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Constraining the Coexistence of Freeze-in Dark Matter and Primordial Black Holes

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Particle dark matter and primordial black holes (PBH) might coexist with appreciable cosmic abundances, with both contributing to the observed dark matter density $\Omega_{\rm DM}$. Large populations of PBH (with $\Omega_{\rm PBH} \sim \Omega_{\rm DM}$) are tightly constrained for PBH heavier than $10^{-11} M_\odot$. However, large fractional abundances with $f_{\rm PBH} \simeq \Omega_{\rm PBH}/\Omega_{\rm DM} \sim 0.01$ are consistent with the limits on PBH for a wide range of PBH masses. Scenarios with significant populations of both particle dark matter and PBH are intriguing. Notably, if the particle dark matter has interactions with the Standard Model, new constraints arise due to pair-annihilations that are enhanced by the PBHs, resulting in dark matter indirect detection constraints on $f_{\rm PBH}$. Here we derive the bounds on mixed scenarios in which PBHs coexist with particle dark matter whose relic abundance is set via freeze-in ("FIMPs"). We show that while the restrictions on $f_{\rm PBH}$ are less constraining for FIMPs than WIMPs, modest bounds still arise for large classes of models. We examine both IR and UV freeze-in scenarios, including the case of ''superheavy" particle dark matter with PeV scale mass.

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