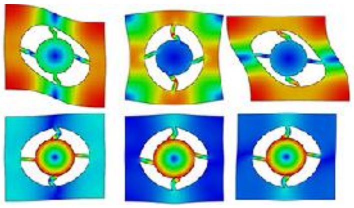
Synopsis: Sound Switch



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Harnessing Buckling to Design Tunable Locally Resonant Acoustic Metamaterials

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Acoustic metamaterials are composite systems that can be used to control the propagation of sound waves in ways impossible with natural materials, with potential applications in noise reduction and in “stealth” technologies. A new design, combining an elastic matrix, structural elements, and metallic cores, features an adjustable acoustic response that can be tuned through squeezing. Experiments with this metamaterial—detailed in Physical Review Letters—show that it behaves like a switch that blocks or lets pass a certain band of sound frequencies, depending on how much it is squeezed.

Similarly to optical metamaterials, acoustic metamaterials combine structural elements that tailor the propagation of waves thanks to band gaps—frequency ranges of strong attenuation. Currently, most acoustic metamaterial configurations are passive and operate at fixed frequencies. But the ability to make them tunable would boost the spectrum of possible applications.

Katia Bertoldi and her colleagues from Harvard University have developed a new tuning strategy based on the mechanical deformation of the structure as a whole. Their acoustic metamaterial is a 50-millimeter-thick silicon rubber block perforated with an array of holes. Inside each hole is a copper core, held in place by four elastic beams. As shown in simulations and experiments, the core-beam microstructures act as acoustic resonators that absorb sound waves with frequencies around 100 hertz. However, when the system is compressed by a few percent in the vertical direction, the elastic beams buckle, causing the resonant absorption band to drop in frequency. When further squeezed, the metamaterial no longer absorbs sound waves at all, like a switch being flipped open. An acoustic switch could play a role in smart systems for vibration/noise reduction, guiding of sound waves, frequency modulation, as well as acoustic imaging. – Michael Schirber