MICROWAVE OVENS AND ASTRONOMY

It is very likely that when you are heating up some food in a microwave oven, you never thought you were using a descendent of the instrument that led to the birth of radio astronomy in Canada. However, that is the case.

The device making your microwave oven possible is the resonant cavity magnetron. They are small yet generate large amounts of radio energy with wavelengths of a few centimetres, just what is needed to warm up yesterday's pizza. Today, magnetrons are small, energy efficient and cheap. However, in the 1940's they were a carefully guarded military secret that changed the course of World War II.

At the start of the war, radar was an important component of defence systems, being used to detect distant ships and aircraft in daylight, fog and during the night. Radars send out short, intense pulses of radio energy. These reflect off distant metallic objects and can be detected. The time interval between the transmission of a pulse and when the echo is received gives the range of the target and the direction the antenna is pointing at the time the echo is received. However, to determine that direction accurately requires the antennas to be as large as possible compared with the radio wavelength used.

That was the big problem. Technologies in use at the time could not produce the required high radio powers at wavelengths much less than a metre or so. This was not a problem for fixed, ground-based radar systems. It was a problem for mobile ground systems and ship-borne radars. For aircraft it was a very big issue. Radar-equipped night fighter aircraft looked like hedgehogs, covered with antennas that were big enough to give at least a hint of the direction in which the target lay.

In 1942 Britain was struggling to defend itself and did not have the resources to develop weapon systems based upon the latest developments. It was decided that the British military secrets would be passed to the United States and Canada, where the expertise and resources were available to develop those much-needed military aids. One of these was the resonant cavity magnetron, developed by Randall and Boot at Birmingham University. This device could develop huge levels of radio energy at very short wavelengths, down to a centimetre or so. This was just what was needed for the implementation of practical radar systems.

Some magnetrons were sent to the National Research Council, in Ottawa, which led to that organization becoming a major centre of radar development. Magnetrons made possible radar systems using dishes as small as 60cm, which could fit in the nose of an aircraft, and mobile radars with dishes with diameters between one and two metres. The magnetrons from Britain operated at wavelengths of around 10cm, so this wavelength was used for radar development.

When the war ended, the National Research Council found itself with lots of radar components and systems that were no longer needed. Arthur Covington and his colleagues, who worked on wartime radar development, had heard about the discovery of cosmic radio waves and used those radar components to build Canada's first radio telescope. They based their design on the receiving portion of an unused radar. Since the magnetron in the transmitter operated at a wavelength of 10.7cm, so did the receiver, which meant this became the operating wavelength of that radio telescope.

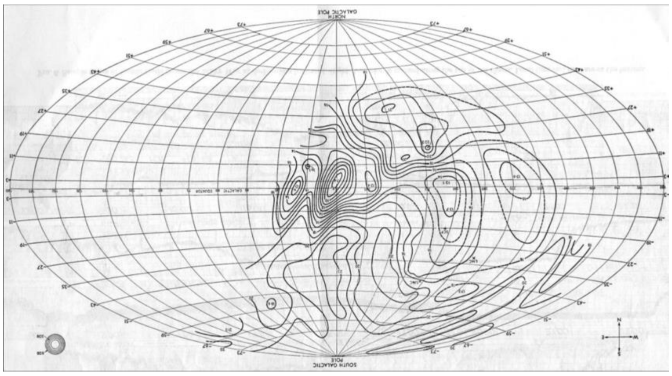

Image of a contour map of galactic radio emissions after Groot Reber in 1968

Among other things this led to the beginning of a solar radio monitoring programme, which continues to the present day, giving the world the F10.7 index of solar activity. Enjoy that pizza.

Ken Tapping, 25th June 2024

Jupiter lies low in the dawn glow, with Mars and then Saturn higher and further to the west. The Moon reaches Last Quarter on the 28th.

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