PHYSICAL MATHEMATICS SEMINAR

From the viscous sewing machine to microfluidic pancake droplets

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ABSTRACT:

This presentation deals with viscous and elastic rods as well as droplet based microfluidic systems. The emphasis is laid on the geometrical constrains that rule and sculpt their dynamics.

Part I: The fluid mechanical sewing machine.

A thin thread of viscous fluid falling onto a moving conveyer belt lays down in a plethora of complex "stitch" patterns depending on the belt speed and the height of fall. A theoretical phase diagram for the patterns is produced. It reproduces the major features of the one found in literature. Fourier analysis of the motion of the thread's contact point with the belt suggests a new classification of the observed patterns that are produced by a combination of simple ratios of the natural frequency of the thread fc. Of particular interest is the alternating loops pattern whose frequencies are locked on the first five multiple of fc/3. We build upon these observations towards a simplified toy model of such a complex system.

Part II: Oval track droplets racing to a circle: a generic behavior for confined droplets relaxation.

Working in a Hele-Shaw cell, the ideal case of the relaxation of a flattened cylindrical droplet of apparent elliptical cross section is considered. Even though the typical Reynolds number imposed by the problem size is extremely low we found out that the investigated pancake droplet relaxes in a remarkable non-monotonous way. After a transient regime, where the droplet adopts a "peanut" shape, it relaxes among a novel family of ovals that to our knowledge has never been reported. These shapes, further referred to as k2 ovals, are recovered from geometrical constrains that arise from a linear stability analysis. Far from being limited to initially elliptical relaxing droplets the k2 ovals appear to be generic and are found in the relaxation of any initially symmetrical shape. This point is well understood thanks to the previously evoked linear stability analysis. A practical example is provided when considering the coalescence of two identical droplets. Experimental movies of oil droplets in a water continuous phase are provided and used for comparison with our theoretical work.

TUESDAY, NOVEMBER 19, 2013
2:30 PM
Building E51, Room 149
(MIT-Tang Center)

Reception following in Building E17, Room 401A
(Math Dept. Common Room)

http://math.mit.edu/pms/fall13/

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