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Nonlinear Performance of Linear Sensor-Based Output Feedback Control of Transitional Channel Flow[1] YIYANG SUN, HUAIJIN YAO, MAZIAR S. HEMATI, University of Minnesota — A large transient energy growth (TEG) of small flow perturbations can lead to laminar-to-turbulent transition in channel flow at sub-critical Reynolds number. Full-state feedback control, such as linear quadratic regulation (LQR), has been demonstrated to suppress TEG and prevent transition; however, access to full-state information is rarely possible in practice. In this study, we investigate two sensor-based output feedback control strategies: (1) static-output-feedback LQR and (2) linear quadratic Gaussian (LQG) control. These controllers use a few sensor measurements at the walls to determine the control input. We study the nonlinear effects on TEG behavior and transition control effectiveness by performing direct numerical simulations (DNS). We find that the nonlinearity serves to saturate TEG, with amplification being reduced as the initial disturbance amplitude is increased. Accordingly, the reduction of TEG in the controlled case also decreases, indicating a degradation of control performance when nonlinear effects become substantial. For LQG control, the nonlinear effects on the relation between physical and estimated states are examined. We investigate the estimator performance in DNS and further assess its influence on the control results.

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