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Effects of Longitudinal Grooves on the Stability of Channel Flow

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— The travelling wave instability in a channel with small-amplitude longitudinal grooves of arbitrary shape has been studied. The disturbance velocity field is always three-dimensional with disturbances which connect to the two-dimensional waves in the limit of zero groove amplitude playing the critical role. The presence of grooves destabilizes the flow if the groove wave number β is larger than $\beta_{tran} \approx 4.22$, but stabilizes the flow for smaller β. It has been found that β_{tran} does not depend on the groove amplitude. The dependence of the critical Reynolds number on the groove amplitude and wave number has been determined. Special attention has been paid to the drag-reducing long wavelength grooves, including the optimal grooves. It has been demonstrated that such grooves slightly increase the critical Reynolds number, i.e., such grooves do not cause an early breakdown into turbulence.

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