

Joint CQSE and CASTS Seminar

Weekly Seminar
Oct. 25, 2013 (Friday)

TIME Oct. 25, 14:30 ~ 15:30
TITLE Radiation of molecules in hyperbolic meta-materials environment
SPEAKER Prof. Vasily Klimov
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PLACE Rm716, CCMS & New Physics Building, NTU

Abstract

Now hyperbolic metamaterials (HMM) are considered as promising media to enhance decay rate of simple quantum systems [1]. Due to huge local density of photon states the decay rate of molecule near surface of HMM tends to infinity as

$$\Gamma^{rad} \propto \frac{2\sqrt{|\varepsilon_x|\varepsilon_z}}{d^3(1+|\varepsilon_x|\varepsilon_z)} \quad (1)$$

where $d \gg 0$ is distance between molecule and HMM and $\varepsilon_x = \varepsilon_y < 0, \varepsilon_z > 0$ are lossless components of permittivity tensor.

However if we take into account losses in HMM it is easy to show that non-radiative (Joule) losses also tend to infinity when molecule gets closer to surface of HMM

$$\Gamma^{nonrad} \propto \frac{\text{Im} \varepsilon}{d^3} \quad (2)$$

where $\text{Im} \varepsilon$ stands for imaginary part of permittivity.

In this work we will present results of investigation of relations between (1) and (2) for different materials, molecule positions and orientations of its dipole momentum, and find conditions where nonradiative losses are minimal.

We will also present new nanoantennas based approaches to extract photons from HMM before they being absorbed.

[1] Jacob, Zubin; Kim, J Y.; Naik, G V.; Boltasseva, Alexandra; Narimanov, Evgenii; and Shalaev, V. M., "Engineering photonic density of states using metamaterials" (2010). *Birck and NCN Publications*. Paper 696; <http://docs.lib.purdue.edu/nanopub/696>.

