Centre de Nanosciences et de Nanotechnologies

Séminaire

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Salle Richard Planel – 11 h

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”Quantum nanophotonics: controlling light with a single quantum dot”

Résumé :
Interactions between light and matter lie at the heart of optical communication and information technology. Nanophotonic devices enhance light-matter interactions by confining photons to small mode volumes, enabling optical information processing at low energies. In the strong coupling regime, these interactions are sufficiently large that a single photon creates a nonlinear response in a single atomic system. Such single-photon nonlinearities are highly desirable for quantum information processing applications where atoms serve as quantum memories and photons act as carriers of quantum information. In this talk I will discuss our effort to develop and coherently control strongly coupled nanophotonic devices using quantum dots coupled to photonic crystals. Quantum dots are semiconductor “artificial atoms” that can act as efficient photon emitters and stable quantum memories. By embedding them in a photonic crystal cavity that spatially confines light to less than a cubic wavelength we can attain the strong coupling regime. This device platform provides a pathway towards compact integrated quantum devices on a semiconductor chip that could serve as basic components of quantum networks and distributed quantum computers. I will discuss our demonstration of a quantum transistor, the fundamental building block for quantum computers and quantum networks, using a single electron spin in a quantum dot [1, 2]. I will then describe a realization of a new cavity QED approach to measure the state of a spin all-optically. This technique enables efficient spin readout even when the spin has a poor cycling transition. Finally, I will discuss our recent effort to extend our results into the telecommunication wavelengths, and to improve the efficiency and scalability of the structure in order to attain integrated multi-dot devices on a single chip.

Biography
Edo Waks is a professor in the Department of Electrical and Computer Engineering at the University of Maryland, College Park. He is also a member of the Joint Quantum Institute (JQI), a collaborative effort between the University of Maryland and NIST, Gaithersburg, dedicated to the study of quantum coherence. Waks received his B.S. and M.S. from Johns Hopkins University, and his Ph.D. from Stanford University. He is a recipient of a Presidential Early Career Award for Scientists and Engineers (PECASE), an NSF CAREER award, and ARO Young Investigator Award for the investigation of interactions between quantum dots and nanophotonic structures. His current work focuses coherent control and manipulation semiconductor quantum dots, and their interactions with photonic crystal devices for creating strong atom-photon interactions.

References

1. Kim, H., R. Bose, T.C. Shen, G.S. Solomon, and E. Waks, *A quantum logic gate between a solid-state quantum bit and a photon.* Nat Photon, 2013. **7**(5): p. 373-377. Available from: http://dx.doi.org/10.1038/nphoton.2013.48.
2. Sun, S., H. Kim, G.S. Solomon, and E. Waks, *A quantum phase switch between a single solid-state spin and a photon.* Nat Nano, 2016. **advance online publication**. Available from: http://dx.doi.org/10.1038/nnano.2015.334.