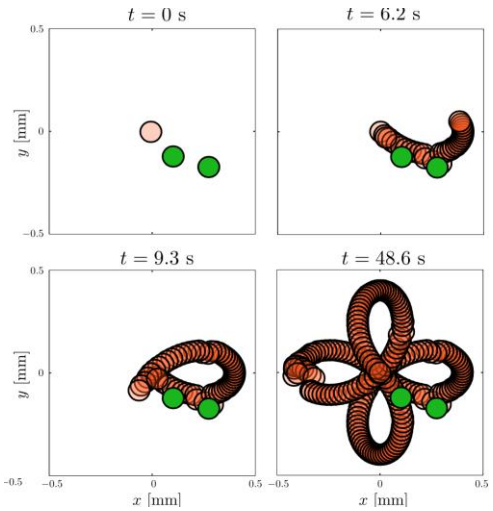
Manipulating air bubbleswithsecondaryBjerknes forces

M. Lanoy[1], C. Derec[2], A. Tourin[1], V. Leroy[2]

1 Institut Langevin, ESPCI Paris, CNRS (UMR 7587), PSL ResearchUniversity, Paris, France
2 Laboratoire Matière et Systèmes Complexes, Université Paris-Diderot, CNRS (UMR 7057), Paris, France

A bubble in a stationary acoustic field is subjected to a force, known as the primary Bjerknes force, which drives it towards the pressure nodes or antinodes. When two or more bubbles are driven by anincident sound field, they scatter a secondary field, which causes another force known as the secondary Bjerknes force[1].Here we report on an original setup where a fixed pulsating bubble is used as an actuator: by applying ultrasound, the trajectory of a bubble flowing in its vicinity is modified through the action of the secondary Bjerknes force. We carefully study the dependence of that force on the radii of the bubbles, their distance and the frequency of the exciting acoustic field. We report the observation of both attractive and, more interestingly, repulsive Bjerknes force when the two bubbles have different radii and can thus be driven in antiphase. Our results also show the importance of taking multiple scattering into account when the bubbles radii become similar[2].

This work paves the way for the development of new acoustic tools for non-contact manipulation in microfluidic devices. Using a code that fully incorporates multiple scattering, we show how a pair of two fixedpulsating bubbles (see figure below) can be used as an actuator for controlling the trajectory of a single bubble.



Simulation of the trajectory of one bubble (with a diameter of 50 μm, in pink) driven by an actuator consisting of two fixed pulsating bubbles (with diameters of 53 μm and 55 μm respectively, in green).

The exciting acoustic frequency is varied step by step over the range 10kHz-100 kHz.

1. F. K. Bjerknes, “Fields of Force”, Columbia University Press, NY, 1906
2. M. Lanoy, C. Derec, A. Tourin, V. Leroy, Appl. Phys. Lett. 107, 214101, 2015