Mesoscopic electrodynamics at metal surfaces: quantum and nonlocal corrections in plasmonics

N. Asger Mortensen, Professor & VILLUM Investigator
Center for Nano Optics & Danish Institute for Advanced Study
University of Southern Denmark

www.mortensen-lab.org

Plasmonic phenomena in metals are commonly explored within the framework of classical electrodynamics and semiclassical models for the interactions of light with free-electron matter. The more detailed understanding of mesoscopic electrodynamics at metal surfaces is, however, becoming increasingly important for both fundamental developments in quantum plasmonics [1] and potential applications in emerging light-based quantum technologies [2]. While this intuitively calls for a full quantum description of plasmon-enhanced light-matter interactions, recent discoveries show how classical electrodynamics may still suffice if appropriately dressed by quantum-corrected mesoscopic boundary conditions [3-5]. Recently, consequences have been explored for a plethora of plasmon-emitter interactions ranging from dipolar and multipolar spontaneous emission enhancement, to plasmon-assisted energy transfer and enhancement of two-photon transitions [6].

[1] N.A. Mortensen, “Mesoscopic electrodynamics at metal surfaces – From quantum-corrected hydrodynamics to microscopic surface-response formalism”, Nanophotonics **10**, 2563 (2021)

[2] A.I. Fernández-Domínguez, S.I. Bozhevolnyi & N.A. Mortensen, “Plasmon-enhanced generation of non-classical light”, ACS Photonics **5**, 3447 (2018).

[3] W. Yan *et al.*, “Projected Dipole Model for Quantum Plasmonics”, Phys. Rev. Lett. **115**, 137403 (2015).

[4] T. Christensen *et al.*, “Quantum corrections in nanoplasmonics: shape, scale, and material”, Phys. Rev. Lett. **118**, 157402 (2017).

[5] Y. Yang *et al.*, “A General Theoretical and Experimental Framework for Nanoscale Electromagnetism”, Nature **576**, 248 (2019).

[6] P.A.D. Gonçalves *et al.*, ”Plasmon-Emitter Interactions at the Nanoscale”, Nat. Commun. **11**, 366 (2020).