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Turbulence suppression in channel flows by transverse wall oscillations MIHAILO JOVANOVIC, University of Minnesota — Although several numerical and experimental studies indicate that properly designed transverse wall oscillations can lead to a turbulence suppression, an obstacle to fully utilizing this sensorless flow control strategy is the absence of a theoretical framework for its design, optimization, and evaluation. We model and analyze the influence of transverse wall oscillations on the evolution of flow perturbations in channel flows. The amplitude and frequency of periodic oscillations enter as coefficients, and the free-stream turbulence or surface roughness enter as stochastic external excitations into our models. We quantify the effect of these excitations on velocity perturbation energy and develop a system theoretic paradigm for the optimal selection of transverse oscillation parameters for turbulence suppression. We demonstrate that depending on the wall oscillation frequency the energy of velocity perturbations can be increased or decreased compared to the uncontrolled flow. Our results provide a first compelling theoretical explanation as to why properly designed transverse wall oscillations can suppress turbulence in the wall-bounded shear flows.

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