Breakthrough technology that could 'kill' headphones: Bending sound straight into the listener's ear

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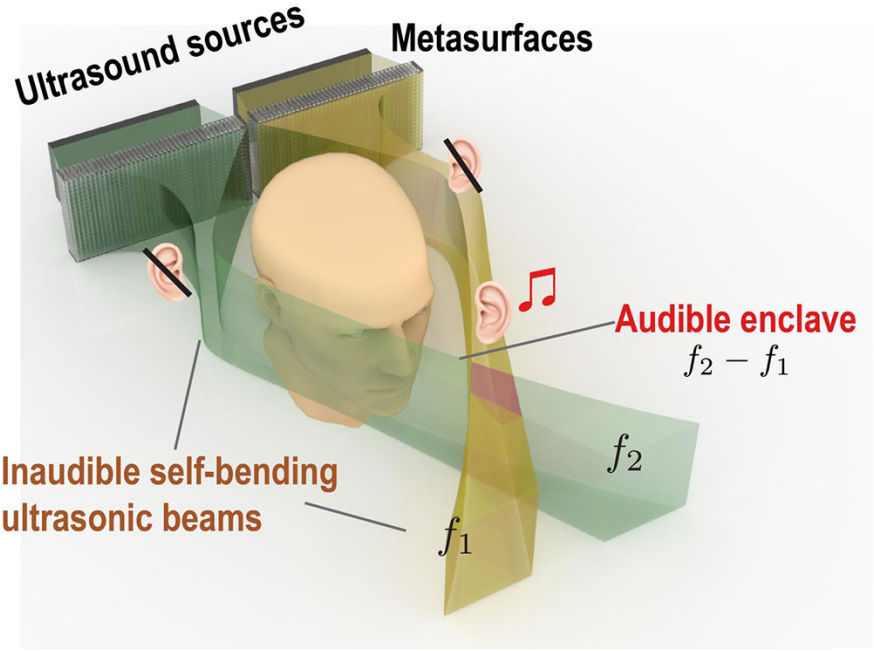
Imagine being able to listen to music or podcasts through external speakers without disturbing those around you—even without headphones. That's exactly what a team of researchers at Penn State University is developing. Led by acoustics professor Yun Jing, they've created a completely new technology called 'audible enclaves'—where sound only comes from a precise point.

The secret lies in combining ultrasonic waves (which are inaudible to the human ear) with 'acoustic metasurfaces' – tiny lenses that bend sound in a predetermined direction. When two ultrasonic beams travel along a curved path and intersect at a point, the sound becomes audible only at that location. 'The person standing at the intersection will hear the sound, while the people around will not hear anything at all,' Professor Jing explains. 'This creates a private acoustic barrier between people.'

The system consists of two ultrasonic speakers and a 3B-printed metasurface lens from the Lawrence Livermore National Laboratory (USA). Each beam of waves has a slightly different frequency, and when they meet, the local reaction makes the sound audible. Remarkably, the individual beams are not large enough - the sound only forms at the intersection.



Dr Jia-Xing "Jay" Zhong, a member of the research team, describes the experiment: "We used a dummy head and torso model with microphones in the ear to simulate human hearing along the path of the ultrasound beam, with a third microphone scanning the intersection area. The results confirmed that the sound only appeared at the intersection point - creating an 'exclusive sound zone'."

The biggest advantage of this technology is that it operates over a wide frequency range (125 Hz to 4 kHz), covering most of the human audible range. The system is still effective in highly echo-filled spaces, and is only about 16cm in size - about the size of a pencil case.

'We've essentially created a virtual headset,' Zhong says. Practical applications could include cars, classrooms, or open-plan offices—where one person can clearly hear the content while those around them are completely oblivious.

Currently, sound can travel about 1 meter at an intensity of ~60 decibels (equivalent to normal conversation). The research team believes that this limit can be raised with more powerful ultrasound waves.

While it may sound futuristic, the technology solves a fundamental problem: precise control of sound direction. For tech and audio design enthusiasts, it could usher in a new era of personalized listening experiences.