Hybrid nanoantennas for nonlinear nanophotonics, and direct probing of the bosonic nature of surface plasmon polaritons

Stefan A Maier[1]

[1]Department of Physics, Imperial College London, London SW7 2AZ, UK

[*]corresponding author: s.maier@imperial.ac.uk

Abstract- We will present nonlinear experiments with hybrid optical nanoantennas, where a nanoscale nonlinear element is placed into the gap of a plasmonic dimer antenna. Such antennas are highly efficient nonlinear sources of radiation, and additionally the strength of third harmonic generation allows for probing of the plasmonic field enhancement. The second part of the talk will present direct evidence for the bosonic nature of surface plasmon polaritions via a Hong-Ou-Mandel interferometric study of quantum interference.

Plasmonic nanoantennas allow for the controlled focusing of the far field into the nanometric near-field region. We will show how this can be exploited for non-linear nanophotonics via studies of third harmonic generation in hybrid antennas where a highly nonlinear element is placed into the feed gap of a plasmonic dipolar antenna. Using a two-step electron beam lithography process, a 20 nm indium tin oxide disk was positioned in the gap of a gold nanoantenna with a positional accuracy on the order of 5 nm. Enhancement of third harmonic generation by more than six orders of magnitude was observed, as were signs of spectral compression of the pump pulse. We will further discuss how this scheme can be utilized to study the strength of the plasmonic near field.

The second part of the talk will focus on the quantum nature of propagating surface plasmon polaritons. In a direct analogue to the Hong-Ou-Mandel quantum interference experiment for photons, we demonstrate the bosonic character of surface plasmon polaritons via quantum interference of single quanta. This is achieved with a visibility > 50% utilizing a compact scattering-element based plasmonic beam splitter in a four-port waveguide geometry. The talk will close with an outlook on challenges and opportunities for quantum plasmonics.