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Experimental investigation of the effect of a singly-periodic perturbation on a rough-wall turbulent boundary layer[1] JONATHAN MORGAN, BEVERLEY MCKEON, Caltech — A 3D printed surface which is singly periodic in the streamwise and spanwise directions was placed in a turbulent boundary layer facility. The zero-pressure gradient boundary layer which developed over this singly periodic roughness was characterized with hot-wire anemometry. Compared to a canonical smooth-wall flow, the periodic roughness introduces through its boundary condition a static, singly-periodic fluctuation in mean velocity. From this linear introduction of a single-mode perturbation into the flow, the nonlinear effects of the perturbation on travelling modes can be tracked through statistics, spectra, and mean flow quantities to establish a link between roughness geometry and flow physics. Variation of the velocity power spectrum within the rough boundary layer as well as variation between smooth- and rough-wall boundary layers show the effect of the roughness to be concentrated at wavenumbers which correspond to the roughness wavelength. The effects of the roughness ultimately manifest nonlinearly as an altered Reynolds-stress field which changes the mean velocity profile of the boundary layer. Implications for more general roughness are discussed.

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