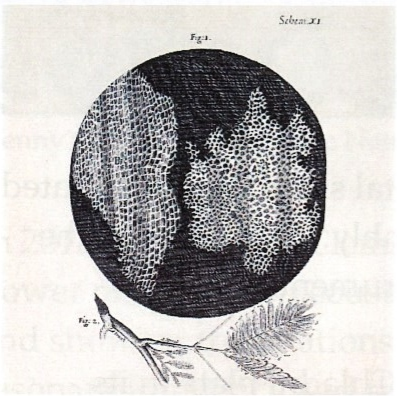
SOUTHERN OHIO Museum

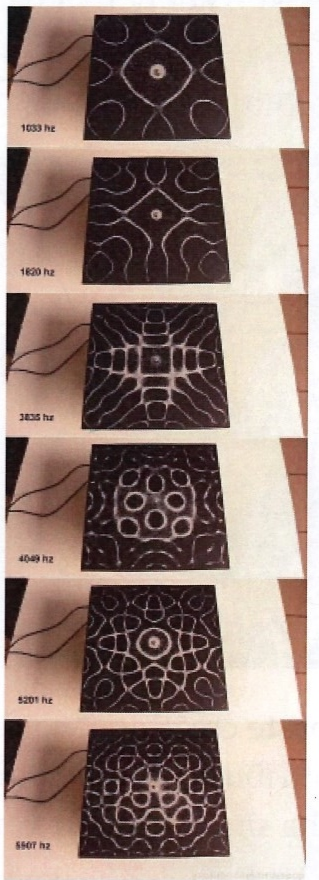
Sound Made Visible: A Scientific History



Microscopic Cork Cell Pattern

The ethereal nature of sound has fascinated humankind for centuries. The relationship between sound and visual phenomena has been observed throughout human history.

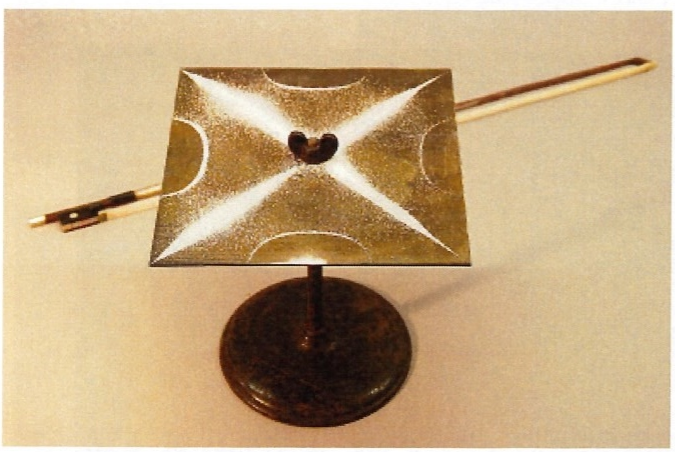
An early practitioner of acoustic science was Robert Hooke (1635-1703). Hooke was an English scientist best known for coining the term, "cell," after looking at thin slice of cork wood under the microscope.



Chladni Figures

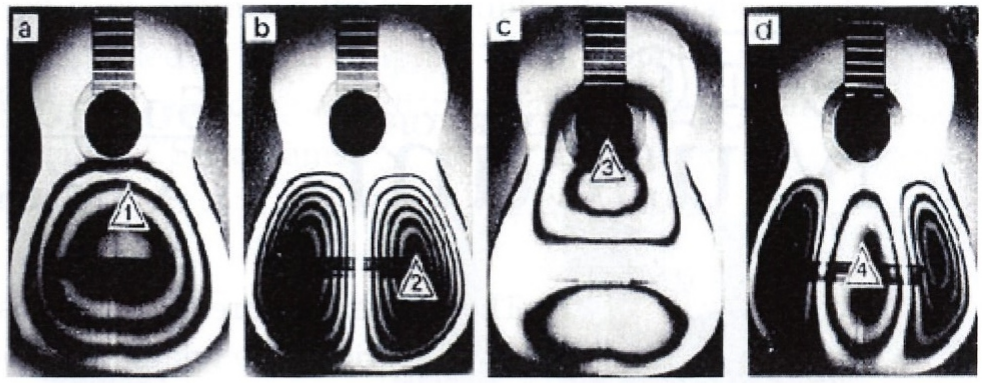
In 1680, Robert Hooke ran a violin bow across the edge of a glass plate covered in flour and observed the patterns created. This was the first observation of nodal patterns formed on a solid surface by vibration.

