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Interface Equation For Slender Capillary Flow in 3D Curvy V Grooves[1] NICHOLAS WHITE, SANDRA TROIAN, California Institute of Technology, 1200 E. California Blvd., MC 128-95, Pasadena, CA 91125 — Capillary driven flow of wetting liquids in microstructures containing V-shaped surface grooves is an especially robust and rapid means of fluid transport in gravity free environments or in miniature flow circuits characterized by negligible Bond number. Such flows are routinely used for propellant management in space applications, lab-on-a-chip devices and cooling of 3D integrated electronic chips. The low-order, inertia-free interface model first developed independently by Romero and Yost (1996) and Weislogel (1996) elucidates the capillary-viscous mechanism driving the flow of a slender layer of Newtonian liquid within a straight V groove. Using differential geometry, we extend their approach to develop the nonlinear interface equation for flow in a 3D curvy V groove in the limit where the radius of curvature of the groove backbone exceeds the film thickness. A first-order perturbation analysis of the governing conservation equation yields an explicit form for the thin film equation in the inertia-free limit. The resulting nonlinear equation, which we demonstrate can describe very complex flows, will allow rapid design of determininistic trajectories for the wicking and transport of thin films in 3D curvy V groove networks.

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