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The sound of boundary-layer flow over a roughness patch[1] QIN YANG, MENG WANG, University of Notre Dame — The sound radiation by a turbulent boundary layer over an array of 4 (spanwise) by 10 (streamwise) hemispherical roughness elements is studied using large-eddy simulation and Lighthill's theory. The roughness height is 12.7% of the boundary layer thickness and 17% of the spacing between neighboring elements in both directions. The momentum-thickness based Reynolds number is 2984. The acoustically compact roughness elements and their images in the wall radiate primarily as acoustic dipoles in the plane of the wall. Similar to previous findings with a pair of roughness elements, the dipole sources are mainly generated by the interaction of roughness elements with incoming turbulent eddies and horseshoe vortices. Spanwise dipoles are stronger than streamwise dipoles in the low and intermediate frequency range, and wake turbulence enhances sound radiation from downstream elements. It is found that the leading row of roughness elements produces the weakest sound. After a small overshoot by the second row, the rows further downstream generate sound of comparable intensity, which is stronger than that of the first row. The correlations between dipole sources associated with neighboring roughness elements are weak, suggesting that the roughness elements radiate as essentially independent sources.

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