Contribution ID: **37** Type: **Talk**

Probing dark QCD sector through the Higgs portal with machine learning at the LHC

Abstract: The QCD-like dark sector with GeV-scale dark hadrons has the potential to generate new signatures at the Large Hadron Collider (LHC). In this paper, we consider a singlet scalar mediator in the tens of GeV-scale that connects the dark sector and the Standard Model (SM) sector via the Higgs portal. We focus on the Higgs-strahlung process, qq
0 → W∗ → W H, to produce a highly boosted Higgs boson. Our scenario predicts two different processes that can generate dark mesons: (1) the cascade decay from the Higgs boson to two light scalar mediators and then to four dark mesons; (2) the Higgs boson decaying to two dark quarks, which then undergo a QCD-like shower and hadronization to produce dark mesons. We apply machine learning techniques, such as Convolutional Neural Network (CNN) and Energy Flow Network (EFN), to the fat-jet structure to distinguish these signal processes from large SM backgrounds. We find that the branching ratio of the Higgs boson to two light scalar mediators can be constrained to be less than about 10% at 14 TeV LHC with L = 3000 fb−1
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Session Classification: BSM

Track Classification: Physics: 10: Physics beyond the SM