Physics Colloquium

Tuesday, January 30th at 3:30 pm in SC 234

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Micro/Nano-Structured On-Chip Photonics: All-Dielectric Metamaterials and Frequency Comb Generation

Silicon photonics, or more generally, on-chip photonics, uses high-index and low-loss dielectrics to confine and guide the light, and it has revolutionized photonic research both fundamentally and technologically. Chip-scale light confinement increases the light-matter interactions, and recent advances in high-Q microresonators have led to advances in various nonlinear optical phenomena such as Kerr frequency combs. In addition, silicon photonics has been recognized as a next generation computing technology, and many industrial companies and governments are actively working to implement. The compatibility with well-established CMOS manufacturing systems makes silicon photonics promising; however, there are still challenges in this area with the large device sizes (compared to nanometer-scale transistors) due to waveguide cross-talks and bending losses.

In this talk, I will present my two recent research projects: 1) frequency comb generation with dispersion-engineered concentric microresonators [1] and 2) photonic skin-depth engineering with all-dielectric metamaterials [2]. First, concerning the frequency comb research, I will present a concentric resonator that can engineer and significantly modify the dispersion. Strong anomalous dispersion has been demonstrated in a thin silicon nitride film which was previously thought to have high normal dispersion, and consequently unsuitable for frequency comb generation. Together with a mode-selective, tapered coupling scheme, coherent frequency combs and soliton pulses have been generated. Next, I will present a method to engineer the skin-depth of photonic waveguides using all-dielectric metamaterials. A new class of waveguide scheme, *i.e.*, extreme skin-depth (e-skid) waveguide is introduced, and I experimentally demonstrate e-skid waveguides that reduce the waveguide cross-talks and bending losses significantly, thus enabling dense integration of optical waveguides on a chip.

Refreshments at 3:00 pm in SC 103