The Center for
Light Matter Interaction
Tel Aviv University

Seminar:

Optical Computed Tomography for Label-Free 3-D imaging of Biological Cells

By - **Gili Dardikman, PhD Student**

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12:30-14:00

Auditorium 011, Engineering Class Room Building,
Faculty of Engineering, Tel-Aviv University

Abstract:

The ability to image the three-dimensional (3-D) structures inside biological cells is highly important to both medical diagnosis and biological research. Tomographic phase microscopy (TPM) provides a means to obtaining the 3-D structure of a cell without the need for staining. Staining for 3-D imaging of cells, used for example in confocal fluorescent microscopy, is time consuming, suffers from photobleaching and may disturb the cellular behavior of interest. Instead, in stain-free TPM, a two-dimensional (2-D) quantitative phase map of the 3-D cell is taken from various angles and the entire set of maps is then processed to reconstruct the 3-D distribution of the refractive index (RI) of the cell. Thus, the cellular RI is the intrinsic source of imaging contrast, where no staining is needed to obtain 3-D imaging of the cell.

In this seminar, I review progress made in the field, and present two contributions to the field. The first contribution is accelerating the reconstruction process, which was until now extremely time consuming, making the analysis of large data sets unreasonably slow and the real-time 3-D visualization of the results impossible. This is done through choosing the most efficient algorithms and parallelizing them, making them suitable for GPU computing. This implementation yields a 3-D reconstruction rate higher than video rate of 25 frames per second for 256 × 256-pixel interferograms with 73 different projection angles (64 × 64 × 64 output). The second contribution is making phase unwrapping possible even from angles for which the object is optically thick for the first time, by utilizing the information present in other angular views. This is important since the 3-D reconstruction uses phase profiles taken at multiple angles, thus a distorted phase reconstruction from some angles can corrupt the entire distribution.