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Three-dimensional flow structures and their interactions around a pair of cubic roughness elements embedded in the inner part of a turbulent channel flow[1] JIAN GAO, JOSEPH KATZ, Johns Hopkins University — The origin, evolution, and interactions of the 3D flow structures around a pair of roughness cubes with different spacings embedded in the inner part of a turbulent channel flow are measured using microscopic tomographic holography. The flow around each cube features open-type separation along the cube surfaces, and interactions among the vortical canopy covering the cube and multiple streamwise vortices. The incoming vorticity in the boundary layer and the cube front surface are major sources for the streamwise vorticity of the horseshoe and secondary vortices and for the wall-normal and spanwise vorticity of the canopy. Vortex stretching plays an important role in the interaction among these structures. Merging of the "tip vortices" developing along the cube upper edge, horseshoe and secondary vortices occur downstream at a distance that increases with the cube spacing. The spacing also affects the legs of the canopy, streamwise vortices along the inner side, dimensions of the separated regions, wall shear stresses, and the arch-type vortex behind the cube. The maximum wall shear stress occurs along the cube sides, between the horseshoe and the secondary streamwise vortices, owing to entrainment of high momentum flow towards the wall.

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