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Measurement the Fine Structure Constant with Bragg Diffraction and Bloch Oscillations WEICHENG ZHONG, RICHARD PARKER, CHENGHUI YU, BRIAN ESTEY, HOLGER MLLER, Univ of California - Berkeley — Measurements of the fine structure constant α, using methods from atomic, condensed-matter, and particle physics, are powerful tests of the overall consistency of theory and experiment across physics. We have measured $\alpha = 1/137.035999046(27)$, at 2.010^{-10} accuracy, via the recoil frequency of cesium-133 atoms in a matter-wave interferometer. We used multiphoton interactions such as Bragg diffraction and Bloch oscillations to increase the phase difference for the interferometer to over 12 million radians, which reduced the statistical uncertainty and enabled control of systematic effects at the 0.12 part-per-billion level. This is an unprecedented test of the standard model of particle physics, being the first direct measurement of α with an error below the 5th order quantum electrodynamics contribution in the electron's gyromagnetic anomaly. It also has implications for the unexplained anomaly of the muons magnetic moment, and strongly constrains multiple dark sector candidates as well as substructure of the electron.

Weicheng Zhong
Univ of California - Berkeley

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