In 1787, German physicist and musician, Ernst Chladni (1756-1827), published a book, "Discoveries in the Theory of Sound," where he modified and repeated Hooke's sound experiment. Chladni invented a technique that illustrated the modes of vibration of a rigid surface. He took a metal plate covered with sand and, like Hooke, used a violin bow to vibrate the edge of the plate. The vibration caused the sand to bounce and settle into nodal lines where the plate did not move. The patterns that were formed were dubbed, "Chladni Figures."



Chladni Plate in the Smithsonian Collection

Ernst Chladni went on to pioneer the study of meteorites and to demonstrate conclusively that they were of extraterrestrial origin. Chladni figures are still in use today, most notably in the manufacture of violins and guitars. Metal shavings are vibrated on the front and back plates of the instruments before assembly. Symmetry in the patterns produced creates the best tones in the finished instruments.

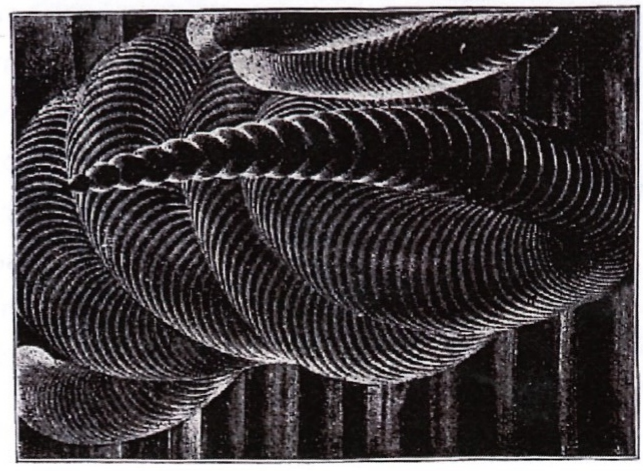


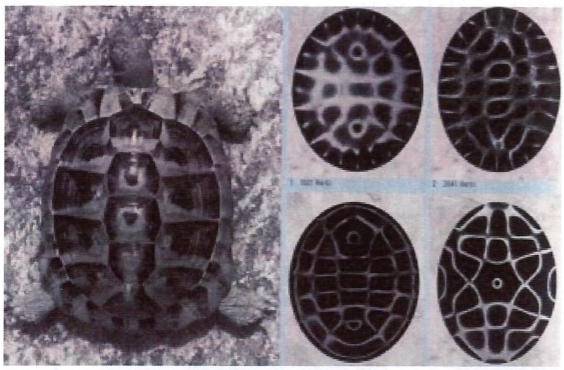
TREE FORM.

The Smithsonian museum has a Chladni plate in its collections which was used in an Ohio high school in the late 19th and early 20th century. At the time, science was commonly taught through the replication of famous experiments.

In 1891, Margaret Watts Hughes (1842-1907), a Welsh singer/songwriter and scientist published a paper called, "Visible Sound." She created a device called the eidophone which transferred the sound produced by the human voice to a rubber membrane covered in liquid or paste creating, "voice figures." The thickness of the rubber membrane and the attributes of the liquid or paste covering it, as well as the tone or tones produced by the singer caused variation in the resulting voice figures.

FERN FORM.



