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Long-lived and unstable modes of Brownian suspensions in microchannels

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We investigate the stability of the pressure-driven, low-Reynolds flow of Brownian suspensions with spherical particles in microchannels. We find two general families of stable/unstable modes: (i) degenerate modes with symmetric and anti-symmetric patterns; (ii) single modes that are either symmetric or anti-symmetric. The concentration profiles of degenerate modes have strong peaks near the channel walls, while single modes diminish there. Once excited, both families would be detectable through high-speed imaging. We find that unstable modes occur in concentrated suspensions whose velocity profiles are sufficiently flattened near the channel centreline. The patterns of growing unstable modes suggest that they are triggered due to Brownian migration of particles between the central bulk that moves with an almost constant velocity, and highly-sheared low-velocity region near the wall. Modes are amplified because shear-induced diffusion cannot efficiently disperse particles from the cavities of the perturbed velocity field.

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