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Acoustic "Invisibility" Cloaks Possible, Study Says

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If sound could bend around objects in just the right way, submarines could evade sonar detection and large beams and columns wouldn't obstruct concert-hall acoustics.

This type of acoustic invisibility is possible, according to physicists who hope to develop the theoretical sound-wave-bending materials.

The result would be a shell that acts as an acoustic cloak—something like an invisibility cloak, but for sound, not light.

Sound waves would bend around a cloaked object and then continue on their original courses.

It would appear as though they had passed directly through the shell, "as if nothing had been there at all," said Steven Cummer of Duke University, lead author of a new study.

Different Waves

After scientists in 2006 successfully built a two-dimensional invisibility cloak based on similar principles—including the development of a material that can bend light waves around objects it covers—some in the scientific community said the same trick with sound waves would be impossible.

Cummer took that as a challenge.

"For a year I've been chipping away at this, deriving the properties of the shell we [would] need," he said.

"In our latest work we've been able to show that there is a set of material properties that would do exactly to sound waves what that invisibility cloak does to electromagnetic waves," he said.

"It's theoretical," Cummer said. "But it looks like it ought to be doable."

The key is a material in which sound waves travel at different speeds in different directions.

"That is not a property that most materials have," Cummer said. "For instance, in air or water, sound speed is the same in all directions."

However, he said, it should be possible to engineer a composite material in which many different substances combined would have the desired overall characteristics.

The study appears in this month's edition of the journal *Physical Review Letters.*

Music Halls

The most obvious use of an acoustic cloak would be hiding submarines from enemy sonar—sound waves that are used to locate underwater objects.

But the advance could also be used in architecture—in music halls and theaters, for instance.

"Right now . . . the acoustics are built into whatever you're doing structurally," Cummer said. "So you probably have a set of tradeoffs, structurally and acoustically."

But with acoustic cloaking technology, "a giant beam that might be important structurally and bad acoustically could be rendered acoustically invisible."

The research carries importance far beyond the potential applications, said Xiang Zhang, a metamaterials engineer and physicist at the University of California, Berkeley, who was not involved in the study.

"It opens up important fundamental research on how you funnel light or sound waves into desired locations," he said.