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Bistability in the Flow of Polymer Solutions in Porous Media CHRISTOPHER BROWNE, AUDREY SHIH, SUJIT DATTA, Department of Chemical and Biological Engineering, Princeton University — Polymer solutions are often injected in porous media to improve oil recovery or groundwater remediation, but applications are limited by an incomplete understanding of the underlying physics. In a tortuous pore space, the flow becomes unstable at sufficiently large injection rates. However, how the spatio-temporal characteristics of this flow state depend on pore geometry is poorly understood. We shed light on this question by systematically varying the spacing between pores. When the pore spacing is large, unstable eddies form upstream of each pore, similar to the case of an isolated pore. By contrast, when the pore spacing is sufficiently small, the flow exhibits a surprising bistability, stochastically switching between two distinct flow states. We hypothesize that this unusual behavior arises from the interplay between the retention of polymer strain between pores, hysteresis in polymer conformations, and fluctuations in the flow. Consistent with this idea, the mean flow state can be tuned by the imposed flow rate. Moreover, we find that while flow state is correlated between neighboring pores, these correlations do not persist long-range. Our results thus help to elucidate the rich array of flow behaviors that can arise in polymer solution flow through porous media.

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