Acoustofluidics for cell manipulation:
Cavity resonances and acoustic radiation forces

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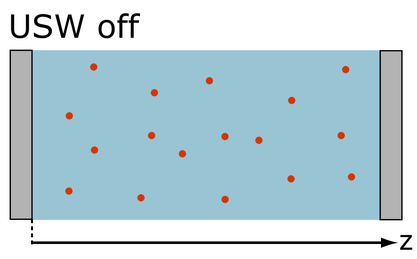
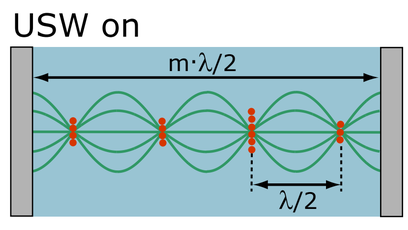
Acoustofluidics for cell manipulation

Principles

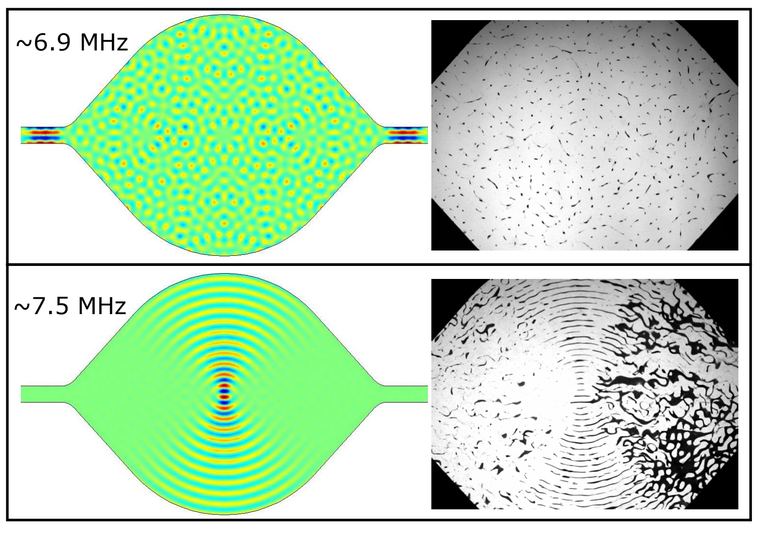
Ultrasonic standing wave (USW) manipulation:
Suspended particles are driven to the pressure nodes



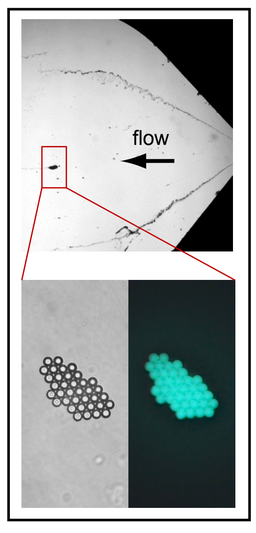


$$F_{USW} \sim p^2 \cdot V \cdot f \cdot \sin\left(2\pi \cdot \frac{z}{\lambda/2}\right)$$

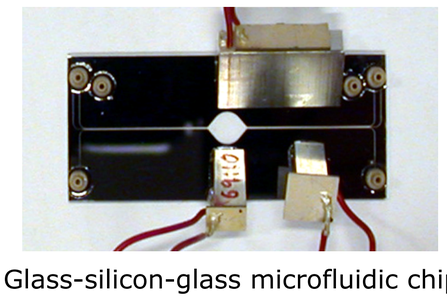
Trapping cells in a microfluidic chip by ultrasonic radiation forces



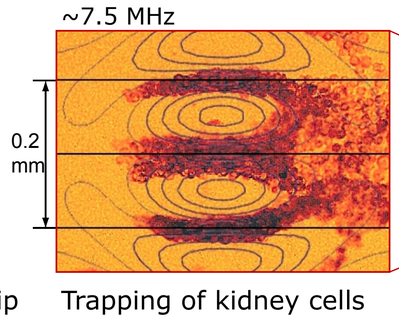
Modelled acoustic field — No-flow operation



