Sub-wavelength photonics: controlling near-field interactions between nanosystems.

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Metallic and dielectric objects are surrounded by fluctuating electromagnetic fields due to thermal and quantum fluctuations of the charge and current density at the surface of the bodies. Immediately outside the objects, this electromagnetic field exists partly in the form of propagating electromagnetic waves and partly in the form of evanescent waves that decay exponentially with distance away from the bodys surface. These fluctuating electromagnetic modes are responsible for a great variety of near-field phenomena such as the Van der Waals force, the Casimir force, near-field heat transfer, and non-contact friction forces. As devices evolve from micro- to nanoscale structures, these forces become relatively stronger, and their effect cannot be disregarded any further. To improve our understanding of these near-field interactions and to develop mechanism to control them, is extremely important for a diversity of seemingly different fields, such as nanomechanics, quantum computing with trapped ions, measurements of gravitational forces at the nanometer scale, and detection of single spins for magnetic resonance force microscopy. In this presentation I will describe the fundamentals of near-field forces, I will review recent scientific advances regarding manipulation of these interactions, and I will illustrate novel applications that could be enabled once we are capable of control these forces.