Low-energy particle physics with precision magnetic fields

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Highest-precision frequency measurements challenge the most precise predictions of the Standard Model (SM) of Particle Physics.

First, I will discuss the latest measurement of the anomalous magnetic moment of the muon and show how it challenges state-of-the-art SM predictions. The experiment is based on a clock comparison using spin-polarized muons confined in a superbly controlled electric and magnetic field environment. I will focus on the high-precision characterization of the magnetic field environment with nuclear magnetic resonance techniques.

Secondly, I will present the first frequency-based neutrino mass limit achieved with the novel technique of Cyclotron Radiation Emission Spectroscopy (CRES). The kinetic energy of individual electrons is determined non-distructively from the relativistic shift of the cyclotron frequency, which is encoded in the feeble cyclotron radiation emitted by single electrons spiraling in a precision magnetic trap. Our neutrino mass limit was derived from a molecular tritium decay spectrum. I will show how CRES opens up an avenue towards an experiment with mass sensitivity to the yet untested inverted mass ordering scheme of neutrino masses.

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