Engage

"The null geodesic equations in the Alcubierre warp-drive spacetime are numerically integrated to determine the angular deflection and redshift of photons which propagate through the distortion of the `warp-drive' bubble to reach an observer at the origin of the warp effect."

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The above quote sounds like science fiction, but in fact it is a quote from "Null geodesics in the Alcubierre warp-drive spacetime" by the above named authors. Of course the Star Trek influence is not to be ignored. After all, the subtitle is, "the view from the bridge." For those not familiar with Star Trek lore, Bozeman, Montana (where these authors were in the Department of Physics) is the location of the "yet to be" first contact between Vulcans and Zephram Cochran after his first Warp flight. But what the heck is an Alcubierre warp-drive?

A theory for achieving a faster-than-light drive like that depicted in Star Trek was laid out by Mexican theoretical physicist Miguel Alcubierre in 1994. Basically he was searching for a valid mathematical approach to such a drive without violating Einstein's General Theory of Relativity and without the serious negative implications of time dilation when traveling at "near light" speeds.

Interestingly enough what he found was that the mathematics supported the possibility and even more interesting the description of such a Warp drive is amazingly similar to the depictions in Star Trek itself. It is indeed a "warp" effect and it would involve a space-time bubble around the ship.

First we should consider a couple of things. How big in diameter is the universe and how old is the universe. Well, in truth we don't know either answer directly. However in researching this an interesting conflict was revealed. The size of the universe is apparently bigger than particles moving at the speed of light would predict. That is, the fastest moving objects in the universe can't make a universe this big this fast. Something is wrong with the picture. What the physicists theorized was that space itself expanded so that particles could get where they are faster without exceeding the speed of light. Essentially this would be like walking on a moving walkway similar to those found in airports.

In this case you are the photon walking along at an average 2 miles per hour. Then you step onto the moving walkway which is also moving at about 2 miles per hour. You keep walking at 2 miles per hour but you cover the distance as if you are walking 4 miles per hour. The moving walkway is an imperfect analogy of space-time itself expanding in the same direction as you are walking. You haven't broken the "speed of light" and you haven't had to expend extra energy by running yet you got to your destination much quicker.

In Einstein's General Theory of Relativity it is shown that exceeding the speed of light relative to local space-time would not be possible. Based upon the equations involved, an object approaching the speed of light approaches infinite mass and requires an infinite amount of energy to push it to the speed limit. This is not possible, yet the clues provided by the expansion of the universe itself suggested another possibility. It's something like the old Greyhound bus commercials that advertised, "Ride the bus and leave the driving to us."

The trick to getting a ship to appear to travel faster than the speed of light is to get space-time to contract in front of it and expand behind it like the moving walkway, and strangely enough the math says that it is possible. To do this you do indeed "warp" space-time and create a space-time bubble around the ship. Within the bubble of space-time (sub-space?) the ship never exceeds the speed of light. In fact, it doesn't even have to move at all relative to its bubble. Instead the whole space-time bubble moves and is completely unrestricted by the speed of light in the same way that the expansion of the universe was not restricted. Interstellar space travel becomes analogous to surfing a wave except that the surfer has to create the wave as well as ride it. The true velocity of travel through the cosmos would be a function of the magnitude of the warp-age of space-time that creates the wave being surfed.

An interesting side effect of faster than light travel within a space-time bubble is that there is no actual forward velocity of the ship relative to its bubble and therefore no time dilation or acceleration effects. That is, if it takes a starship crew a week to fly to Alpha Centauri and a week to fly back to earth then it will only be a two week trip to those on earth as well as those on the ship. It would not be like a near-light-speed trip that might take months for the crew and tens of thousands of years as perceived by those on earth. Also the crew will not experience any acceleration when transitioning from sub-light speed to faster-than-light speed because, as far as they can tell, they are not moving. This is exactly the kind of drive that would make travel between stars both practical and likely in a sufficiently advanced civilization. But there is a problem.

No one knows for sure how to initiate the bubble and how to stop it once it is initiated.

Warping space-time is not something that is easily done. In the early universe space time was warped by a combination of extraordinary energy in a small volume of space. For a practical interstellar ship, even though the warp bubble can be relatively small, a very large amount of energy will still be required. In addition the math tells us that "exotic matter" will be required (not to be confused with anti-matter). Exotic matter can have very unusual properties such as negative mass (anti-matter is believed to have positive mass). So to control a warp drive we have to control large amounts of energy and a form of matter that we have yet to find or produce. Of course it may be that a matter/anti-matter reaction might be induced to create exotic matter in a way that we could manipulate into creating a warp bubble, but this is still far from a working theory at this point. If we assume this might eventually prove to be true there is still one other problem.

When you are inside a warp bubble how do you know where you are going?

Inside of a space-time warp bubble you are isolated from the rest of space-time. To navigate a faster-than-light ship you really need to know where you are going and how fast you are moving relative to the external space-time. Unfortunately, observations outside of the bubble will be about as difficult as seeing outside of the event horizon of a black hole. The very thing that makes travel above light speed possible also isolates everything inside of the bubble from everything outside of the bubble. However, perhaps something analogous to dead reckoning would be possible.

If you know exactly where you are pointed before initiating the warp bubble one could assume you are going to go in the direction you are pointed. Then it become mostly an issue knowing how fast you are moving, or more accurately how fast space is moving past you. Essentially you need a measure of how fast a warp bubble slides through normal space-time as a function of the magnitude of the warp-age created by the ship. At higher levels of warp-age the velocity will be faster and a lower levels it will be slower. The problem here is that we simply have no idea if the effect is linear or non-linear. That is, for twice the warp do you go twice as fast, four times as fast, exponentially faster or is it even more complicated than that. Certainly it seems that there should be a quantifiable relationship, but some degree of trial and error will probably be required to discover what it is. At that point travel would then consist of a number of straight line jumps of various durations interspersed with sub-light course corrections to get wherever you wish to go.

Then all that is left to do is, “Lay in a course for the Eagle Nebula... Engage!”