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Search for a muon EDM using the frozen spin technique at PSI

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The discovery of an electric dipole moment (EDM) of the muon would break time invariance and violate the combined symmetry of charge and parity (CP), shedding light on the imaginary parts of coupling constants in the muon sector of beyond standard model physics (BSM). A search for a muon EDM is an exciting test of the standard model complementary to the recently reported combined 4.2σ deviation from the SM in the anomalous magnetic dipole moment “(g-2)” and the observed tensions in B-decays at the large hadron collider. A dedicated muon EDM experiment will not only push EDM searches beyond the first generation of fundamental particles, but also probes the role of lepton flavor universality in nature.

At PSI we propose an experiment to search for the EDM of the muon based on the frozen-spin technique. We intend to exploit the high electric field, $E=1\text{GV/m}$, experienced in the rest frame of the muon with a momentum of $p=125\text{MeV/c}$ when passing through a large magnetic field of $B=3\text{T}$. Measured muon fluxes at the muE1 beam line of PSI permit an improved search with a sensitivity of $\sigma(d\mu)\approx 6\text{E-23 ecm}$, about three orders of magnitude more sensitive than for the current upper limit of $|d\mu|\leq 1.8\text{E-19 ecm}$ [G.W. Bennett, B. Bousquet, H. N. Brown, et al., PRD 80, 052008 (2009)]. In this contribution we will discuss and illustrate the concept and design of the muon EDM apparatus being setup in two phases at PSI.

A discovery of a muon EDM at the proposed experimental sensitivity would establish the existence of physics beyond the Standard Model, while a null result would set a significantly improved upper limit on an otherwise un-constrained Wilson coefficient in an effective-field-theory description of BSM physics.

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