Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Ed White's Glove.*

This 365 days podcast is about various things in orbit, of which Ed White's glove is often mentioned in an iconic fashion. Ed White was part of the Gemini 4 crew which flew in June 1965 and Ed White was the first American to do a space walk during which one of his spare gloves floated out of the open hatch of Gemini 4, an event captured on film. And long after the Gemini space craft had landed, the glove continued to orbit the Earth at 27,000 km/hr or 8 km/sec. And, lets face no-one really wants to get anywhere near a space glove moving at 8 km/sec.

So why is does everything in orbit move so fast? Well, let's start with the solar system. About 5 billion years ago a huge cloud of gas and dust began to collapse in on itself as the accretion of a critical mass of particles created a gravitational centre for the rest of the cloud to fall into. As though someone had just pulled the plug in a huge bath, everything was drawn down into a gravity well, but there was such a vast volume of material that most of it could only spiral towards, rather than falling straight into, the growing centre of mass. This spirally, spinning motion flattened down the cloud into a disk, kind of like what happens with pizza dough when you spin it up in the air.

Nearly all the dust and gas in that spinning disk did eventually fall into, and become, the Sun – which today represents about 99.9% of the mass of the solar system. But, while the solar system was still forming a tiny proportion of the accreting material was falling at just the right trajectory and at just the right speed so that it fell around the Sun – carried by its own momentum back out to the apoapsis of an ellipse before being drawn back again by the Sun's gravity.

And as long this accreting material continued moving interrupted at the same speed it could just keep falling around the Sun again and again because in the vacuum of space there's nothing much that can slow an object down.

Of course, the closer you get to the Sun, the faster you have to go to maintain that orbit, because you are in steeper part of the Sun's gravity well. The material that accreted down into a sphere and became Mercury, orbits the Sun at an average distance of 58 million kilometres by maintaining a speed of 48 kilometres a second. Earth at 150 million kilometres distance moves at less than 30 kilometres a second – and Neptune which is over 4 billion kilometres from the Sun moves at a more leisurely 5 kilometres a second.

It is pretty much all about speed – if you could magically double, or even triple the mass of the Earth without perturbing its orbit or its velocity, it would still continue along the same orbital path that it does now. The only change would be a very slight adjustment in the centre of mass about which both the Sun and the Earth are orbiting – a point called the barycentre. Although when I say the Sun orbits, it really just kind of wobbles a bit while the Earth is being flung about a huge ellipse at nearly 30 kilometres a second.

This is because the barycentre is well within the body of much more massive Sun. You would have to increase the mass of the Earth by something like 100,000 times – for the barycentre to sit outside the body of the Sun – at which point you would have to start calling the two objects a binary system, rather than a Sun and a planet.

Anyway, getting back to the real Earth – since it is much less massive than the Sun, it doesn't generate nearly as steep a gravity well, so the orbital velocities we are used to are not so extreme as those around the Sun. For example, the Moon orbits the Earth at about 1 kilometre a second at an average distance of 380,000 km.

Nonetheless, to maintain an orbit closer to the Earth you are going to need greater speeds. For example, to maintain an orbit about 36,000 km above Earth, an object needs to move at about 3 kilometres a second. You may be aware that is called a geostationary orbit because if you orbit something here it will appear motionless in the Earth's sky as it keeps pace with the Earth's rotation.

Even closer to the Earth is another important orbit, at just over 20,000 km altitude, where a constellation of GPS satellites do exactly two orbits for every one rotation of the Earth by maintaining a speed approaching 4 kilometres a second.

Then, when you are getting right down towards low earth orbit, you can find the Hubble Space Telescope at about 560 kilometres altitude moving at 7.5 kilometres a second – and lower down again you can find the International Space Station at around 300 kilometres in altitude moving at almost 8 kilometres a second.

Various spacecraft like the Space Shuttle, Apollo, Gemini – even Yuri Gagarin's Vostok 1 have managed orbits even lower than this. But, because it's Earth, orbits at this height cannot be maintained for long periods, at least without burning a lot of fuel due to the drag of the very rarefied, but still detectable atmosphere present at these altitudes.

The ISS only manages to stay in orbit by firing two engines attached to the Zvezda module several times a year – or otherwise getting a boost from a visiting space shuttle. And this boosting is required more frequently during periods of high solar activity when the atmosphere heats and expands outwards adding more drag to any low orbiting objects.

So, with a tinge of sadness, I have to report that Ed White's glove is long gone – as are various other astronaut discards in low Earth orbit – like Michael Collins camera from Gemini 10 and a toothbrush from an unknown crew member of the Mir space station.

However, Heidemarie Stefanyshyn-Piper's toolkit which she lost in November 2008 during the space shuttle mission STS 126 is still up there and can be seen with binoculars or sharp eyes at the right time of an evening. Just go to heavens (dash) above.com and look for ISS toolbag – and maybe you want to do this soon, like maybe in 2009 the International Year of Astronomy, because it won't stay up there forever.

My favourite object in orbit is called J002E3 – which was detected in 2002 and first thought to be an asteroid, until closer inspection found it was covered with white titanium dioxide paint. Back tracking of its orbit suggested it had come back to Earth after being in a solar orbit since at least 1970. With a little detective work, it was determined that it was in fact the third stage of a Saturn V rocket – indeed the one diverted into a solar orbit after launching Apollo 12 – but which ran out of fuel before achieving a full solar orbit insertion.

J002E3 disappeared in 2003, presumably to return to its broken solar orbit. It will probably come back to Earth for another visit in 2032.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where you don't have to be a rocket scientist to make some savings. No ads, no profit, just good science. Bye.