

Beyond the Ensemble: Resolving Sample Heterogeneity in Space and Time

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Abstract:

Biological samples are inherently heterogeneous, yet traditional biosensing typically relies on ensemble measurements that mask critical information. In this talk, we present several optofluidic platforms that integrate advanced optical detection, microfluidics, and surface chemistry to resolve biological complexities at the single-analyte level.

We first introduce an optofluidic platform leveraging Interferential Scattering Microscopy (iScat) for the label-free fingerprinting of cell secretomes at the single-particle level. By implementing a multiplexed digital immunoassay, we extract high-dimensional data with sensitivity reaching the single-protein limit [1]. Furthermore, we incorporate polarization-sensitive detection to enable single-shot retrieval of optical activity images, uncovering spatial chirality variations that are typically invisible to bulk analysis [2].

The second part of the talk introduces a high-throughput, droplet-based platform for multiparametric kinetic analysis of aptamer-target interactions. By integrating picoliter-volume droplets with Förster resonance energy transfer (FRET), our approach allows for real-time monitoring of binding and structural switching with unprecedented spatiotemporal resolution. This methodology provides detailed insights into conformational dynamics and binding kinetics, overcoming the fundamental limitations of endpoint or low-resolution techniques [3].

Keywords:

Photonic sensing, cell secretome, digital assay, single molecule, microfluidics

References:

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