

Department of Physics and Astronomy Colloquium Series

Tuesday, January 31th, 2023, 2:30pm - virtual talk

Speaker: Prof. Gerald Gabrielse

Institution: Trustees Professor and Director of the Center for Fundamental Physics
Department of Physics and Astronomy, Northwestern University

Title: New Measurement of the Electron Magnetic Moment

Abstract:

A one-electron quantum cyclotron, quantum non-demolition (QND) detection, inhibited spontaneous emission, a split dilution refrigerator, and a self-shielded superconducting solenoid have been used to measure the electron's magnetic moment. This most precise determination of a property of an elementary particle, to 1.3 parts in 10^{13} , was made to test the most precise prediction of the Standard Model of Particle Physics (SM). In the most precise confrontation of theory and measurement, the SM prediction agrees with what we measure to 1 part in 10^{12} . BSM (beyond the SM) particles and electron substructure could make the measurement and prediction differ (like quark substructure shifts the proton moment). The measurement precision will allow a much better SM test once discrepant measurements of the fine structure constant are resolved.

SM sectors involved include the Dirac prediction, QED (quantum electrodynamics) through the 10th order with muon and tauon contributions, along with hadronic and weak interaction contributions. The quest to test the SM to find BSM physics is well-motivated because the SM is known to be incomplete. No known CP violation mechanism is large enough to keep matter and antimatter produced in the Big Bang from annihilating as the universe cooled, dark matter has not been identified, and dark energy and inflation have no SM explanation.

A new approach to detecting meV dark photons produced a 75 times lower limit that can be extended to a broad energy range with purpose-built apparatus.

New electron magnetic moment measurement: <https://arxiv.org/pdf/2209.13084.pdf> (In press at PRL) New dark photon limit: <https://arxiv.org/pdf/2208.06519.pdf> (in press at PRL)