

of radar during World War II. The author describes the lengthy constant frequency and the short frequency sweep emissions that bats use as echolocation signals, but he misses the main points regarding their pulsed nature and the particular abilities that the pulses afford: Bats do not hear effectively during their own broadcasts, and pulses allow them to listen to and analyze the returning echoes during the interpulse intervals. Constant frequency signals enable bats to estimate the velocity of flying prey; sweep signals give extremely precise information on how far away they are. Those issues could have been resolved with a close peer review, and such missed opportunities render the book less valuable for nonbiologists, who would benefit most from accurate descriptions.

Goldsmith carefully distinguishes longitudinal sound waves from various transverse mechanical waves, such as those that occur in earthquakes, but he does not relate the distinction to animal communication signals. Because the types of mechanical waves are often muddled in the biological literature, bio-

logists would have benefited from the author's physical perspective, which could highlight why the distinction is critical for understanding how different types of signals disperse in the environment. The book includes a number of line illustrations, and many of them are quite helpful for depicting complex acoustic phenomena. But the book's compact size and small print is best suited to schematic diagrams, and the several drawings that attempt to depict biological and instrumentation details are not particularly effective.

Despite those shortcomings, *Sound: A Very Short Introduction* is an enjoyable read. I learned quite a lot about many topics in the process of my review. The book has something for everyone, and the author has done a remarkable job in assembling so much information and condensing it into a truly pocket-size edition. I do not know of another title that covers so much about sound in a nontechnical yet scientific manner.

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Quantitative Viral Ecology Dynamics of Viruses and Their Microbial Hosts

Joshua S. Weitz

Princeton U. Press, 2016. \$69.95 (360 pp.). ISBN 978-0-691-16154-9

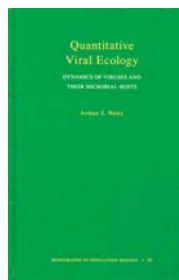
Quantitative Viral Ecology: Dynamics of Viruses and Their Microbial Hosts takes on a topic of vast scientific and societal importance. Consider, for example, the ocean's surface, where microbes constitute most of the biomass. Viruses control the microbe population through infection and release organic carbon and other nutrients back into the environment. That has big effects on ecosystem function, since without the turnover of biomass, many sources of food would not be available to other organisms.

The same scenario plays out in many locations. Indeed, microbes, and consequently microbial viruses, inhabit essentially every natural niche on Earth, including waters, soils, sediments, higher organisms, and air. They also live in artificial environments such as homes, waste reactors, and city streets.

The book's topic is not something a

traditional physicist would study. However, physical ways of thinking permeate every chapter. Author Joshua Weitz, whose research is in ecology but who holds a PhD in physics, takes a theoretical, model-building viewpoint as the key to interpreting classic and state-of-the-art experiments. Modeling is a central and defining feature of physics, and often-times simple models—of springs, beads, liquid droplets, and so forth—are immensely useful for conceptualizing problems and identifying main drivers of observed behavior.

The book is aimed at a scientifically educated audience ranging from students to researchers. Each chapter ends with a concise, point-by-point summary that I found useful for quick reference. The chapters contain tutorials on important modeling tools such as mean-field



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theories, dimensional analysis, and qualitative analysis of dynamical systems. There are also simple explanations of sophisticated tools, including agent-based models and complex networks. I personally loved the book's spherical-cow attitude—though I should talk about “spherical viruses” in this case—and I use this approach in my daily working routine.

The tone is relaxed and matter-of-fact, and Weitz avoids promoting specific visions, paradigms, or interpretations. Rather, he gives a precise account of the state of debates in the literature and explicitly addresses both the limitations and the potential of current approaches. Chapter 2, one of my favorites, contains dimensional analysis of the key parameters—“life history traits” in ecological terms—that affect viral dynamics. It contains some extraordinarily clear demonstrations of the powerful insight dimensional reasoning can provide. Chapter 6 is also intriguing; it gives a global perspective on ocean viruses' abundance and diversity and discusses virus-microbe infection networks. Viral diversity and sheer number are incredible and probably still incompletely understood.

Chapters 3–5 use ordinary differential equation models to describe population dynamics and the evolution of viruses and their microbial hosts. Chapter 7 addresses the wide-open and complex problem of the coexistence of many viral and microbial species in the ocean, where predators such as zooplankton are also

present. The last chapter offers a more speculative overview of open problems and should be valuable for any reader.

My favorite quote from the book is, “A healthy scientific field requires a balance of theory and empiricism,” and I can definitively say that the text practices what its author preaches. Although the emphasis is on theory, both classic and state-of-the-art experiments are discussed and compared with predictions—and at times theory and experiment obviously disagree. Readers with an experimental background can obtain ideas for new experiments and specific questions to test.

The book will be especially exciting for theorists with an applied math, engineering, or physics background. According to Weitz, quantitative viral ecology is an area in which new, “big” data are becoming available. But, as many probably know, a big pile of messy data does not necessarily mean more knowledge. New theoretical tools will be needed, together with new theoreticians to design them. *Quantitative Viral Ecology* offered me a great opportunity to discover a new area, and I cannot exclude the possibility that I will be among those exploring it.

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