Phenomenology 2022 Symposium: From Virtual to Real



Contribution ID: 10

Type: not specified

Electroweak ALP Searches at a Muon Collider

Monday 9 May 2022 15:30 (15 minutes)

A high-energy muon collider with center-of-mass energy around and above 10 TeV is also a vector boson fusion (VBF) machine, due to the significant virtual electroweak (EW) gauge boson content of high-energy muon beams. This feature, together with the clean environment, makes it an ideal collider to search for TeV-scale axion-like particles (ALP) coupling to Standard Model EW gauge bosons, which current and other future colliders have limited sensitivities to. We present detailed analyses of heavy ALP searches in both the VBF and associated production channels at a muon collider with different running benchmarks. We also show projected constraints on the ALP couplings in the effective field theory, including an operator with its coefficient not determined by the mixed Peccei-Quinn anomaly. We demonstrate that a muon collider could probe new ALP parameter space and push the sensitivities of the couplings between the ALP and EW gauge bosons by one order of magnitude compared to HL-LHC. The projected limits and search strategies for ALPs could also be applied to other types of resonances coupling to EW gauge bosons.

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Session Classification: Axion