The Iby and Aladar Fleischman
Faculty of Engineering
Department of Materials Science and Engineering

אוניברסיטת תל-אביב
TEL AVIV UNIVERSITY

הפקולטה להנדסה
ע"ש איבי ואלדר פליישמן
המחלקה למדע והנדסה של חומרים

You are cordially invited to attend this seminar to be held on

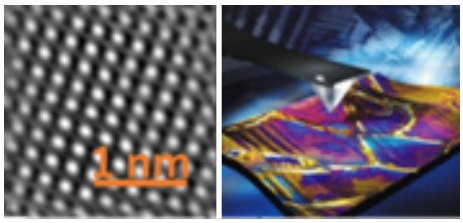
Towards the Onset of Collectiveness in Nano-Functional Materials

Seminar of the Department of Materials Science and Engineerin

Tuesday, December 9th, 16:00
Room 206, Wolfson Mechanical Engineering Building

Dr. Yachin Ivry

Department of Materials Science and Engineering, Tel-Aviv University



Left: NbN (SC) stoms on a few-layer-graphene suspended membrane (filtered TEM micrograph); **Right**: ferroelectric-ferroelastic domains (with functional AFM).

Understanding and controlling functional materials at the nanoscale is a major common goal of materials science, physics, chemistry and the high-tech industry. The existence of collective responses to external excitations in nano-functional systems, such as Ferroelectrics (FELEs) and superconductors (SCs) forms an elegant platform for addressing central questions, including the competition between order and disorder in nature and solid-solid phase transitions. Likewise, the enhanced functionality of these smart nano materials is being implemented in technologies ranging from low-power computaters to resonators and single-photon detctors. Nevertheless, to-date, the onset of 'collectiveness' in these functional systems has remained elusive to us, mainly due to challenges involved in controlling and imaging the collective behaviour near its onset in these materials.

We will discuss how the longstanding dispute over the FELE domain switching mechanism can be resolved when introducing recently-discovered FELE-ferroelastic domain types and their interplay with material properties, such as grain boundaries and structural defects. These domains were discovered thanks to a new method that allows an order of magnitude enhancement of FELE domain imaging, with respect to the traditional methods. These methods also allows simultaneous FELE and ferroelastic domain imaging, which helped reveal the hidden role of ferroeleasticity in the ferroelectric size dependence.

Likewise, we will discuss how material properties dictate size effects in SCs, mainly by introducing a recently-found universal scaling law that describes superconductivity close to its emergence. I will also demonstrate how the discovered universality helps improve material preparation, including e.g. graphene-SC hybrids. In addition, I will survey technological applications that benefit and result from the above discoveries, such as advanced superconducting nanowire single photon detectors, non-volatile memory devices, thermal sensors and high-frequency programmable electro-acoustic resonators.

Finally, I will mention some future avenues for exposing the onset of collective interactions in FELEs and SCs that are a direct continuation of the above discoveries.

Biosketch

Dr. Ivry received his BSc from the HUJI (physics & chemistry) and his MSc from the Weizmann Institute (physics & materials science), while his PhD is from the University of Cambridge (Nanoscience Centre) and he is currently a postdoctorate scholar in the Quantum Nanostructures and Nanofabrication group at at MIT. His work on ferroics and SCs has already produced more than 15 publications in prestigious journals and won him with more than 10 prizes and wards, including the British Council Award for Excellent Students.