JWST

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Ken Tapping, 13th January, 2015

The Hubble Space Telescope (HST) is one astronomical instrument everyone has heard about. It has an eventful history. It was intended for launch in 1986, but was delayed due to the tragic explosion of the space shuttle Challenger during launch, which cost the lives of all aboard. It finally went into orbit in 1990. Then, as the tests and setup procedures went ahead, a problem appeared; it would not focus properly. However, a correction system was developed and in 1993 astronauts installed it. This was a landmark in or learning to work and conduct sophisticated repairs in space. The result was a triumph. The images the HST sent back to Earth astounded everyone, not just the astronomers using the data. Since then the HST has been a critically important astronomical research tool. Over its years of operation space missions have been carried out to install new instruments, expanding its capabilities. Now we are preparing a new instrument: the James Webb Space Telescope (JWST).

For most of the history of astronomy we have had to do our observations from the ground, seeing the universe through our moody and murky atmosphere. This causes some serious problems. Firstly during the day the sky glows so brightly it is difficult or impossible to observe. During the night it may be hazy or cloudy. Just as frustrating is the effect of turbulence in the atmosphere. This makes the stars twinkle, which is pretty, but makes the things we observe shimmer and shake, as though we are looking at them on the bottom of a stream. Then, finally, the atmosphere is only transparent to light and part of the radio spectrum. If we want to observe other parts of the electromagnetic spectrum we need to be above the atmosphere. Things get better if we put our observatories above much of the atmosphere, by putting them on tops of high mountains. However things get even better if we put the telescope in space, where there is no daytime sky glow, no clouds and no shimmering, and where the entire electromagnetic spectrum is available for us. That was the rationale behind the HST, and the scientific return on the investment was far better than we dared hope. So we are now working on a new instrument for doing astronomy in space: the James Webb Space Telescope. This is not a replacement for the HST; it intended to access parts of the spectrum the HST cannot.

The Hubble Space Telescope orbits close to the Earth, which was fortunate because this made it accessible for repair. However this raised problems. Part of the time it is in sunlight and solar heat, and the rest of the time it is in cold darkness, and a large part of its “sky” is blocked by the Earth. The JWST will be parked at a point 1.5 million kilometres away, on the opposite side of the Earth from the Sun, where the gravitational attractions of the Earth and Sun combine to provide a place where if we put a spacecraft there, it will stay there. The emissions from most cosmic objects are very weak, so we need to use the most sensitive detectors and imagers we can come up with. In general, the colder we make these devices, the more sensitive they become. Being permanently in shadow provides free refrigeration. To achieve this we use a heat shield comprising multiple sheets of metallized plastic the size of a tennis court. This will block out heat from the Sun and Earth, allowing the telescope to cool to –220 C or colder.

The JWST is optimized for infrared observations, since at these wavelengths we can see what is happening inside clouds of gas and dust. It will also enable us to explore what the universe was like in its extreme youth, when the first galaxies were forming. Canada is a participant in this project, and we look forward to seeing the data the JWST will be giving us.

Venus shines brilliantly low the sunset glow, with Mercury close by. Jupiter dominates the southern sky during the night and Saturn rises in the early hours. The Moon will be New on the 20th.

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