CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
Janell P. Bryant

Project Number
J1508

Project Title
The Whispering Gallery Effect: Sound Propagation Near a Curved Surface

Abstract

Objectives/Goals
This experiment deals with the study of the acoustics of a whispering gallery. The type of gallery I am studying does not involve focussing of the sound, but rather a channeling of the sound along the curved surface of the wall. I wanted to test the results of several previous studies (some of which contradicted each other) and see if I could discover anything new. Most of these studies are quite old and predate modern electronic test equipment needed to verify their claims experimentally.

Methods/Materials
I loosely based the design of my gallery upon St. Paul#s Cathedral, a well-known example of this type, located in London, England. I made a circular model, about 3 meters (10 feet) in diameter, that is one-eleventh the scale of that of the real gallery. The walls of St. Paul#s Cathedral are made of stone; however; I built my gallery out of hardboard, which my tests confirmed reflected sound adequately for my experiments. I used a small speaker to generate the sound and a microphone to receive the sound. I used high frequencies, 2.5kHz to 20kHz, to produce short wavelength sound waves for my scaled model. I used several pieces of electronic equipment including a signal generator, two amplifiers, a filter, an oscilloscope and a digital voltmeter.

Results
My results confirmed that sound waves travel along the curved surface of the gallery. I found that the signal strength fluctuates rapidly with the position of the microphone and speaker as suggested by some references and not by others. I found an unexpected and dramatic improvement in performance at low frequencies, the opposite of what was suggested by other studies. I also found less enhancement of the effect than expected when the speaker was moved closer to the wall.

Conclusions/Discussion
My most important new result is the enhancement of the gallery effect at lower frequencies. Several of the previous studies suggested that the gallery should work better at the higher frequencies corresponding to whispering than to the lower frequencies of normal speech.

Summary Statement
This is an experimental study of the acoustics of a scale model of a circular whispering gallery, which found new results including a frequency dependence that is opposite to that suggested by previous studies.

Help Received
My father, Paul Bryant, provided technical help and advice. Some electronic equipment used was provided by my father#s work, Recording Physics, Inc.