

Cylindrically symmetric wormholes $WhCRe$: The motion of test particles

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Abstract

© 2016 American Physical Society. We study the radial and nonradial motion of massive test particles and photons in a three-parameter family of cylindrically symmetric wormholes $WhCRe$ generated by the electromagnetic, dilaton, and scalar fields, with particular attention paid to the extent to which the wormhole is traversable. The wormholes are not asymptotically flat and contain a curvature singularity at one end of the wormhole. In the case of nonradial motion with conserved energy and angular momentum along a hypersurface $z=const$ ("planar orbits") we show that, as in the Kerr and Schwarzschild geometries, we should distinguish between orbits with impact parameters greater or less than a certain critical value D_c , which corresponds to the unstable circular orbit of radius u_c . For $D^2 > D_c^2$ there are two kinds of orbits: orbits of the first kind arrive from infinity and turn around at the orbit's minimum radial coordinate u ("pericenter") greater than u_c , whereas orbits of the second kind turn around at maximum radial coordinate u ("apocenter") less than u_c and terminate at the singularity at $u=-$. For $D=D_c$ orbits of the first and second kinds merge and both orbits spiral an infinite number of times toward the unstable circular orbit $u=u_c$. For D^2