Universität Basel

Swiss Nanoscience Institute

SNI SWISS NANOSCIENCE INSTITUTE
EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

Development of nanoscale acoustic tweezers for mechanobiology applications

Principle investigators:

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This project explores ultrasound mechano-biology and mechano-genomics by developing nanoscale acsoutic tweezers (ATZs) for non-invasive intracellular manipulation.

Mechanobiology addresses the crosstalk between the mechanical function of cells and the biochemical reactions that drive them. Some key examples include the separation of sister chromatids by the spindle apparatus during cell division, reorganization of the cytoskeleton in somatic cells under mechanical stress, and transformation of fibroblasts into stem-cell like states due to physical confinement [1]. Yet, in spite of being fundamental to cells, intracellular forces remain poorly resolved. This is due in part to a lack of non-invasive methods that facilitate such measurements.

We aim at conducting such experiments by using nanoscale ATZs utilizing acoustic radiation pressure [2,3]. Different from optical tweezers, ATZs exploits density differences within a specimen to manipulate small particles and cells in liquid, and reaches submicron spatial resolution at acoustic frequencies of 0.1-1 GHz.

Developed ATZs will be applied to study the impact of mechanical deformation of intra-cellular organelles in-situ; for example, deformation of the nucleus by monitoring the accumulation and import of nuclear localization signal (NLS), which cells use to recognize protein cargoes destined for selective uptake into the cell nucleus via nuclear pore complexes (NPCs) [4], that will also probe nuclear leakage during nuclear deformation and rupture.

This highly interdisciplinary project takes advantage of established expertise and experimental capabilities in both collaborating labs: S. Tsujino (mechano gemonics group, PSI) is an expert in micro-/nano-electronic devices (design, fabrication, and measurement) and ultrasound technology. R. Lim (Biozenturm and the Swiss Nanoscience Institute, Uni. Bas) is an expert in cell nanomechanics and nucleocytoplasmic transport.

A successful caididate has a MS degree in physics/electronics/mechanics or cell biology. Experiences in electronic and/or microfluidic device fabrication and charcaterization in clean room environment, or instrumentation on high resolution microscopy are plus. We seek a scientifically ambitious individual and enjoy working in a interdisciplinary collaborative environment on a highly competitive subject together with international partners.

References

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[2] S. Tsujino and T. Tomizaki, *Ultrasonic acoustic levitation for fast frame rate X-ray protein crystallography at room temperature*, Sci Rep 6: 25558 (2016);
[3] S. Tsujino and T. Tomizaki, *Applications of acoustic levitation in chemical analysis and biochemistry*, in *Acoustic Levitation ~ from physics to applications* eds. D. Zang (Springer Nature, Singapore, 2020);
[4] C. Zelmer, L. P. Zweifel, L. E. Kapinos, I. Craciun, Z. P. Güven, C. G. Palivan, and R. Y. H. Lim, *Organelle-specific targeting of polymersomes into the cell nucleus*, PNAS 117 (6) 2770-2778 (2020)