Preprint Series in Particles and Cosmos Physics
nº IPARCOS-UCM-26-024

INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

IPARCOS

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

by Dražen Glavan, Darío Jaramillo-Garrido

May 2026

Plaza de las Ciencias, 1 28040 Madrid, Spain
www.ucm.es/iparcos/

UNIVERSIDAD COMPLUTENSE MADRID

IPARCOS
INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

# Abstract

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. Working in the test-field regime, we show that this hair exhibits both temporal and spatial growth on superhorizon scales. This growth 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 even 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 frames the test-field regime as a transient, and helps explain the difficulties encountered in attempts to construct self-consistent static solutions.

UNIVERSIDAD COMPLUTENSE MADRID