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WHERE SPACE BEGINS

Ken Tapping, 19th November, 2013

A few days ago, the European Space Agency's spacecraft Goce burned up and disintegrated in the Earth's atmosphere. Observers in the Falkland Islands had a grand-stand view of the spacecraft as it crossed the sky, breaking up as it went. The debris came down somewhere in the South Atlantic. There was a lot of media discussion of the spacecraft re-entering the Earth's atmosphere and being destroyed. Actually it never left.

Lots of the older books about space and astronomy hint there is a definite boundary between where we live, and space. They imply that where we live we have air to breathe and gravity to hold everything down, while in space there is a vacuum and there is no gravity, or even `microgravity`. This is just not true, either in the case of the atmosphere or gravity. As we go upwards, the air gets increasingly rarefied. That is why we put observatories at the tops of high mountains or in space to reduce or escape the effects of the atmosphere on our observations. However there is no definite place where the air ends and space takes over.

Gravity does not end either. As you get higher, and further from the centre of the Earth, gravity weakens. Double the distance and the gravitational pull decreases by a factor of four. However, that does not end either. It reaches far out into space, getting weaker and weaker.

If there is any reasonable boundary it would be where the atmosphere has become so rarefied it blends in with the solar wind, or at such a distance that the Earth's gravitational attraction is about the same as all the other gravitational attractions acting on any body at that location.

Spacecraft do not stay in orbit because there is no gravity. If we could build a tower 400km high, to where many satellites orbit, we would find the gravitational attraction at the top to be just a little weaker than it is at the Earth's surface. If we were dumb enough to step off, we would head straight down at high speed. When we launch a spacecraft, we lift it above most of the atmosphere and then gradually turn the rocket so that it is moving more or less parallel with the Earth's surface. The engines continue to operate, accelerating it to around 30,000 km/hr, parallel with the ground. When the right speed is reached, the engines are shut down and the spacecraft released. With no means of propulsion, the spacecraft starts a long, curving fall to the Earth's surface. However, it never hits because the Earth curves away beneath it. The best description is that it is in "free fall". In free fall, there is no sensation of weight. We could experience exactly this feeling in a falling elevator, but not for as long. Chris Hadfield and the other astronauts in the International Space Station were falling around the Earth. Inside the ISS there is plenty of gravity, so it is not a microgravity environment; it is more an environment where gravity is not as apparent.

Since the atmosphere extends far into space, all our orbiting spacecraft are actually moving in it. If we are high enough, say 2,000 km, the air is so thin that the drag will probably not affect us for centuries or longer. At lower altitudes, spacecraft such as the International Space Station, orbiting about 420km above the ground, experience much more drag, and without an occasional boost, the ISS would soon come down.

The only manned spacecraft so far to truly re-enter the Earth's atmosphere were those carrying the Apollo astronauts. And in future, people returning from new missions to the Moon and of course our first expeditions to Mars.

Venus shines brightly, low in the southwest after sunset. Jupiter and Mars rise around 8pm and 1am respectively. Look for Mercury low in the southeast before dawn. The Moon reaches Last Quarter on the 25th.

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