

Experiences

Visit of Andrew Senesi to the Tel Aviv University

The exchange program at TAU was an amazing experience and gave me the opportunity to expand my horizons, both scientifically and outside of the lab.



Visit of Selim Shahriar to the Tel Aviv University

I was very pleased with the overall experience. Both Tel Aviv University and the Hebrew University of Jerusalem are truly impressive in the quality of research being carried out there. My host, Prof. Jacob Scheuer of TAU, was extremely courteous. My interactions with him, his colleagues and students were also very productive scientifically.



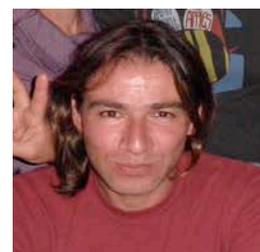
Visit of David Seidman to the Tel Aviv University

Professor David N. Seidman, Department of Materials and Engineering, has been interacting with Professor Yossi Rosenwaks of Tel Aviv University's Department of Electrical Engineering -Physical Electronics for about five years. The Northwestern University-Tel Aviv University exchange program helped them to be awarded a US-Israel Binational Science Foundation grant on the subject of silicon nanowires. David Seidman will spend the period December 12th to December 27th, 2010 at Tel Aviv University as a result of the NU-TAU exchange program.



Visit of Uri Givan to Northwestern University

During June-September I spent over three months as a visiting scholar in Northwestern University in professor L. Lauhon's lab on



account of a scholarship I received from the Tel-Aviv – Northwestern universities collaboration. During that time I participated in several on-going studies to which I was able to contribute out of my experience. In addition, I was able to lead a project of my own. To summarize, the visit was very successful both in its scientific impact (I believe I will take part in several papers and lead at least one on my own) and as a learning experience, I was exposed to a verity of new cutting edge research directions and facilities that were not accessible to me otherwise

Visit of Elad Koren to Northwestern University

Koren spent two weeks with the Lauhon group working on quantitative measurements and modeling of semiconductor nanowire devices. In the context of this collaboration, they have conducted Kelvin probe force microscopy measurements at TAU on nanowires grown by the Lauhon group. Scanning photocurrent measurements at NU identified the doping distribution along a single phosphorous-doped silicon nanowire grown by the vapor-liquid-solid method. This work led to a joint publication regarding the radial distribution and diffusion of phosphorous in silicon nanowires.



Visit of Elad Mentovich to Northwestern University

A novel strategy incorporating dip pen nanolithography for doping in nanoscale electronic devices was explored during this visit. DPN-doping combines the two groups' extensive knowledge of chemical lithography with recent advances in self-limiting methodologies to form ultra-shallow doping profiles for the selective nanoscale positioning of dopants in silicon wafers and in plastic electronics based devices.



Visit of Michal Oren to Northwestern University

Oren visited NU to learn about the TDFD algorithm in the analysis interaction of light with nanojunctions. The project aims to develop a theoretical and computational framework for describing the interaction of light with molecular conduction junctions. The resulting theory provides a description of the optical response and electrical transport through molecular junctions under the combined effects of potential bias, optical fields and thermal relaxation. This work offers new understanding and tools towards technological innovations involving molecular junctions

Visit of Yoram Selzer to Northwestern University

Dr Yoram Selzer from the school of chemistry in Tel Aviv University, has been interested in the past few years in developing vibrational spectroscopy



methods to analyze and probe inelastic processes in conducting molecular junctions. One of the main tools in this study is Surface Enhanced Raman Spectroscopy (SERS). In order to develop advanced time-resolved measurement techniques based on SERS, Dr Selzer is currently on sabbatical in the group of the researcher who discovered SERS, Prof. Richard Van Duyne from the chemistry department at Northwestern University. Dr. Selzer will spend the period between August 2010 - August 2011 at Northwestern. Partial support for his visit is funded by the Northwestern University-Tel Aviv University exchange program.

Visit of Israel Ganot to Northwestern University

The focus of the visit was to design a set of experiments to understand, model, and measure subcellular refractive index changes using near-field scanning optical microscopy. In parallel, a computer simulation based on Mie theory was employed to enable modeling the cell and subcellular structure. A manuscript describing this work, "Simulation of light scattering from spherically symmetric structures in biological cells using a multilayer Mie model," is currently in progress.



