5 SEEING THE INVISIBLE

THE CONE NEBULA

The bright pink and red points in the centre of this stunning photograph are newborn stars that are only 100 000 years old. They are located in the Cone Nebula, a star-forming region in the constellation of Monoceros, the Unicorn. Thick layers of dust obscure these young stars in normal photographs, but they are clearly visible in this infrared Spitzer Space Telescope image.

The Universe is a black void, with a scattering of stars, nebulae and galaxies — or so it appears to observers using visible light. But if we include other forms of radiation invisible to us, the picture changes completely: clouds of interstellar hydrogen gas, emitting radio waves; stellar nurseries, glowing in the infrared; explosive outbursts of gamma rays and the all-sky background hiss of the Big Bang, diluted by almost fourteen billion years of cosmic expansion. So how do astronomers learn about the unseen Universe? By building telescopes and detectors that can see the invisible.

“Studying the Universe using visible light alone is like attending a concert with a severe hearing problem”

Listen to your favourite music and you will hear the full spectrum of sound, from the deepest bass rumblings to the highest-pitched vibrations. But if your ears were sensitive to only a tiny part of the audible frequency range you would miss much of the performance. This was the problem for astronomers, confined to the visible by the limits of the human eye; they were locked into the middle register of the electromagnetic spectrum for hundreds of years.

Visible light consists of electromagnetic waves. Each colour corresponds to a certain wavelength. Red light has a wavelength of about 700 nanometres (0.0007 millimetres). Blue light is more energetic, with a higher frequency and a correspondingly shorter wavelength of about 400 nanometres. The human eye is sensitive to this optical range of colours, but not to electromagnetic waves with longer or shorter wavelengths. The Universe emits radiation at all wavelengths so studying the Universe using visible light alone is like attending a concert with a severe hearing problem.

The existence of most of the non-visible radiation arriving here from the depths of space was unknown until a century ago. Cosmic radio waves, for instance, were accidentally discovered in the 1930s. Although some of these waves have the same frequency as terrestrial radio stations, it doesn’t mean that the Universe is broadcasting to us. Radio waves from space are extremely weak and there’s nothing special to listen to — if you converted them into sound, you would only hear cracks and hisses. To “tune in” to the Universe, you need a radio telescope — usually a big dish. Radio telescopes can easily be much larger than optical telescopes as the dish surface doesn’t need to be as smooth as an optical mirror since radio waves have longer wavelengths.

ANTENNAS OF CSIRO'S AUSTRALIA TELESCOPE COMPACT ARRAY

The Australia Telescope Compact Array, consisting of six 22-metre radio antennas in the Australian outback, is located some 500 kilometres northwest of Sydney. It is the premier radio interferometer in the southern hemisphere. The antennas can be moved around across an area six kilometres wide, to change between relatively wide-angle, low-resolution views and very detailed observations of a small part of the sky.

In the late 1930s, young American radio amateur, Grote Reber, built a 9.5-metre radio dish in his mother's backyard in Wheaton, Illinois. Reber made the first crude maps of the radio sky in which the Milky Way clearly stood out. Dutch astronomers Jan Oort and Henk van de Hulst immediately saw the enormous potential of the new technique: a radio telescope tuned to a wavelength of 21 centimetres could be used to map the distribution of cold, neutral hydrogen gas in the Universe. Very soon large radio telescopes were constructed all over the world, including the 76-metre Lovell Telescope in Jodrell Bank, England, which was completed in 1957.