

[online] Revisiting PBH Accretion, Evaporation and Their Cosmological Consequences

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Primordial black holes (PBHs) provide a unique probe of the early Universe. Their cosmological evolution is governed by the competition between mass accretion and Hawking evaporation. In this paper we look into the details impact of accretion. Most of the earlier analysis relied on non-relativistic accretion models. In this work, we reinvestigate this in a fully relativistic framework for Kerr PBHs in the radiation-dominated era. We derive relativistic accretion rate and compute spin-dependent efficiency $\lambda_{\text{Kerr}}(a_*)$. Using this result, we construct coupled evolution equations for the PBH mass and spin that include both relativistic accretion and spin-dependent evaporation. Our analysis shows that relativistic accretion significantly increases PBH masses and consequently suppresses their spins, causing all PBHs to become effectively Schwarzschild well before evaporation. These effects strengthen the Big Bang Nucleosynthesis (BBN) bound on the initial PBH mass by a factor of $\sim 4 - 5$, reduce the mass required for survival to the present epoch to $\sim 2.7 \times 10^{14} \text{g}$, and shift the viable particle like DM parameter space. Notably the early accretion induced spin-down effect further washes out the well known high-frequency, spin-induced feature in the high frequency stochastic gravitational-wave background, modifying predictions for future detectors.

Primary author(s) : Mr KALITA, JITUMANI (Indian Institute of Technology Guwahati)

Co-author(s) : Dr MAITY, DEBAPRASAD (Indian Institute of Technology Guwahati)

Presenter(s) : Mr KALITA, JITUMANI (Indian Institute of Technology Guwahati)

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