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# Acoustic lattice resonances and generalised Rayleigh–Bloch waves

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## Abstract

Rayleigh–Bloch waves are modes localized to periodic arrays of scatterers with unbounded unit cells. Here, Rayleigh–Bloch waves are studied for line arrays of sound-hard circular scatterers embedded in a two-dimensional acoustic medium, for which it has recently been shown that Rayleigh–Bloch waves exist for higher frequencies than previously thought. Moreover, it was shown that Rayleigh–Bloch waves can cut off (disappear) and cut on (reappear), and additional Rayleigh–Bloch waves can cut on and interact with the existing ones. These complicated behaviours are reconsidered using a family of quasi-periodic Green’s functions that allow particular plane-wave components to become unbounded away from the array so as to trace the trajectories of the Rayleigh–Bloch wavenumbers as they swap between Riemann sheets that are categorized according to the unbounded plane wave(s) and provide new understanding of Rayleigh–Bloch waves around the critical frequency intervals where they cut on/cut off/interact.

These theoretical investigations are complemented by experimental results in airborne acoustics, in which we experimentally observe the first generalised Rayleigh–Bloch waves above the first cut-off, i.e., in the radiative regime. We consider radiative acoustic lattice resonances along a diffraction grating and connect them to generalised Rayleigh–Bloch waves by considering both short and long arrays of non-resonant 2D cylindrical Neumann scatterers embedded in air. On short arrays, we observe finite lattice resonances under continuous wave excitation, and on long arrays, we observe propagating Rayleigh–Bloch waves under pulsed excitation.

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