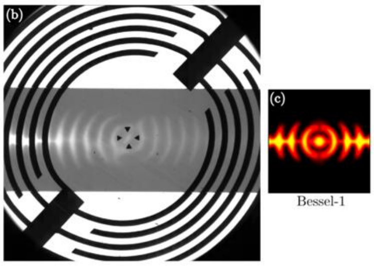
PR. MICHAEL BAUDOIN
UNIVERSITY OF LILLE, IEMN LABORATORY
MICHAEL.BAUDOIN@UNIV-LILLE.FR
HTTPS://PRO.UNIV-LILLE.FR/EN/MICHAEL-BAUDOIN

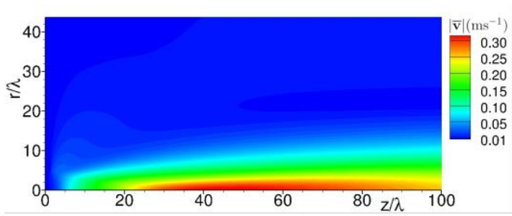
PR. HENRIK BRUUS
TECHNICAL UNIVERSITY OF DENMARK
BRUUS@FYSIK.DTU.DK
HTTPS://WWW.STAFF.DTU.DK/BRUUS

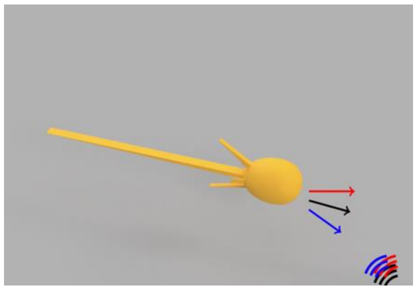
DR. SARAH CLEVE
CNRS, IEMN LABORATORY
SARAH.CLEVE@UNIV-LILLE.FR
HTTPS://PRO.UNIV-LILLE.FR/SARAH-CLEVE

HTTPS://WWW.IEMN.FR
HTTPS://FILMS.UNIV-LILLE.FR
HTTPS://WWW.STAFF.DTU.DK/BRUUS/RESEARCHTOPICS

PhD proposal in Acoustofluidics







Research context

A unique PhD 3-year scholarship in the field of acoustofluidics, starting in autumn 2024, is available in our group at IEMN, Université de Lille, France and in collaboration with DTU Denmark. The scholarship is fully funded in the scope of the international chair of Prof. Henrik Bruus (DTU) at the University of Lille. Acoustofluidics is the interplay between small scale fluid dynamics and acoustics and gains increasing interest due to its potential of contactless manipulation of fluids and small objects such as individual cells. It thus offers countless applications, for instance in the biological and medical field.

PhD research topic

In this PhD project we propose to explore one of the three topics of the international chair:

1) **Opto-acoustofluidics:** When shining focused light from lasers or LEDs on an acoustofluidic device, the local acoustic properties, such as local resonance conditions, acoustic streaming, and the acoustic radiation force, are changed due to thermoviscous effects. These phenomena enable enhanced control of handling of particles and solutions. The project aims at studying the underlying physical mechanisms and to propose and develop new acoustofluidic applications based on opto-acoustofluidics.
2) **GHz streaming:** GHz acoustic waves emitted into microfluidic devices are absorbed efficiently by the fluid over short distances in the μm-range. This absorbed absorbed energy is turned into high speed (up to 10m/s) microjets flow by a nonlinear phenomenon called "acoustic streaming". This very localized and strong microjets open new avenues for precision fluid and particle manipulation at micro- and nanometric scales. The project aims at studying the underlying physical mechanisms and to propose and develop new acoustofluidic applications based on high-frequency streaming.
3) **Development of a fully steerable 3D acoustic micro-swimmer:** Fully controlled micro-swimmers have large potential for medical and biological applications such as targeted drug delivery or micro-surgery. One of the

main difficulties of current attempts to create artificial micro-swimmers is their full 3D steerability. The aim of this project is to explore nonlinear acoustic effects, called microstreaming, used so far for the propulsion of such swimmers. While the effect is known, the detailed physical mechanisms are still to be understood and will allow us to achieve full motion control of micro-swimmers.

The candidate is free to choose the topic of interest. The topic will be investigated from both the experimental and theoretical and/or numerical point of view. Supervision will be ensured by Prof. Michael Baudoin (IEMN, Université de Lille), Prof. Henrik Bruus (Department of Physics, DTU), and Dr. Sarah Cleve (IEMN, CNRS). The team has extended expertise in and theoretical, numerical, and experimental acoustofluidics. The position is available until filled.

Qualifications

Candidates should have a two-year master's diploma or similar degree in physics, applied physics, engineering or similar studies. Prior knowledge of microfluidics, acoustics or nonlinear physics phenomena is highly beneficial. We expect self-motivation, enthusiasm, the capacity to autonomously get familiar with new topics, and the efficient participation in team work.