Hotspots: A naive Photonics modules consistency validation

System is a 2D adapted version of the original particle in cavity (PIC) architecture [1]. Particle is a cylinder made of Ag [2] with radius $r_p = 0.12(2N+1)$ where $N = 200$ is a useful parameter to defining points per side in the square unit cell used here for 2D periodic system representation. Thus, cylinder's diameter is defined by 96/401 points. Cavity has a truncated cylindrical shape with radius $r_v = 0.42(2N+1)$, it is a void in Ag also with a transverse cut at height $h = 1.5r_v$. Host is air. Test was made by means of calculating ϵ^M and microscopic electric field using Photonic modules WE/R2, WE/S, LE/NR2, and LE/S. To compare results between Longitudinal (LE) and Wave Equation (WE) homogenization methods, the long wavelength approximation was introduced for the PIC configuration. We scale unit cell size to $L = 50$ nm, then $r_v \equiv a = 21.07$ nm and $r_p \equiv b = 6.11$ nm. The wavenumber is defined by $q = \hbar\omega/1239.8$ and wavevector $\vec{k} = 1.2q\hat{e}$, with $\hat{e}$ the polarization direction. Differences between results obtained by all of such methods are not meaningful. In all cases $Nh = 200$ Haydock coefficients were used. Fig.1 displays at the left panel, the real and the imaginary parts of ϵ^M_{yy} component versus photon energy $\hbar\omega$. The right panel of Fig.1 displays the self consistent microscopic field modulus in false color with the scale bar at the figure right side. Arrows represent real part of the microscopic field convenient scaled and decimated for a clear representations of the field directions. The particle is just touching the cavity and the indicated point on the curves at the left part of Fig.1 corresponds to $\hbar\omega_0 = 2.88$ eV. The microscopic field are obtained when a probe field with $\hat{e} = \hat{y}$ polarization direction and frequency $\hbar\omega_0$ excite the system. Note that Fig.2 it is similar to Fig.1 but now for $\hbar\omega_1 = 2.63$ eV tuning also a resonance with a large but localizaed microscopic field intensity (hotspot). Fig.3 displays the real and the imaginary part of $\hat{x}\hat{x}$ component of the macroscopic dielectric function. Fig.4 displays the microscopic field for $\hbar\omega_2$ and $\hbar\omega_3$. The corresponding microscopic electric field for all frequencies can be visualized via *totem* codes or many other used for to manage `mp4` format.

