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The flow field around a pair of cubes immersed in the inner part of a turbulent boundary layer measured using holographic microscopy¹ JIAN GAO, JOSEPH KATZ, Johns Hopkins University — The objective of this study is to characterize the interaction of a turbulent boundary layer with roughness elements. Digital holographic microscopy is applied to measure the flow structure and turbulence around a pair of cubic roughness elements aligned in the spanwise direction with height $a = 90\delta_{\nu}$ and embedded in the inner layer of a turbulent channel flow at $Re_{\tau} = 2500$. The ratio of half-channel height to cube height is 25, and the cubes are separated by 1.5*a*. The field-of-view size is $385\delta_{\nu} \times 250\delta_{\nu} \times 190\delta_{\nu}$ and the vector spacing of the 3D 3-component velocity fields is $5.4\delta_{\nu}$. Ensemble statistics, which provide distributions of mean velocities and Reynolds stresses, demonstrate the boundary layer separation upstream of the obstacles and resulting formation of vortical semi-rings around each cube, dominated by vertical vorticity on the sides and spanwise vorticity on top of the cubes. The vortical "canopy" persists and hovers around the separated region behind the cubes, but then becomes scrambled in the turbulent wake further downstream. The necklace vortices form upstream of the cubes and remain concentrated near the wall as streamwise vortices between the cubes, but expand substantially in the wake region. Effects of the neighboring cube include accelerated flow channeling in the space between the obstacles and differences between the spatial distributions of vorticity at the inner and outer sides.

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Jian Gao Johns Hopkins University

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