SEMINAR: Nanomechanical and Microwave Sensors for Sensing, Dynamics and Computation

SELIM HANAY

February 09, 2026
12:00 to 13:00
Seminar Room

Nano-electromechanical systems (NEMS) occupy a unique regime where extreme sensitivity, low dissipation, and strong nonlinearity coexist within a single physical platform. Operating far beyond the linear response, these systems provide experimental access to nonlinear dynamical phenomena such as buckling, snap-through, and multistability, while simultaneously offering new opportunities for information processing in the physical domain, including reservoir computing. A central challenge in translating these capabilities into real-world sensing and functional devices is operation under ambient conditions-in air or liquid-where dissipation, noise, and coupling to complex environments dominate the dynamics.

In ambient conditions NEMS sensors can achieve mass resolutions at the MegaDalton scale, enabling the detection of nanoparticles and viruses in the hundred-MDa range. However, transporting analytes to the nanoscale sensing region had remained a significant hurdle. With the integration of an ion lens on the NEMS chip [1], we demonstrated high-efficiency nanoparticle detection using the ?self-focusing' NEMS technology. We recently improved this technique with the use of devices featuring a central paddle-like collection area, which yields higher efficiency and requires simpler electronics [2].

While NEMS do not show high performance in liquid environments, its electromagnetic cousin -microwave resonators- can probe matter through its electrical polarizability, granting access to permittivity-based contrast at the microscale. This approach enables label-free material classification [3] and functional assays such as drug-resistance testing in cancer cells [4], illustrating how electromagnetic and mechanical degrees of freedom can be combined to interrogate complex biological systems.

Overall, this work highlights how the dynamics of nanomechanical and microwave resonant sensors can be utilized to cover various applications in biologic and environmental sensing.

Hosted by: Prof. Dr. Adrian Bachtold