Sonoluminescence Encyclopedia Article

Sonoluminescence

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Sonoluminescence

Sonoluminescence is the emission of **light** from bubbles of air trapped in water which contains intense **sound waves**. Hypothesized in 1933 by Reinhardt Mecke of the University of Heidelberg, from the observation that intense sound from military **sonar** systems could catalyze chemical reactions in water, it was first observed in 1934 by H. Frenzel and H. Schultes at the University of Cologne. Modern experiments show it to be a result of heating in a bubble when the surrounding sound waves compress its volume by approximately a million-fold.

The precise details of light generation within an air bubble are not presently known. Certain general features of the process are well understood, however. Owing to water's high degree of incompressibility, sound travels through it in the form of high speed, high **pressure** waves. Sound waves in air have smaller pressure, since air is highly compressible. The transmitted **power** in a wave is proportional to the product of its pressure and the amplitude of its vibrational **motion**. This means that the **wave motion** is strongly amplified when a sound wave travels from water to air.

Since the **speed of sound** is much greater in water than in air, a small bubble within water carrying sound waves will be subjected to essentially the same pressure at every point on its surface. Thus, the sound waves within the bubble will be nearly spherical.

Spherical symmetry, along with the large amplitude of displacement of the surface of the bubble, results in extreme compression of the air at the center of the bubble. This compression takes place *adiabatically*, that is, with little loss of **heat**, until the air is at a high enough **temperature** to emit light. Temperatures within a sonoluminescing bubble range between 10,000-100,000K (17,540-179,541°F; 9,727-99,727°C).

Theorists are working on models of sonoluminescing bubbles in which the inward-traveling wave becomes a shock wave near the center of the bubble; this is thought to account for the extremely high temperatures there. Although the maximum temperatures within a sonoluminescing bubble are not known with any certainty, some researchers are investigating the possibility of using these imploding **shock waves** to obtain the million-degree temperatures needed for controlled **nuclear fusion**.