TYPE Editorial
PUBLISHED 27 February 2023
DOI 10.3389/fphy.2023.1167905

Check for updates

OPEN ACCESS

EDITED AND REVIEWED BY
Guoliang Huang,
University of Missouri, United States

*CORRESPONDENCE
Glauber T. Silva,
gtomaz@fis.ufal.br

SPECIALTY SECTION
This article was submitted to Physical Acoustics and Ultrasonics, a section of the journal Frontiers in Physics

RECEIVED 16 February 2023
ACCEPTED 20 February 2023
PUBLISHED 27 February 2023

CITATION
Baudoin M, Meacham JM, Sen AK and Silva GT (2023), Editorial: New trends in acoustofluidics: Modeling, experiments, and applications.
Front. Phys. 11:1167905.
doi: 10.3389/fphy.2023.1167905

Editorial: New trends in acoustofluidics: Modeling, experiments, and applications

Michaël Baudoin[1], J. Mark Meacham[2], Ashis K. Sen[3] and Glauber T. Silva[4]*

[1]IEMN Laboratory, Université de Lille, Lille, France, [2]Department of Mechanical Engineering and Material Science, Washington University, St. Louis, MO, United States, [3]Indian Institute of Technology Madras, Chennai, India, [4]Physical Acoustics Group, Institute of Physics, Federal University of Alagoas, Maceió, Alagoas, Brazil

KEYWORDS

acoustofluidics, microfluidics, particle manipulation, acoustic radiation force, acoustic levitation, fluid dynamics

Editorial on the Research Topic
New trends in acoustofluidics: Modeling, experiments, and applications

The field of acoustofluidics [1] has seen outstanding growth and advancements in recent years, driven by the increasing need for techniques that allow the manipulation and study of small particles and biological samples in fluids. The field's significance continues to increase as new applications are explored. This Research Topic is dedicated to providing a comprehensive overview of some of the latest findings in this field. In this editorial, we aim to shed light on the key contributions and implications of each of the five papers included in this Research Topic. These papers range from theoretical models of the acoustic radiation force and torque [2,3] to practical applications, showcasing the diversity of topics and approaches being taken in acoustofluidics. By highlighting these papers, we hope to demonstrate the potential for acoustofluidics to make a significant impact in various fields, from fluid dynamics to the life sciences. The authors of these papers are at the forefront of this exciting and rapidly evolving field, and their contributions serve as a testament to the interdisciplinary nature of acoustofluidics.

The paper by Sepehrirahnama and Oberst focuses on the acoustic momentum exchange between objects and fluids. The authors examine the transfer of momentum to objects in the non-planar pressure field of an acoustic Bessel beam, which is generated by an array of transducers arranged in a cylindrical manner. The authors derive analytical expressions for the radiation force and torque acting on both symmetric and asymmetric objects and show that the non-planar wavefront of the Bessel beam can be used to control the magnitude and direction of the force and torque. These findings have important implications for the design and optimization of acoustophoretic systems as they provide valuable insight into the physics of acoustofluidics and the mechanisms of particle manipulation.

Fankhauser et al. introduce the Open-Source AcoustoFluidics Theories (OSAFT) library, a Python code that can be used to study acoustofluidics. The library provides six different theoretical models for the problem of a single spherical particle in an infinite 3D domain subjected to an incident plane wave. The library's API allows for comparisons between different theories and is designed to be extensible with a library of fluid and solid material models, facilitating the implementation of new theories. The authors aim to make the library as extensive as possible and to continue advancing the field of acoustofluidics and are actively seeking collaborators to achieve this goal.

The study by Bellebon et al. investigates the biophysical properties of mesenchymal stromal cells (MSCs) using acoustic levitation. The authors designed an optical technique to measure the size, acoustic contrast factor, and density of the cells, to determine their compressibility. The results of the study highlight the large heterogeneity of donor/patient-derived cells compared to cultured cells and demonstrate the importance of using this technique to measure cell properties. This is a significant step forward in the field of acoustofluidics, as it provides new insight into the biophysics of cells and opens up new avenues for research and application.

The study by Luzuriaga et al. presents a proof of concept demonstrating the ability of ultrasonic waves to perform acoustophoretic processes in hybrid millifluidic resonators. The resonators include channels embedded in extremely soft media with properties similar to liquids. The results showed that the particles were driven by acoustic radiation forces and collected rapidly along a central line, opening the door to bioprinting applications. This is a significant advancement in the field of acoustofluidics, as it provides a new approach to the manipulation of biological samples and opens up new avenues for research and application.

Finally, in the study by Løvmo et al., a new tool for high-resolution imaging of biological samples is described. The authors developed an acoustofluidic chip that can trap and manipulate sub-millimeter-sized biological samples, and then adapted it to support multi-view imaging. The samples are levitated by an optically transparent transducer and two orthogonal side transducers, which can induce an acoustic torque to rotate the samples for imaging. These findings are important in the life sciences, where there is a growing need for contactless tools for the inspection of live biological samples.

In conclusion, the Research Topic of Frontiers in Physics showcases the rapid advancements in the field of acoustofluidics. From theoretical models to practical applications, the papers illustrate the interdisciplinary nature of this field and its potential for future growth. Topics explored include acoustic momentum exchange in objects, an open-source acoustofluidics library, biophysical properties of mesenchymal stromal cells, ultrasonic acoustophoretic processes in millifluidic resonators, and high-resolution imaging of biological samples. These contributions demonstrate the potential for acoustofluidics to make a significant impact in various fields and we look forward to continued growth and exciting discoveries in this rapidly evolving field.

Author contributions

GS drafted the first version of the editorial. AKS, JM, and MB made contributions to the papers they edited. All authors contributed to the manuscript revision, read, and approved the submitted version.

Funding

This work was supported by the National Council for Scientific and Technological Development—CNPq (Grant no. 309240/2022-0) and Coordination for the Improvement of Higher Education Personnel—CAPES (Grant no. 88887.711903/2022-01).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Bruus H, Dual J, Hawkes J, Hill M, . Laurell T, Nilsson J, et al. Forthcoming Lab on a Chip tutorial series on acoustofluidics: Acoustofluidics-exploiting ultrasonic standing wave forces and acoustic streaming in microfluidic systems for cell and particle manipulation. *Lab Chip* (2011) 21:3579–80. doi:10.1039/c1lc90058g

2. Baudoin M, Thomas J-L. Acoustic tweezers for particle and fluid micromanipulation. *Ann Rev Fluid Mech* (2020) 52:205. doi:10.1146/annurev-fluid-010719-060154

3. Silva GT, Lobo TP, Mitri FG. Radiation torque produced by an arbitrary acoustic wave. *Europhys Lett* (2012) 97:54003. doi:10.1209/0295-5075/97/54003