about one third of the entire ALPHA collaboration. 14 out of 41 ALPHA co-authors in the reported work are with ALPHA-Canada: Andrea Gutierrez, Walter Hardy (Univ. of British Columbia), Tim Friesen, Robert Thompson (Univ. of Calgary), Mohammad Ashkezari, Michael Hayden (Simon Fraser Univ.), Chanpreet Amole, Andrea Capra, Scott Menary (York Univ.), Makoto Fujiwara, David Gill, Leonid Kurchaninov, Konstantin Olchanski, Art Olin (TRIUMF).
See http://alpha.web.cern.ch/alpha

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