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A 3000-KM RADIO TELESCOPE

Ken Tapping, 11th April, 2017

Fifty years ago, two Canadian radio telescopes were combined to form the biggest radio telescope in history. One was the 46m dish at the Algonquin Radio Observatory, in Ontario, and the other the 26m dish at the Dominion Radio Astrophysical Observatory, near Penticton, BC. The result was a radio telescope 3073 km across, and the birth of a powerful tool for astronomy and geophysics: Very Long Baseline Interferometry or VLBI.

The project was triggered by the desire to find out what quasars were. Discovered in the 1950's, they appeared in optical telescopes as points of light, just like stars, and were consequently called quasi-stellar objects, which soon was shortened to "quasars". They lie a long way away, and along with other radiations, produce strong radio emissions that vary over months. By cosmic standards, quasars therefore have to be small, processing a tremendous amount of energy in a small volume. To find out what quasars are required radio images. That was a big problem. We had no radio telescopes anywhere close to being able to image such tiny objects. The largest single-antenna radio telescopes have antennas 100m or so in diameter, and can discern details down to maybe a tenth of the diameter of the Moon, totally incapable of imaging a quasar. So radio astronomers turned to interferometry, in which two antennas are connected to the same radio receiving system by long lengths of cable. In this case the ability to discern detail is determined by the distance between the antennas.

However, interferometers with antennas tens of kilometres apart still showed quasars as featureless dots. We needed a much greater separation, further than could be achieved using antennas connected by cable. That's when scientists realized there was another way. The solution depended upon two new pieces of technology: the video tape recorder and the hydrogen maser. The video tape recorder could be used to record the radio signals and the maser would provide the precise radio frequencies and timing signals needed for an extremely accurate clock. This would make it possible to record the signals and timing signals at two far-separated radio telescopes, and then bring the tapes to a processor, synchronize the recordings using the timing signals and then combine them. With no longer any need for the cable, there would be no limit to how far apart the antennas could be. They just both have to be able to observe the object of interest at the same time. In the spring of 1967, after some trials in Ottawa, the two masers were set up alongside each other and synchronized. Then one tape recorder and one maser, along with all the additional electronics needed to support them were shipped from Ottawa to the Dominion Radio Astrophysical Observatory, and the other setup to the Algonquin Radio Observatory. After the observations were complete the tapes were taken to a specially set up analysis centre at NRC in Ottawa, where the two recordings were precisely synchronized and combined. The experiment was a success! From these and subsequent observations we found that quasars lie in the cores of active galaxies and are probably driven by black holes.

An important by-product of VLBI observations is an extremely accurate measurement of the distance between the antennas. By putting antennas on different tectonic plates we can measure the rates at which the plates are moving. VLBI, developed for astronomy, is at least as important a tool for studying the Earth.

In 1971 the American Academy of Arts and Sciences awarded the Canadian VLBI Team the Rumford Medal for its achievement.

Mars lies low in the Southwest after sunset. Jupiter rises soon after dark and Saturn in the early hours. The Moon will reach Last Quarter on the 19th.

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