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Control of transition in Poiseuille flow using streamwise traveling waves. Part 1: Receptivity analysis¹ RASHAD MOARREF, MIHAILO R. JOVANOVIĆ, University of Minnesota — We assess the efficacy of a zero-net-mass-flux blowing and suction in the form of streamwise traveling waves for transition control in Poiseuille flow. As shown by Bewley (2009), the net efficiency is always negative if the uncontrolled flow stays laminar. We show, however, that a positive net efficiency can be achieved in situations where the uncontrolled flow becomes turbulent but the controlled flow remains laminar. Starting from this observation, we develop a framework for selection of traveling wave parameters for control of transition with a positive net power balance. Our detailed parametric study shows that, relative to the uncontrolled flow, the velocity fluctuations around the upstream traveling waves at best exhibit similar receptivity to background disturbances. In contrast, the properly designed downstream traveling waves can significantly reduce receptivity which makes them well-suited for preventing transition. Our theoretical predictions are confirmed by direct numerical simulations of the Navier-Stokes equations in Part 2 of this paper.

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