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3He Magnetometry for the Fermilab Muon g-2 experiment

Friday 8 August 2025 10:00 (20 minutes)

The Fermilab Muon g-2 Experiment measures the precession frequency of the muon spin relative to its momentum in a 50m circumference storage ring with a 1.45T vertical field and quadrupole electric fields. The magnetic-moment anomaly $a_\mu = (g_\mu - 2)/2$ is determined from this anomalous precession frequency and precision determination of the magnetic field over space and time using a combination of proton-NMR magnetometers. The calibration chain for these magnetometers includes optically-pumped ^{3}He magnetometry based on metastability-exchange optical pumping (MEOP). Corrections to a "perfect" magnetometer that would accurately measure the magnetic field at a specific position are determined to less than 14 ppb in the 1.45 T field. The application to calibration of the muon g-2 proton-NMR magnetometer array and other applications will be discussed. Prospects for improved measurement of the diamagnetic shielding of protons in H_2O will also be presented.

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