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## Dirac tunneling: superluminal velocities and closed time-like curves?

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The Hartman effect –first discovered by MacColl, in 1932 –is the claimed observation that, when a particle tunnels, it arrives at the opposite side of the barrier the moment it encounters the barrier. If this is so, then sufficiently wide barriers and fast particles should produce superluminal effective velocities. However, such superluminal effective velocities have been dismissed as attributable solely to uncertainty in the initial position of the particle. We examine this position, and further investigate this motif for superluminal velocities, and associated backward time travel –the latter expected in the particle frame of reference, when the particle travels superluminally in the barrier frame.

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