The Center for
Light Matter Interaction
Tel Aviv University

LMI Seminar:

Photon correlations as a resource in microscopy and spectroscopy

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Wednesday November 23rd, 2022

13:00-14:00

Light refreshments and drinks will be served at 12:30

Auditorium 011, Engineering Classroom Building, Faculty of Engineering, Tel-Aviv University

Abstract: Far-field optical microscopy beyond the Abbe diffraction limit, making use of nonlinear excitation (e.g. STED), or temporal fluctuations in fluorescence (PALM, STORM, SOFI) is already a reality. In contrast, overcoming the diffraction limit using non-classical properties of light is very difficult to achieve due to the difficulty in generating quantum states of light and their inherent fragility. Here, we experimentally demonstrate practical superresolution microscopy based on quantum properties of light naturally emitted by fluorophores used as markers in fluorescence microscopy. Our approach is based on photon antibunching, the tendency of fluorophores to emit photons one by one rather than in bursts.

Since the non-classical intensity correlations carry higher spatial frequency information, they can be utilized to enhance image resolution. We demonstrate how antibunching can improve the resolution capabilities of image-scanning confocal microscopy in all three dimensions1. Finally, we show that these methods are compatible with currently developed SPAD arrays, serving as small single-photon imaging detectors, and thus require little infrastructure investment2.

The use of similar experimental and theoretical tools also enables to significantly outperform currently available spectroscopy methods of single quantum emitters, using spectral-temporal (rather than spatial-temporal) correlations3. These opportunities will be briefly discussed.

References

[1] R. Tenne et al., “Super-resolution enhancement by quantum image scanning microscopy”, Nature Photonics 13, 116 (2019).

[2] G. Lubin et al., “Quantum correlation measurement with single photon avalanche diode arrays”, Optics Express 27, 32863 (2019).

[3] G. Lubin et al., “Heralded spectroscopy reveals exciton-exciton correlations in single colloidal quantum dots”, Nano Lett. 21, 6756 (2021).

Bio: Prof. Uriel Levy is the head of the nano-opto lab and the director of the center for nanoscience and nanotechnology at the Hebrew University, Jerusalem Israel. His research spans over diverse aspects of nanophotonics and light-matter interactions, with focus on device oriented research. Over the years, he pioneered several key concepts in nanophotonics, including silicon based photodetection in the short wave infrared (SWIR), nanoscale polarization optics, and the chip scale atomic vapor technology. His research covers both fundamentals of light-matter interactions, as well as diverse applications in imaging, communications, sensing, metrology, energy harvesting, memories, displays and other chip scale optoelectronic devices. Over the years, Prof. Levy published nearly 200 journal papers, presented his results in hundreds of invited talks and he holds dozens of patents. Prof. Levy is a fellow of OPTICA (formerly the optical society of America) and is the recipient of several notable prizes, including for example the Kaye innovation award, an ERC consolidator grant, and the Hebrew University President award for young Investigator. He holds a BSc in Physics and materials science from the Technion and a PhD in electro optics from Tel Aviv University. Prior to joining the Hebrew University, he spent nearly four years as a post graduate researcher in the University of California, San Diego. Prof. Levy is also active in tech transfer. He is a co-founder of Trieye, developing CMOS based cost effective SWIR imaging solutions for the automotive industry and for other verticals