Visit of Jacob Scheuer to Northwestern University

This joint research program focused on ultra-sensitive optical sensors based on integrated optics white light cavities. The goal is to introduce a negative dispersion element into an optical cavity to enhance the resonance wavelength sensitivity to changes in the detected parameter. This is highly important for detecting effects which are inherently small (e.g., rotation, gravitational waves, etc.) without necessitating very large cavities which in turn are vulnerable to thermal and mechanical noise sources. In addition to higher sensitivity, the concept allows for the realization of ultra-compact sensors while retaining high sensitivity. Following the visit, a BSF joint grant application was funded and a joint DARPA research program proposal is under development.



Visit of Ashish Basuray to the Weizmann Institute

This past summer, I participated in a joint venture between the Stoddart Mechanostereochemistry Research Group and Klajn's group in the Department of Organic Chemistry at the Weizmann Institute of



Science. The collaboration involved incorporating novel, thiol-functionalized molecular Borromean Rings with gold nanoparticles to form a co-crystallized, reticulated, hybrid material. Over 250 experiments were conducted, utilizing a variety of solvents, temperatures, ligands, and purification techniques. Significant progress was achieved towards achieving a single crystal of a reticulated network incorporating thiol-functionalized Borromean Rings with gold nanoparticles, as further characterization is performed. The exchange was scientifically rewarding, as well as an amazing opportunity to explore Israel.

Visit of Einat Zalckvar to Northwestern University My visit at Professor Widom's lab was exciting and extremely fruitful. Not only did I learn advanced methods that led to important progress in my current research (advisor Eran Segal, Weizmann Institute), but I was also given the rare opportunity to have a brief exposure to the post doctoral training at Northwestern University, where I am considering conducting my second postdoc. I am looking forward to my next visit in 2011. The project I worked on is aimed at achieving a better understanding of nucleosome sequence preferences.



Most biological systems rely on the ability to establish specific gene expression programs. Such programs are encoded within DNA sequences by a regulatory code, and recent work has considerably advanced our understanding of it, by deciphering the binding specificities of key building blocks such as nucleosomes. Nucleosomes, the basic unit of eukaryotic chromatin, have greatly varying affinities to different DNA sequences, thought to reflect the energetic cost of sharply bending different DNA sequences around the histone octamer to conform to the nucleosome structure. Early characterizations of *in vivo* nucleosome-bound sequences identified ~10 basepair periodicities of specific dinucleotides along the nucleosome length. These dinucleotide periodicities formed the basis of earlier models of nucleosome sequence preferences. More recently, genome-wide collections of nucleosome-bound sequences enabled us and others to identify longer sequence motifs that are generally favored or disfavored by nucleosomes. Incorporating these motifs into models of nucleosome sequence preferences resulted in a significantly improved ability to predict, from sequence alone, nucleosome occupancy *in vivo*. However, despite these major advances in characterizing nucleosome sequence preferences, several important open questions remain. Since most of the measurements were done on naked yeast DNA, the derived models may have a limited ability to predict the affinity of nucleosomes to DNA sequences of other organisms that may have different statistical properties and base compositions. What is missing are experiments in which the affinity of nucleosomes to all possible sequences will be measured. Although direct nucleosome affinity measurements to all of the possible 147bp sequences is not feasible, *in vitro* selection experiments on chemically synthesized random DNA, such as those done on a small number of sequences, can now be combined with high-throughput sequencing to provide affinity measurements for millions of sequences. Models derived from such data will provide a better description of nucleosome affinities to the entire sequence space and should thus be applicable to any sequence and any organism.

Recently, there has been significant progress in understanding the sequence preferences of nucleosomes. Although some of these experiments were done *in vitro*, they were mostly done by assembling purified histones on yeast genomic DNA. Thus, it is not clear to what extent current models apply to DNA sequences of other species that may have different base compositions and structural properties. Even though we cannot directly measure the affinity of nucleosomes to every possible sequence of length 147bp, we believe that we will gain

significant insights by combining traditional SELEX methods with current high-throughput sequencing. Specifically, we will chemically synthesize random DNA ~150bp in length, reconstitute nucleosomes on them, and then isolate DNA molecules that form nucleosomes. We will repeatedly apply this procedure and then apply high-throughput sequencing with long reads to nucleosome-bound sequences from various selection steps. A similar experiment performed over a decade ago by Jonathan Widom identified key sequence preferences of nucleosomes, but owing to technical limitations, this experiment was restricted to only ~100 nucleosome-bound sequences. By obtaining millions of such measurements, we expect to derive much better models of nucleosome sequence preferences that should be universally applicable to the genome of any organism. Since genomes differ in their G/C content, we also propose to repeat this experiment using several random pools, each with a different G/C base composition.

