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## THE RED PLANET: PART 3

Ken Tapping, 2<sup>nd</sup> January, 2018

So far there are only two places beyond the Earth we are seriously considering for long-term manned visits or permanent bases: the Moon and Mars.

The Moon is a pretty hostile place, but it is nearby and relatively easy to support from home. We can get there in a couple of days and it is conceivable that it won't be long before we can get there faster than that. Mars is less hostile, but lies many months away using current space technology.

One scenario is that the Mars expedition gathers at the International Space Station, orbiting the Earth at a height of 408 km, at a speed of 7.7 km/s. We have to escape from the Earth's gravity and then put ourselves into a transfer orbit to Mars. Firing the engines long enough to increase our speed to 11.2 km/sec will escape the Earth's gravity so that we become an independent object orbiting the Sun, moving at the same orbital speed as the Earth, 30 km/s. To get us into the transfer orbit to Mars requires us to increase our speed by an additional 2.5 km/s. Now we just sit back and relax for many months, as we coast outwards. There are other scenarios, with different compromises between fuel economy and time spent in transit.

We plan our departure time so that when we arrive at Mars' orbit, Mars is there to meet us. At that time our speed will be about 21 km/s, whereas Mars will be moving at 24 km/s. So we will need our engines again to match speeds, otherwise Mars will whiz past and we will start falling back sunwards. Now we are in orbit around Mars. To get to the surface we will need the engines again, and then maybe a combination of parachutes, wings or other means to reach the surface safely.

With a supply line many months long, the expedition will have to take advantage of locally available resources. The atmosphere is far too thin to breathe and contains no oxygen. However, there is a wealth of solar energy available and there are bodies of ice below the surface. So water

is available and using solar-generated electricity we can break down water to yield oxygen to breathe. The Martian soils are loaded with toxic chemicals formed by the action of solar ultra-violet radiation. These together with the daily temperature extremes would be too much for any earthly crop, but soils can be cleaned and it is conceivable that our Martian visitors or colonists would be able to grow crops in heated greenhouses. Despite Mars being further from the Sun, most days are clear and sunny.

It might be better to put our base completely underground. The temperature changes would be less extreme and the solar radiation hazards would be reduced. With lots of solar electricity available the greenhouses could be underground too. Oxygen is a by-product of plant photosynthesis, which would be useful to the colonists, and the carbon dioxide they breathe out would be useful to the plants. The surface rocks contain a lot of iron and other metals, so using solar energy for smelting ores could be a valuable source of raw materials. Minimizing the need for stuff that has to be shipped at huge cost from Earth would help with the viability of our foothold on Mars.

However, the idea of Martian settlers making their own way right from the beginning is unrealistic. Life on Mars will be dependent upon advanced technologies, some of which we have yet to develop. In addition, to remain healthy, how much of our environment do we need to take with us? Experience with long-term stays on the Mir and International Space Stations has shown us that missions of a year or two are certainly feasible, but long-term colonization will probably have to wait.

Jupiter and Mars lie close together in the Southeast before dawn. Mercury is low in twilight and Saturn even lower. The Moon will reach Last Quarter on the 8<sup>th</sup>.

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