Title: ***Radio Science for the Radio Amateur***
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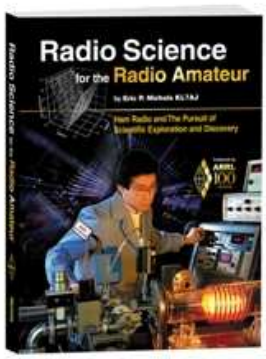
Reviewer: Whitham D. Reeve



Science is the knowledge usually gained through systematic observations and experimentation. **Radio science** is that science associated with electromagnetic radiation and propagation. This book does not explain radio or science to any significant extent, but it does attempt to explain to radio amateurs what they can do to contribute to the science of radio propagation, in particular ionospheric propagation, about which there is much to learn.

Surely there is something here for amateur radio astronomers. However, it should be noted that discussions in this book about the ionosphere's effect on radio propagation is from the perspective of transmitting from one terrestrial station to another whereas radio astronomers are more concerned with propagation from space through the ionosphere to a terrestrial station. The experiments described in this book do not involve transmitting, so anyone with an appropriate receiver is able to participate.

The author claims to have worked on numerous projects involving radio propagation, including the recently shut down High Frequency Active Auroral Research Program, HAARP, in Alaska. His role in these projects is not at all clear. He is not a scientist or engineer but he is a radio amateur and he claims to have written many articles for the amateur radio press. His premise in ***Radio Science for the Radio Amateur*** is that radio amateurs can do *Big Science*. For purposes of the book, he defines *Big Science* as science involving lots of observers scattered over a very wide geographical area. Given that there are thousands of radio amateurs around the world, this is theoretically achievable through the connectivity provided by the worldwide web (the author offers a nod to the SETI program's data collection model).

This is not a technical book, but the author warns readers to "*avoid the temptation to skim over the early chapters...*". It is more of an introductory book that sort-of provides the background needed to understand what science means, but with as little depth as possible. In fact, some of the chapters have so little depth I had to wonder about their purpose. For example, chapter 7, *The Electromagnetic Spectrum at a Glance* is six pages, but other than a 1/2-page breakdown of medium wave (MW) to super high frequency (SHF) in terms of wavelength (but not frequency), there is not much else usable. There is a pretty good non-technical refresher on using a Smith Chart in chapter 13, *Smith Charts, Scattering Parameters, and Sundry Science Tools*, but this chapter is otherwise empty and much too short. I was surprised to find no references, bibliography or suggestions for further reading anywhere in the book, a serious omission.

Radio Science for the Radio Amateur does not contain many illustrations, and I frequently wondered about the purpose of the few that are included. According to the front papers, two people at ARRL did the proof-reading and I think they did a good job, which sets this book apart from almost all of its contemporaries. The style is

active and very informal, characterized on the book's back cover as a "fresh and playful approach". As a reader I have learned that this type of description is a warning signal, and this book is no exception. As I read the book I noticed there are many over-simplifications and an overuse of quotation marks. For example, the author talks about "mobs" of electrons and electrons that "slosh" back and forth and s-parameters that are "beautiful things", all quoted here as written. Apparently, these are used in place of "better" words or phrases or perhaps they are part of that "playful approach". Occasionally, the reader will come across some interesting tidbits of information – for example, someone calculated that the mass of Earth's entire ionosphere is about 1 metric ton (1000 kg) and that plasmas constitute more than 99% of the visible universe, both in chapter 10, *The Big Picture – Plasma as Pachyderm*. I did not take the time to determine if these are credible estimates or the wild guesses or claims of a crackpot.

One flaw that stands out is the author's extended discussion of how he thinks "real science" (paid science) works. Instead, there should have been more emphasis on how amateurs can organize to make the grand contributions that the author advocates (unpaid science or, perhaps, "crowd science"). He offers no plan on how to tie together the observations and data collected, which he finally describes in the last chapter. He does provide procedures for individuals to carry out experiments but does not mention how they can collaborate with each other to process or correlate their results or even what to do with their results. Sure, grand experiments must start somewhere and sometime, but organizing a very large number of radio amateurs (or anyone for that matter) around the world to do anything in close collaboration is no easy task. The task should have been addressed nevertheless.

As I read ***Radio Science for the Radio Amateur***, I kept wondering when I was going to get to the grand experiments – the "real radio science" experiments. Well, I finally did at the end of the book in chapter 19, *Now for Some Real Radio Science*. The book describes three experiments, all involving simple dipole antennas to receive the WWV (or presumably WWVH) transmitter on 15 MHz. There is no explanation why WWV on 15 MHz is to be used except that the reception must be by sky wave (ionospheric reflection or refraction). WWV and WWVH simultaneously operate on several other frequencies and there are comparable high frequency time transmitters operated by other countries. Presumably these will work as well but the author offers no guidance to the reader in this regard.

The amateur radio scientist is to record the received signal levels over time – days, months, and years – so that more can be learned about the ionosphere. This kind of activity has been undertaken around the world using ionosondes since at least the 1920s, but it never has been done with the granularity provided by thousands of receiving stations operating as one. According to the author, this is where radio amateurs can do their missionary work for mankind's benefit. However, he does not specifically say what is to be learned.

Two of the three experiments use ordinary radio receivers (the author says that even vintage radios, "boat-anchors", may be used) but the grand experiment requires two receivers with in-phase and quadrature-phase (I-Q) audio outputs. Each receiver is connected to its own dipole antenna and the dipoles are crossed, one oriented east-west and the other north-south. According to the author, recordings of the signals received by this arrangement can be processed to reveal polarization and other useful scientific details but, unfortunately, readers are not told in this book how to process the data or what those other useful details are.

For the grand experiment the author recommends that readers build two direct conversion receivers described in a March 1999 QST magazine article ("A Binaural I-Q Receiver" by R. Campbell). I have seen the article and constructing even one of the receivers will be a challenge to the average amateur. However, this project is well within the capabilities of someone with knowledge of electronics construction and the motivation to do it. Presumably any receiver that can tune 15 MHz and has I-Q outputs will work in the grand experiment, so I was very surprised the author did not mention software defined radios (SDR). Even the most inexpensive software defined radios available today have this capability (the book was published in 2013 so it is not "pre-SDR").

There are many other gaps in the author's project plan. For one thing, he offers no advice on ensuring the data is properly time-stamped, which undoubtedly is important, and his description of the data collection method is too brief to ensure that the data is even usable. Obviously the receivers used in the grand experiment will be dedicated to the experiment, and the same can be said of the PC that collects the data. To ensure success of this project, the author should have taken a systems approach perhaps like the Radio Jove Project in which all facets of hardware, software and data collection are well-defined.

I obtained ***Radio Science for the Radio Amateur*** for US$22 from Amazon.com (including free shipping), over 20% cheaper than the non-member price at ARRL. ARRL members get a whopping 10% discount from the non-member price. I have mentioned in previous ARRL book reviews that readers should shop around for a better price than ARRL offers to its own members. However, even at the non-discounted price, this book will not break the bank.

In summary, this book will not appeal to anyone expecting technical content because there is none (I spotted one equation). I probably would have a more positive attitude toward the book if it actually had some technical content. On the other hand, the book is unique in the amateur radio press. It might serve as an initial stepping stone to some "real" collaborative radio science by amateurs. However, the questions still remain: How is useful information derived from the recordings, what do the data and results mean, and what is the disposition of the data after it is collected? Unfortunately, this book does not provide any answers. A second edition, if there ever is one, should address these obvious omissions. Also, it would not hurt if most of the chapters are rewritten and "beefed up" to give them some substance.