EINSTEIN-MAXWELL-DILATON NEUTRAL BLACK HOLES IN STRONG MAGNETIC FIELDS: TOPOLOGICAL CHARGE, SHADOWS, AND LENSING

Haroldo C. D. Lima Junior[1], Jian-Zhi Yang[2], Luís C. B. Crispino[1], Pedro V. P. Cunha[2] and Carlos A. R. Herdeiro[2]

[1] Faculdade de Física, Universidade Federal do Pará, 66075-110, Belém, Pará, Brasil.
[2] Departamento de Física da Universidade de Aveiro and CIDMA, Campus de Santiago, 3810-183 Aveiro, Portugal.

The light rings (LRs) topological charge (TC) of a spacetime measures the number of stable LRs minus the number of unstable ones. It is invariant under smooth spacetime deformations obeying fixed boundary conditions. Asymptotically flat equilibrium black holes (BHs) have, generically, TC=−1. In Einstein-Maxwell theory, however, the Schwarzschild-Melvin BH — describing a neutral BH immersed in a strong magnetic field — has TC = 0. This allows the existence of BHs without LRs and produces remarkable phenomenological features. We investigate the generalized Schwarzschild-Melvin solution in Einstein-Maxwell-dilaton theory, scanning the effect of the dilaton coupling. We find that the TC changes discontinuously from TC = 0 to TC = −1, precisely at the Kaluza-Klein value. We relate the TC change with the non-trivial asymptotic Melvin behavior for different values of the dilaton coupling. We also study the shadows and lensing of the generalized Schwarzschild-Melvin solution for different values of the dilaton coupling.