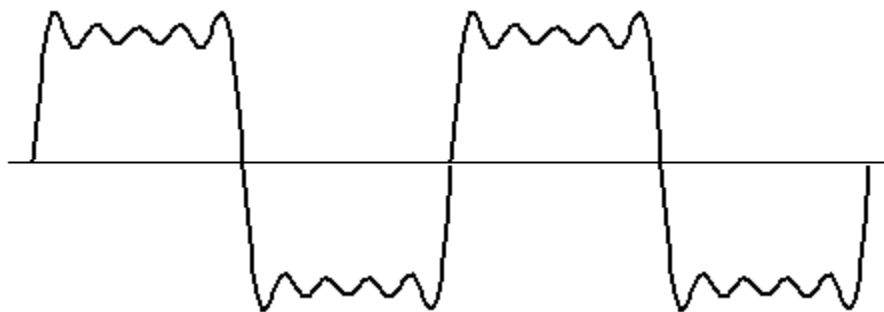
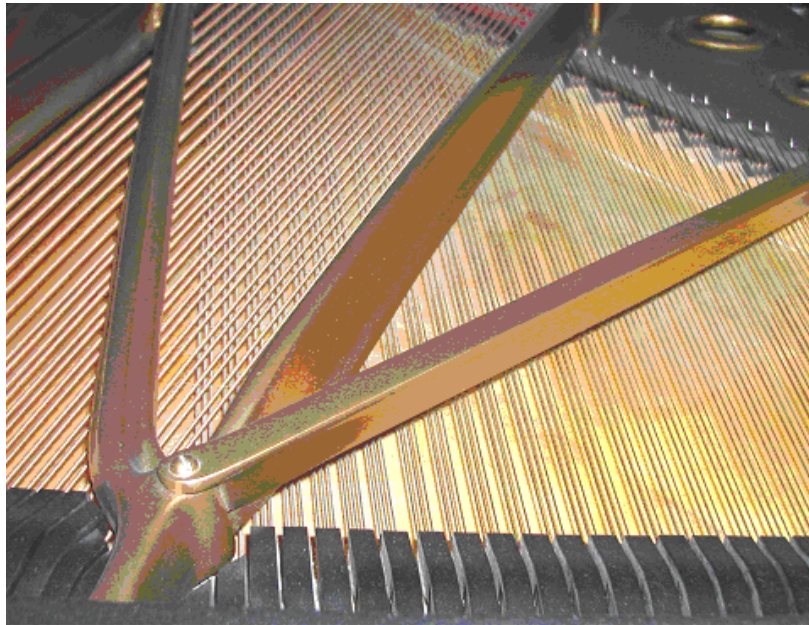


The Physics of Sound and Music

Fourth Edition (2012)

Michael J. Ruiz, Ph.D.

University of North Carolina at Asheville



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Forward

The Physics of Sound and Music is written for a general-education science course at the *University of North Carolina Asheville (UNCA)*. There are no prerequisites for this course. If you know how to balance your checkbook (most of the time), you know enough mathematics to understand this text.

PHYS 102 *The Physics of Sound and Music* has been taught at *UNCA* since the early 1980s. It was developed by the author for the general student not majoring in science. However, any student may take the course. Originally the course was patterned closely after a similar one developed at the *University of Maryland* by Richard E. Berg in the 1970s. The author worked as a teaching assistant for Prof. Berg at that time. Since then, the course at *UNCA* has evolved into a course of its own.

In the 1970s, music synthesizers were very expensive. A company, *PAIA Electronics*, began making synthesizer kits. *UNCA* acquired one of these around 1980. This old synthesizer was never really suitable for performance; however, it served for many years as a source for excellent demonstrations to illustrate sound.

The course now features applets that illustrate the physics of sound synthesis in remarkable ways. The added advantage here is that you get to play with the "toys" from home!

The *UNCA* lectures that developed around the modular synthesizer have been published in *The Physics Teacher*. The synthesizer takes a central position in our course. Legendary Bob Moog (1934-2005), one of the independent inventors of the synthesizer lived in Asheville for the last quarter century of his life. He had many interactions with Music at UNC Asheville and one year he taught a physics course.

The *Physics of Sound and Music* and its sister course, PHYS 101 *Light and Visual Phenomena*, are two of the most popular science classes at *UNCA*. Sound was written up in the

school newspaper in 1987 ("Sounds of Music," *The Blue Banner*, December 10, 1987, p. 3) and Light was featured on WLOS, *Evening News*, in 1989.

Then in Fall 2002, the uses of computer technology in these courses and our astronomy course were featured on *CNN* with anchor Ann Kellan. We made top story in technology over the August. 31, 2002 weekend. A 5-minute piece was aired throughout the world on the program *NEXT@CNN*. You can view the video at our website.

You will develop through this text and the supplemental material at our website an understanding of sound and its applications in our daily lives. You will also acquire an appreciation of the beauty of science and an integrative understanding of science across many disciplines.

The author is a theoretical physicist (elementary particles) with a Ph.D. from the *University of Maryland* in 1978. He is also a musician. He studied classical piano under Stewart Gordon and jazz piano under Ron Elliston, at the *University of Maryland* in the 1970s. He has composed three piano concertos, one for each of his children. All three children have performed these concertos with the *Winston-Salem Symphony*.

The author is also a software developer. He and his son Evan designed a unique course web management system for this course. You will need regular access to the internet in order to experience this state-of-the-art learning adventure. All your assignments are done online.

The author received the 1995 *UNCA Distinguished Teacher Award*, the 1997 *UNCA Distinguished Teacher Award in Natural Sciences*, and the 2004 *Board of Governors Teaching Award*. He is a former Chair of the *UNCA Department of Physics* (1980-2000).

Revised Summer 2012, Asheville, NC

Chapters

- A. What is Sound?
- B. Vibrations
- C. Waves
- D. Wave Applications
- E. Modulation
- F. Frequency Ratios
- G. Strings

- H. Pipes
- I. Fourier Analysis
- J. The Moogerfooger
- K. The Laws of E&M
- L. Sound Systems
- M. Analog Electronics I
- N. Analog Electronics II and Digital Electronics

- O. Signal Processing
- P. Moog Synthesizer I
- Q. Moog Synthesizer II
- R. The Ear
- S. Perception
- T. Audiology
- U. Spectrograms

- V. Musical Temperament
- W. Woodwinds
- X. Brass
- Y. Strings and Percussion
- Z. Circle of Fifths

- Appendix: Harmonic Mysteries