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(I) Three advanced lab experiments on fluids and pattern formation

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This talk will describe three new experiments recently developed for the advanced physics lab at the University of Toronto. Students work alone and have 18 class hours to complete a lab. [1] When a low viscosity fluid (in this case air) is pumped into a narrow gap between two plates filled with a more viscous fluid (here mineral oil), the resulting expanding bubble is unstable to the formation of fingers. Students measure the number and shape of the fingers, and compare this to theory. Strongly forced bubbles form fractal objects, like snowflakes, whose fractal dimension can be measured. [2] Solitons are localized nonlinear waves that keep their shape as they propagate. Using a long water tank and an automated soliton generating device, students create and collide solitons. They compare these waves to classic KdV solitons.[3] Granular materials (here bronze particles) form patterns when they are vibrated on an oscillating plate. Various very regular patterns are observed depending on the depth of the layer and the amplitude and frequency of the shaking. Students measure the wavelength of the pattern and the phase diagram of states observed. These are compared to theory and simulations.

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