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Dark Matter Freeze-out Beyond the WIMP Paradigm

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The nature of dark matter poses one of the most pressing questions in fundamental physics today. While the thermal freeze-out of weakly interacting massive particles (WIMPs) has theoretical appeal, its validity is increasingly questioned due to experimental null results from colliders as well as direct and indirect detection experiments. In this talk, we explore dark matter genesis mechanisms beyond the WIMP paradigm, focusing particularly on the mechanism of conversion-driven freeze-out. This mechanism enables the thermalization of dark matter despite its very weak couplings. While the corresponding parameter region evades conventional WIMP searches, it predicts novel signatures of long-lived particles at colliders, making it a prime target for upcoming LHC searches. We review various realizations of this mechanism from the literature, establishing connections to other unresolved problems of the standard model. Notably, we discuss a recently discovered possibility: the simultaneous explanation of the baryon asymmetry of the Universe through conversion-driven leptogenesis within this framework.

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