An Analytical Method to Investigate High Dimensionality Signatures in Static and Spherically Symmetric Black Holes

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With the constant advancement of science and technology, particularly in astronomy, more effective resources have been developed for understanding the Universe. In 2015, the first observation of gravitational waves took place, leading to the Nobel Prize in Physics in 2017. Subsequently, in 2019, we witnessed the first photograph of a black hole, marking a historic milestone for humanity. In this scenario, the study of the optical properties of black holes becomes relevant. Photon spheres are regions around black holes where the trajectory of light is closed. They are crucial for scientific development, as their identification extracts numerous properties of a black hole, contributing to a better understanding of the Universe. This project investigates observational evidence of highdimensional Schwarzschild-de Sitter (SdS) black holes, usually called high-dimensional signatures. To perform this task, we studied some basic concepts of general relativity and, using the geodesic equation, systematized lemmas, and theorems concerning photon spheres and gravitational redshift. Such results were applied to two different types of black holes, four-dimensional and five-dimensional Schwarzschild-de Sitter. We performed the validation of the four-dimensional case with the literature and, then, we compared the results between the two types of black holes, four and five-dimensional SdS. This work suggests that there is observational evidence of high dimensionality to these kinds of black holes and they are closely related to their photon spheres, shadows, and gravitational redshift profile.

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