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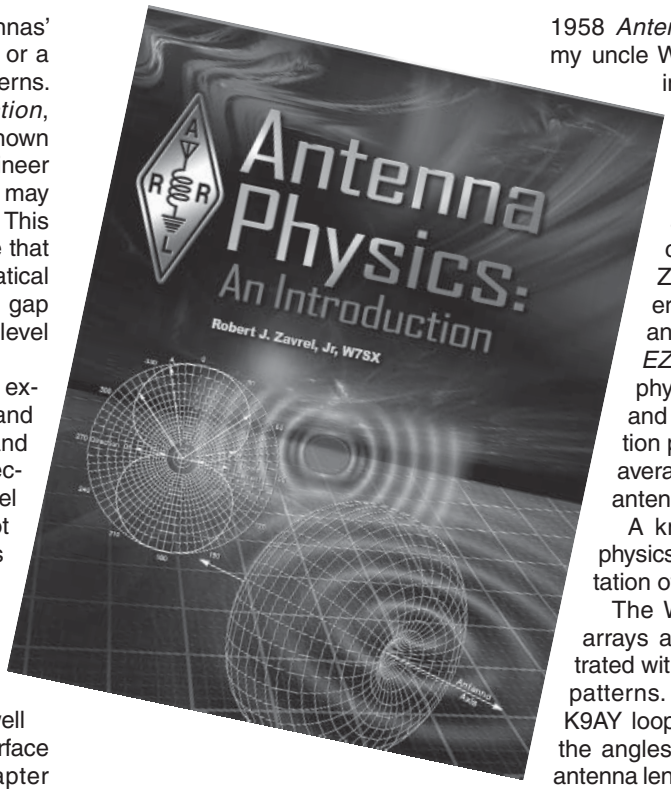
NCJ Book Review: *Antenna Physics: An Introduction* by Robert J. Zavrel, W7SX

Most contesters know their antennas' gain figures and have used *EZNEC* or a similar program to plot radiation patterns. In *Antenna Physics: An Introduction*, Robert J. Zavrel, W7SX — a well-known author and professional antenna engineer — challenges us with the physics we may or may not have learned in school. This is not a "how-to" book but rather one that presents a theoretical and mathematical approach to the topic, bridging the gap between basic theory and college-level engineering texts.

Chapters on radiation efficiency explain the isotropic radiation pattern and energy transfer using antenna gain and distance in the non-ionospheric reflection situation. In his introduction, Zavrel observes that he's encountered a lot of misunderstanding when it comes to antenna theory. His motivation in writing this particular volume is to attempt to help clarify and explain antenna physics for the Amateur Radio population.



The formula for the path loss is well explained, using the area of the surface of two spheres. A fascinating chapter addresses the theoretical limit of radio communication.

Of particular interest to me was the analysis of the corner reflector and the eight-vertical directional array. The basics of Yagi pattern calculations are presented in a way that the reader might more thoroughly understand *EZNEC* analyses.

One fascinating chapter is the analysis of ground losses in the unloaded vertical situation. This is, of course, pertinent to the knowledge of any ham who uses verticals. I would guess that the average contester has memorized the appropriate number of radials for a ground-mounted vertical with various radial lengths, and this chapter correlates well to this knowledge. Also covered are elevated verticals and the actual relationship of ground losses to the intensity of the radiated signal.

Zavrel explains the basic physics of coaxial cables, including characteristic impedance and velocity factor, as well as the basic formulas for calculation of impedance for parallel wire transmission lines and coaxial lines.

Maxwell's four equations and their relationship to free-space loss, aperture, gain, and the like are explained, as well as Ampere's Law and the wave equation. These extremely important equations are just taken for granted by the average contester. I found this chapter extremely intriguing and have re-read it many times.

Most interesting are the figures and radiation patterns of the 8-vertical array that are included. I had no idea this was how cardioid patterns in broadside/end-fire arrays worked until reading this book.

Of personal interest to me is the discussion of helical antennas. I have homebrewed these for satellite communications, and I considered using this type of array for moonbounce, although I ended up with N6NB quagis, and, later, Cushcraft 32-19 Yagis. The detailed discussion of the corner reflector is always fascinating, and this antenna continues to be useful today. I personally enjoy the derivation in Kraus's 1958 *Antennas*, which I inherited from my uncle W2MS (SK). *Antenna Physics* includes numerous references and diagrams from Kraus's *Antennas* (1988 edition).

There are detailed analyses of multi-element Yagi-Uda and collinear antennas, and of course, the extended double Zepp. The average contest operator may be familiar with the antenna modeling of these from *EZNEC*, but not the associated physics. Most of the free-space and perfect-ground antenna radiation patterns have been run by the average contester for his or her own antenna configurations.

A knowledge of the associated physics greatly facilitates the interpretation of the *EZNEC* patterns.

The W8JK antenna and collinear arrays are, of course, covered, illustrated with *EZNEC*-generated radiation patterns. The beverage antenna and K9AY loop are covered. Rhombics and the angles between elements for given antenna length are also explained, as they have been extensively in many editions of the *ARRL Antenna Book.*

There is a fascinating chapter on the origin of radio astronomy, featuring the work of Reber and Penzias/Wilson. Who could imagine building a 20-foot parabolic reflector in one's backyard in the 1950s?

One interesting chapter addressed the fundamental limitations of a radio link. Shannon's limit is explained. This may help to explain the failure so far of the search for extraterrestrial intelligence (SETI).

The primary strength of *Antenna Physics* is to refresh the typical ham's knowledge of antenna physics in an understandable and comprehensible manner. This volume should enhance your knowledge of antennas and how they work.

Antenna Physics: An Introduction, ARRL, Newington, Connecticut, 2016. ISBN: 978-1-62595-049-9, 8-3/16 × 10-7/8 inches, softcover, 160 pages. Available from ARRL, Item No. 0499, $29.95. Kindle edition available from Amazon.com, $9.99.