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Marangoni induced fracturing in two-dimensional frictional flows

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The competition between different driving forces (pressure gradients, gravity, internal friction, etc.) typically leads to various instabilities together with the development of a wide range of visually impacting patterns. The particular case of frictional flows, which consists in the displacement and structuring of a granular phase under viscous or capillary stress, can be considered as a deformable porous medium. Here particle-particle interactions are crucial, and major efforts have been put into characterizing the morphology and dynamics of developing fractures when the frictional fluid is deformed. Surface tension effects usually emerge as an opposing force to the fracture growth to minimize the growth of an interface. Typically, the condition for the development of a fracture is that an external driving force (for example an imposed pressure difference) has to be higher than a certain threshold set by surface tension and/or internal friction. In this work we study the opposite scenario in which surface tension is forcing the fracture development. We employ a very simple table-top setup consisting of a two-dimensional suspension of particles located on the surface of a liquid. A gradient in surface tension is induced by use of a surfactant in the liquid. This perturbation is fracturing the homogeneous suspension and a flow is triggered along cracks. We have used high-speed and high-resolution techniques coupled to image analysis routines to study the emerging fracture patterns.

References

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