Engineering One Layer of a Two-Dimensional Acoustic Band Gap Material and Reconstructing the Sound Pressure Field Using Acoustic Holography

Wesson, Ella (School: Manhasset High School)

Acoustic band gap materials are periodic arrangements of scattering materials that harness the properties of waves to create band gaps—areas of space where waves of specific frequencies cannot propagate—through destructive interference through the material. Acoustic holograms are one effective method of determining the presence of band gaps, as they can give insight into the phase and amplitude of a propagating wave with respect to time elapsed and the wave's position. The goal of this study was to engineer one sheet of a two-dimensional acoustic band gap material using cylindrical balloons filled with helium and sulfur hexafluoride and to test for expected properties of acoustic waves using acoustic holography. The indices of refraction of these gases have a high contrast, which is important in choosing scattering materials. A pure tone of 10kHz was played through a grating of helium-filled and sulfur hexafluoride-filled balloons, and the phase and amplitude of the pressure field were recorded and used to render holograms of the sound field. Holograms were created by using Python code to back-propagate the sound waves using the Rayleigh-Sommerfeld approximation of the Fresnel diffraction integral. Acoustic holography confirmed the effects of both singular balloons of helium and sulfur hexafluoride as well as the diffraction grating on the propagation of the incident sound waves. This innovative study can be utilized in the largely unexplored field of acoustic sciences, including the intentions of developing sound localization and acoustic cloaking, which can be evolved into stealth technology.

Awards Won: