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Fully Quantum Measurement of the Electron Magnetic Moment[1]

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I report the first fully quantum measurement of the electron magnetic moment. This 0.6 parts per trillion result is the most accurate to date and is combined with existing Quantum Electrodynamics theory to yield a new value for the fine structure constant. The measurement uses quantum spectroscopy of transitions between the ground and first-excited cyclotron and spin states of a single electron, eliminating errors associated with relativistic mass corrections of excited states. A dilution refrigerator provides the 0.1 K temperature needed to cool the cyclotron motion, ensuring that only the ground state is occupied, and to cool the axial motion, reducing thermal broadening of the cyclotron and spin-flip resonances. The measurement is performed in a cylindrical trap cavity with well characterized electromagnetic standing-wave modes, making possible the first cavity-shift correction to the measured magnetic moment.

[1]In collaboration with Brian D'Urso, current affiliation Oakridge National Laboratory, David Hanneke, Harvard University, and Gerald Gabrielse, Harvard University