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COSMIC RADIO BURSTS

Ken Tapping, 19th July, 2016

In 2001 the 64-metre diameter radio telescope at Parkes, Australia, picked up something strange. However, it was not recognized as strange at the time. The signal was a burst of intense emission only a few milliseconds in duration. In short, at first sight it looked like another example of human-caused interference. The electromagnetic pollution we generate is the bane of radio astronomy, and is the reason we locate our facilities at remote sites of largely uninhabited places surrounded by hills, or both. The cosmic signals we study are very weak. A cell phone on the Moon will give us a stronger signal than we receive from any cosmic radio source. This could be useful if we ever find ourselves marooned on the Moon.

In 2006 a researcher was scanning through those old Parkes records and came across that burst, and decided to look at it more carefully. The first interesting thing was that the burst splattered across a wide band of frequencies. There are natural phenomena such as lightning, which produce pulses covering a wide band of frequencies. However, manmade signals do not do that. In order to stop our transmitters interfering with others, each one is allocated a specific, narrow band of frequencies in which to operate.

The second strange thing was that the higher radio frequencies in the burst arrived slightly before the lower frequencies. This process, called dispersion, happens when radio signals travel extremely long distances through the rarified particles and magnetic fields in space. Since we have a fair idea of what the space environment is like, we can use the dispersion to calculate how far that burst of emission travelled before being captured by Parkes' 64-metre dish. The result was stunning – three billion light years. A light year is the distance light travels in a year, almost 10,000,000,000,000 kilometres. The next key fact is that the burst was only a few milliseconds in duration. That means its source cannot be larger than a few hundred kilometres. In order to produce the strength of signal we received, from three billion light years away, the energy released must have been huge. A good candidate for the source is a black hole. These are very small and efficiently convert the material they swallow into energy. The bursts could be emitted by explosions in the tangle of hot matter and magnetic fields as they disappear.

Large, single-dish radio telescopes like the one at Parkes measure the total radio emission being received from one tiny patch of sky, far smaller than the Full Moon. The only reason it detected the burst is that it happened to be looking in the right direction at the right time. Since then Parkes and some other radio telescopes in the world have detected a few more of these bursts, but radio telescopes like Parkes are not the right instruments for searching for these events, now called "Fast Radio Bursts", or FRB's. We need a sensitive radio telescope that can image a large area of sky with high resolution, over a wide range of radio frequencies. One such instrument is now well into construction at our observatory, near Penticton, British Columbia. Its antenna consists of four huge metal troughs, providing a signal collecting area of 0.8 hectares. The instrument is called "CHIME", short for Canadian Hydrogen Intensity Mapping Experiment, because its primary purpose is to map the distribution of hydrogen and the beginnings of structure in the early universe. However, it is intended also to be a large "catcher's mitt" for detecting these elusive FRB transmissions from space. It has been estimated that around a dozen FRB's occur a day. With such an instrument we should be able to catch more of them, and identify the objects producing them.

Jupiter is very low in the west after sunset, and Mars and Saturn lie in the southern sky. Mars is the bright one; Saturn is fainter and to Mars' left. The Moon will be Full on the 19th and will reach Last Quarter on the 26th.

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