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Viscous flows on curved surfaces

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Thin-film flows in curved geometries are not exceptional in nature, they are the norm. They playing a key role in phenomena ranging from geophysical to embryonic flows, to everyday occurrences like bubbles bursting and cake frosting.
However, our understanding of viscous flows in curved spaces is largely limited to homogeneous shapes such as spheres and cylinders.
In this letter, we investigate the impact of curvature heterogeneities on viscous flows using model microfluidic experiments.
We demonstrate that anisotropic curvature fluctuations result in long-ranged flow distortions, while isotropic bumps lead to exponentially localized dipolar flows.
By combining electrostatic analogy, analytical theory, and numerical simulations, we establish the robustness of our experimental findings and explain the generic features of flow perturbations caused by curvature heterogeneities.

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