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Tumblers: A Novel Collider Signature for Long-Lived Particles

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In this talk, we point out a novel signature of physics beyond the Standard Model which could potentially be observed both at the LHC and at future colliders. This signature, which emerges naturally within many proposed extensions of the Standard Model, results from the multiple displaced vertices associated with the successive decays of unstable, long-lived particles along the same decay chain. We call such a sequence of displaced vertices a “tumbler.” We examine the prospects for observing tumblers at the LHC and assess the extent to which tumbler signatures can be distinguished from other signatures of new physics which involve multiple displaced vertices within the same collider event. As part of this analysis, we also develop a procedure for reconstructing the masses and lifetimes of the particles involved in the corresponding decay chains. We find that the prospects for discovering and distinguishing tumblers can be greatly enhanced by exploiting precision timing information such as would be provided by the CMS timing layer at the HL-LHC. Our analysis therefore provides strong motivation for continued efforts to improve the timing capabilities of collider detectors at the LHC and beyond.

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