Question 1:

Dear Cheap Astronomy: Is faster-than-light communication possible?

Hmmm…..no. We just have to accept that space-time really is space-time.

If you want to communicate with people almost instantaneously, that's easy, just whisper in their ear. But once you put distance between you and them, you just can't communicate instantaneously anymore. Because we communicate with each other on Earth at the speed of light, over distances of just a few thousand kilometres, it feels like instantaneous communication. But we know from experience that talking to someone on the Moon involves a 1.5 second delay, talking to our spacecraft at Mars involves a 6 to 20 minute delay and a message sent to or from Voyager 1 takes 17 hours.

The idea of instantaneously communicating with people who are a light year away is just nonsensical. They are a light year away… a year, by light. We have to accept that space is time and time is space, we can't have one without the other.

Theorists have suggested various ways around this seemingly-insurmountable barrier. The main contenders are quantum entanglement and wormholes.

Whether you believe in quantum entanglement or not, it's unlikely to offer an effective way of communicating information. It's true that two particles, once entangled, maintain a certain congruency when separated. So, for example, once you determine the spin of one, you can immediately know the spin of the other. Indeed, you will also know what someone else will see if they try to determine the spin of that other particle – even if it is light years away.

However, it is unclear how you could turn this phenomenon into a communication system. You don't actually know what the spin of the particle near you is, until you go and measure it. So, just knowing what the other person will measure at the other end, after you've done your measurements, doesn't really help you to send them a meaningful message.

If you follow the Copenhagen interpretation – that observing something collapses its wave function into a live or a dead cat – then observing the state of a particle close to you should cause its distant entangled partner to immediately collapse into the opposite state. This is Einstein's so-called 'spooky action at a distance'. But this effect doesn't really help you to build a communications system either, since the person at the other end can't distinguish pre-collapsed wave functions from unobserved wave functions until they observe all the particles in their vicinity – which will immediately collapse all the particle waveforms in their vicinity.

If we can ever figure out how to recognise a particle whose wave function had already collapsed prior to us measuring it, we could be onto something. At least we could be onto something if there really is such a thing as 'spooky action at a distance'.

Communication via wormholes is similarly doubtful. Wormholes are at best hypothetically possible, with utterly no evidence for their existence having been found to date. Even on a hypothetical basis, once formed they should either collapse immediately or otherwise become a black hole. So we have little reason to think they would be capable of relaying a clear signal from one end to the other.

Hard core theorists that propose a stable wormhole could be achieved using exotic matter with negative energy density, but this doesn't amount to much more than physicists' hand-waving.

So FTL communication? Hmmm… no.

Question 2:

Dear CA – How does the Higgs boson fit with Einstein's relativity theory?

A lot of people are starting to ask this now – with the Higgs boson confirmation last year and the Nobel Prize for confirming its existence this year.

The interaction between the Higgs boson and the Higgs field is what creates inertial mass. So if you imagine a mass floating out in fairly empty interstellar space, you will have to exert a force on it to move it forward. And you will have to exert more force to move a bowling ball than you will to move a golf ball. This is because the bowling ball encapsulates more matter than the golf ball does, which means that it has more Higgs bosons than the golf ball does – and those Higgs bosons create more drag on the Higgs field, a field which apparently pervades the entire Universe.

All that said though, the standard Higgs analogy, where Higgs bosons create drag through the Higgs field, like parachutes create drag through the air, is not a particularly good analogy. The Higgs interaction only resists acceleration. A mass can move at a constant velocity through a vacuum, potentially forever, without it ever experiencing the slightest amount of drag. This is Newton's First Law of Motion.

But anyway, let's now take the bowling ball and the golf ball and drop them off the Leaning Tower of Pisa. And since this is a thought experiment, let's have them drop in a vacuum. As you might guess, although they are two very different masses, they both accelerate at the same rate and they hit the ground at the same time.

Newton would have argued that the mass of the Earth and the masses of the two balls are important here. The-more-massive bowling ball experiences a stronger gravitational interaction with the Earth than the less-massive golf ball does. But Newton's Second Law of Motion tells us that the more-massive bowling ball needs more force to achieve the same acceleration as the less-massive golf ball does – so both the bowling ball and the golf end up accelerating at exactly the same rate and they hit the ground at exactly the same time.

The Higgs interaction explains this scenario in much the same way. The more-massive bowling ball – which might have accelerated faster than the golf ball, experiences more Higgs field resistance than the golf ball does – so both the bowling ball and the golf ball end up accelerating at the same rate and they both hit the ground at the same time. So, the Higgs interaction is really just different way of expressing Newton's Second Law - that is, you need a stronger force to equivalently accelerate a heavier mass.

But of course, Newton's Second Law and Einstein's relativity don't see eye to eye. Newton assumed that if you kept increasing the force acting upon a certain mass, you could accelerate that mass indefinitely, or indeed infinitely. Einstein effectively proved that nothing can be accelerated faster than the speed of light – and hence Newton's Second Law of Motion breaks down at very high velocities. There will always come a point at which you just cannot accelerate a mass any further, regardless of the amount of force that you exert upon it.

So, the Higgs boson fills a gap in the quantum-physics-based Standard Model by explaining mass. But it is doesn't manage to explain the behavior of mass at high velocities and it doesn't manage to explain gravity – indeed the whole of quantum physics doesn't really manage to explain gravity. So the Higgs boson discovery has done little to heal the current schism between relativity theory and quantum mechanics – all it really does is provide further support for the quantum theory perspective.

So, for now, we suggest that if you can fit the Higgs boson and relativity theory together, you should hire a tux or an evening dress and book your flight to Stockholm – another Nobel Prize will surely await you.