electromagnetic field, which suggests nonzero entropy at 0 K. However, such energy flow is not unprecedented, and apparent violations of the third law are resolved when the complete system is considered. Hopefully later editions of the book will streamline much of the repetitive discussion of the transverse electric mode issue and elaborate on the role of the third law.

The book's general incompleteness is startling, given that the body of the text runs to 701 pages. Much recent progress is missing, particularly with regard to the new numerical calculation techniques based on the fluctuation–dissipation theorem in the time domain. Lessening the book's usefulness is a weak subject index and the lack of an author index, which is normally expected when the author/date method of referencing is employed. *Advances in the Casimir Effect* cannot be considered up-to-date, nor can it be taken as a scholarly review of the field, since it merely rehashes the authors' own views. And although the book's intended audience includes advanced graduate and undergraduate students, I expect only experts will be able to draw anything from it.

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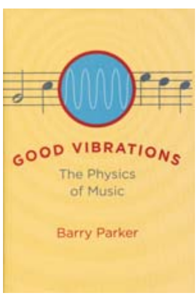
Good Vibrations

The Physics of Music

Barry Parker
Johns Hopkins U. Press, Baltimore, MD, 2009. $27.95 (274 pp.). ISBN 978-0-8018-9264-6

The quest to forge a connection between the physical sciences and music can be traced at least as far back as Johannes Kepler and the classical concept of the music of the spheres. Given my two decades of building guitars and teaching the physics of musical instruments, the mathematical development of musical scales, and guitar construction, I welcome books that aim to meld those fields.

Into this genre comes *Good Vibrations: The Physics of Music*, a book that seeks to "be of interest to musicians who are interested in learning more about the science behind music and to students and fans of physics, most of whom are also music lovers." Written by Barry Parker, professor emeritus of physics at Idaho State University, *Good Vibrations* covers an impressive variety of topics, including the physics of sound-wave generation and propagation, the overtone series, and the mathematical development of musical-scale theory, from the contributions of Pythagoras to equal temperament. In discussing the physics of various acoustic instruments, the book explains the harmonic differences between open and closed pipes and what makes a piano different from a harpsichord. Parker also delves into electronic instruments, room acoustics, sound recording, and even MIDI (musical instrument digital interface) software. I particularly liked the sections on acoustics, brass and woodwind instruments, and the physics of the human ear and the singing voice.



Overall, I applaud Parker's accessible writing style, but the real challenge in writing a book about the physics of music is to include an appropriate mix of the scientific and mathematic principles needed to understand the physics of acoustical phenomena and their application to music. In that light, *Good Vibrations* is too anecdotal in places and not focused enough on science. For example, we learn about guitar heroes such as Jimi Hendrix and Eric Clapton, but nothing of Les Paul, whose seminal contributions to the development of the electric guitar and multitrack sound recording are more relevant to physics. Elsewhere in the book, a useful demonstration of the mathematical foundation of the basic diatonic and chromatic scales precedes a large section devoted to such topics as modes, chord sequences, and rhythm—but the section fails to connect those musical theories to physics. And the discussion of MIDI—and even iPods—reads more as product instruction than an explanation of their operative scientific principles. Several important instrument categories are omitted: There is no discussion of xylophones and marimbas; membrane-based drums; the first true musical synthesizer, the acoustic pipe organ; or the first electronic instrument, the theremin. In their absence, much potentially useful scientific discussion is lost.

Moreover, *Good Vibrations* contains editing errors and factual inaccuracies that may confuse readers outside the field's cognoscente. For example, in one sequence, the book erroneously uses the same diagram to describe both the first and second overtone patterns in a pipe; on the next page, the same topic is again covered in a slightly different diagram sequence that correctly shows the two different patterns. The frequency of the note "middle C" is expressed in different places in the book as 256 Hz, 261.6 Hz, or 262 Hz without any explanation as to why these values differ (256 Hz is "scientific" C, while 261.6 Hz is "musical" C in modern 12-tone equal temperament). The author also states that "the banjo and the mandolin have a bridge, but the ukulele does not." However, ukuleles *do* have bridges. Also, an open window has an acoustic absorption coefficient of 1, not 0, as stated. And the assertion that hearing loss above 5000 Hz "doesn't seriously affect your ability to appreciate music" would likely be challenged by musicians and audiologists who appreciate the subtle differences in sound timbre contributed by higher harmonics.

