QPhysics
AT QUEENS COLLEGE

Colloquium Notice

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Heterogeneous photonics for next-generation optoelectronics and analog processors

Photonic technologies are at the forefront of the ongoing 4th industrial revolution of digitalization supporting applications such as virtual reality, autonomous vehicles, and electronic warfare. The development of integrated photonics in recent years enabled functional devices and circuits through miniaturization. However, fundamental challenges such as the weak light-matter integration have limited silicon and III-V-based devices to millimeter-scale footprints demanding about a million photons-per-bit.Overcoming these challenges, in the first part of this talk I will show how nanoscale photonics together with heterogeneous integration of emerging materials into foundry-based photonic chips enables strong nonlinearity, which we use to demonstrate attojoule and compact optoelectronics. Here I will discuss our recent devices demonstrating ITO-based MZI modulators, 2D-material excitonic photodetectors, and exotic epsilon-near-zero modes empowering record-efficient phase shifters for applications in data-comm, LiDAR, and photonic neural networks (NN). Further, I will show that the usually parasitic Kramers-Kronig relations of altering the optical index can be synergistically exploited delivering new modulator operations.

With Moore's law and Dennard scaling now being limited by fundamental physics, the trend in processor heterogeneity suggests the possibility for special-purpose photonic processors such as NNs or RF-signal & image filtering. Here unique opportunities exist, for example, given by algorithmic parallelism of analog computing enabling non-iterative O(1) processors, thus opening prospects for distributed nonvan Neumann architectures. In the second part of this talk, I will share our latest work on analog photonic processors to include a) a feed-forward fully-connected NN, b) mirror symmetry perception via coincidence detection of spiking NNs, c) a Fourier-optics based convolutional processor with 1 PMAC/s throughputs at nanosecond-short delays for real-time processing, d) a photonic residue arithmetic adder, and e) mesh-based reconfigurable photonic & metatronic PDE solvers. In summary, heterogeneous photonics connects the worlds of electronics and optics, thus enabling new classes of efficient optoelectronics and analog processors by employing the distinctive properties of light.

Monday
October 21, 2019
Starts at 12:15 PM
Coffee at 12:00 PM
Physics Conference Room, SB B326