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A model independent probe for dark sectors at neutrino experiments

In this talk, I will consider light dark sectors (DS) interacting with the Standard Model (SM) through irrelevant portals that are motivated on general principles. I will talk about how we can derive bounds on such scenarios using the decay of dark sector excitations inside neutrino detectors based on proton beams. Our approach is model-independent and applies to a wide range of dark sector models. In this approach, the dark sector is characterised by two energy scales: $\Lambda_{\rm UV}$ (mass scale of mediators generating the portals) and $\Lambda_{\rm IR}$ (mass gap of the dark sector). At intermediate energies, far away from these scales, the theory is approximately scale-invariant, and allows calculation of production rates independent of the threshold corrections. We look at various DS production processes such as meson decays, direct partonic production, and dark bremsstrahlung. We find that future neutrino experiments are able to probe new regions of parameter space, inaccessible in high-energy experiments, and are comparable to future fixed-target/beam-dump experiments. Future neutrino experiments will probe new parts of parameter space on a relatively shorter time scale, as compared to other DS search dedicated experiments, and provide an efficient probe of dark sectors.

Summary

Light dark sectors interacting with SM via irrelevant portals can be probed in proton beam-based neutrino experiments. Using certain assumptions that allow us to be model independent while calculating signal cross sections, we show that neutrino experiments complement current DS searches at high-energy collider experiments.

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