HAPPEx results hint at strangely magnetic proton

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New results from research performed at the Department of Energy's Jefferson Lab hint that strange quarks may contribute to the proton's magnetic moment. If confirmed by data to be taken later this year, these surprising results would indicate that strange quarks in the proton's quark-gluon sea contribute to at least one of the proton's intrinsic properties. The HAPPEx results strengthen the trend found by the SAMPLE experiment at MIT-Bates and the A4 experiment at the Mainz Laboratory in Germany. Results are being presented by University of Massachusetts at Amherst Physicist Krishna Kumar at the APS April Meeting.

Kumar is a Jefferson Lab user and a co-spokesperson on the Hall A Proton Parity Experiment (HAPPEx). The experiment measures the neutral weak force between a beam of electrons and target nuclei at a length scale of around one femtometer (roughly the size of a proton or neutron). These measurements will help physicists learn about the strong force that binds up and down quarks into protons and neutrons (nucleons) and the up, down and strange quark contributions to the nucleon's charge and current distributions.

In the experiment, HAPPEx researchers sent a polarized beam of electrons into hydrogen and Helium-4 nuclei. The researchers alternated the electron beam's polarization (spin) throughout the experiment. The electromagnetic force is mirror-symmetric (the electrons' spin will not affect the number of electrons scattered), while the weak force is not (electrons polarized one way will interact differently than electrons

spinning oppositely). So measuring the fractional difference in the number of scattered electrons due to the beam's changing polarization allowed the researchers to calculate the neutral weak force.

According to Kumar, the results indicate that the strange quark contribution to the nucleon's charge and current distribution is zero within the sensitivity of each measurement. "However, there seems to be a trend towards a positive (non-zero) value for the average contribution of strange quarks to the proton's magnetic moment. If confirmed with more precise measurements, such a conclusion would be surprising and exciting," Kumar notes.

The HAPPEx experiments took data in June and July of 2004, and the final results are being prepared for submission to Physical Review Letters. Kumar says the next stage of HAPPEx may provide further insight. "The HAPPEx measurements will be repeated with higher precision later this year. A statistically significant measurement of a strange quark contribution to the charge and current distributions may be within reach," Kumar says.

Data from several recent experiments, including SLAC's (the Stanford Linear Accelerator Center) E158, the SAMPLE experiment at MIT-Bates, the A4 experiment at the Mainz Laboratory in Germany, and the G-Zero experiment at Jefferson Lab are beginning to shed further light on the weak interaction.

A white paper of this talk is available in the APS April Meeting 2005 Press Room.

Source: DOE/Thomas Jefferson National Accelerator Facility