Prof. Kentaro Nakamura, Tokyo Institute of Technology

Title: Optical instrumentation of high intensity ultrasonic fields for exploring applications of ultrasonic manipulation technique

Abstract: It has been known that high intensity ultrasonic field generates static force and constant flow in air and liquid. The phenomena are referred as acoustic radiation force or acoustic streaming, respectively, and attracting attention for the purpose of non-contact manipulation of small objects and plates.
In the first half part of the lecture, the presenter will introduce some of the examples of non-contact manipulation of small particle or droplet with ultrasonic standing waves and travelling waves in air. Ultrasonic levitation and transportation of a very large glass plate will be also demonstrated. To design the ultrasonic vibration system efficiently, precise instrumentation method is required. In the latter half part, optical methods to quantitatively measure the high intensity ultrasonic field in air and liquid will be explained, where fiber optic thin probe and optical interferometer are utilized. The key of the optical measurements of ultrasonic field is the modulation of optical refractive index of media due to ultrasonic field. The relationship between the sound pressure and the variation of refractive index will be shown. The fiber optic probe has the diameter of approximately 0.1 mm and enables the sound field measurement in a small area without disturbing the field distribution. If an optical interferometer is used, the sound pressure can be measured with higher sensitivity, and fully non-invasive measurement of sound field becomes possible.

Short biography: Professor Kentaro Nakamura received B. Eng., M. Eng., and D. Eng. degrees from Tokyo Institute of Technology (Tokyo Tech), Japan, in 1987, 1989, and 1992, respectively. He has been a professor of Precision and Intelligence Laboratory (currently, Institute of Innovative Research), Tokyo Tech, since 2010. He is interested in high power ultrasonic technologies, optical/ultrasonic measurements, and fiber optic sensors. He was a president of the Acoustical Society of Japan from 2015 to 2017. He is currently a chairperson of the Photonic Sensing Consortium, Japan.

Prof. Takeshi Morita, The University of Tokyo

Title: High-power ultrasonic transducer for megahertz range, multi-modes and non-sinusoidal waveform operations

Abstract: Bio-acoustic research breaks new ground but it requires the strong collaborations between biomedical scientists and ultrasound engineers. This seminar is given from the standpoint of the ultrasonic engineering. For long time, high-power ultrasonic technology supports the various fields such as medicals science, chemical, mechanical, and machinery engineering. For example, it is utilized for promotion of chemical reaction by cavitation, wire-bonding and ultrasonic cleaning for semiconductors by using Langevin transducer as the high-power ultrasonic sources. This transducer is useful for generating high-power

ultrasound; however, this only applies for relatively lower frequency range around 100 kHz and only single frequency operation is possible in general.
To discover new research fields, our laboratory proposed the original transducers whose characteristics overcome these drawbacks of the conventional Langevin transducer. In this seminar DPLUS and f+2f transducer will be introduced, which enables unique and interesting ultrasonic wave generation. The DPLUS (Double Parabolic refLectors wave-guided high-power Ultrasonic tranSducers) irradiates MHz range high-power ultrasonic wave from the tip of the thin waveguides, and multi-modes operation is possible from kHz to MHz range. The f+2f transducer can combine two vibration modes whose resonant frequencies are precisely controlled to be 1:2. As a results, you can obtain quasi-saw and trapezoidal shaped waveform, in other words, non-sinusoidal waveform. It is useful for stick-slip piezoelectric actuator driving, ultrasonic levitation and cavitation control system. These transducers would be promising for next generation applications, such as bio-acoustic research fields.

Short biography: Professor Takeshi Morita received B. Eng., M. Eng., and Dr. Eng. degrees in precision machinery engineering from The University of Tokyo in 1994, 1996, and 1999, respectively. After being a postdoctoral researcher at RIKEN (the Institute of Physical and Chemical Research) and at EPFL (Swiss Federal Institute of Technology Lausanne), he became a research associate at Tohoku University in 2002. He returned to The University of Tokyo as an associate professor in 2005 and has been a full professor since 2018. His research interests include ultrasonic transducer, piezoelectric actuators and sensors.

Prof. Henrik Bruus, Technical University of Denmark

Title: Physical aspects of the acoustic body force in inhomogeneous fluids

Abstract: An incident ultrasound wave in an inhomogeneous fluid gives rise to an acoustic body force with profound fluid dynamic consequences. The inhomogeneity may originate from gradients in solute concentrations or in the temperature field of the fluid. The physical mechanism generating the acoustic body force is discussed, including the derivation of the governing equations and an outline of the basic features of the acoustic body force. Then follow examples studied by numerical simulations together with experimental validation of different physical phenomena induced by the acoustic body force. For fluids with an inhomogeneous concentration field of a miscible solute, we discuss how the acoustic body force can stabilize concentration gradients against gravitational collapse, how it can suppress acoustic streaming, and how it can pattern concentration fields. For fluids with an inhomogeneous temperature field, we discuss how the acoustic body force can lead to fast acoustic streaming and to a transition from boundary- to bulk-driven acoustic streaming. The acoustic body force is arguably a promising tool in the field of acoustofluidic handling of fluids and fluid suspensions.

Short biography: Professor Henrik Bruus received his Ph.D. degree in physics from Niels Bohr Institute (NBI), University of Copenhagen in 1990, and then worked as postdoc at Nordic Institute of Theoretical Physics 1990-92, Yale University 1992-94 and CNRS Grenoble 1994-96. He returned to NBI as associate professor 1997-2001, before moving to Technical University of Denmark in 2001. There, he became full professor of lab-chip systems in 2005 and of theoretical physics in 2012. His research interests include acoustofluidics, micro/nanofluidics, and electrokinetics. He has (co)authored more than 170 journal papers and two textbooks, including "Theoretical Microfluidics", Oxford University Press.