Question 1:

Dear Cheap Astronomy – Is warp drive looking any more possible?

Well, no, insofar as it looks about as possible as it ever did, which is to say, it's probably impossible, but at the same time, it's best to never say never. As we've covered before, the nature of space-time precludes the possibility of faster than light travel simply because light travels as fast as it is possible to travel in space-time. That's not because there's anything special about light. It just so happens that light, being massless, can travel up to and at the universe's speed limit, and anything that does have mass can't do that.

But any theorist will tell you that doesn't rule out the possibility of warp drive since the whole idea of warp drive is to warp space-time and hence get around the speed limit in that way. There are at least two highly theoretical possibilities to explore here. Firstly, we could create wormholes in space-time. We know that black holes represent very deep gravity wells in space-time. So with a bit of intellectual gymnastics, one can create the possibility that you could connect one such well to another well and hence create a tunnel which might extend from one point in space-time to another point at a huge distance away, a distance that you could never hope to cross in a lifetime if you were travelling in space-time rather than around it.

But again, this is highly theoretical. While it's clear that a black hole can create a very steep gravity well, it's not clear how or why such a well should then become a tunnel. And surely the only reason the well is created in the first place is because of the black hole creating such an enormous concentration of mass-density. So, entering that well will just send you into the black hole, noting that you and your starship will be spaghettified on the way down.

If the wormhole story is correct, the other end of a supposed black-hole-generated wormhole is a white hole, where everything pulled into the black hole is ejected back out due to some kind of negative mass and negative energy activity. To date, we've not observed anything like a white hole spewing stuff back out into the universe – and if it did, it would be contrary to most traditional laws and principles of physics and cosmology. And so, until we do observe a white hole, it's best to just keep on calling this highly theoretical thinking.

Another option is to appeal to quantum physics, where quanta are the smallest indivisible measurements of things like length, volume, energy or whatever. And at those quantum levels there is always a level of uncertainty in those measurements. So, nothing is ever really zero, and nothing is ever really a vacuum. Particles and antiparticles appear and then annihilate, such activity being what people sometimes refer to as vacuum energy. And this is where the Casimir effect comes into play. For example, if you put two metal plates very close together, they start being drawn together, apparently because there's more vacuum energy outside the plates than in the narrow, restricted space between the plates. So, people like to say that between the plates, there's a negative vacuum energy density.

And there supposedly is that negative physics we need when we're trying to find work arounds to the space-time speed limit. But beyond establishing that general theoretical framework, it's mostly hand-waving about how on Earth we might build a starship to take advantage of that framework. Nearly every speculative article about warp drive refers to Miguel Alcubierre's paper proposing the generation of a warp bubble within which a starship could move without breaching the space-time speed limit, because it's just that bubble of space-time that's moving through space-time. But why that bubble should persist when it has a massive starship within it is where you start appealing to negative energy, which is not only highly theoretical, but even if it does exist, you'd need an awful lot of it.

And there have been alternative solutions to create warp bubbles with positive energy, that is known energy, but they also require a heck of a lot of it. Something like the mass-energy contained within the sun. And that then raises the question of how your starship could maintain its structural integrity in the face of such energy, be it positive or negative.

So once again, warp drive seems highly unlikely, and even if theoretically feasible, may require extraordinarily vast sources of energy to actually drive it, meaning you might not only kill yourself and destroy your starship, but also destroy the star system that you're travelling from and the star system that you're travelling to. And so, even if you could, you'd have to wonder why you'd want to.

Question 2:

Dear Cheap Astronomy – What is X-17

X-17 is a mysterious and somewhat hypothetical new particle. Somewhat hypothetical means there is some evidence for its existence, although it's more a case of there being evidence of something unusual, rather than definitive evidence of a new particle that does unusual things. The evidence comes from observations of nuclear decay, where you fire a particle beam at lithium-7 film, briefly forming beryllium 8, which quickly decays and shoots off electron positron pairs, but some of these separate at anomalous angles – anomalous insofar as they differed from their predicted behaviour, and then the same team found the same phenomenon in helium atoms. Particle interactions are very predictable events, so the anomalous angles need an explanation, and the team proposed that if a particle of 17 megaelectron volts had also been produced in the interaction, that would explain the anomaly – and that new particle was named x-17.

When we say it's a new particle, the current proposition is that it's a boson – a force carrying particle – rather than a hadron which is a material particle like a proton or neutron. The X-17 boson's effect is to alter the angle of deflection of two particles - so it does seem to apply a force. This is on the one hand terribly exciting insofar as there are only four known forces – gravity, electromagnetism, the strong and weak nuclear forces – with four associated bosons – that is, graviton for gravity, the photon for the electromagnetic force, the gluon for the strong force and the W and Z bosons for the weak. So, any new boson represents a possible fifth force, which is usually the headline click bait in any popular science articles on the x-17 particle.

But while a newly discovered fifth force of nature does sound terribly exciting, it doesn't apparently do all that much. Its action seems somewhat akin to the established weak nuclear force, which is mediated by the established W and Z bosons. So, the beryllium and helium anomalies could be hinting at some extra feature involved in how hadrons are held together, or otherwise how they fall apart, but that's kind of it. And we need to be a bit skeptical since we are just dealing with two instances of anomalous findings, with both having been found by the same team. There's been some preliminary work towards replicating the experiment with no definitive success or failure reported to date. And it doesn't really seem that anyone is really trying all that hard.

If it seems surprising that every particle physicist didn't urgently divert their attention towards discovering a new fifth of force of nature, well that's science. Bold claims get made and often fizzle out over time – and no-one else has seen any hint of this new boson despite it being produced fairly-modest energy collision levels. Indeed, there's been vastly more articles written about X-17 in popular science articles than in peer reviewed science journals. So, it is not altogether easy to get a big government grant to investigate something that sounds a bit dodgy. It probably will be the case that someone will squeeze a test into some other piece of research they are pursuing, but even then these things to take years and the beryllium and helium findings only came out in 2016 and 2019 respectively.

Of course, there's been some very bold claims in all the popular science articles. The fifth force angle gets a lot of coverage – although mostly just to write an article about the known four forces, leaving the reader to ponder what fabulous new physics may be on the horizon, without dwelling on the fact that that this alleged fifth force somewhat diverts the deflection angle of a few nuclear decay particles – maybe.

There also a hand-wavey narrative about how this new finding will lead to a new understanding of dark matter – despite the fact that it's a freaking boson, it doesn't have any mass! The logic seems to be that since this finding is a mysterious maybe, it will help us understand other mysteries. Sheesh.

(29) What is the best sci-fi movie that most people haven't seen? - Quora