



Contribution ID: 229

Type: Oral

Present status and future experiments in fundamental muon physics

Wednesday, October 19, 2016 2:30 PM (30 minutes)

Current and planned experiments using muons as a probe, or as particle to be studied in and of itself, continue to shed light on fundamental physics many decades after its discovery. We continue to be fascinated by the atomic physics implications of the muonic Lamb shift measurements on the proton radius, the nuclear astrophysics implications related to determining the muon capture rate in deuterium, and the highly-sensitive particle physics tests centered on charged lepton flavor violation (LFV) searches and on the comparison of the muon's anomalous magnetic moment to the Standard Model prediction. Innovative and new experimental efforts at J-PARC, Fermilab, and PSI are all being prepared now. These will improve the precision on muonium hyperfine splitting and on the muon $g-2$ significantly. They will explore new clues related to the proton radius puzzle. They will make an unprecedented assault on LFV with a next-generation $\mu \rightarrow e\gamma$ experiment, an ambitious $\mu \rightarrow eee$ initiative, and two major $\mu \rightarrow e$ conversion experiments; the latter aim for up to four orders of magnitude sensitivity improvements compared to previous limits. The aim of this talk will be to briefly paint this broad overview –other speakers will provide details –and then focus on the new $g-2$ experiment that will start within the next year.

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Session Classification: We - 3

Track Classification: Fundamental physics and precision experiments with muons, pions, neutrons, antiprotons, and other particles