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Measuring the electric dipole moment the muon at PSI

The Standard Model of particle physics is a widely accepted and well-established theory that is able to describe electromagnetic, weak, and strong interactions using a common framework. However, phenomena such as masses of the neutrinos, the matter–antimatter asymmetry and the nature of dark matter and dark energy remain unexplained. At the Paul Scherrer Institut (PSI) we are setting up an experiment to search for the electric dipole moment (EDM) of muons. A non-zero EDM would indicate a violation of charge-parity (CP) symmetry, thus might help understand the baryon asymmetry in the universe and would be a signal of beyond Standard Model (BSM) physics.

The EDM of elementary particles such as electrons or muons are the simplest systems, where the violation of CP symmetry can be probed. However, the EDM of an electron is measured in molecules or ions, thus different CP violating sources might affect the observable effective EDM. In contrast, our measurement will directly measure unbound muons, thus the only CP violating source is the EDM of the muon. The current best direct limit of the muEDM, established by the g-2 collaboration at the Brookhaven National Laboratory, is $d_\mu < 1.8 \cdot 10^{-19}$ e·cm.

At the Paul Scherrer Institut, we are setting up a compact, high-precision experiment to measure the EDM of muons using the frozen-spin technique. The muEDM experiment is carried out in two phases, where in Phase 1 the collaboration is aiming at a sensitivity of $\sigma(d_\mu) = 4 \cdot 10^{-21}$ e·cm using muons with 23 MeV/c momentum. During Phase 2 the objective is to achieve a sensitivity of $\sigma(d_\mu) = 6 \cdot 10^{-23}$ e·cm using muons with momentum 125 MeV/c.

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