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Promptly decaying SUEP signals at the LHC

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Models with dark showers represent one of the most challenging possibilities
for new physics at the LHC. The most difficult to detect variety of
these models is so-called Soft Unclustered Energy Pattern (SUEP). This signature presents significant challenges to trigger on and search for, in part due to the lack of isolated hard objects to identify in the detector as well as the large amount of QCD background in the relevant SUEP phase space.
Signatures like this appear in models with a hidden valley sector that is both
pseudo-conformal and strongly coupled. In such models large-angle emissions are unsuppressed during the showering process. If the hidden sector hadrons decay promptly back into Standard Model hadrons, the result is a high-multiplicity shower of SM final state particles with a more democratic distribution of energies and a much higher degree of isotropy than typically seen in QCD jets.
We outline an analysis strategy to look for SUEP produced by exotic decays of the Higgs boson, using both conventional cuts on event-level observables as well as supervised and unsupervised machine learning anomaly detection methods. We identify the regions of dark shower parameter space which yield SUEP-like Higgs decays and discuss different exclusion methods for various benchmarks. We discuss how search strategies differ depending on the details of the signal generated in different regions of parameter space.

Summary

Authors: PLEHN, Tilman (Heidelberg University); KASIECZKA, Gregor (Hamburg University (DE)); CURTIN, David (University of Toronto); BARRON, Jared (University of Toronto); SPOURDALAKIS, Aris-George-Baldur

Presenter: SPOURDALAKIS, Aris-George-Baldur

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