Implausible Engineering – Episode 3a: Interstellar travel

There is so much imagined interstellar flitting about in star trek, wars etc, that it seems almost inevitable it will all really happen one day. That is, that we might set off from Earth in the morning and arrive at Alpha Centauri system in time for tea. It's only 4.3 light years away after all.

Moving at light speed through spacetime, seems pretty clearly impossible, since the whole idea of spacetime is that time is distance and distance is time. So you can't travel any distance without some time also passing. You can reduce the duration of travel between points A and B, by going faster and faster, but once you reach the speed where the duration of travel reaches zero, that's as fast as you can go. And that speed is not infinite speed, it's actually 300,000 km/sec, the Universe's speed limit. Even the fastest things in the Universe, light and gravity can only go that fast.

On the bright side, there is still a way for you to get to Alpha centauri in less than 4.3 years, because as you approach light speed time dilation kicks. Indeed you could actually leave earth and arrive at Alpha Centauri by tea time, as long as we mean your tea time. It will still be the case that for you to cross that distance at least 4.3 years will have to pass back on Earth – and probably a lot more than that since you'll never actually reach light speed – and it will take time to accelerate up and then decelerate back down at the other end.

Of course there are ways we might get around having to move through spacetime. There's some theoretical notions about creating warp bubbles – meaning you don't actually move through spacetime, you move spacetime instead – as though you sit still atop a moving wave. But even allowing the implausible engineering required to create such a wave, getting it to move at anything other than a constant speed in a straight line creates a whole nother layer of implausibilities, since you will have to interact with the world outside the bubble in order to accelerate, decelerate or turn.

And then of course there's wormholes – seeming tunnels through spacetime, although they are really tunnels of spacetime, where the spacetime manifold has been shaped into not just a gravity well, but a seemingly bottomless pit. Trouble is, the only plausible explanation for such extreme geometry is that the wormhole has some huge mass-energy density within – and while that thing might create a spacetime tunnel from point A and another spacetime tunnel from point B – but to get from point A to point B you have to pass through that thing in the middle – which would be something equivalent to a very dense black hole, although some argue it would then become a white hole on the other side. But even then, that just means you either die on the way in or you die on the way out.

And so back to the first idea, you really can cross vast distances in the Universe without a lot of personal time passing if you can achieve speeds close to the speed of light. Trouble is space isn't as empty as it looks and even over the relatively-short distance of 4.3 light years you are going to encounter dust grains or something bigger – and given the speed you are going at that will be a problem, both in terms of collision damage, as well as it just plain slowing you down. So you need something like a deflector dish, of the star trek variety. Allegedly this projects out a something equivalent to the shields which can be put around the ship during combat. What exactly shields are is never clear, when switched on they invisibly surround the ship and can take a certain pounding before the crew begins counting down their decline in percentage gradations. When it suits the plot shields can also be projected out around other objects to protect them and so presumably, whatever shields are, can also be projected out from the deflector dish to deflect things away from the front of the ship when it's flying at high speed. But even allowing for shields to be real, the underlying physics is still problematic – anything that pushes something out of the way, will also be back pushed upon. Also up near light speed length contraction operates in the direction of travel, such all that pushing that happens 100 metres away at normal speed is just outside the hull near light speed.

But let's say the deflector dish fired out something like a gamma ray laser, where rather than pushing things out of the way it just vaporized them. Near light speed all that it's still happening just outside the hull, so hull damage is still a risk, but at least the ship flies through a cloud of subatomic particles rather than larger and denser particles. And you still get slowed, but it's more like driving through rain than driving through hail.

So, you still won't get to light speed but this approach might get you a bit closer – all assuming you have a drive system with a stupendous amount of propellant, some kind incredibly-efficient energy source, perhaps based on matter-antimatter annihilation, or maybe you just have lots and lots of nuclear bombs that you drop out the back of the ship to push you forward. For all its failings, humanity is pretty good at finding ways to go faster.

