Particle Physics on the Plains 2023



Contribution ID: 12

Type: not specified

Muon spin force

Saturday 14 October 2023 10:53 (18 minutes)

Current discrepancy between the measurement and the prediction of the muon anomalous magnetic moment can be resolved in the presence of a long-range force created by ordinary atoms acting on the muon spin via axial-vector and/or pseudoscalar coupling, and requiring a tiny, $\mathcal{O}(10^{-13} \,\mathrm{eV})$ spin energy splitting between muon state polarized in the vertical direction. We suggest that an extension of the muon spin resonance (μ SR) experiments can provide a definitive test of this class of models. We also derive indirect constraints on the strength of the muon spin force, by considering the muon-loop-induced interactions between nuclear spin and external directions. The limits on the muon spin force extracted from the comparison of ¹⁹⁹Hg/²⁰¹Hg and ¹²⁹Xe/¹³¹Xe spin precession are strong for the pseudoscalar coupling, but are significantly relaxed for the axial-vector one. These limits suffer from significant model uncertainties, poorly known proton/neutron spin content of these nuclei, and therefore do not exclude the possibility of a muon spin force relevant for the muon g - 2.

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Session Classification: Intensity Frontier