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The sound of boundary-layer flow over a roughness element[1] QIN YANG, MENG WANG, University of Notre Dame — As a first step toward predicting rough-wall boundary layer noise, the sound radiation from a single hemispherical roughness element in a turbulent boundary layer at $Re_\theta = 7500$ is investigated numerically. The roughness height is 3.6% of the boundary layer thickness, or 95 wall units. The flow field is computed by large-eddy simulation using an unstructured-mesh code developed at the Center for Turbulence Research. The velocity statistics show reasonable agreement with the experimental values measured at Virginia Tech. Acoustic calculations are based on the Curle-Powell integral solution to the Lighthill equation for an acoustically compact roughness element. The sound radiation is dominated by unsteady drag dipoles and their images in the wall. It is found that the spanwise dipole, which has often been overlooked in previous studies of roughness noise, is of similar magnitude or stronger compared to the streamwise dipole. The viscous contribution to the drag dipole is negligible relative to the pressure contribution. The effects of roughness height and upstream wake on noise generation are examined, and source mechanisms are discussed in terms of diffraction and turbulence generation by the roughness element.

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Meng Wang
University of Notre Dame

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