In recent years, Segal and Widom have established an extremely fruitful collaboration between their groups. Their joint work led to important progress in our understanding of nucleosome sequence preferences, and it was published in high-profile journals. There is no doubt that our planned experiments will lead to significant progress in this field of research, and will provide novel insights into key questions regarding nucleosome sequence preferences. I believe that a one-month stay at the lab of Widom, who has performed a similar experiment in the past, will enable us to establish this experimental system. With regard to my scientific training, I am currently doing my post-doc at Segal's lab, and I am planning to do a second post-doc abroad. This will enable me to gain new expertise, and to continue my training as a research scientist, so that I will be able to return to Israel and head a research team of my own. I am certain that staying at Widom's lab will contribute enormously to my development as an independent researcher. Widom's lab produces impressive, high-caliber research, using advanced methods, especially in the nucleosome field. Moreover, this lab is part of Northwestern University; thus, I will be exposed to high-level research and will be able to interact with top-notch scientists, and will be given the opportunity to have a brief exposure to the post doctoral training at Northwestern University.

Visit of Leila Motiei to Northwestern University During my visit to Northwestern University I learned how to prepare solar cells. These devices were fabricated and tested with chemically modified metal-oxide substrates prepared in our lab in the Department of Organic Chemistry at the Weizmann Institute. Our devices are very efficient and we have reported on them recently together with our collaborators in the following publications: **Self-propagating molecular assemblies as interlayers for efficient inverted bulk hetero-junction solar cells** Motiei, L.; Yao, Y.; Choudhury, J.; Yan, H.; Marks, T. J.; van der Boom, M. E.; Facchetti, A. *J. Am. Chem. Soc.* **2010**, *132*, 12528-12530.



Visit of Elijah Shirman to Northwestern University Elijah Shirman spent 10 days at NU during the summer of 2007. Most of his work was devoted to photophysical studies using the equipment and expertise of the Wasielewski group (that we lacked at that time). Elijah was able to study femto- and nanosecond transient absorption of several metal complexes of perylene diimide, and water-soluble perylene diimide systems. Elijah also worked on a project devoted to perylene diimide radical anion and dianion in water using EPR and utilized the expertise of the NU group in radical photophysics. Part of these results were included in a publication (**Stable Aromatic Dianion in Water** Shirman, E.;



Ustinov, A.; Ben-Shitrit, N.; Weissman, H.; Iron, M. A.; Cohen, R.; Rybtchinski, B. *J. Phys. Chem. B* **2008**, *112*, 8855-8858). Elijah also contributed to the NU group by introducing them to a facile method of PDI reduction in water, which was used in conjunction with Wasielewski/Lewis's research devoted to DNA/perylene diimide hybrids. The expertise Elijah gained at NU helped us develop photophysical methodologies that we currently use to study our systems (using the laser equipment on campus, with Iddo Pinkas). These methods are also used by other WIS groups. Overall, Elijah's visit to NU was critical for establishing the approaches to photonic studies that we extensively employ in our research.

Visit of Matthew G. Reuter to the Weizmann Institute My visit to the Weizmann Institute of Science, sponsored by the student exchange program, introduced me to new cultures, allowed me to combine my research expertise with those of other world-class scientists, and helped me forge lasting friendships and collaborations. The main purpose of my



