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•Editorial•
Special Topic: Acoustic Metamaterials

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Editorial

Acoustic metamaterials are artificial materials composed of subwavelength building blocks with rationally-designed shape, geometry, size, and arrangement. They have emerged as excellent platforms for manipulating acoustic waves in ways previously considered impossible. In stark contrast to conventional materials, the physical properties of acoustic metamaterials depend on how the unit cells are structured and can therefore extend beyond (the meaning of the Greek word "meta") those of the base materials themselves. As a result, it becomes possible to design special artificial structures at scale that are much smaller than the working wavelength to obtain extraordinary effective acoustic properties in the bulk, which are not achievable in nature. After nearly two decades of rapid development, research on acoustic metamaterials has progressed from the stage of demonstrating unconventional yet usual low-efficiency and narrowband acoustic manipulation to the discovery of new physics inspired by topology and non-Hermiticity, and the pursuit of novel applications based on unprecedented high efficiency and broadband functionalities.

This special topic on acoustic metamaterials, composed of four articles, aims to help researchers in related fields to better see the recent advances in the novel physics and functionality of acoustic metamaterials and the possible future development directions. Much research effort has been expended in investigating the topology in acoustic metamaterials in recent years with rapid growth seen in the studies of topological acoustics. By applying topological insulators in the acoustic adiabatic passage, the adiabatic transfer of sound energy between two topological end states in the Su-Schrieffer-Heeger cavity chain can be investigated, which is considered to be an acoustic analog of the quantum chirped-pulse excitation [1]. In addition to topological insulators, considerable attention has also been paid to research on topological semimetals without band gaps. In the News & Views, the intriguing physical phenomena associated with quadratic Weyl points in metacrystals are introduced which are one type of artificial periodical structure that have been proven to be an effective experimental platform for studying new topological phases of matter and other quasiparticles with higher topological charges [2]. High-efficiency concentration of broadband acoustic waves coming from all directions in three-dimensional (3D) space is desired for many important applications such as acoustic sensing and energy harvesting, which is difficult to accomplish with conventional materials. A theoretical design and experimental demonstration of a 3D omnidirectional and broadband metamaterial-based concentrator is reported in ref. [3], simply implemented by perforating a solid spherical shell with radially shrinking cross-section, with no need for a complicated gradient index or hyperbolic dispersion. Metamaterials have also been proven to be capable of outperforming conventional acoustic absorbers and have potential application in noise control, for example. An acoustic metamaterial, which serves as an asymmetric absorber at an exceptional point with a compact configuration and deep-subwavelength thickness, has been experimentally realized and is presented in ref. [4]. This is in contrast to conventional side-branched sound absorbers in dual-port systems which necessarily have thick and irregular structures.

We would like to thank all the authors who have contributed to this special topic. We believe that the novel physics and promising directions proposed here will benefit the development of acoustic metamaterials and have far-reaching impacts in acoustics and related fields.

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