

Scalar multi-wormholes

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Abstract

© 2016 IOP Publishing Ltd. In 1921 Bach and Weyl derived the method of superposition to construct new axially symmetric vacuum solutions of general relativity. In this paper we extend the Bach-Weyl approach to non-vacuum configurations with massless scalar fields. Considering a phantom scalar field with the negative kinetic energy, we construct a multi-wormhole solution describing an axially symmetric superposition of N wormholes. The solution found is static, everywhere regular and has no event horizons. These features drastically tell the multi-wormhole configuration from other axially symmetric vacuum solutions which inevitably contain gravitationally inert singular structures, such as 'struts' and 'membranes', that keep the two bodies apart making a stable configuration. However, the multi-wormholes are static without any singular struts. Instead, the stationarity of the multi-wormhole configuration is provided by the phantom scalar field with the negative kinetic energy. Another unusual property is that the multi-wormhole spacetime has a complicated topological structure. Namely, in the spacetime there exist $2N$ asymptotically flat regions connected by throats.

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Keywords

Bach-Weyl approach, phantom scalar field, wormholes