Title:	***Radio Nature***
Author:	Renato Romero
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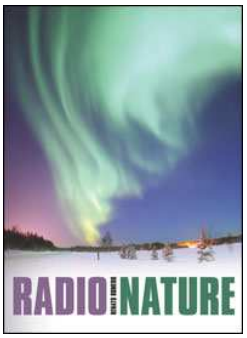
Reviewer:	Whitham D. Reeve



In the preface of this paperback book the author warns "We've lost the direct physical contact with what surrounds us" and it "seems like scientific research by the individual belongs to the past or that it is possible only in hyper-technological environments." He wrote this book to help the reader understand that these statements are wrong. His stated objective is to offer a "panoramic view" of naturally originating radio signals. The main focus is on how these phenomena can be observed, not how or why they occur. With twenty-five chapters in only 220 pages, a lot of ground is covered very quickly.

The naturally originating radio signals described in this book are limited to terrestrial electromagnetic phenomena with frequencies in and below the VLF band, around 100 kHz to as low as fractions of a hertz. Included are *spherics* (which he also calls *static*), *tweeks*, *the insects* (also called *buzzer*, and not the pesky crawling kind), *whistlers*, *auroral chorus*, *auroral hiss*, *flying saucers* (not the alien kind) and *seismic precursors*. Many of these are influenced or directly controlled by the Sun but some arise through terrestrial weather storms, earthquakes and other natural events.

Many of these phenomena occupy the band of frequencies that we could hear if we had an electric ear instead of a sonic ear. The sources of some are speculative and not widely agreed upon. The author's explanations are similar to what one would find in credible science articles and books but sprinkled with what apparently are his own interpretations. I found them interesting and worth following up through online resources and other books.

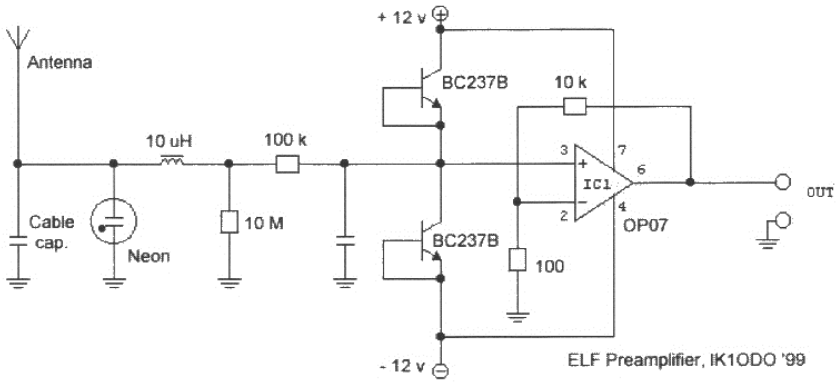
Some natural radio emissions, such as whistlers, are produced by terrestrial lightning and propagated along Earth's magnetic field lines. Whistlers produce eerie sounds in a receiver because the radio waves are dispersed as they travel great distances. Other natural radio emissions are related to the aurora. The auroral chorus usually is heard in the range of 400 to 1000 Hz. It can be detected with a large loop of wire connected to headphones or a PC sound card. It also is called the dawn chorus because it is most often heard in the early morning hours. The chorus consists of a series of short rising tones that sound like a tree full of birds. In the evening, the auroral hiss is more likely to be heard. It ranges from about 2000 Hz to 100 kHz.

The author also describes what he calls "artificial signals". These include hum and cyclic noises from electric power transmission and distribution systems, electric motors and, not to be forgotten, nuclear explosions. He classifies some as "false signals in the audio band" and others as "mysterious". False signals include noise due to cross-modulation and receiver saturation, the "microphone effect" (commonly called *microphonics*, which are the transformations of mechanical vibrations into electrical noise – a phenomenon common in vacuum tubes), insects (the crawling kind), static discharge and wristwatches, among others.

The author says these false signals could be mistaken for radio nature. It should be noted that some man-made electrical noises described in this book are uniquely received in Europe, such as Alfa (or Alpha), a Russian navigation system, and certain low frequency (LF) and very low frequency (VLF) transmitting stations. These may or may not be observable in North America or other continents. The author defines mysterious signals as signals that sound natural but really are not. Many are received in areas of heavy industry. The author claims some are produced by extremely high power transmitting stations similar to the High Frequency Active Auroral Research Program (HAARP) in Alaska. I found the author's explanations of some so-called mysterious signals speculative and dubious.

Some people like to argue that humans are not part of the natural environment, and by extension I suppose they also would argue that man-made radio signals are not part of nature. Nevertheless, it is convenient to separate man-made signals from all others. The author's narrative of the sounds that result from detection of both natural and human signals is very descriptive: "fiiiuuu", "fiiiiuuuuuu", "hissing", biiiboooo sequence" and others that help us to recognize them. I seldom see this type of description, and it is one thing that sets this book apart from others – the information actually is useful and the reader is not left wondering what they received, if anything.

