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## WORKING ON THE MOON

Ken Tapping, 26<sup>th</sup> March, 2019

One day we will have observatories on the Moon. Since the Moon has no atmosphere, they will encounter no cloudy nights and all the cosmically interesting radiations from space will reach the telescopes. There will be no street light glare or other human-made light pollution, our radio interference will be over 400,000 km further away, and if we put our telescopes on the other side of the Moon, never above our horizon. There is another huge advantage to putting telescopes on the Moon. We can have people nearby to operate, maintain and upgrade them. Orbiting telescopes such as the Hubble Space Telescope avoid the problems of trying to observe from the Earth's surface, but at the expense of an instrument that has to survive the rigours of being launched, deploy its equipment automatically and then work reliably for years. That is very hard.

Imagine a cluster of optical, X-ray, infrared and radio telescopes surrounding a lunar base housing scientists, engineers, technologists and others. The base will contain the laboratories, workshops and living space needed for long-term occupation. It will be something like one of our bases in the Antarctic, designed to support living and working in an extremely hostile environment.

The absence of an atmosphere, which is an astronomical advantage, is also a challenge. Many of the radiations from the Sun and elsewhere in the cosmos are hazardous to living creatures. An atmosphere provides an insulator and heat trap, making Earth temperate and mostly comfortable. Without this the Moon's surface experiences daily temperature variations ranging from above the boiling point of water to below a hundred degrees Celsius below zero. On the plus side, guaranteed sunny weather every day makes solar power a good option for providing electricity to the telescopes and to the Moon Base.

The temperature changes and radiation levels on the surface make it an undesirable place for long-term human habitation. However, a few metres

underground the temperature is an unchanging minus fifty Celsius, which is much easier to live with. It gets colder than that in Canada; -63 degrees C has been recorded in the Yukon!

Ice has been discovered on the Moon. This is good news because it means water won't have to be expensively imported from Earth, and with abundant electrical power, oxygen for breathing can be obtained from that water. Greenhouses lit and heated by locally generated power, and irrigated with locally obtained water would provide at least some of the food requirements of the local inhabitants. However, that ice could also provide an engineering challenge, as it does in the Arctic.

There is a lot of ice in the ground in the Canadian Arctic. It is called permafrost because under normal conditions it never melts. If for some reason it does melt the ground collapses and so do any buildings sitting on it. To avoid heat from those buildings melting the permafrost they are mounted on piles so that there is an air gap between their floors and the ground.

The situation with the Moon Base will be a bit more complicated, since it will actually be in the ground. The engineering challenge will be to ensure the ground in contact with and supporting the base will always remain well below zero. However, there are buried buildings in the Antarctic and other places, so we are at least part way to a solution.

At the moment the biggest impediment to setting up and running a base on the Moon, with a good collection of scientific instruments, is not the engineering of the base itself, but more the transportation problem. How do we get there?

Mars lies in the southwest after dark. Jupiter rises around 2am, Saturn 4am and Venus 5am, in the predawn glow. The Moon will reach Last Quarter on the 27<sup>th</sup> and be New on the 5<sup>th</sup> of May.

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