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# Scilight

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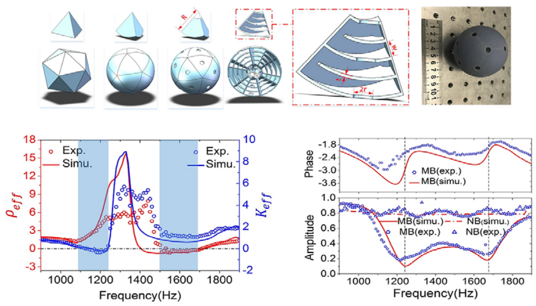
**A computational model demonstrates sound cloaking and super-tunneling capabilities of a system built out of metamaterial balls.**




Acoustic metamaterials, or materials engineered to have acoustic properties not found in nature, have promising applications like acoustic cloaking, subwavelength imaging and acoustic wave manipulation. Most experiments have focused on 2-D acoustic metamaterials for manipulating in-plane sound waves, or 3-D designs that can only control waves coming in from certain directions.

In *Applied Physics Letters*, researchers report on the design of a 3-D acoustic metamaterial ball with isotropic negative characteristics. A larger metamaterial system using these balls as building blocks demonstrated both sound cloaking and super-tunneling within a finite space. The system blocks the low frequency sounds between the monopolar and dipolar resonances in both numerical and experimental investigations.

The ball's design evolved from a regular icosahedron consisting of 20 identical tetrahedrons. Each tetrahedron, rounded off to form a cone, contained a labyrinthine structure to artificially extend the propagation path of sound waves. The ball, with a radius of 35 millimeters, was then 3-D printed in a photosensitive resin.

The authors performed eigenstate analysis via computer simulation, finding that the metamaterial system had two significant Mie-type eigenmodes: a monopole resonance at 1135 hertz and a dipole resonance at 1722 hertz. After confirming the negative properties, where the metamaterial has near-zero density near the dipole resonance, the experiment investigated the ball hanging from a thread in a standing wave tube. Here, too, they observed blocking of sound waves in the low-frequency range between monopole and dipole resonances.

In a two-scale computational model, a structure created with the balls as building blocks was able to cloak a rigid obstacle from being detected by an acoustic wave. The wave shape remained unchanged without any distortion of the wavefront in a finite 3-D space.

According to co-author Xiaodong Huang, future research in this area includes the systematic design of acoustic metamaterials utilizing a topology optimization technique.

**Source:** "A 3-D space coiling metamaterial with isotropic negative acoustic properties," by X. F. Fu, G. Y. Li, M. H. Lu, G. Lu, and X. Huang, *Applied Physics Letters* (2017). The article can be accessed at https://doi.org/10.1063/1.5005553.



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