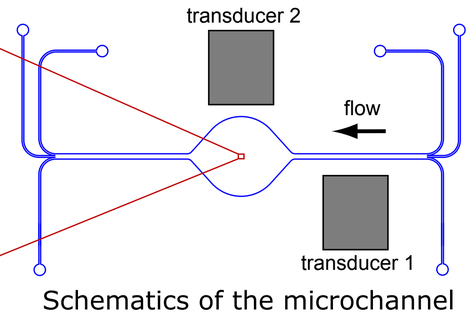
Flow-through operation



Glass-silicon-glass microfluidic chip with three ultrasound transducers



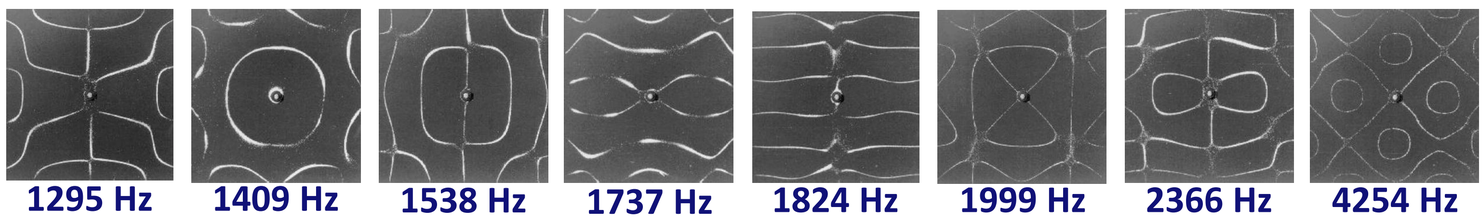
Trapping of kidney cells



Schematics of the microchannel and ultrasound transducers

Cavity resonances

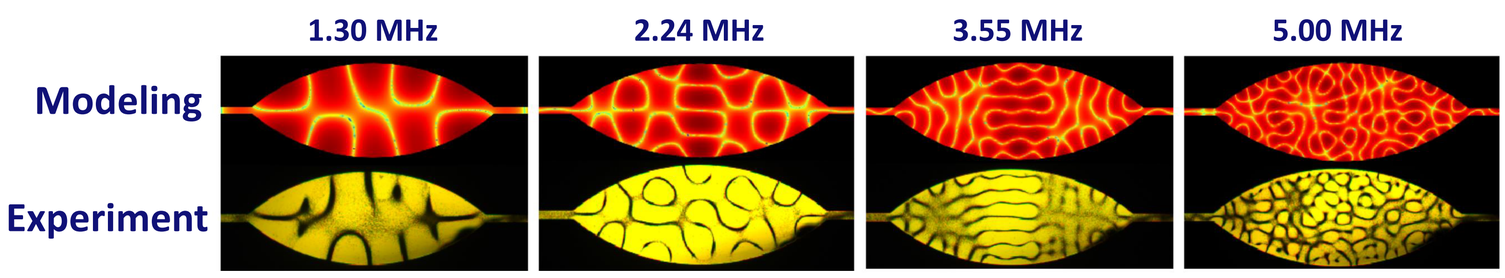
Chladni figures: Pattern of sand on a vibrating plate



Acoustic resonances of a vibrating plate

A thin metal plate is vibrated at a resonance frequency causing sand to move into the vibration nodes forming beautiful patterns called Chladni figures.

Chladni figures in microfluidics:
Modelling and trapping of 5 µm polymer beads



Acoustic radiation forces

Acoustic levitation of particles

A 28 kHz ultrasonic transducer (green) and a spherical reflector (red) are separated by a distance corresponding to a multiple of half the acoustic wavelength.

Reference

J. Svennebring, O. Manneberg, P. Skafte-Pedersen, H. Bruus and M. Wiklund, *Biotechnol. Bioeng.* **103**, 323-328 (2009)