We begin our journey with a brief review of half a century of SETI science. The material in this introductory chapter is offered for the benefit of those educated laypersons whose enthusiasm for the Search for Extraterrestrial Intelligence exceeds their detailed knowledge of the relevant technologies. It is my hope that readers of this volume will better appreciate the material which follows if they first have a basic understanding of SETI concepts. Hence, I offer an overview, which is intended not to be exhaustive, but rather representative. Together, we will explore the nature of radio telescopes, experimental design strategies, SETI instrumentation, signal analysis, and the hallmarks of artificiality that allow us to differentiate between natural astrophysical emissions and intelligent interstellar transmissions. If you are already a technical specialist in these areas, feel free to bypass this introduction, and proceed directly to the subsequent chapters.

1.1 Birth of Radio Astronomy

Are we alone, the sole sentient species in the vast cosmos, or might there be others out there, with which we may some day hope to communicate? This is a fundamental question, which has haunted humankind since first we realized that the points of light in the night sky are other suns. Now, for perhaps the first time in human history, we have the technology to seek a definitive answer.
That technology derives largely from radio astronomy, a relatively young science which was born quite accidentally in the 1930s, with the chance discovery that stars emit electromagnetic radiation in the radio spectrum. At Bell Laboratories in New Jersey, USA, a young radio engineer, Karl Jansky, was tasked with tracking down a source of interference that was plaguing transatlantic radiotelephone communications. Building a large, steerable directional antenna, he tracked the noise source across the sky to determine its periodicity. The interference did indeed repeat, on a 23 hour, 56 minute cycle. From this observation, Jansky concluded that the emissions were not originating on Earth or from the Sun, but rather from interstellar space. Today, we know that Jansky was detecting radio emissions from the center of the Milky Way galaxy. Thus was radio astronomy born.

Jansky’s report, published in a radio journal, was read with considerable interest by another radio engineer, Grote Reber, in Wheaton, IL, USA. It was Reber, an accomplished amateur radio experimenter, who built the first modern radio telescope, a 10-meter diameter parabolic reflector, and in 1937 used it to produce the first known radio maps of the Milky Way.

Although in hiatus during the Second World War (during which most of the world’s physicists were otherwise occupied with matters of weaponry), radio astronomy emerged as an observational science in 1951, with the first detection (by Harold Ewen, a graduate student at Harvard University, and his research advisor, Edward Purcell) of the 21-cm hyperfine emissions from interstellar Hydrogen, the most abundant element in space.

### 1.2 Radio Telescope Modalities

The three primary operating modes for modern radio telescopes include radiometry, spectroscopy, and interferometry. Each mode requires unique hardware and a specific experimental design.

The early observations of Jansky and Reber are examples of total-power radiometry, a time-domain measurement in which the thermal blackbody emissions from astrophysical sources are plotted against antenna aiming coordinates. Aiming can be either dynamic (i.e., actively varying the antenna in azimuth or elevation) or drift-scan (in which the Earth’s rotation causes the antenna to sweep varying right ascensions over time). Radiometers are the simplest of radio telescopes, requiring only that the incoming signal be sufficiently amplified, and then applied to a square-law detector.

Spectroscopy is a frequency-domain mode, used to observe the molecular absorption or emission lines of the source being monitored. Ewen’s pioneering hydrogen emission detection was an early example of astrophysical radio spectroscopy. In its most common implementation, spectroscopes involve