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Nanophotonics in systems of large sizes

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Nanophotonic structures provide unique ways to control and manipulate light, due to the small feature sizes in the order of hundreds of nanometers. However, many real-life applications favor devices of large sizes, due to practical considerations such as heat management and electrical pumping. As a result, large-area nanophotonic systems have drawn great interest in the photonics community. On the one hand, the nanoscopic features provide exotic and novel ways to control light; while on the other hand, the large size of the system makes them useful for applications such as displays, high-power lasers, sensors and filters. In this talk, I will present three topics in our recent results along this research direction. First, I will discuss our theoretical and experimental work on "bound states in the continuum," an exotic type of resonances first predicted in 1929, along with their connections to the field of singular optics and vector beams. Secondly, I will present our recent achievements in single-sided radiation and perfect absorption without using mirrors. I will describe the underlying physics and discuss their uses in silicon photonics devices (such as LIDAR antennas), grating couplers, and metasurfaces. Finally, I will move to exceptional points, a unique type of degeneracies in non-hermitian physics. I will present our recent experimental work demonstrating that a ring of exceptional points can be spawned from a single Dirac point, and I will discuss their uses in achieving higher power photonic crystal surface emitting lasers and new types of sensors.

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Label-free detection and serotyping of *Salmonellae* by surface enhanced Raman spectroscopy with immunomagnetic separation

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Salmonella spp. are one of the leading causes of foodborne outbreaks in the United States and globally. Current detection and characterization techniques for *Salmonellae* are time consuming, and rapid methods could greatly benefit outbreak investigation, new case prevention and disease treatment. In this presentation, the potential of surface enhanced Raman spectroscopy (SERS) in label-free detection and serotyping of *Salmonella* will be discussed. Immunomagnetic separation (IMS) with anti-*Salmonella* antibody coated paramagnetic beads can capture target bacterial samples in a cell level. SERS methods are used by applying single colony suspensions on polyvinyl alcohol stabilized biopolymer encapsulated silver nano-substrates. Spectra from multiple colonies and experiments are collected and analyzed by chemometric analysis for classification. The detection accuracies are evaluated in real mixture samples. IMS-SERS coupled with classification models yielded accuracies of between 86.7% and 99.8% for detecting *Salmonella*. However, when validated in mixture samples consisting of six bacteria samples including S. typhimurium, S. Infantis, S. Kentucky, S. enteritidis, E. coli, and S. aureus, prediction accuracies decreased. The potential of simultaneous detection and characterization of multiple foodborne pathogens and serotypes using label-free SERS coupled with IMS has the potential as a new bio-sensing method, which provides an inexpensive and rapid alternative method. However, further improvement in spectral reproducibility and classification accuracy are needed, particularly for characterization of *Salmonella* serotypes in food matrices.

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