

## Question 1:

*Dear Cheap Astronomy – How bad is gender bias in space?*

In a perfect world, special consideration of women in space would be unnecessary. There would just be consideration about generic humans where we might ponder a range of physical differences. So, for example, the shortest astronaut in space was Peggy Whitson, at 1.6 metres, the first female commander of the International Space Station and the tallest astronaut was Jim Wetherbee at 1.93 metres, who flew the most space shuttle landings, five. The youngest astronaut was Gherman Titov at 25 years old and the oldest astronaut was John Glenn at 77 years old.

But since we don't live in a perfect world, it is the case that women are substantially under-represented in the astronaut population, making up around 10% over the history of human spaceflight, though things have been improving with women making up around 30% of active-flying NASA astronauts right now. The gender bias somewhat arises from child-rearing where the average age of flying astronauts is around 38, so mothers tend to be disadvantaged in the very competitive world of astronaut career advancement should they choose to take some time out. That's the only issue though, women and men have had children after flying to space. Various early concerns about menstruation needing gravity to work came to nothing – after all it's not like women stand upright 24 hours a day. If there were ever any equivalent concerns about men's sperm losing their way in microgravity, these never got much attention. Men and women's plumbing differences are largely irrelevant – early on women managed to adapt to toilets primarily designed for men – and nowadays there is an essentially unisex toilet aboard the ISS, with no particular reason for there having not being one before.

To be fair, the initial US push to get astronauts into space was gender-biased with a purpose. By ensuring that astronauts were military personnel and quite often test pilots, it meant they were people who already had a higher than average likelihood of dying at work. That said, the Russians seemed a bit more relaxed about it all, flying both Valentina Tereshkova in 1963 (two years after Yuri Gagarin) and Svetlana Savitskaya in 1982 before Sally Ride from the US went up in 1983. Over the course of the astronaut age there have been 19 fatalities in flight, 15 US and 4 Russian, with 4 (all US) being female. This is all tragic, particularly losing the first teacher in space, but none of these deaths, male or female were absolute show-stoppers. So, just because something's dangerous, doesn't mean you should just send men.

And a quick aside here, did you know about the Fallen Astronaut installation on the Moon? In 1971, the Apollo 15 crew dropped an apparently-unauthorized plaque listing the fourteen US and Russian astronauts that had died up to that time. The installation includes a 9cm aluminum astronaut figurine lying prone on the ground amongst astronaut footprints in the lunar soil.

So, while human beings may be tragically flawed, they still do occasionally shine and all the gender discomfort is just dumb-stupid Earthling stuff. Since space exploration seems the best answer to our ongoing existential dilemma about what should we do next, we should also be aiming to accommodate the whole of humanity in our space travel plans.

A March 2019 plan for the first spacewalk to be conducted by two women had to be canned, because there weren't enough small size spacesuits to accommodate both women. There is a reason for this insofar as space suits are expensive so limited stock means the majority will fit an average sized person. But this exemplifies the whole gender bias issue. If most of the available space suits are too big to accommodate the female crew, because most spacewalks are done by men, then most spacewalks will continue to be done by men. This is just a failure to address the requirements of 50% of humanity. As it turned out a two women spacewalk did go ahead in October 2019, where a subsequent female crew member was able to wear a medium sized space suit. The next generation of spacesuits planned for the Artemis missions are expected to be more accommodating of different sized people and will hopefully get the first woman on the Moon. It's about time.

## **Question 2:**

*Dear Cheap Astronomy – What is time made of?*

So firstly, time is not something you can deal with in isolation. It is just one aspect of spacetime, where the other aspect is space. The reason the Universe has an ultimate speed limit is that you can never cross any distance of space without time also passing. By using more energy and better technologies you can certainly reduce the duration of travel between points A and B, but that duration will never reach zero. Similarly when we look far out into the universe, or even when we look across the room we are also looking into the past – and the further away something is, the further back in time it is. Time and space are so intrinsically connected that we just call the whole thing spacetime.

So what is spacetime made of? Tricky. It is intangible to any of our senses in a material sense. We can measure the distance between objects, noting that distant objects are distant in both space and in time. But all we are doing there is measuring the expanse without saying anything about what it's actually made of.

There are various grounds for arguing that spacetime does not really exist – although if you're stuck in a queue to pass customs and your international flight departs in 15 minutes you may not be all that partial to this line of thinking. But consider the humble photon, it moves from point A to B with no proper duration of time, that is if it had some kind of consciousness or some kind of measuring device, it could neither experience nor measure the passage of time. Equally if no time passed between it moving from point A and point B, then it would be at point A and B at the same time – indeed if you extended its line of travel out to point C it would also be a point C at the same time. So just as a photon would have no perception of time, it would have no perception of distance (or space) either.

But really this is just an issue of frames of reference. For a photon, it's absolutely true that there is no time and space, but that's because a photon moves at the speed that defines the interconnection between space (distance) and time. Spacetime in our universe is measured as the ratio of 300,000 kilometres of distance to 1 second of time, so if you can cross 300,000 km of distance in one second then there's no duration and there's no gap, but if it takes you two seconds to cross 300,000 km, then you start to notice that there is a gap and

that it takes a bit of time to cross that gap. And if you're a slightly overweight sub-light speed entity facing a 16 hour flight from Sydney to Los Angeles – that's 50,400 seconds to cross just 12,000 km – and you're stuck in a queue to pass customs and the flight departs in 15 minutes, then you'll have no problem in acknowledging that spacetime is very real.

But what's it made of, or why don't we just ask what is it? Well, we do think there was no spacetime before the Big Bang and immediately after there was – and there's a heck of lot more of it now. So, it could be argued that an external observer would see an energetic quantum fluctuation burst into momentary existence, its momentary bubble of energy quickly expanding so as to cool back down to the background zero point energy possessed by the background tapestry of whatever fundamental reality allows the occasional and temporary outbursts of Universes.

As we like to say here at Cheap Astronomy, this is just an example of avoiding the origin problem. If your response to the question of how the Universe came to be is to say that well actually there's a multiverse in which Universes appear and disappear all the time, you're not really adding much in the way of useful information. Thanks dude, but I actually want to know how this Universe came to be, because my (bleep) international flight is leaving in 15 (bleep) minutes and it's a (bleep) long way to (bleep) Los Angeles. So, I don't give a flying (bleep) about anyone else's Universe I want to know about this one. OK?

A good deal of the world's philosophical conundrums are readily dealt with such circumstances. I queue, therefore I am – indeed, the Universe must be, because why the (bleep) else would I be queueing. I hate queueing.