LIGHT RINGS AND MARGINALLY STABLE CIRCULAR ORBITS FROM EFFECTIVE 2D METRIC

Pedro V. P. Cunha[1], Carlos A. R. Herdeiro[1] and João P. A. Novo[1]

[1]Mathematics Department, Aveiro University, 3810-193, Aveiro, Portugal.

The motion of particles on general stationary 1+3 dimensional spacetimes can, under some assumptions, be described by the geodesics of a 2 dimensional manifold. This corresponds to the optical manifold for null trajectories and to the Jacobi manifold for timelike ones. In this work we resort to these 2 dimensional metrics to study circular geodesics of generic static, spherically symmetric, and asymptotically flat 1+3 dimensional spacetimes containing non-extremal black holes or horizonless compact objects. This is done by studying their Gaussian curvature as well as the geodesic curvature of circular curves on these. This study considers both null and timelike circular geodesics. The study of null geodesics in this formulation retrieves the known result of the number of light rings (LRs) on the spacetime outside a black hole and on spacetimes with horizonless compact objects. With an equivalent procedure we formulate a similar theorem on the number and location of marginally stable circular orbits of a given spacetime satisfying the previously mentioned assumptions.