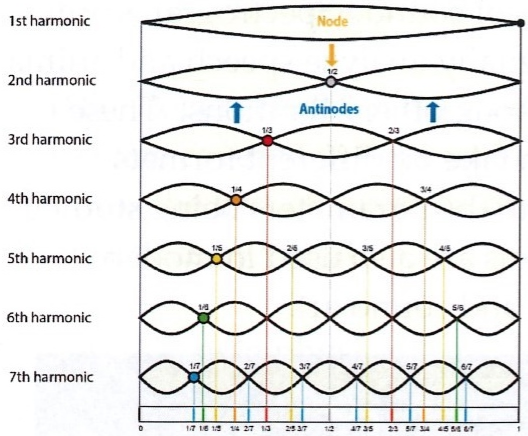


Jenny's Cymatics Resemble Natural Patterns

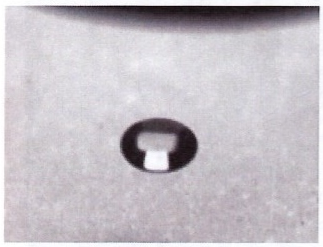
In 1967, Hans Jenny (1904-1972), a Swiss scientist interested in nature and music published the first volume of his book, "Cymatics: The Study of Wave Phenomena." The book was a written and photographic documentation of the effect of sound vibration on fluids, pastes and powders. Jenny called the effect of sound a, "dynamic but ordered pattern." He also made a popular film documentary on the same subject.

Jenny's Acoustic Dynamics

In 2013, scientists at Clemson University demonstrated the power of sound by acoustically levitating a water droplet and showing the relationship between the harmonics of its resonant frequency and the fluid dynamic shape of the droplet.

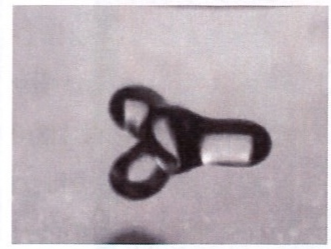


Harmonics are frequencies that are related to each other by simple whole number ratios. The first harmonic is considered the fundamental frequency. The second harmonic is exactly twice the frequency of the fundamental, which is an octave difference (the same note at a higher pitch). The third harmonic is considered a perfect fifth in Western music.



