

Visible, invisible and trapped ghosts in wormholes and black universes

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We construct explicit examples of globally regular static, spherically symmetric solutions in general relativity with scalar and electromagnetic fields, describing (1) traversable wormholes with flat and AdS asymptotics and (2) regular black holes, in particular, black universes. (A black universe is a regular black hole with an expanding, asymptotically isotropic space-time beyond the horizon.) The existence of such objects requires invoking scalars with negative kinetic energy (phantoms", orghosts"), which are not observed under usual physical conditions. To account for that, the so-called trapped ghosts" were previously introduced, i.e., scalars whose kinetic energy is only negative in a restricted strong-field region of space-time and positive outside it. This approach leads to certain problems, including instability (as we illustrate by derivation of an effective potential for spherical perturbations of such systems). To avoid that, we use for model construction what we call invisible ghosts", i.e., phantom scalar fields sufficiently rapidly decaying in the weak-field region. The resulting configurations contain different numbers of Killing horizons, from zero to four. Their global structure has been studied with the aid of Carter-Penrose diagrams.

Presentation type

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