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Effect of roughness shape on rough-wall boundary-layer noise[1]
QIN YANG, MENG WANG, University of Notre Dame — Turbulent boundary-layer noise induced by arrays of 10×4 sparsely distributed roughness elements is investigated using Lighthill's theory with acoustic sources obtained from large-eddy simulation. Two types of roughness elements, hemispheres and cuboids with the same height $h = 0.124\delta$ ($h^+ = 168$), are considered. The acoustic formulation shows that each roughness element acts as compact in-plane dipole sources strengthened by their images in the wall. The acoustic characteristics are found to be strongly dependent on the roughness shape. For the hemispherical array, the dipole sources are mainly generated by the interaction of hemispheres with incoming turbulent eddies, spanwise dipoles are stronger than streamwise dipoles, and the leading row of hemispheres produces the weakest sound. In contrast, for cuboid elements, unsteady separation and reattachment around the front edges are important acoustic sources, the spanwise dipoles are slightly weaker than the streamwise dipoles, and the leading row produces the strongest radiation. Correlations and coherence between dipole sources associated with neighboring roughness elements are found to be weak, particularly for cuboids and in the spanwise direction.

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