Master *Matière Condensée et Nanophysique*

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Title : Ring collapse under the applied pressure of a two-dimensional gas

Gases and liquids are usually transported in circular pipes because this shape is very robust when the internal pressure is higher than the external one. In the reverse conditions, pipes can collapse abruptly above a given threshold.
Similarly, a circular ring subjected to an external pressure of a two-dimensional (2D) gas will deform above a given threshold. This phenomenon has been theoretically predicted but scarcely studied experimentally due to the difficulties associated with the 2D nature of the geometry.
A 2D gas can be realized by insoluble molecules at the air-water interface, a system known as a Langmuir monolayer. Here, the surface pressure can be increased by compression the insoluble molecules with a barrier, very much as a classical gas and piston experiment. Surface thermodynamics teach us that the 2D pressure increase can be measured from the reduction of the associated water-air surface tension. An example of such measurement is shown in red in the central figure below.
Depositing a ring on this monolayer will create two compartments, each having a fixed number of molecules. By moving the barriers of the Langmuir through, the density of the outer compartment is increased, which can lead to an increase of the surface pressure. The inner compartment, inside the ring, remains circular, with a constant density, and hence a constant surface pressure, up to a threshold difference leading to a deformation of the ring, that in turn will lead to a density increase or the inner compartment. This leads to the blue curve below.
During this internship, we will explore the behavior of a ring under a differential pressure in a Langmuir through, both under static and dynamic conditions. We will explore the limits of existing theories and identify the challenges facing an accurate physical description of these 2D systems. Beyond becoming familiar to work under Langmuir conditions, the intern will also learn how to analyze the images captured during experiments in order to test theoretical predictions.