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Linear stability analysis of pressure-driven channel flow of a Newtonian and a Herschel-Bulkley fluid[1] KIRTI SAHU, PRASHANT VALLURI, PETER SPELT, OMAR MATAR, Imperial College London — The linear stability of pressure-driven channel flow of a Newtonian layer past a non-Newtonian fluid is studied; the latter is assumed to possess a finite yield stress and to exhibit a power-law behaviour. Coupled Orr-Sommerfeld-type eigenvalue equations are derived and solved using a spectral collocation method in the absence of unyielded regions. The numerical solutions of these equations are in agreement with analytical predictions valid in the long-wave limit. Our results indicate that increasing the yield stress (prior to the formation of unyielded regions) and shear thickening tendency of the non-Newtonian fluid promote instability. An analysis of the disturbance 'energy' illustrates the presence of an unstable, 'interfacial' mode at all Reynolds numbers studied, and an additional, less unstable 'shear' mode at relatively high Reynolds numbers. The influence of non-Newtonian rheology on the stability characteristics of these modes is elucidated.

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Omar Matar
Imperial College London

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