Many of nature's electrical signals are at audio and sub-audio frequencies. Audio frequencies are in the range of around 20 Hz to 20 kHz – the range depends on who you talk to. It should be clear by now that the signals of interest are electrical and not sound and, therefore, we cannot hear them directly. If we wish to listen to these signals, we must first convert them from electrical to sound. Signals of interest usually will be fed from a detector or amplifier to a PC soundcard for spectrum analysis and processing. The soundcard and associated speaker convert the signals in the audio band from electrical to sound. However, signals below the audio band must be speeded up by software processing in the PC, in which case we listen to an adaption of the original signals to the human ear.



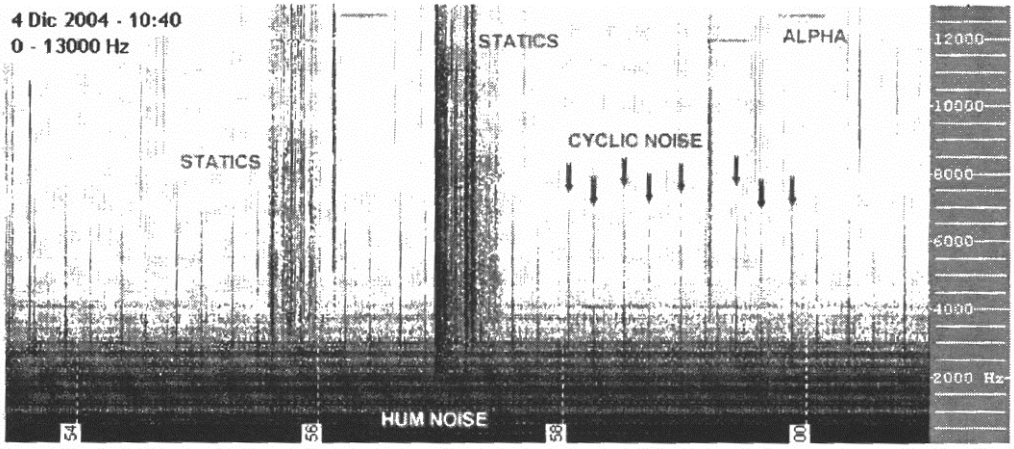
This circuit of a simple ELF receiver is able to accept the signal from a small whip, but also able to tolerate very long wire antennas without distortion (Marco Bruno's project, IK1ODO).

In some ways ***Radio Nature*** is like a few other books that cover radio waves at low frequencies or extremely long wavelengths but it provides much more detail. The author includes descriptions and schematics for monitors that can be used to capture radio nature, audio recording methods, analysis software, and advice on unattended operation and coordinated listening. All of these are tools that most amateur radio astronomers already use, so in many ways they have half the problem of receiving and recording radio nature already solved.

The schematics (example above, from page 127) and descriptive information are sufficient for anyone with electronics experience to build suitable equipment from readily available components. Most of the circuits have been around for a while and an internet search will reveal numerous versions of the same schematic. In some cases, a search will reveal improvements but in other cases just the opposite. With this book, however, readers have access to the circuits and antenna designs in one place. It should be noted that most of the schematics and construction details are, for the most part, nothing special – simple amplifiers and filters made from operational amplifier (opamp) integrated circuits and loop antennas or whip antennas – but with made-up names that try to indicate a special design (which they are not).

The author refers to some apparently established designs by their model number, and in several cases I could not find any useful information about them. Also, some technical explanations seemed over-simplified and have significant doses of hand-waving, and I would advise the reader to attempt to independently verify them. Of course, the proof is in the results; that is, if the circuit or antenna works as intended then the seemingly flawed explanations can be overlooked for the time being.

Radio Nature explains spectrum analysis from an applications point-of-view. It has a chapter on "managing FFT parameters", which uses a little algebra but at least it is not mathematically opaque. The author also describes software filtering, including HUMID (Hum Instant Destroyer), and radio localization (or radio direction finding, RDF). The book includes many spectrogram images that have been annotated to help readers understand them. The only drawback is that the images are in black-and-white and, thus, the color intensity information has been converted to a gray scale making them somewhat difficult to interpret (for example, see the spectrogram below from page 46).



Unfortunately, ***Radio Nature*** proves once again that book publishers no longer employ editors. The book contains many typographical errors and grammatical mistakes. These are relatively minor annoyances for readers with the motivation to study the material but will be frustrating to people who enjoy reading correctly formed sentences.

In summary, ***Radio Nature*** has considerable useful information backed up by the author's experience. It is for motivated readers who want to detect natural electromagnetic signals from VLF down to sub-audio and are willing to experiment with a suitable detector, soundcard and PC running spectrum analysis software with

recorder capability. To be successful, the detector setup should be a way from man-made electromagnetic interference, and this almost always means rural locations some distance from electric powerlines.

Reviewer - Whitham Reeve has lived in Anchorage, Alaska his entire life. He worked as an engineer and engineering firm owner/operator in the airline and telecommunications industries for more than 40 years and is now a director of SARA and contributing editor for the SARA journal.