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3D optical microscopy for quantifying T lymphocyte activation
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Abstract
The tomographic diffractive microscope (TDM) can be implemented in either transmission configuration or reflection configuration. TDM in reflection configuration has higher Fourier spatial frequency data along the optical-axis of the microscope in comparison to the transmission configuration and also reflective samples can be imaged. We have recently exploited the specific features of such a configuration. This optical tomographic microscope coupled to sophisticated inversion schemes could be a good candidate for detecting the immunological synapse of T lymphocyte activation. Presently, no technique permits to perform a fast detection of T lymphocyte activation at an early stage which is very promising in medical diagnosis applications. In doing so we have first considered polystyrene bead (comparable to the size of T-cell) in water medium and detected the interface. This same experiment could be used for detecting the immunological synapse.

Keywords: Reflection tomography, T lymphocyte, Immunological synapse

Experimental setup: reflection diffraction tomography

Theory of off-axis holography
The signal as reflected by the sample \( E_s \) and the reference wave \( E_{\text{ref}} \) interfere and the camera record the hologram.

\[
I(r) = |E_s|^2 + |E_{\text{ref}}|^2 + E_s^*E_{\text{ref}} + E_{\text{ref}}^*E_s
\]

The signal \( E_s \) (both phase and intensity) is then separated using 2D Fourier transform from the hologram in k-space.

Immunological synapse
To reconstruct a 3-D RI tomograms, multiple 2-D holograms of a cell are measured at various angles of illuminations using an interferometric microscope in transmission.

Ref : K. Murphy et al., Immuno Biology, 9th edition

First measurements on a polystyrene bead. (diameter 6µm)

Ref : T. Zhang et al., Optica, 3, 2016

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Improvement of resolution brought by diffraction tomography

Ref : T. Zhang et al., Optica, 3, 2016

Acknowledgment