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Manipulation of acoustic wavefronts by resonator-based metasurface

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Acoustic metasurfaces, a relatively new class of 2D metamaterials with subwavelength thickness [1], have attracted a lot of interest in the recent years, due to their extraordinary properties for extended wavefront manipulation, which cannot be realized by their 3D counterparts. By introducing suitable phase modulations along the acoustic path, metasurfaces provide an unprecedented way to control the direction of reflected and refracted waves, even going to negative angles, thus opening new possibilities in designing metasurfaces for many practical applications in wave engineering.
In this work, locally resonant acoustic metamaterials (LRAMs) [2] are considered as the building units of the metasurface, which owe their favourable properties to the local resonances at the microstructural level. Full phase control of reflected waves can be achieved by designing unit cells with varying mechanical or geometrical properties, which greatly influence the local resonance frequencies of each substructure. Anomalous and negative reflection phenomena for ultrasound waves are demonstrated numerically by means of a finite-element analysis for a fluid-metasurface-solid structure. Furthermore, a thorough analysis of the influence of the constituent material parameters of the metasurface, incident angles and operating frequencies on the phase shift of the reflected waves is performed. The results of this study provide new insights and detailed guidelines to design metasurfaces for controllable acoustic wave reflection.

REFERENCES

[1] B. Assouar, B. Liang, Y. Wu, Y. Li, J.-C. Cheng, Y. Jing, Acoustic metasurfaces. *Nat Rev Mater*, Vol. **3**, pp. 460-–472, 2018.

[2] Z. Liu, X. Zhang, Y. Mao, Y. Zhu, Z. Yang, C. Chan, P. Sheng, Locally resonant sonic materials.*Science*, Vol. **289**, pp. 1734—1736, 2000.