First Harmonic

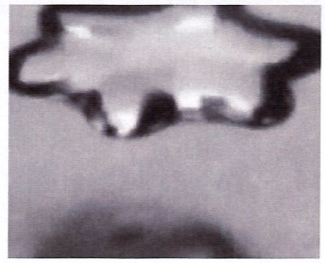
Second Harmonic



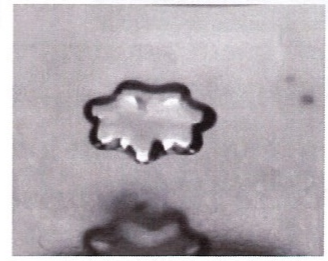
Third Harmonic

Fourth Harmonic

Fifth Harmonic



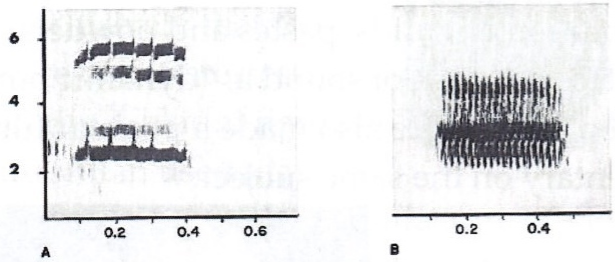
Sixth Harmonic



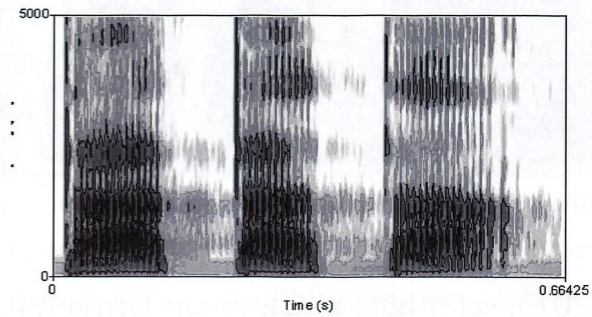
Seventh Harmonic

Eighth Harmonic

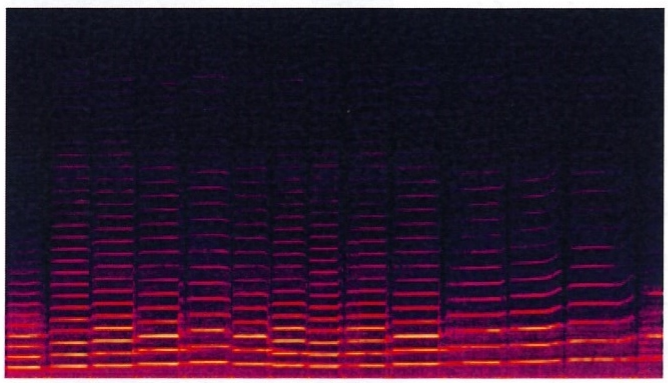
In 1951, the Kay Electric Company produced the first publically available machine for audio spectrographic analysis, called a "Sona-Graph." This machine was widely popular with birders interested in recording and distinguishing between bird calls. The images produced were called, "Sonagrams."



Sonagram of a Thrush Bird Call

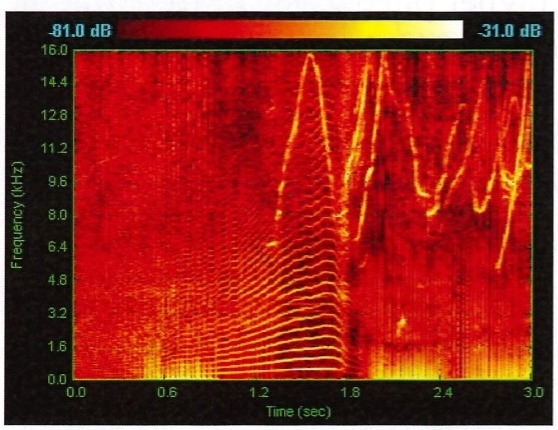


Spectrogram of the Human Voice, "Ta, Ta, Ta"

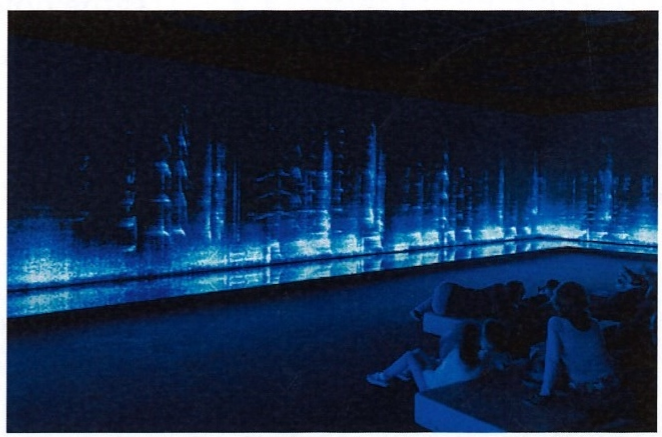


Spectrogram of 14 Draws of a Violin Bow

Today, we call these images, "Spectrograms." Spectrograms are a visual representation of the spectrum of frequencies of sound. Spectrograms are used to digitally analyze speech and animal sounds, among other vibrations. These images can take on different formats according to the parameters being studied. Spectrograms are also used in modern conceptual and sound art.



Spectrogram of a Dolphin Vocalization



Spectators Enjoying Sound Art in a Gallery

Southern Ohio Museum & Cultural Center
825 Gallia St.
Portsmouth, Ohio 45662

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