

Davide Fermi

Dipartimento di Matematica
Università degli Studi di Milano

Free fall into the past. A time orientable spacetime with closed timelike curves

Abstract. Inspired by recent works of Tippett-Tsang and Mallery-Khanna-Price, we present a new spacetime model which, besides possessing no curvature singularity and being both time and space orientable, also contains closed timelike curves. This model is constructed using an “interpolation strategy” similar to those of Alcubierre, Krasnikov *et al.* More precisely, we postulate an *ad hoc* Lorentzian metric on \mathbb{R}^4 which possesses some desired, exotic features and differs from the Minkowski analogue only inside a region bounded by two concentric tori; the corresponding matter distribution is derived a posteriori, demanding the Einstein’s equations to hold true. Our model shares some similarities with the one of Ori-Soen; however, it enjoys a larger number of symmetries, allowing for the explicit computation of a class of geodesics. The most remarkable feature emerging from this computation is the presence of future-oriented, timelike geodesics starting in the outer Minkowskian region, moving to the inner spacetime region, and then returning to the initial spatial position at an earlier time. We also determine the tidal forces and energy densities measured by observers who move along such geodesics, proving in particular that the classical energy conditions are violated. (Joint work with L. Pizzocchero; arXiv:1803.08214v2)