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The Alcubierre metric and the superluminal interstellar travels in general relativity

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In Minkowski spacetime, the maximum speed at which all information can travel is the speed of light. For an arbitrary spacetime, this also holds locally. On the other hand, it is known that the Hubble-Lemaître law and cosmic inflation admit, for two comoving observers, relative superluminal separation velocities.

In 1994, Alcubierre proposed a mechanism that would allow, in principle, superluminal interstellar travel. Said mechanism consists of the impulse of a spaceship in continuous rest, and locally immersed in a Minkowski space-time. In its neighborhood, at a certain distance from it (to avoid being disturbed by huge tidal forces), behind and in front of the spaceship, locally space-time would expand and contract, respectively. Because of this, relative to an observer far away in the neighborhood of the spaceship, the spaceship would be moving arbitrarily faster than the speed of light. However, the spaceship would at all times describe time-like curves, and thus causality would not be violated.

This mechanism is known as Warp Drive, and is described by the Alcubierre metric. This metric describes a globally hyperbolic spacetime and is expressed in the 3+1 formalism.

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