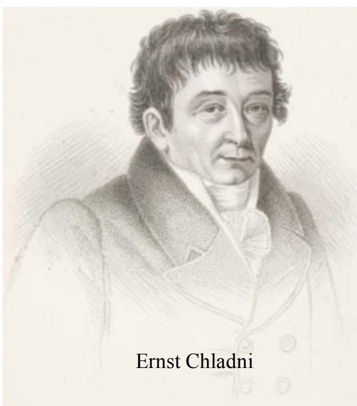
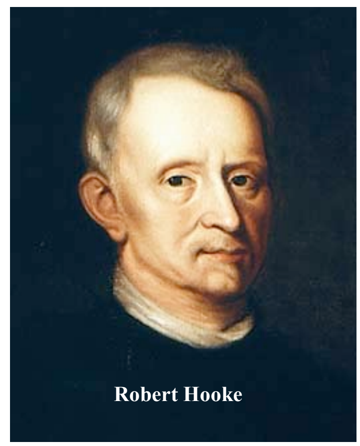
Wave Goodbye to Sound Waves

John Stuart Reid

Sound is a wave, right? If you share this commonly held belief it is probably because everything you have ever read or been told about sound, whether from high school, popular science books or university courses has said so. And yet, if our eyes could see sound, we would not see waves wiggling their way through the air. Instead, we would see something quite surprising, as you will soon learn.

So how did the popular belief in 'sound waves' begin? The confusion may have begun with German musician and physicist Ernst Chladni (1756-1827), sometimes described as 'the father of acoustics.' Chladni was inspired by the earlier work of English scientist Robert Hooke (1635–1703), who made contributions to many fields including mathematics, optics, mechanics, architecture and astronomy. In 1680 Hooke devised an apparatus consisting of a glass plate covered with flour that he 'played' with a violin bow. He was fascinated by the resulting patterns.





Around 1800 this phenomenon was further explored by Ernst Chladni, who used a brass plate and sand. Brass is a highly resonant metal and the bell-like sounds he created resulted in the sand grains organizing themselves into complex geometric patterns. These archetypal patterns are now referred to as 'Chladni Figures,' although the originator of the invention was actually Hooke. Chladni demonstrated this seemingly magical phenomenon all over Europe and he even had an audience with Napoleon. The French leader was so impressed that he sponsored a competition with The French Academy of Sciences in order to acquire an explanation as to the mechanism behind the sand patterns.

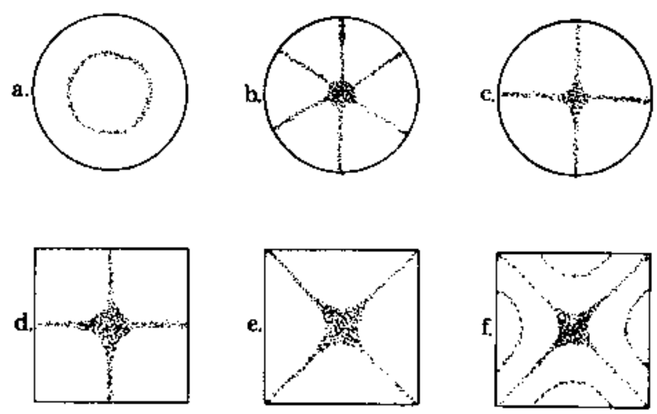


Figure 9-1. Chladni figures showing different vibration patterns for square and circular plates.

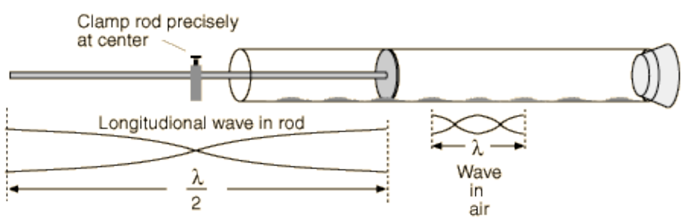
A young French woman, Sophie Germain (1776-1831), won Napoleon's 3,000 franc prize in 1816. She wrote a mathematical explanation involving wave-like functions to describe how sound created the geometric patterns. The inference was that sound 'waves' were responsible for creating areas of vibration and areas of stillness on the surface of Chladni's plate. In other words, it was believed that the crest of the 'waves' caused certain areas of the plate to vibrate while the corresponding troughs caused other areas to remain still. The sand gathered in the still areas. The term ‘wave’ has been used to describe sound ever since.


Sophie Germain

To my knowledge, no one has questioned the appropriateness of the term ‘sound wave’ and few scientists have, apparently, thought it an interesting enough question to enquire what shape sound takes as it travels through air, water or solids. Science has been content with the wave model of sound. The fact that sound has been invisible throughout history hasn’t helped to bring clarity to the situation.

Before we look at the true shape of sound, it has to be admitted that there has been some cause to believe in the existence of sound waves. For example, there is Kundt’s classical acoustics experiment that creates a wave-like disturbance in talcum powder. Waves caused by dropping a stone in water also support this misconception.


