DEMONSTRATIONS IN ACOUSTICS

Dr. Richard E. Berg
Dr. David G. Stork
Lecture-Demonstration Facility
Department of Physics
University of Maryland
College Park, MD 20742

How to order your DVD copy of Demonstrations in Acoustics

TABLE OF CONTENTS

experiment is first performed in the studio, and then outside, to eliminate effects of reflection off the walls, floor and ceiling. An experiment is presented illustrating the effects of reversing the phase between two stereo loudspeakers.

Demonstration 10 (DVD 1): Diffraction (5 minutes)

Using a sound collimator constructed from a speaker and a sound absorbent tube, diffraction effects are shown to be greater at low frequencies than at higher frequencies. The diffraction of sound waves from a small loudspeaker, which leads to interference and a marked decrease in sound intensity, can be largely eliminated, as demonstrated using a simple baffle constructed from a 2 foot square piece of plywood with a small hole in the center, behind which the speaker is placed.

Demonstration 11 (DVD 1): Doppler Effect (3 minutes)

The Doppler Effect is illustrated by throwing a ball in which a 3000 Hz electronic whistle is sounding.

Demonstration 12 (DVD 1): Beats (5 minutes)

Using two audio oscillators, a mixer amplifier, a loudspeaker and a dual trace oscilloscope, various aspects of beats are studied. The individual waves are shown, with the sum sound varying in amplitude as the phase of one wave shifts with respect to the other. By changing the time scale on the oscilloscope, the envelope of the beat pattern can be observed, and the sum wave can be correlated with the loudness of the sound.

Demonstration 13 (DVD 1): Shive Wave Machine - Standing Waves (9 minutes)

Standing waves in a Shive Wave Machine are shown with both ends fixed, with both ends free, and with one end fixed and one end free.

Demonstration 14 (DVD 1): Standing Sound Waves (8 minutes)

After a brief exposition on the origin of standing waves, a standing sound wave is created between two speakers about a meter apart. One source is then replaced by a metal plate, and a standing wave is produced by the wave from the speaker with the reflected wave. Some details of standing sound waves are shown using a Kundt's Tube driven by an audio oscillator.

Demonstration 15 (DVD 1): Reflection of Pulses (10 minutes)

Reflection of pulses of a transverse wave from fixed and free ends is examined using a Shive Wave machine. A detailed study is then presented showing how sound pulses reflect off open and closed ends of an air column.

Demonstration 16 (DVD 1): The Overtone Series (10 minutes)

The overtone series through the tenth harmonic is illustrated using a Fourier synthesizer. First, the individual tones of the series are shown, and then the sum is obtained. The harmonics obtained in air columns are illustrated using a corrugated plastic tube. Harmonics are excited in a violin string by bowing while touching it lightly at 1/N of its length. The harmonics of an aluminum rod are excited by stroking the rod with resin on fingers. Chords are illustrated by the Fourier synthesizer and a Savart's disk demonstration.

Demonstration 17 (DVD 1): Standing Waves in a String (6 minutes)

A large rope wave generator is used to illustrate standing waves. A tightly stretched string and a stroboscope are used to study details of a standing wave.

Demonstration 18 (DVD 2): Mersenne's Laws (6 minutes)

A two-stringed sonometer is used to show the effect of changes in length, tension and mass per unit length on the fundamental frequency of a wire under tension.

Demonstration 19 (DVD 2): Standing Waves in Air Columns (11 minutes)

A tuning fork is used to excite the fundamental mode in an air tube. The relationship between the fundamental modes of open and closed tubes of the same length is shown. A nichrome heater inserted into a 4" diameter, ten foot long tube mounted vertically creates convection currents which produce noise, driving the tube at its resonant frequency of about 55 Hz. A vacuum cleaner draws air rapidly through a Twirl-A-Tune, producing up to fifteen harmonics. A manometric flame tube, in which a loudspeaker drives a six-foot long 4" diameter horizontal gas tube, illustrates standing waves in a very dramatic way.

Demonstration 20 (DVD 2): Basic Trumpet Acoustics (6 minutes)

Blowing a plastic tube at one end in the manner of a trumpet shows that the tube behaves acoustically like a closed tube, with the lip end closed. The technique of obtaining the notes on a standard trumpet is demonstrated by inserting a trumpet mouth piece into the end of a piece of flexible tube, showing that all harmonics can be obtained. Adding a bell made from a metal funnel increases the loudness of the sound.

Demonstration 21 (DVD 2): Chladni Plates (10 minutes)

After a brief demonstration of the standard bowed Chladni plate, the use of magnetostriction in a thin-walled, annealed nickel tube to drive the Chladni plates is explained and demonstrated. Figures are generated in square, circular, violin-shaped and necktie-shaped metal plates.

Demonstration 22 (DVD 2): Fourier Synthesis (9 minutes)

Using a Fourier synthesizer constructed at the University of Maryland, triangular, square, sawtooth, and pulse train waves are synthesized. The sum wave and the harmonic being added are shown simultaneously on a dual-trace oscilloscope, and the tone is heard as the harmonics are added or removed. The frequency of the synthesized wave is varied while the phases of the harmonics are locked to preserve the wave shape, thus illustrating the consistency of tone quality for a given wave shape over a large frequency range.

Demonstration 23 (DVD 2): Fourier Analysis (11 minutes)

Wave shapes and Fourier spectra are displayed simultaneously for some standard waves: sine, square and sawtooth, as well as for notes on a recorder, a violin, a crumhorn, and a clarinet.

Demonstration 24 (DVD 2): Resonance Curves (12 minutes)

Resonance curves are shown for a Helmholtz resonator, an open tube and a closed tube, and some applications are described.

Demonstration 25 (DVD 2): Modulation (12 minutes)

Frequency modulation, amplitude modulation and balanced (or ring) modulation are illustrated through appropriate oscilloscope displays while the resulting waves are heard simultaneously.

Demonstration 26 (DVD 2): Musical Synthesizer Fundamentals (12 minutes)

An introduction to the analog musical synthesizer is given using an ARP 2600 synthesizer. The differences between control and audio signals are discussed. The various synthesizer components, such as keyboard, VCO, VCA, envelope generator (or ADSR), low frequency control oscillators, noise generators, filters, ring modulator, and sample and hold, are discussed and illustrated individually and in various combinations.

Demonstration 27 (DVD 2): Vocal Formants (8 minutes)

Vocal formants are defined and then observed using a Fourier analyzer. Several brief demonstrations are performed which illustrate the formant regions of certain vowel sounds as well as the effect of changing the fundamental frequency on the formants.

Demonstration 28 (DVD 2): Audio Spectrograms (10 minutes)

Simple audio spectrograms for some basic electronic sounds are presented. Comparison and contrast of the four vocal sounds "see", "soo", "nee" and "noo", are made with the use of the Fourier spectrograms. The word "wow" is electronically synthesized and compared with the sound of the spoken word.

Demonstration 29 (DVD 2): Effect of Gas on Voice (4 minutes)

Formant frequencies change as a result of a change in the gas inhaled. This effect is illustrated by singing and talking after inhaling a light gas (He), and then a heavy gas (SF_6).

For comments or constructive criticism of this document please e-mail Dr. Richard Berg,reberg@physics.umd.edu or send message by phone or to the address on the home page.

Go back to Lecture-Demonstration Home Page.