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Effects of Primordial Black Holes on Dark Matter Models

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We investigate the effects of producing dark matter by Hawking evaporation of primordial black holes (PBHs) in scenarios that may have a second well-motivated dark matter production mechanism, such as freeze-out, freeze-in, or gravitational production. We show that the interplay between PBHs and the alternative sources of dark matter can give rise to model-independent modifications to the required dark matter abundance from each production mechanism, which in turn affect the prospects for dark matter detection. In particular, we demonstrate that for the freeze-out mechanism, accounting for evaporation of PBHs after freeze-out demands a larger annihilation cross section of dark matter particles than its canonical value for a thermal dark matter. For mechanisms lacking thermalization due to a feeble coupling to the thermal bath, we show that the PBH contribution to the dark matter abundance leads to the requirement of an even feebler coupling. Moreover, we show that when a large initial abundance of PBHs causes an early matter-dominated epoch, PBH evaporation alone cannot explain the whole abundance of dark matter today. In this case, an additional production mechanism is required, in contrast to the case when PBHs are formed and evaporate during a radiation-dominated epoch.

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