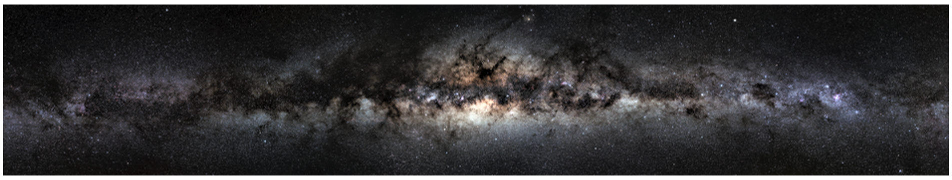

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Primordial Black Hole Domination: Dark Matter, Dark Radiation, and Gravitational Waves

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If even a relatively small number of primordial black holes (PBH) were created in the early universe, they will constitute an increasingly large fraction of the total energy density as space expands. It is thus well-motivated to consider scenarios in which the early universe was dominated by short lived PBH ($M < 10^9$ grams, $t < 1$ sec) whose Hawking radiation produces both the Standard Model radiation bath and other exotic gravitationally coupled species. Within this context, we consider Hawking radiation as a mechanism to produce dark radiation and dark matter. In a PBH dominated era, we find that Schwarzschild Hawking evaporation produces dark radiation at a level ΔNeff~0.03−0.2 for each light and decoupled species of spin 0, 1/2, or 1. During this era, dark matter could also originate as Hawking radiation, although such dark matter candidates must be very heavy ($m > 10^{11}$ GeV) to avoid overproduction. Furthermore, if the PBH undergo mergers before evaporating, the subsequent population acquires nonzero spin, so the resulting Kerr Hawking radiation efficiently produces gravitons whose contribution to ΔNeff is within the reach of future CMB experiments; such mergers also predict a characteristic spectrum of primordial gravitational waves at high frequencies correlated with the progenitor PBH mass.

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