Other recent publications have more effectively bridged physics and music. The third edition of Ian Johnston's *Measured Tones: The Interplay of Physics and Music* (CRC Press, 2009) employs an informal conversational and storytelling style and blends the science, mathematics, and historic personalities. Its comprehensive coverage includes all major instrument types—acoustic and electric—as well as the basics of singing and the human ear. Covering similar ground is P. U. P. A. Gilbert and Willy Haeberli's *Physics in the Arts* (Academic Press, 2008; see the review in PHYSICS TODAY, March 2009, page 51), a more formal, textbook-type volume with example problems and work sets that is still accessible to the general reader.

Although it misses the mark in places, *Good Vibrations* provides many interesting facts and connections between physics and music for the general reader. It falls short, though, of being a convincing tome for anyone who comes to the game with a detailed knowledge of either physics or music.

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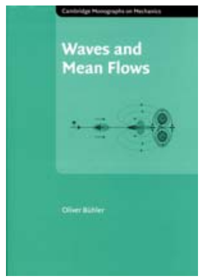
Waves and Mean Flows

Oliver Bühler
Cambridge U. Press, New York, 2009. $99.00 (341 pp.). ISBN 978-0-521-86636-1

Periodic propagating disturbances, or waves, and their underlying mean flows are ubiquitous in fluid dynamics. Most books that discuss the theory of waves and fluid flow tend to focus on water waves—although that observation may reflect my own bias toward the ocean. Three of the most accessible of those are Gerald Whitham's *Linear and Nonlinear Waves* (Wiley-Interscience, 1974), J. S. Turner's *Buoyancy Effects in Fluids* (Cambridge University Press, 1973), and James Lighthill's *Waves In Fluids* (Cambridge University Press, 1978). By contrast, Oliver Bühler's *Waves and Mean Flows* draws evenly from atmospheric and oceanic systems—for example, waves that actively drive flows as illustrated by surf on a beach and the quasi-biennial winds in the Pacific equatorial atmosphere.



Bühler's well-organized textbook is excellent in all the most important ways. It proceeds from a brief but clear summary of the basic concepts and equations of fluid dynamics to an introduction of linear waves and the effect of a mean flow, and finally to its meatiest topic: the generalized Lagrangian mean (GLM) formulation for handling—in theory, at least—finite-amplitude waves in arbitrarily complex mean flows. Whitham provides a more detailed discussion of nonlinear surface waves and several other interesting kinds of nonlinear waves, and Turner and Lighthill cover internal waves and related phenomena over a wider set of examples, contexts, and applications. But Bühler's text is unique in its clear and rigorous exposition of the inextricably linked coevolution of combined wave–current systems.

The author is well known in the field for applications of the GLM formulation to real-world problems, and his book will likely become the authoritative resource on that subject. *Waves and Mean Flows* presents its readers with a clearly written text that is comfortable to read. For each progressively more advanced technique, it provides interesting examples that apply the lesson. As a logically laid-out, internally consistent, and self-contained work, it will be useful both as a textbook and as a handy reference for researchers. The first half is suitable for an introductory graduate course, whereas the last half—particularly the discussion of the intimidating task of applying GLM to practical problems—is more appropriate for advanced graduate classes and for researchers.

More than anything else, this book pays its way with its clear and complete exposition of the GLM methodology. The utility of the GLM lies in how it gives exact conservation laws for the wave-averaged quantities with the same generality, and even similar form, as the fundamental conservation laws for such unaveraged equations as Navier–Stokes, mass conservation, action conservation, Kelvin's circulation theorem, and potential vorticity. These have clear GLM-averaged analogues, though sometimes those include surprising modifications.

The price paid for such powerful formal rigor comes in the mathematical (and sometimes conceptual) overhead required by the GLM. For example, averaging and differentiation do not simply commute under the GLM, as they normally do. Thus, calculating the vorticity of the GLM-averaged flow requires subtracting the waves' "pseudomomentum" from the GLM mean flow before taking the curl. That is easily illustrated with surface waves, in which the pseudomomentum equals the Stokes drift. The Stokes drift, in turn, has vertical shear, but that property doesn't alter the fact that the waves, and hence the associated drift, are entirely irrotational. That kind of unexpected detail can lead to confusion in the application of GLM in practice, making this book all the more valuable for its clarity.