Tampere University

Physics Colloquium

Enhanced light matter interaction in waveguides with extreme nanofocussing

Speaker: **Prof. Rupert Oulton**

Imperial College (London, UK)

Date: **Thursday 21st March 2024**

Time: **16:15 o'clock.**

Location: **Tietotalo TB109**

hosted by Dr. Mikko Huttunen

Abstract:

We report three recent studies of nanophotonic waveguides capable of greatly enhancing interactions between light and matter. Our approach is based on gap plasmonic waveguides that enable efficient photonic-to-plasmonic mode conversion, linking light constrained by the diffraction limit to modal areas <lambda^2/100. While metals introduce loss, here low insertion loss is possible due to the capability to rapidly nano-focus and nano-defocus. We are thus capable of designing metallic components that efficiently focus light to a 10 nm scale where linear and nonlinear processes may be greatly enhanced. Unlike optical resonators, waveguides support a mode continuum that offers broad bandwidth enhancement; electronic and optical states do not require tuning and in principle, multiple electronic states may be simultaneously coupled to a single optical mode. We initially discuss how to achieve low-loss conversion from photonic-like states to plasmonic gap modes. We will then explore three applications of these waveguide for both nano-focusing and nano-defocusing. In the first case, nano-focusing allows intense optical fields to be achieved at relatively low input powers. This is highlighted in a our recent demonstration of four wave mixing (FWM) over micron-scale interaction lengths at telecommunications wavelengths [1]. In the case of nano-defocusing, we present new data on the collection of Erbium fluorescence from these waveguides [2]. Finally, we explore surface enhanced Raman scattering in confined nanophotonic waveguides, showing their ability to not only enhance Raman scattering, but also to direct it via a single mode with near unity efficiency [3].

[1] M. P. Nielsen, X. Shi, P. Dichtl, S. A. Maier, and R. F. Oulton, Science, 358, 1179 (2017).
[2] N. A. Güsken, M. Fu, M. Zapf, M. P. Nielsen, P. Dichtl, R. Röder, A. S. Clark, S. A. Maier, C. Ronning, R. F.
[3] M. Fu, M. P. dS. P. Mota, Xi Xiao, A. Jacassi, N.A. Gusken, Y. Chen, H. Xiao, Y. Li, A. Riaz, S. A. Maier, R. F. Oulton, Nature Nanotech. (2022)