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LANDING ON A COMET

Ken Tapping, 25th November, 2014

Over the last few weeks the Rosetta space mission to investigate Comet 67P has attracted a lot of interest. After a ten year journey, the Rosetta spacecraft successfully rendezvoused with the comet and went into orbit round it. Then a lander, Philae, was dropped onto the comet's surface to take samples and to have a really close look at the comet and what goes on there. Philae has already given us enough data to keep us quiet for quite a while. However, some challenges arose, which is not to be unexpected when we did not have a clear idea of what sort of thing we were landing on.

Comets have been described as "dirty snowballs" – big lumps a few kilometres across of the sort of stuff we see by the side of Canadian city streets in late winter – grey or even black mixtures of ice, dust, grit and petrochemicals. Since comet bodies are so small, their gravity is extremely weak compared with what we experience here on Earth. We would therefore expect that with so little force holding them together, they would be soft.

On our planet, gravity is a key contributor to most things we do. Without gravity we could not walk. Being firmly anchored to the ground makes it easy to use tools such as wrenches, drills and screwdrivers, and to push or pull things. Take gravity away and even simple tasks require a rethink, as astronauts know only too well. For most of us the nearest experience we will ever have to being weightless is when swimming.

Have you ever tried to just sit on the bottom of a pool, or to do simple tasks underwater? The density of our bodies is close to that of water, so underwater we are more or less weightless. The slightest movement or disturbance will lift you off the bottom of the pool, and doing any sort of operation becomes hard when any effort pushes you off in the opposite direction. This gives us an idea of the problems associated with landing on a comet and then doing things there. Comet 67P's surface gravity is very roughly 100,000 times weaker than it is on our world.

A famous experiment that Galileo might or might not have actually carried out was to drop two iron balls of different sizes off the Leaning Tower, in Pisa, Italy, to show they would reach the ground together. The fall would have taken about 3.4 seconds, with the balls moving at about 33 metres a second on impact. If that tower were on Comet 67P, the same drop would take almost 18 minutes and the balls would hit at about 10 centimetres a second. Falling to the surface of the comet was no problem for Philae; neither was the impact velocity. The problem was to avoid bouncing off again.

To deal with this the lander was intended to fire anchors into the surface material. To stop the recoil of firing those anchors, a little rocket motor would push downwards when they are fired. The anchors would also be needed to prevent using sampling drills and other devices from pushing the Philae upwards, off the surface, or making the lander topple over. However the surface it landed on was harder than expected, and the anchors did not work, so Philae bounced, bounced at least once more, and finally landed in the shadow of a rocky outcrop, where it could not catch enough sunlight to recharge its batteries. This led to the science timetable being speeded up as much as possible before the batteries were depleted and Philae had to go into hibernation. Hopefully, as the comet gets closer to the Sun, the intensity of the sunlight will increase and the project team expects the Philae to revive and to astound us some more. However, the results obtained so far are stunning and have already made the mission worthwhile. The latest announcement is that organic chemicals have been found, lending credence to the idea that this is how the raw materials for making life arrived on the young Earth, over three billion years ago.

Jupiter rises around 10pm. Mars still lies very low in the sunset glow. The Moon will reach First Quarter on the 29th.

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