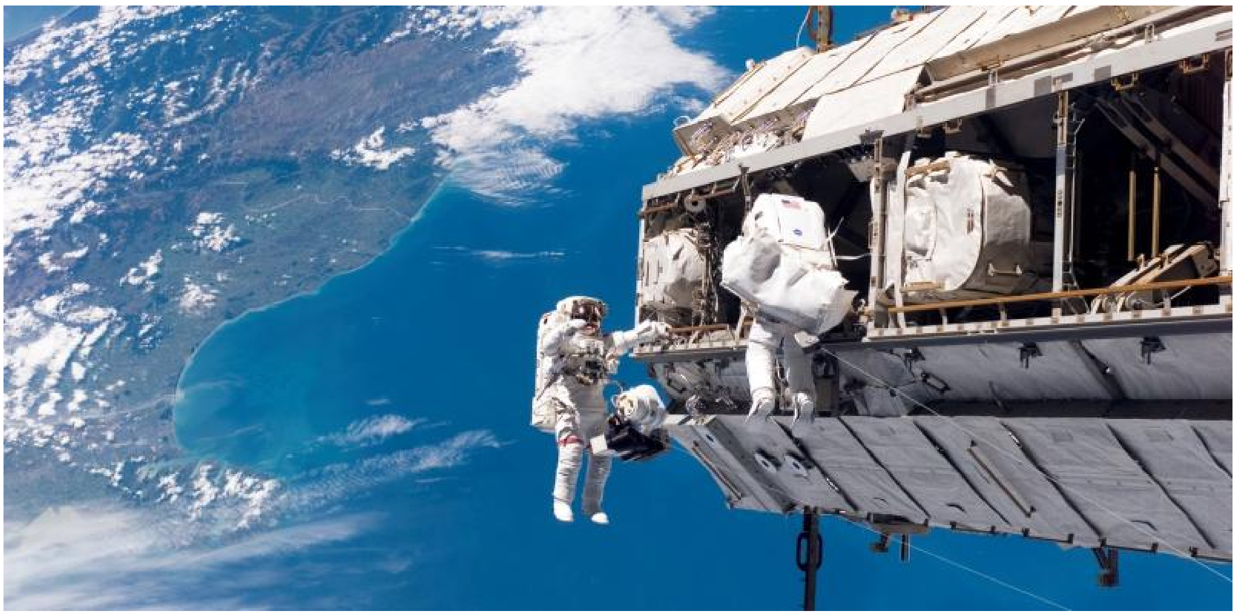
Explainer: What is microgravity?

April 27 2016, by Sabrina Gaertner, The Open University



Spacewalk. Credit: NASA

It's easy to assume that astronauts float in space because they are far away from the Earth's gravitational force. But look at the moon. It is much further away than the International Space Station, yet it orbits around the Earth because it is perpetually attracted by its gravitational pull. So if the Earth's gravity can affect the moon, the astronauts cannot be floating because there is no gravity where they are.

Gravity is an attractive force, which is always present between two objects that have a mass. It's such a weedy force, however, that we need huge objects such as planets or moons to realise it's there at all. We usually describe the acceleration of an object with mass towards the centre of the Earth by Earth's gravitational "pull" with the constant "g" – it is just less than 10 metres per second squared. This pull decreases as the distance between the objects increases. But to get rid of it entirely we would have to go an infinite distance away from anything with any mass.

However, we can create environments in which we don't experience the effects of gravity. Usually people refer to such "microgravity" environments as "zero-g", because they make objects appear weightless. But what does it actually mean to be "weightless"? The thing about forces is that you only notice them when there is another force counteracting them. Since you have a mass, the Earth's gravitational pull is always accelerating you towards its centre. Luckily, the ground is in the way. But if there was nothing to stop you from falling, you wouldn't feel the ground "push back" and you would feel weightless.

This is the first way to "get rid" of gravity: free fall! Some people think of skydiving, but in fact a skydiver is never really in free fall – air drag can slow objects down. For scientific experiments, however, researchers can overcome the air resistance issue by pumping out air from a huge tower, some 150m high. Then they shoot experiments up to the top of the tower –- and drop them – yep it's called a "drop tower". The experiment, and everything inside it, is in "microgravity" as it falls – for about four seconds – until BANG, it hits the ground. That violent end means the type of experiments scientists do in drop towers need to survive regular crashes, which is not always ideal.

Another way to achieve "free fall" is to put things into orbit (such as the International Space Station). A force, called the centrifugal force, "pushes" an object travelling in a circle away from the centre of the motion. Go around a corner fast on your bike and if you don't lean into the "bend" you'll find it difficult to stay on the bike and steer at the same time – lean too far and the wheels will get "pushed out" from underneath you. It's all a matter of balancing forces.

So, an object in "free fall" orbiting the Earth at just the right speed and altitude can appear weightless. This is the case with the ISS. Here, astronauts and everything else in it all travel in free fall, making it an amazing microgravity science laboratory.

NASA parabolic flight. Credit: NASA

Microgravity research

But why do scientists need microgravity? The majority of processes on Earth are influenced in some way by gravity, which means exploiting microgravity environments for research is a clever way to learn more about the way in which the world around us works.

There have been some amazing research firsts already. Materials scientists looking at how metals interact in alloys in microgravity, for example, have created lighter components in turbine blades in aircraft engines. Time accuracy on Earth is also being improved by the presence of atomic clocks in space and medical instruments first developed to test the pressure in astronauts' skulls are now used to monitor head-trauma patients in hospitals.

In my own research, we use microgravity to tackle the conundrum of how planets form. We know from observations that the dominating material in planet-forming regions is small grains of dust and ice. So, how can we stick those together to form a planet? So far, we can explain why very small things (km) stick together – gravity. The problem is, how do we get from grains of mm sizes to km sizes? We don't know.

And it turns out experiments on Earth are difficult as the particles are so fragile and slow that the dust grains will soon break apart or simply hit the ground because of gravity. We are therefore using a microgravity environment created by something called a parabolic flight, in which test pilots with special training very carefully adjust the flight path to follow a curve that produces the feeling of "weightlessness" for those inside the plane. This feeling lasts for about 22 seconds so they are repeated again and again – at least 31 times per flight – like a three-hour rollercoaster ride. While we have successfully collided particles in this way, we haven't managed to make them stick yet. But stay tuned.

While the future of Earth-bound microgravity environments is assured as long as they can be funded, the lifetime of the ISS is currently confirmed only until 2020-2024. So what's next? Some major companies are developing "space planes", which could take tourists to the "edge of space" for a few minutes to experience weightlessness. But such flights are also ideal opportunities for scientists to conduct experiments. Likewise, nano-satellite industries are looking to build small cheap satellites, which could potentially also be used for scientific experiments. It's a pretty exciting time to do microgravity research.

This article was originally published on The Conversation*. Read the* original article.

Source: The Conversation