Linear and Nonlinear Optical Nano-Antennas

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In this talk, we review our recent work on the linear and nonlinear operation of optical antennas, bridging far-field radiation with the near-field interactions between light and matter. We discuss the use of plasmonic and dielectric nanoparticles, and combinations of them, to locally enhance linear and nonlinear optical field interactions, to efficiently trap, absorb, scatter the incident light, to receive and transmit nanoscale signals through wave propagation and radiation, and to tailor the impinging radiation at a subwavelength scale. We discuss in particular the relevance of translating established concepts of radio-frequency antenna theory into the realm of nano-optics, and the inherent challenges and unique opportunities associated with this field of science and technology. In our talk, we will provide physical insights into the proposed nanoantenna geometries, and discuss a variety of nanodevices aimed at processing and tailoring in unconventional ways the nanoscale interaction of nanoparticles with light. We will discuss the concepts of meta-transmitarrays and meta-reflectarrays, obtained by suitably patterning metasurfaces in the transverse direction with suitably designed nano-antennas, in order to tailor at will the impinging light. We will also discuss how these concepts may be extended to nonlinear operation and to time-varying systems. Finally, we will discuss the realization of magnetic nano-antennas that can enhance and exploit the typically weak magnetic effects at visible frequencies using proper arrangements of plasmonic nano-clusters, as well as the application of nano-antennas to realize single and multiple wireless links for light, opening exciting possibilities for nanophotonics and broadband optical communications. More generally, we will provide an overview of the exciting possibilities opened by the fields of plasmonics and metamaterials when combined with antenna concepts, and the fertile ground opened by the combination of these fields of research.