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Scalar wormholes with nonminimal derivative coupling

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Abstract

We consider static spherically symmetric wormhole configurations in a gravitational theory of a scalar field with a potential V() and nonminimal derivative coupling to the curvature described by the term (εg μν + κG μν)φ , μφ ν in the action. We show that the flare-out conditions providing the geometry of a wormhole throat could be fulfilled both if ε = -1 (phantom scalar) and ε= +1 (ordinary scalar). Supposing additionally a traversability, we construct numerical solutions describing traversable wormholes in the model with arbitrary κ, ε=-1 and V(φ) = 0 (no potential). The traversability assumes that the wormhole possesses two asymptotically flat regions with corresponding Schwarzschild masses. We find that asymptotical masses of a wormhole with nonminimal derivative coupling could be positive and/or negative depending on κ. In particular, both masses are positive only provided κ < κ 1≤0; otherwise, one or both wormhole masses are negative. In conclusion, we give qualitative arguments that a wormhole configuration with positive masses could be stable. © 2012 IOP Publishing Ltd.

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