August Kundt



German physicist August Kundt (1839-1894) designed the classical apparatus referred to as the ‘Kundt Tube’, which consists of a horizontal glass tube with sealed ends. A small amount of fine powder such as talcum is placed inside before sealing. When the tube is excited by a sound, the powder forms in wave-like heaps along its length. Upon seeing such neatly arranged heaps, one could deduce that they were caused by air-borne sound ‘waves.’ The reality, however, is that the sound in the tube has areas of loudness and quietness and the powder is pushed away from the areas of loudness and gathers in the areas of quietness. The natural smooth transition between the loud and quiet areas results in the powder coming to rest in wave-like formations. **This does not mean that sound is a wave, but rather that powders have a natural tendency to form in wave-like heaps under the influence of sound.**

Ripples on ponds are another example that may have added to the sound-wave myth. When a stone is dropped into a pond, everyone knows that concentric waves are created that travel outward. Without going into a lengthy discussion as to why the elastic-like bonds between water molecules behave the way they do, suffice it to say that the physical result is indeed a wave disturbance on the water’s surface. But water waves, such as those caused by a pebble, are simply the natural reaction to the water’s displacement, not a result of the ‘plop’ sound you hear.*

Now let's look at how sound travels through air. Sound sets air molecules vibrating. When an audible sound occurs, such as a handclap, these vibrations rush away in all directions simultaneously in an ever-expanding sphere. **Put simply, the vibrations leave the source of sound as a bubble: Sound is round!**

For added clarity, audible sounds also travel spherically in water and solids, just like their movement through air. Almost every sound you have ever heard from the moment of your birth has travelled to you as a sphere, not as a wave.

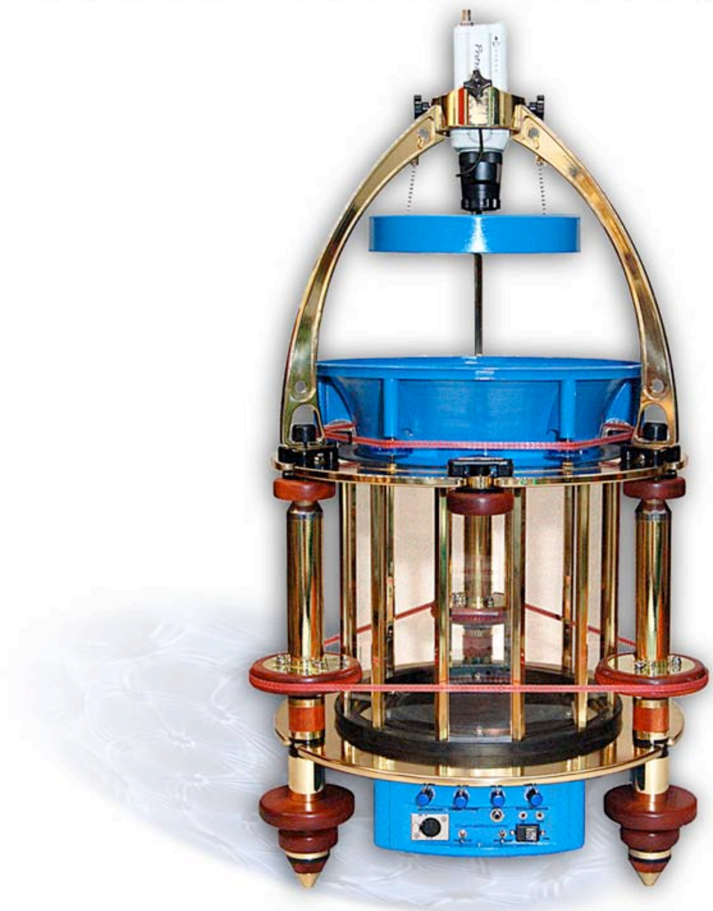
The sound vibrations within the sphere are passed from one molecule to the next, in a domino-like effect. When we hear someone's handclap or voice, nothing actually travels to our ears except vibrational information. All the molecules stay in their own little area of space, bumping into their neighbors to pass on the sound vibrations.

All sound bubbles expand very rapidly, around 700 miles an hour at sea level and a little slower on mountain tops. To visualize a sound bubble we must go into slow motion. As it expands, we see that its surface is trembling. That tremble is the result of all the air molecules vibrating in unison. These vibrations are due to the original sound vibrations travelling outward, away from the epicentre of the sound event. *Every single air molecule carries with it all the vibrations that could be 'read' as the original sound.*

The CymaScope ®
The CymaScope is the first instrument to provide a window into the energy patterns within sound bubbles. Like the Chladni plate, it has a horizontal surface on which matter is either quiescent or in a state of vibration. However, unlike a rigid metal plate, the CymaScope's super-sensitive membrane is able to display a precise 'imprint' of sound, thus allowing the hidden structures within to be revealed, right up to the lower harmonics.

The spherical nature of sound will eventually replace the old paradigm of sound waves. 'Round sound' has actually been with us since the beginning of time and now that we can visualize its patterns, the world and the Universe will never look quite the same.

CymaScope
SOUND MADE VISIBLE



*The ‘plop’ sound caused by a pebble dropped in water does minutely push the water and would create a tiny surface wave disturbance. This does not mean that sound is a wave, but that sound has the power to disturb water in a wave-like manner. The plop sound penetrates the depths of the water and therein travels spherically.

John Stuart Reid is an English acoustics engineer, scientist and inventor. He has studied the world of sound for over 30 years and speaks extensively to audiences throughout the USA and the UK. His work has revealed some surprising aspects of sound, including its spherical and holographic nature. He is the inventor of the CymaScope, an innovative instrument that makes visible sound’s once hidden structures, just as the microscope and the telescope have brought previously hidden realms into view. Inspired by acoustic pioneers Ernst Chladni, Margaret Watts-Hughes and Hans Jenny, John Stuart Reid has taken their findings to a new level.

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