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FAST RADIO BURSTS

Ken Tapping, 27th February, 2018

In 2007, astronomers looking at archived data from 2001 found something odd. It had come from the 64-m dish at Parkes, Australia. It was just a very short, few-millisecond burst of intense radio emission. In radio astronomy, most of the intense pulses of radio emission we detect are produced locally, by us. For example, a high-power electrical relay, or even just a dodgy light switch can produce such pulses. What makes this sort of interference particularly annoying is that it spans a wide range of frequencies, so you cannot tune away from it. We refer to such things as "broadband interference". This pulse was broadband too, but its character had been changed by an extremely long journey through space. Having come such a huge distance, from well outside our galaxy, that pulse must have been extremely powerful when it was transmitted. Was this a once-only event, or are these pulses common? This sent the scientists back into the archives, and they came up with another fifteen.

Radio telescopes like the Parkes dish can only "see" a tiny patch of sky at a time, typically 10% or less of the diameter of the Full Moon, rather like looking at the sky through a particularly narrow drinking straw. To get 16 events over a few years using an antenna that can see only a tiny patch of the sky suggested that these pulses, which became known as "Fast Radio Bursts" or "FRBs", should be common; as many as 10,000 a day!

On one occasion an FRB was observed in real time, and it was possible to get other instruments pointed in the direction the pulse came from. One detected a fading burst of gamma rays. These are the highest energy form of electromagnetic waves. If the gamma rays and the FRBs are coming from the same place, some really extreme physics must be taking place there. So far we have no good ideas as to what FRBs are and would like very much to observe more of them, in more detail. What we need is something that can keep an eye on as much sky as possible, where we can identify events promptly enough for us to get other instruments in play.

Fortunately recent improvements in radio telescope and signal processing technology are making this sort of investigation possible. Instead of having to use radio telescopes designed to see tiny patches of sky in great detail, we are now developing ones that can observe almost all the sky above the horizon in one operation, and can do this rapidly enough to see things flashing on and off. Suitable instruments are now being developed by various countries around the world, including Canada – here at DRAO. The Canadian Hydrogen Intensity Mapping Experiment (CHIME) radio telescope, comprising four trough-shaped antennas totalling the area of 80x100 metres, is capable of mapping in the whole sky visible over the observatory in a single operation. Its primary objective is to map the early universe, but it is also an ideal FRB detector. Details can be found at https://chime-experiment.ca/instrument.

All we know at the moment is that FRBs come from the cores of distant galaxies, millions or even billions of light years away. They are extremely high energy, and because of the shortness of the pulses, the emitters of the FRBs have to be very small – far smaller than the Solar System. In addition, the only objects we know that are capable of producing the concentrations of energy needed to drive the emissions are black holes. However, we have little idea what is going on here, and would really like to find out.

Jupiter rises after midnight, followed by Mars, and then Saturn. The Moon will be Full on the 1st; the last Full Moon of winter – the "Worm Moon", because the worms should be out and hopefully the robins back. That's a thought to hang onto.

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