Subwavelength Total Absorption by Membrane Type Metamaterial

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Perfect absorption of low frequency sound with subwavelength absorbers has always been a challenge, owing to the difficulty in achieving impedance matching and the inherent weak aborption coefficients of materials at low frequencies. Recently it was shown that when a membrane-type resonator's modes are hybridized through the addition of a thin air-sealed cell with a back reflecting surface, perfect absorption of low frequency acoustic wave can be achieved at a particular tunable frequency. Here we use a geometric perspective, based on the fact that the membrane is very thin and therefore the displacements on both sides of the membrane must be the same, to gain a unified framework for deriving absorption upper bounds as well as for understanding the hybrid resonance and the coherent perfect absorption on the same footing. The latter is another scheme for perfect absorption based on the phase coherence of two counter-propagating waves incident upon the membrane-type resonator. Experiments were carried out to verify some relations predicted by the general framework based on this geometric perspective. Excellent agreement between theory and experiment is seen.