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WHY PUT IT THERE?

Ken Tapping, 29th August, 2017

High on the arid Atacama Plateau in Chile, 5,000 metres above sea level, is ALMA, the Atacama Large Millimetre Array, one of the world's most important radio telescopes. This instrument is an international effort in which Canada is a partner. The location for ALMA was chosen after a detailed search for the best site. Similarly, the site for the Dominion Radio Astrophysical Observatory, Canada's national facility for radio astronomy was chosen after a nationwide search for the best possible location within Canada's borders. It lies in a natural bowl surrounded by hills, only about 500 metres above sea level. DRAO has a number of currently operating radio telescopes, and a new, very large radio telescope CHIME (the Canadian Hydrogen Intensity Mapping Experiment) will soon be in operation. In addition the site is used for development of new radio astronomical technologies. Both these sites are chosen because they were the best available. However, if they are both the best locations of radio astronomy facilities, why are they so different?

It's all a matter of the radio wavelengths to be observed. Radio waves, infrared, visible light, ultraviolet, X-rays and gamma rays are all electromagnetic waves. The only thing that distinguishes them is their length, referred to as wavelength – the distance between two wave peaks. There is no clear delineation between, for example, radio waves and infrared waves. As the radio waves get shorter, they start showing the properties of infrared, and shorter wavelength infrared radiation becomes visible as red light.

The longest radio waves have wavelengths of many kilometres. Waves longer than about 20 metres are useful because they bounce between the ground and an ionized layer in the upper atmosphere called the ionosphere. This is maintained by ultraviolet and X-ray emissions from the Sun. This bouncing means we can use these radio wavelengths for worldwide communication. However, at wavelengths shorter than about 10 metres the ionosphere becomes transparent, and our transmissions go straight out into space. This is useful for FM radio stations because it avoids interference to stations in other communities. It also means cosmic radio emissions can reach the ground, where we can observe them.

At wavelengths where the ionosphere and atmosphere are really transparent, we can put radio telescopes at locations at which it is comfortable to work. However, at wavelengths longer than a few centimetres, we have to contend with our own radio transmissions. So the best location is low down, in a bowl in the mountains, where the hills screen out most of the cacophony of manmade radio transmissions. These radio wavelengths are good for studying gas in space, exploding stars, the Sun and the strange interactions between ionized cosmic gases and magnetic fields. This is the main thrust of research at DRAO, at a site ideal for that work.

However, studying the birth of stars and planets requires us to observe radio emissions from the dust clouds that are the raw materials taking part in those births. These radiate at very short radio wavelengths, a few millimetres – almost infrared. Manmade transmissions are not the main problem here, at least not at the moment. The problem is our atmosphere, particularly if it is damp. It absorbs those short wavelengths. It is currently impractical to put really large radio telescopes in space, so we chose the next best thing, a high-altitude place, above a good chunk of the atmosphere, and where what's left is very dry. Such a location is the Atacama Plateau in the Chilean Andes, where we built ALMA.

Jupiter is now getting lost in the sunset glow. Saturn lies low in the south. Spectacularly brilliant Venus rises in the early hours. The Moon reaches First Quarter on the 29th and will be Full on the 5th.

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