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Quantum Spin Hall Effect in Ultrasonic Metamaterials S. HOSSEIN MOUSAVI, University of Texas at Austin, ALEXANDER B. KHANIKAEV, City University of New York, ZHENG WANG, University of Texas at Austin — The discovery of topological order without breaking time-reversal symmetry, such as that in Quantum Spin Hall (QSH) effect and Topological Insulators, is one of the most groundbreaking advancements of recent years in condensed matters physics. The approach to topological order without breaking time-reversal symmetry is particularly important in elastics because no natural elastic materials show linear nonreciprocal response. Here we illustrate the first elastic-wave system emulating QSH effect and demonstrate existence of topologically protected elastic edge states. The system represents an elastic metamaterial-based phononic crystal. In this crystal, we achieved degenerate linear dispersion for two sets of modes, classified by one of the system's symmetries. Then, by relaxing and removing that symmetry by deliberately engineering a gauge field emulating a strong spin-orbit coupling of QSH, we observe opening a complete topological bandgap. Finally, the hallmark of the topological order, namely the presence of one-way chiral edge waves insensitive to nonmagnetic defects and disorders, is demonstrated in such elastic metacrystals. We illustrate the unique property of these elastic edge waves to flow around sharp corners without back-reflection or localization.

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