Implausible Engineering – Episode 3b: Space colony

A standard theme of science fiction and science forecasting is that we'll establish space colonies one day. This is certainly possible, if not likely, but there are a number of issues to think through. Most importantly, you need energy – so if you are going to build a real space colony that's in space then the Earth – Moon Lagrange points 4 and 5 might be good since they keep pace with the Moon around its Earth orbit and so will get Earth-Moon levels of solar flux. Or you might float a gondola above the clouds of Venus and get even more solar flux – or you might do the traditional thing and build on the surface of a celestial body. The Moon is good for all sorts of reasons, although Mars tends to be where people look to.

But on Mars, energy is hard to come by. The solar flux is lower than at Earth and is also a bit unreliable, given Mars' propensity for dust storms, including global ones that can persist for months. So you either need some substantial and reliable battery storage or you could go nuclear. The latter would require shipping refined uranium or may thorium from Earth, or otherwise sourcing these from Mars. Shipping a large and potentially toxic mass from Earth would be expensive and unpopular, since we may run out of economically-viable deposits of uranium ore on Earth in a few hundred years. It's likely uranium may be as abundant on Mars as it is on Earth, which is to say, not all that abundant – but it's not like you can just shovel the stuff straight into a nuclear reactor. Martian ore would need to be refined on Mars, requiring some fairly substantial industrial-scale infrastructure. So, none of this is impossible, but it's certainly not easy, making energy security yet another reason to not send a bunch of starry-eyed colonists on a one way trip to Mars.

In comparison, establishing a colony on the Moon's surface would be a piece of cake. Position your solar panels around the poles provides uninterrupted solar power. The Moon also has one of the most desirable qualities in any space colony - with Earth only three days away, you don't have spend your life there. It's not likely that any first generation space colonies are going to have aged care facilities. If you are on Mars or anywhere even more inaccessible you can expect your seventieth birthday to be shortly followed by a gentle hand on your shoulder congratulating you on a relatively long and fulfilling life and thanking you in advance for returning your body fluids to the recycling unit and everything else to the fertilizer plant.

Anyhow, it's likely we will go to Mars because it's there, but whether we will stay there is another matter. The planet doesn't have a lot going for it really. It's hard to land and launch from, its mining potential is limited and as a tourist destination, well there's only some many red rocks you can look at – although Valles Marinaris and Olympus Mons would make for great day trips.

It's likely the Earth will get overcrowded, if it isn't already, but if alternative accommodation is mostly unpleasant and potentially life threatening, the only people who will choose that alternative will be those with no other options, that is the financially disadvantaged. But then, where's the incentive to fund massive infrastructure costs in order to house people who can barely afford the rent. If living in inhospitable places using high tech infrastructure was a solution to overcrowding we'd have public housing available in the Sahara or Antarctica - which are vastly more hospitable places than Mars is. Of course we do house people in inhospitable places through the use of hi tech infrastructure, but those people are generally employees supporting mining or tourism and even research. They are not generally places were people have babies or grow old.

Our current solution to overcrowding on Earth is high density housing. So although individuals aren't paying a lot of rent, there are a huge number of individuals stacked up high on one small unit of land. So, imagine the Moon becomes a huge industrial complex where you crash asteroids on the far side and then extract what you want to provide materials for the manufacturing plants on the near side. You don't want your workforce living in the middle of all that, but nor do really you want them commuting in and out of the Earth's gravity well – which would be both costly and polluting. So high density apartments constructed on a huge rotating ONeill cylinder positioned at the Earth-Moon Lagrange points 4 or 5, means the workers are just as close to the Moon as the Earth is but the daily commute can be done without all that tedious mucking about with Earth's gravity and atmosphere. And living on the inside of a rotating cylinder avoids the space radiation issues that make living on Mars or the Moon problematic. The cylinder would be made of aluminium which can be extracted from lunar regolith, which also melts down to make good bricks and contains good quality iron and titanium – so, it is all feasible. So, what are we waiting for? Well, the first thing a space colony will need is energy, the second thing it will need is an economic reason for being. Until then, we need to keep on making things work down here on Earth.