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Understanding subcellular dynamics with nanoplasmonic apertures

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This talk describes optical molecular imaging and sensing techniques based on plasmonic light localization which recently has drawn significant interests as a way to manipulate optical signal within the nanoscale area beyond diffraction limit and thereby acquire biological information with a high signal-to-noise ratio and precision. By colocalized label-free sensing of light-matter distribution using plasmonic nanoaperture arrays, it was shown that improvement of detection sensitivity by several orders of magnitude would be plausible. For imaging, although many emerging microscopy approaches have been highly successful to produce super-resolved images beyond imagination, we explore alternative techniques based on plasmonic nanoarrays by which achievable resolution may be customized to fit specific imaging needs. Feasibility studies on subcellular dynamics of molecular complexes such as internalization of virus particles, sliding microtubules, intracellular mitochondrial movement, and bacterial motility on random and periodic plasmonic nanoaperture patterns were performed. Enhancement of axial resolution for the detection of intracellular protein distribution is reported by extraordinary light transmission using linearly graded plasmonic nanoapertures. We have also conducted plasmon-enhanced fluorescence correlation spectroscopy of cellular organelles with improved precision. To be also described in this presentation is the switching-based light localization to circumvent the diffraction limit of far-field optics under the Rayleigh criterion, thereby implement full-field super-resolution microscopy. Localization switching can also be used to improve image resolution of label-free surface plasmon microscopy which suffers from plasmon scattering in a conventional set-up. Improvement of surface coverage of localized fields is discussed using random nanocomposite islands for light switching.