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A no-go theorem for rotating cylindrical wormholes in general relativity

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It is known that the vortex gravitational field in rotating cylindrically symmetric configurations leads to an exotic contribution in the total effective stress-energy tensor, which is favorable for the formation of cylindrical wormhole throats. This leads to an opportunity to obtain wormholes without exotic matter, and there are examples of such exact wormhole solutions (including vacuum ones and those with a massless scalar field). However, none of them are asymptotically flat, hence they cannot describe local configurations in our Universe, which is, on the average, very weakly curved. A possible way out is to build configurations with flat asymptotic regions by the cut-and-paste procedure: on both sides of the throat, a wormhole solution is matched to a properly chosen region of flat space (taken in a rotating reference frame) at some surfaces Σ_- and Σ_+. It is shown, however, that if we the throat region has, as a source of gravity, a minimally coupled scalar field with an arbitrary self-interaction potential, then one or both thin shells appearing on Σ_- and Σ_+ inevitably violate the Null Energy Condition. In other words, although rotating wormhole solutions are easily found without exotic matter, such matter is still necessary for obtaining asymptotic flatness.

Presentation type

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