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BACK ON THE GROUND

Ken Tapping, 20th January, 2015

With the high-quality data we get from spaceborne observatories such as the Hubble Space Telescope and what we expect to get from the James Webb Space Telescope (JWST), why observe from the ground at all? Actually there are very valid reasons for us to continue building ground-based observatories. For many things they can produce more data per dollar spent than is possible with space equipment. It is easier and much cheaper to build ground-based telescopes, and is far easier to maintain and upgrade them.

We can also make ground-based telescopes larger. At the moment we are not able to build large telescopes in orbit. We have to build them on the ground and design them so they will fold up to fit into the launch vehicle, and then pray they unfold and deploy properly in orbit. This limits their size and makes them technically complicated. It is difficult but possible to maintain and upgrade the Hubble Space Telescope as it orbits the Earth. Once the JWST is at its intended location 1.5 million kilometres away, it will be inaccessible.

This means a need for very careful testing of components and the systems into which they are incorporated. Such testing includes environmental extremes and violent shaking, as will be encountered during launch. These requirements make the project development take a long time, and mean the design has to be “frozen” fairly early in the project. It is hard to change the design later in the construction to accommodate new discoveries or new technologies because it could jeopardize the reliability of the instrument when in orbit. This meticulous implementation process is the reason there are spacecraft scattered around the Solar System and beyond which have been doing their thing untouched for decades, some in the outermost reaches of the Solar System.

Spaceborne instruments do not replace ground-based telescopes; they complement them. Ground-based facilities are cheaper to construct and can be made bigger. With technologists, engineers and scientists usually only a few minutes away, state-of the art detectors and other hardware can be deployed quickly. Technical innovations can be attached to the telescope as soon as they are working. Any requirements for babysitting and frequent maintenance are not a problem. Telescopes can be reconfigured rapidly to follow up on a new discovery, such as a nearby supernova. Ground-based instruments are great for student involvement. Around our observatory we have lots of hardware and software innovations developed by students as part of their research.

The main disadvantages of the ground-based instruments come from having to observe through the atmosphere. Clouds and bright skies during the day lead to periods where observations are restricted or impossible. In addition, the atmosphere blocks most of the electromagnetic spectrum. These problems can be partially alleviated by putting our observatories on the tops of carefully chosen mountains and high plateaux.

It is interesting that one of the main arguments for putting telescopes in space has been partially overcome through technical innovations at ground level. A recent development now used at the Canada France Hawaii Telescope and others is “adaptive optics”. A thin, computer-deformable mirror is used to undo the distortions caused by the atmosphere. The basic principle is simple; the technology to do it is complex. So far it looks as though ground and space-based instruments will not replace each other, but their expanding capabilities will together help us to study the puzzles with which the universe is filled.

Mars shines low in the western twilight. Jupiter dominates the southern sky overnight and Saturn rises in the early hours. The Moon will be New on the 20th, and will reach First Quarter on the 26th.

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