the limitations of the sampling strategy. Snapshots may be taken at arbitrary times, without any influence on the robustness of the method. It is seen that NU-DMD succeed to catch flow fields dominant modes and dominant frequencies, even when there is too few snapshots for DMD t0 converge.

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MS04: Mechanics of transport in microfluidic devices
16:00–18:00, Monday, 20 August
Dino Di Carlo, USA, Chair
Henrik Bruus, Denmark, Chair
Room: 210B

16:00–210B

Nature-inspired microfluidic propulsion using magnetically-driven artificial cilia

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In this work, we explore a new way to propel fluids through microchannels of lab-on-a-chip devices by mimicking the fluid transport mechanisms of natural ciliates, such as Paramecia. Fluid propulsion of Paramecia takes place by means of hair-like motile appendages known as cilia that beat in an asymmetric manner. In addition, the individual cilia beat out-of-phase which results in a wave-like motion (metachronal waves). Here, we design magnetic artificial cilia that can be externally actuated to mimic these non-reciprocal deformations. The artificial cilia can be realized using thin films consisting of a polymer matrix filled with magnetic nano-particles, allowing actuation by means of an external magnetic field. We use a coupled magneto-mechanical solid-fluid model to explore the conditions at which a magnetic film will mimic the asymmetric motion of natural cilia. The response of the artificial cilia is studied in terms of the dimensionless parameters that govern their physical behavior and identify the parameter space in which the cilia can generate maximal flow.

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16:20–210B

Cell membrane dynamics during sonoporation investigated by microfluidic single-cell analysis

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This paper presents studies on membrane dynamics of single HeLa cells in the presence of ultrasound (US)-activated microbubble clusters (MCs). A microfluidic approach was developed for the in-situ quantification of cell membrane strain and permeabilisation during US exposure. An ultrasonic wave was generated within the microdevice, and microbubble clustering was observed in close proximity to the cell. MC oscillations induced the formation of fluid streaming which resulted in cell membrane deformation and subsequent membrane permeabilisation. Unique characteristics of membrane sonoporation dynamics were observed (i.e. heterogeneous membrane permeabilisation localised only in specific membrane microdomains), which was reflected by the temporal and spatial evolution of cell membrane strain, measured by tracking fluorescent beads linked to the cell membrane. The approach developed may lead to novel insights into the bio-physical mechanisms associated with cell sonoporation, though further studies are required to gain deeper understanding of the governing principle.

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16:40–210B

Electro-elasto-capillarity: electric field driven unwrapping of water drop with elastic film

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Electro-elasto-capillarity (EEC) is a new method for droplet encapsulation controlled by electric field. Here we report, for the first time, EEC is realized in experiments, which is also an electrowetting progress on moving substrate. Under the combined effect of surface tension, elastic force and Coulomb force, the flexible thin film can encapsulate and release a tiny droplet, controllably and reversibly. When the voltage reaches a critical value, the film is pulled-in to the substrate and release the droplet. When applied with AC voltage, the droplet vibrates in the frequency of the twice of the frequency of the input electric field. A theoretical model was established to describe the frequency doubling phenomenon and it was found that the theoretical data show good agreement with the experimental results. Our finding may offer a practical method for drug encapsulation and microfluidic devices actuation.

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17:00–210B

Rotation of non-spherical particles in square chambers using ultrasonic standing waves

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The ultrasonic micromanipulation is commonly used to position and move particles with the help of acoustic radiation forces. The method presented here allows the rotation of non-spherical particles using the acoustic radiation torque. Therefore, a varying pressure field with changing orientation of the corresponding potential force field is needed. This is realized using amplitude modulation of two orthogonal standing waves. Another option is the excitation of a double mode by two sources and a slight frequency difference or a varying phase. Successful experiments of both methods have