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Shadows of rotating hairy Kerr black holes coupled to time periodic scalar fields with a nonflat target space"

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We study the shadows cast by rotating hairy black holes with two non-trivial time-periodic scalar fields having a non-flat Gaussian curvature of the target space spanned by the scalar fields. Such black holes are a viable alternative to the Kerr black hole, having a much more complicated geodesic structure and resulting shadows. We investigate how a nontrivial Gauss curvature alters the pictures for different amounts of scalar hair around the black holes, quantified by a normalized charge. Our results indicate that for high charge values near the boson star limit, chaotic shadows with multiple small, disconnected components appear across all Gaussian curvatures. With moderately large scalar hair and corresponding normalized charge, chaotic behavior persists, but a dominant shadow component forms, significantly influenced by Gaussian curvature. For example, in flat target space, highly chaotic shadows develop a large central region as Gaussian curvature increases, even with heavy scalar hair. At lower normalized charge values, the shadows resemble those of Kerr black holes, with minimal impact from Gaussian curvature.

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