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On cosmological properties of black-hole hair in linearly coupled scalar–Gauss–Bonnet theory

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We investigate the superhorizon behavior of scalar hair sourced by black holes in de Sitter spacetime in the linearly coupled shift-symmetric scalar–Gauss–Bonnet theory. This hair exhibits both spatial and temporal growth, which has been suggested to be problematic. We show that this growth is expected, as it is not a special consequence of the black hole, but instead follows from the dynamics of a minimally coupled massless scalar field in expanding de Sitter spacetime. Moreover, it is not specific to black holes, but also arises for a point scalar charge in de Sitter, indicating that a scalarized black hole acts effectively as a localized subhorizon source of scalar perturbations. Backreaction, when important, first arises on subhorizon scales and does not by itself eliminate the superhorizon profile. The time-dependent scalar hair also carries a steady outward energy flux, which helps explain the difficulties encountered in attempts to construct self-consistent static solutions.

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