Wormholes supported by chiral fields

Bronnikov K., Chervon S., Sushkov S.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

We consider static, spherically symmetric solutions of general relativity with a non-linear sigma model (NSM) as a source, i.e., a set of scalar fields $\Phi = (\Phi_1,...,\Phi_n)$ (so-called chiral fields) parametrizing a target space with a metric $h_{ab}(\Phi)$. For NSM with zero potential $V(\Phi)$, it is shown that the space-time geometry is the same as with a single scalar field but depends on h_{ab}. If the matrix h_{ab} is positive-definite, we obtain the Fisher metric, originally found for a canonical scalar field with positive kinetic energy; otherwise we obtain metrics corresponding to a phantom scalar field, including singular and nonsingular horizons (of infinite area) and wormholes. In particular, the Schwarzschild metric can correspond to a nontrivial chiral field configuration, which in this case has zero stress-energy. Some explicit examples of chiral field configurations are considered. Some qualitative properties of NSM configurations with nonzero potentials are pointed out. © Pleiades Publishing, Ltd., 2009.