Getting rid of paramps

Tapping, Ken

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/23000183
Skygazing: Astronomy through the seasons, 2014-09-02

GETTING RID OF PARAMPS

Ken Tapping, 2nd September, 2014

One of the first things I had to do as a radio astronomer was to learn how to set up an amazing device called a “parametric amplifier” – “paramp” for short. Cosmic radio waves are incredibly weak, and require state of the art receiving systems. In the 1970’s and even into the early 80’s, the most sensitive tools available were paramps. Unfortunately, these devices were tricky to set up and unstable. Instead of the sort of power that comes from batteries or power outlets on the wall, these machines needed their power in the form of high frequency radio waves. These were produced by a device called a klystron, which required a large power supply providing thousands of volts.

Setting one up for observing was an exercise in patience and required the delicate fingerwork of a safecracker. If pushed too hard, it was quite common for these animals to go unstable after they were laboriously installed on the radio telescope. This meant getting out the cherry picker and all the set-up equipment and going up onto the antenna to readjust the paramp. In order to maximize the sensitivity, it was quite common to put the paramp in a vacuum vessel so it could be cooled down to –260 Celsius without the oxygen and nitrogen in the air condensing on it like super-cold dew. When better technology appeared, the demise of the paramp was unlamented. I have an old paramp sitting in my office – without the vacuum vessel and power supply. We also have one in a glass case in the foyer of our observatory.

Last week, over coffee we were discussing the modern replacements for paramps. Today, we can get more sensitivity, more stability and more amplification out of a little gold-plated box between one and two centimetres square and a few millimetres thick. These devices, called HEMT (high electron mobility transistors) amplifiers, are at least 50 times cheaper than paramps. How did we get from paramps to HEMTs?

Like many of the inventions that have changed life so much, the story started in the laboratory, where physicists were interested in how Mother Nature works. In this case they were researching the class of materials known as “semiconductors”. Using this knowledge, other scientists and engineers worked out how to use these substances to make components for use in amplifiers and other electronic devices. Radio astronomers saw these as a way to get paramps out of their lives and develop sensitive, stable and reliable radio receivers to install on radio telescopes. These still required delicate handling, but nothing like as much as paramps demanded. The military saw the value of these sensitive amplifiers in communication and radar systems and provided the motivation to turn HEMT amplifiers into the robust, cheap devices we see today. They are now not only in science and defence, but in satellite TV receivers, cell phones, GPS navigation systems and elsewhere. These tougher, cheaper and more reliable amplifiers and components have found their way back into radio astronomy.

Radio astronomy or any other hitech field of human endeavour depends upon curiosity and innovation in many areas. Without all those ingredients nothing would have happened. Someone had to come up with the basic science. This may happen years before someone else realizes how this knowledge can be applied. Then somebody invents a device, and others turn it into viable tools for research and commercial applications. The trick is to nurture all these ingredients in an environment where they can be connected together. Sometimes these eggs of innovation take time to hatch.

Jupiter and Venus, the two brightest planets lie close together low in the predawn glow. Venus is the brightest one but getting low and hard to see in the glare. Saturn and Mars lie close together in the sunset twilight. Mars is furthest west. The Moon will be Full on the 8th.

Ken Tapping is an astronomer with the National Research Council's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.

Tel (250) 497-2300, Fax (250) 497-2355

E-mail: ken.tapping@nrc-cnrc.gc.ca