

When Einstein introduced the theory of relativity he introduced the concept of c , the speed of light. His Principle of Invariant Light Speed explained that light has a definite speed in empty space independent of the state of motion of the light source. It is commonly accepted that an object would need infinite energy to accelerate to the speed of light and so cannot go any faster¹. This puts a very hard limit on what of our interstellar system humanity can visit in a lifetime. Are there any ways to get around this constraint to reach our far off neighbors in a human life time (excluding the use of cryogenics)?

As stated above c is the speed of light in a vacuum and this is the hard limit for the speed matter can achieve, but what about not in a vacuum? The speed of light in a medium is c/n where n is the refractive index (some constant dependent on the medium)². One would assume that the speed of some matter through a medium must be less than or equal to that based on the Principle of Invariant Light Speed. The refractive index of water is ~ 1.33 but an electron can be accelerated to be faster than $c/1.33$ (this commonly occurs in nuclear reactors). This has been proven by observing the Cherenkov radiation that is emitted and calculating the speed at which electrons must be moving to cause it³. Well there we go, a particle moving faster than light, Einstein was wrong, problem solved. Unfortunately it doesn't really work that way, light is slowed down greatly in certain mediums via its interactions with the particles of the medium. In this case its not a particle moving faster than light, but light slowing down to a particle's speed.

The main reasoning by the limit of the speed of light is the energy needed to accelerate a particle to that speed is infinite, but what if we could teleport? A concept called quantum tunneling seems to do just that. An object's position is subject to uncertainty, so when it is faced with a barrier of sorts, there is slim probability that it will exist on the other side of the barrier. This means that occasionally the object will "teleport" to the other side of the barrier. It was experimentally proven that by putting a barrier in its way, a beam of photons arrived faster than the speed of light⁴. This doesn't violate the Principle of Invariant Light Speed as the particle didn't move faster than light, it jumped over some space. One again this doesn't look like a promising way to travel a human faster than light. The probability of jumping through the barrier is inversely proportional to the mass of the object and humans are far too massive to pull this off realistically.

The vacuum referred to when describing the speed of light is a vacuum in terms of particles, it is not a vacuum to electromagnetic waves. When two uncharged plates are put next to each other in this vacuum certain wavelengths cannot fit, this means that there is a difference in energy between these two plates relative to the rest of the area, this result sin them being attracted to each other. If we move these plates quickly enough the vacuum waves become real ones. One calculation suggests that photons traveling across these plates would move slightly faster than light due to these vacuum waves⁵. This has not been experimentally proven though. Unfortunately the plates have to be a very minuscule distance apart as the force between them drops off greatly with distance, and they really only work on photons, so we couldn't use this to speed across the cosmos.

There are many theories about faster than light travel. Above are just three potentials listed, there are many more including the use of wormholes, tachyons, and warp drives. The above concepts

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- 1 Gamblin, R. L. (2011). Special relativity in a Newtonian space. *Physics Essays*, 24(1), 131+. Retrieved from <http://go.galegroup.com.proxy.lib.uwaterloo.ca/ps/i.do?p=AONE&sw=w&u=uniwater&v=2.1&it=r&id=GALE%7CA249959042&asid=75121d879d505747d24ed6b3e8dccccad>
 - 2 Kotel'nikov, G. A. (2009). Kinematics of Cherenkov's effect with noninvariant velocity of light. *Russian Physics Journal*, 52(1), 53-58. doi:10.1007/s11182-009-9195-6
 - 3 Kotel'nikov, G. A. (2009). Kinematics of Cherenkov's effect with noninvariant velocity of light. *Russian Physics Journal*, 52(1), 53-58. doi:10.1007/s11182-009-9195-6
 - 4 Steinberg, A. M., Kwiat, P. G., & Chiao, R. Y. (1993). Measurement of the single-photon tunneling time. *Physical Review Letters*, 71(5), 708-711. doi:10.1103/physrevlett.71.708
 - 5 K. Scharnhorst: On propagation of light in the vacuum between plates. *Physics Letters B* 236(1990)354-359 (DOI: 10.1016/0370-2693(90)90997-K).

all rely on very small masses or distances and aren't really viable solutions to interstellar travel. So far it appears that an improbability drive is our best bet for faster than light travel, just don't leave Zaphod at the helm.