Dear Cheap Astronomy - Episode 005

Question 1:

Dear Cheap Astronomy - So, what's your take on the Higgs Boson?

The July 2012 announcement of the Higgs Boson was made with an appropriate degree of caution. The good folks at the Large Hadron Collider reported they had found a new particle in the energy range that corresponded to the range predicted for the Higgs boson.

This is still exciting and worthy of the world-wide press coverage that it got. But, there is no direct evidence that this new particle is what gives things the property of mass. So sure it's a new boson - but the Higgs boson? That's yet to be determined. It's as though we have arrested someone who was at the crime scene at the time of the murder, but we are yet to positively identify their fingerprints - or their DNA - on the murder weapon. So it's reasonable that we detain this particle, question it and refuse it bail - but the case for the prosecution requires further development before we can establish a conviction.

The predicted energy range of the Higgs boson comes from consideration of what the smallest possible excitation of the hypothetical Higgs field should be.

The concept of the 'smallest possible excitation' is a central tenet of quantum mechanics. Any energetic event that takes place in the universe can be deconstructed down to its simplest and most basic components. The photons being produced from the heating of a metallic filament in a flashlight globe represent the smallest possible excitation of the electromagnetic field. Photons are electromagnetic bosons. But although they are the smallest possible excitation, there are still certain energy ranges within these smallest possible excitations which produce anything from radio waves to gamma rays.

In a similar way the smallest possible excitation of the theoretical Higgs field is a Higgs boson. And there could well be a range of Higgs boson energies - after all, different fundamental particles do have different masses which aren't obviously multiples of a single unit. So there might be light Higgs bosons and heavy Higgs bosons - just like there are radio wave photons and gamma ray photons.

This is what happens after great moments in science, we can go crazy for a while with wild speculations. A whole new field of enquiry has opened up - of which we know so little.

Of course the really interesting part of the whole Higgs picture is the Higgs field. Allegedly, it's a scalar field that pervades the whole universe and which acts like treacle on anything that has Higgs-boson-related-mass, but the field has no effect at all on photons, or any other mass-less particles.

This means the Higgs field is not the same as space-time - which when curved can alter the path of photons and even prevent them from moving at all, in the case of a black hole.

But perhaps the Higgs field does play some role in the relativistic scenario of a spacecraft accelerating up towards light speed - but never managing to get to that speed as its relativistic mass grows towards infinity. Is this, in some way, a cumulative treacle effect - meaning that you can push a massive particle through the resistant Higgs field so much - but no further?

Who knows - a new door has opened. We should all go forth and ask questions - none of which should be considered dumb.

Question 2:

Dear Cheap Astronomy. What would happen if a Star Trek transporter transported me from the Equator to the North Pole? Isn't there a conservation of angular momentum problem?

Wow - great question. Yes, it's true that a whole bunch of physics problems arise if you try to imagine a device that can deconstruct all the information about your physical presence - transmit that information to a distant location and then decode the information back into physical manifestation.

So, yes if a transporter was to transport information about the relative momentum of person, at their origin on the equator, to a distant location at either of the Earth's poles - then upon re-materialisation, that person would be flung laterally to crash violently through the wall of the transporter bay.

This is because, relatively speaking, an object at the equator is rotating laterally at 1,500 kilometres per hour, while an object standing at either of the geographic poles only needs the tiniest of motion to achieve a complete rotation once every day.

In fact, you can face a similar problem in transporting someone from an orbiting spacecraft down to the surface of a planet - which is a more familiar Star Trek transportation scenario. For example, to maintain a geostationary orbit your spacecraft would need to move at a velocity of about 11,000 kilometres an hour. So, if you transported from that geostationary 11,000 kilometre an hour orbit down onto the surface, that is moving no more than 1,500 kilometres an hour - that will also see you flung through the walls of the transporter bay.

Of course you could program the transporter so that it didn't carry any information about a person's intrinsic momentum. But that might not work out well, since your cardiovascular system would then have to restart itself from a static state, your heart needing to push very hard to restart the flow of a whole 5 litres of adult blood volume, with the first few pumps being vital to re-infuse the heart muscle with fresh oxygen and subsequent pumps then desperately working to re-oxygenate your brain, as well as clearing out the CO2 that will accumulate while you are freaking out that your blood has stopped circulating.

And, of course, instructing your transporter to transfer a person with no lateral momentum down to a part of the planet that is moving at 1,500 kilometres an hour, will also see that person flung through a different wall of the transporter bay - notwithstanding that person may be experiencing a heart attack, as well as cerebral hypoxia and acidosis, while they are being flung.

So if Star Trek style transportation is really going to work, we will need to program transporters to ensure that they always mind your surroundings. They will need to initially assess the inertial frame of reference that you are transporting from - and also assess the inertial frame of reference that you are transporting to - and then mathematically adjust your intrinsic momentum settings so that you will fit comfortably into your distant location's inertial frame of reference without you being flung through any of the walls of the transporter bay.

Of course once you have a machine that can readjust your intrinsic physical settings to allow you to be transformed to fit within a different inertial frame of reference - you pretty much have the makings of an anti-gravity machine and quite possibly a time machine. Good luck with that.