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Charged-averaged elastic lepton-proton scattering cross section results from OLYMPUS

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Measurements of the proton's form factor ratio made with polarization transfer show a striking discrepancy relative to the ratio extracted from unpolarized elastic electron-proton scattering cross sections. One hypothesis is that the discrepancy is caused by hard two-photon exchange (TPE), a typically neglected radiative correction that may bias the two approaches differently. This hypothesis has been challenging to confirm. Theoretical estimates of TPE are model-dependent, and recent experimental determinations of TPE lacked the kinematic reach to be conclusive. The possible impact of TPE remains a cloud over our knowledge of the proton's form factors. Recently, the OLYMPUS experiment published new elastic scattering cross sections that are insensitive to the effects of TPE: specifically the average of electron-proton and positron-proton cross sections. The OLYMPUS experiment, conducted at DESY, Hamburg, measured elastic $e^- p$ and $e^+ p$ scattering by detecting the scattered lepton and recoiling proton in coincidence in a large-acceptance, toroidal magnetic spectrometer. OLYMPUS was designed to measure the $e^+ p / e^- p$ cross section ratio to isolate the effects of TPE. By exploiting the over determined kinematics of the reaction, the absolute efficiency of spectrometer could be verified, allowing cross sections to be extracted from the data. These results can help refine our knowledge of the proton's form factors, especially in the squared momentum-transfer region of 1–2 GeV^2, where some previous measurements are in tension.

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