visit to the Weizmann Institute was to learn how to implement PARSEC, a real-space density functional theory code. Within the first week of my visit, I ran numerous tests with the numerical parameters (grid spacing, system size), which helped me understand the code. Shortly afterwards, I worked with Leeor Kronik and Amir Natan, one of Kronik's students, in implementing complex absorbing potentials (CAPs) in the code. Initial tests of this extension were promising; however, larger and more physically interesting tests proved troublesome. After correcting various preexisting errors in the code, we found that our use of CAPs ran quite slow, to the point of rendering real calculations intractable. We soon realized that the main computational bottleneck, the diagonalization of the Hamiltonian, was caused by a poor choice of computational domain shape. More specifically, the sphere mandated by PARSEC wasted many resources when we tested long molecular wires. By extensively augmenting PARSEC to handle non-spherical domains (such as cylinders), the time for diagonalization was reduced from many hours to several minutes. Once again, the initial tests looked very promising. We soon found that domains straying far from spheres, such as long, skinny cylinders, incorrectly computed the Hartree potential for the Hamiltonian, leading to incorrect eigenvalues and eigenvectors. Investigations that followed showed that the culprit was the multipole expansion used to quickly evaluate the Hartree potential. The expansion only converged for distances outside a critical radius, a condition not satisfied for all points on the cylinder. When the multipole expansion was replaced with the general expression for the Hartree potential, correct solutions to the Kohn-Sham equations were obtained; however, the calculation of the Hartree potential now required many hours. The remainder of my visit focused on speeding up the calculation of the Hartree potential. Amir and I devised new ways for handling the boundary conditions, which were implemented by Amir and led to an order-of-magnitude improvement in the run time. While Amir made these changes, I worked on programming the fast multipole method (FMM) (H. Cheng, L. Greengard, and V. Rokhlin *J. Comput. Phys.* **1999**, *155*, 4681), which can be used to further accelerate the calculation. In tests outside of PARSEC, my FMM removed another factor of three to five from the run time, in addition to Amir's improvements. When I returned to Northwestern, we were still trying to incorporate the FMM into PARSEC and also to integrate the CAP functionality with the choice of domain. Given the main goal of learning PARSEC, my visit was a success. Additionally, I was able to successfully install PARSEC on the local computer at Northwestern, where I have continued to work on the above tasks. My visit also exposed me to the current problems in density functional theory by interacting with Kronik and his group, and it helped me learn about software engineering resources including the SVN

software for version control. Finally, my research gained additional international exposure through my attendance at the 74th Meeting of the Israel Chemical Society.

Visit of Tanya Shirman to Northwestern University During my visit I prepared several organic polycrystalline thin films by physical vapor deposition with compounds I prepared at the Weizmann Institute. Subsequently, the films were analyzed in Israel. The structure and physicochemical properties of these materials are controlled by weak interactions (e.g., halogen bonding). We published our results with Antonio Facchetti from Northwestern University in *JACS* (**Assembly of crystalline halogen-bonded materials by physical vapor deposition** Shirman, T.; Freeman, D.; Diskin Posner, Y.; Feldman, I.; Facchetti, A.; van der Boom, M. E. *J. Am. Chem. Soc.* **2008**, *130*, 8162-8163).



Visit of Anat BenZvi to the Weizmann Institute The collaboration between Maya Schuldiner and Anat Ben Zvi focused on identifying the metazoan's insertion machinery for tail-anchored proteins (GET complex) using *C. elegans* as a model system and characterizing the *C. elegans* insertion machinery for tail anchored proteins. Tail Anchored (TA) proteins are a diverse and essential family of proteins, which are anchored to intracellular membranes by a transmembrane domain (TMD) located at their C-terminus. Schuldiner (Weizmann Institute) has recently shown, both in vitro and in vivo, that members of the *S. cerevisiae* GET complex serve as the machinery for inserting secretory pathway TA proteins into the ER membrane of yeast. The finding that the human Get3p homolog, ASNA1, can act to insert a model substrate in vitro strongly indicates that the GET system is conserved all the way up to mammals. In *C. elegans*, loss of ASNA-1 is detrimental to the animal, manifested as pleiotropic effects on development and growth. ASNA-1 function is essential for secretion of Insulin, indicating that its functions are probably conserved. To date there is no information on what may constitute the ER receptor for ASNA-1 because no obvious homolog can be found for Get1p and Get2p in metazoans. The aim of our proposal was to use *C. elegans* as a model system to study the GET complex in metazoans. As part of this collaboration, I spent 7 weeks in Maya Schuldiner's laboratory at the Weizmann Institute working on the GET complex using *C. elegans* as a model system. Specifically, we have used animals expressing ASNA-1 tagged with Green Fluorescent Protein (ASNA-1::GFP) to assay for physical interactions of ASNA-1 and identified the other component of the GET complex in *C. elegans*. We have optimized the conditions needed to pull down ASNA-1::GFP from *C. elegans* extracts, using GFP-specific antibodies. The proteins that co-immunoprecipitate with ASNA-1::GFP were sent for protein identification by Mass Spectrometry. We have identified several possible interactions with both cytosolic and ER chaperones. However, we did not find any membrane-associated protein that may act as a functional homolog for Get1 and Get2.