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Asymptotic solutions for flow in microchannels with ridged walls and arbitrary meniscus protrusion TOBY KIRK, Imperial College London — Flow over structured surfaces exhibiting apparent slip, such as parallel ridges, have received much attention experimentally and numerically, but analytical and asymptotic solutions that account for the microstructure have so far been limited to unbounded geometries such as shear-driven flows. Analysis for channel flows has been limited to (close to) flat interfaces spanning the grooves between ridges, but in applications the interfaces (menisci) can highly protrude and have a significant impact on the apparent slip. In this presentation, we consider pressure-driven flow through a microchannel with longitudinal ridges patterning one or both walls. With no restriction on the meniscus protrusion, we develop explicit formulae for the slip length using a formal matched asymptotic expansion. Assuming the ratio of channel height to ridge period is large, the periodicity is confined to an inner layer close to the ridges, and the expansion is found to all algebraic orders. As a result, the error is exponentially small and, under a further "diluteness" assumption, the explicit formulae are compared to finite element solutions. They are found to have a very wide range of validity in channel height (even when the menisci can touch the opposing wall) and so are useful for practitioners.

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