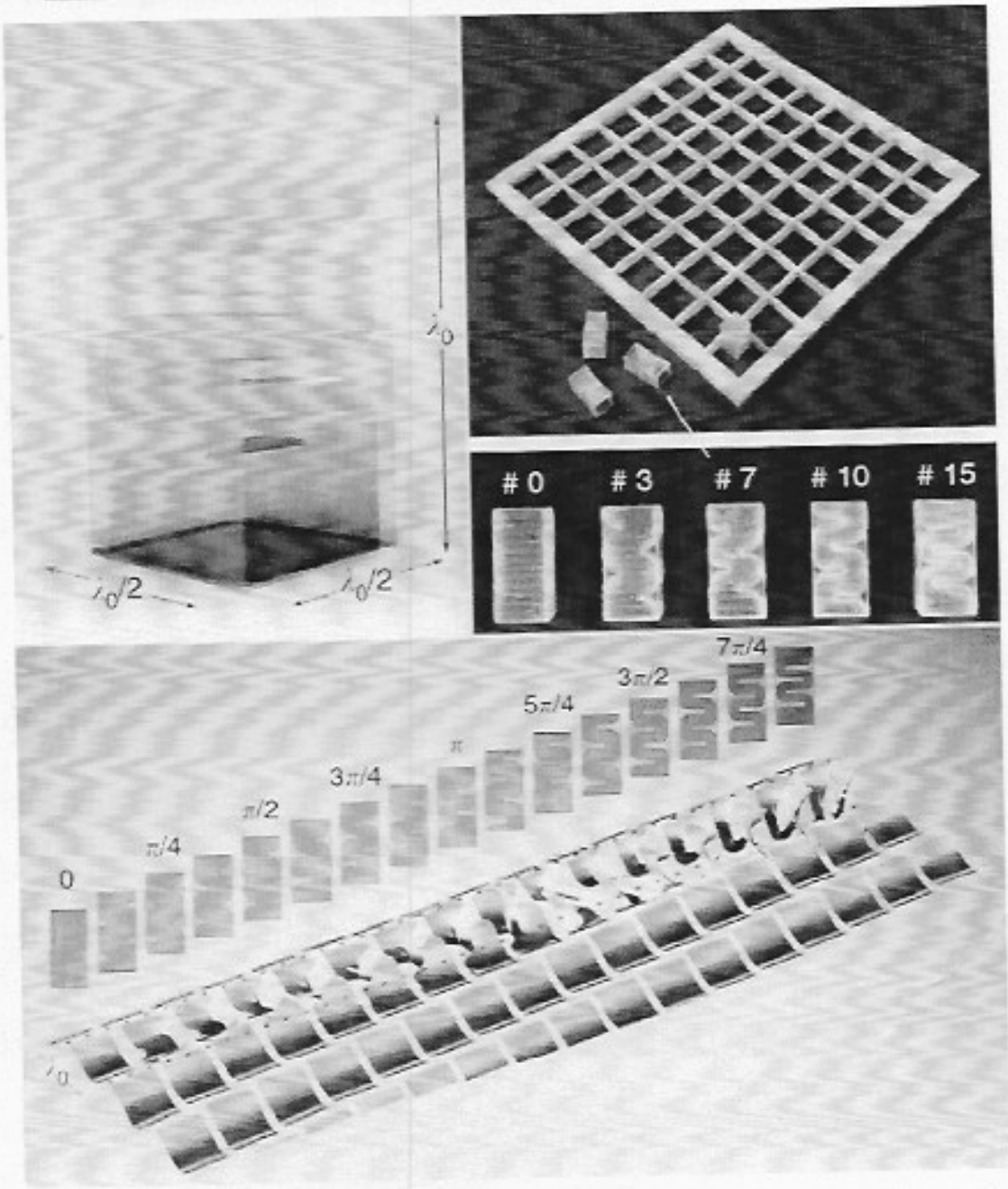
## Researchers Invent Sound-Shaping Metamaterial

Feb 28, 2017 by News Staff / Source

**A team of researchers from the Universities of Sussex and Bristol, UK, has invented the first metamaterial that easily bends, shapes and focuses sound waves that pass through it, as described in a paper published in the Feb. 27 issue of the journal *Nature Communications*.**




Sound-shaping metamaterial bricks. Upper left: 3D rendering of a brick. Upper right: photograph of the fabricated bricks and the grid to contain them; the numbers at the top of each brick denote the corresponding phase shift. Bottom: cross-sections of 16 selected bricks and the corresponding phase maps at normal incidence. Image credit: Gianluca Memoli *et al*, doi: 10.1038/ncomms14608.

Metamaterials — human-made composites that are engineered to exhibit exotic properties not found in nature — have already shown remarkable results with light manipulation.

But Universities of Sussex researcher Dr. Gianluca Memoli and co-authors have now shown that metamaterials also work with sound waves.

"Finely shaped sound fields are used in medical imaging and therapy as well as in a wide range of consumer products such as audio spotlights and ultrasonic haptics," the scientists said.

They assembled a metamaterial layer out of lots of small bricks that each coil up space.

The space coiling bricks act to slow down the sound meaning that incoming sound waves can be transformed into any required sound field.

"Our metamaterial bricks can be 3D printed and then assembled together to form any sound field you can imagine," Dr. Memoli explained.

"We also showed how this can be achieved with only a small number of different bricks."

"You can think of a box of our metamaterial bricks as a do-it-yourself acoustics kit."

"Our metamaterial bricks are designed for operating at 40 kHz, nevertheless the presence of the labyrinth meander means that each brick can also work at lower frequencies," the authors added.

The new metamaterial layers could be used in many applications:

(i) large versions could be used to direct or focus sound to a particular location and form an audio hotspot;

(ii) much smaller versions could be used to focus high intensity ultrasound to destroy tumors deep within the body. Here, a metamaterial layer could be tailor-made to fit the body of a patient and tuned to focus the ultrasound waves where they are needed most.

In both cases the layer could be fitted to existing loudspeaker technology and be made rapidly and cheaply.

"We want to create acoustic devices that manipulate sound with the same ease and flexibility with which LCDs and projectors do to light," said senior author Prof. Sriram Subramanian, Head of the Interact Lab at the University of Sussex.

"Our research opens the door to new acoustic devices combining diffraction, scattering and refraction, and enables the future development of fully digital spatial sound modulators, which can be controlled in real time with minimal resources."

"In the future I think there will be many exciting applications of this technology," said co-author Prof. Bruce Drinkwater, from the University of Bristol.

"We are now working on making the metamaterial layers dynamically reconfigurable."

"This will mean we can make cheap imaging systems which could be used either for medical diagnostics or crack detection."

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Gianluca Memoli *et al.*/2017. Metamaterial bricks and quantization of meta-surfaces. *Nature Communications* 8, article number: 14608; doi: 10.1038/ncomms14608