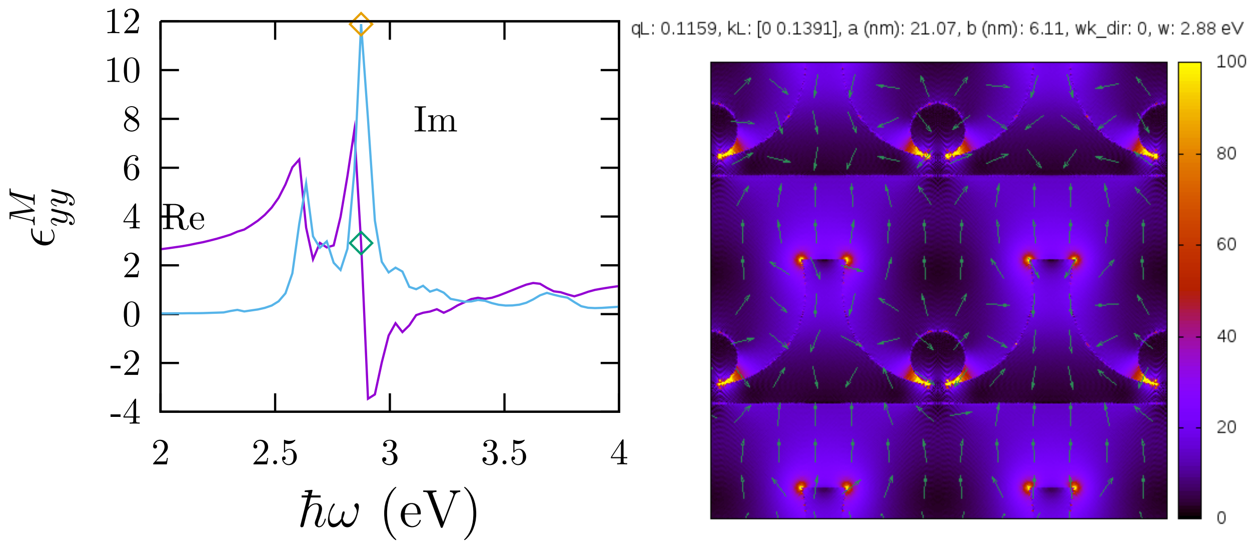

Figure 1: Left panel: The real and the imaginary parts of the macroscopic dielectric function ϵ^M_{yy} component versus photon energy $\hbar\omega$. Points on curve indicates $\hbar\omega_0 = 2.88$. Right panel: Microscopic electric field modulus in false color according to scale at the right side. Title indicates dimensionless qL and $\vec{k}L$, particle (b) and cavity (a) radius in nm, wave vector direction (wk_dir), and $\hbar\omega_0$. Arrows represents direction of the real part of the microscopic field, vertical direction is defined by $\hat{y}$.

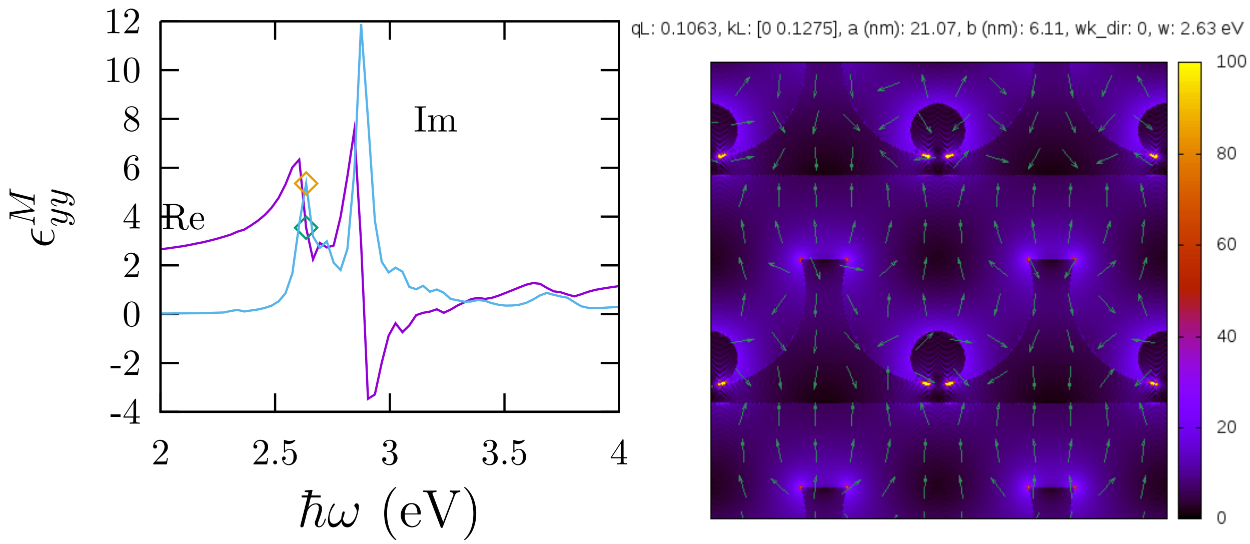

Figure 2: Idem as Fig. 1. Now it is indicated $\hbar\omega_1 = 2.63$ eV on the curve at left panel and the microscopic field for such frequency at the right panel. Note that qL and kL modifies accordingly.

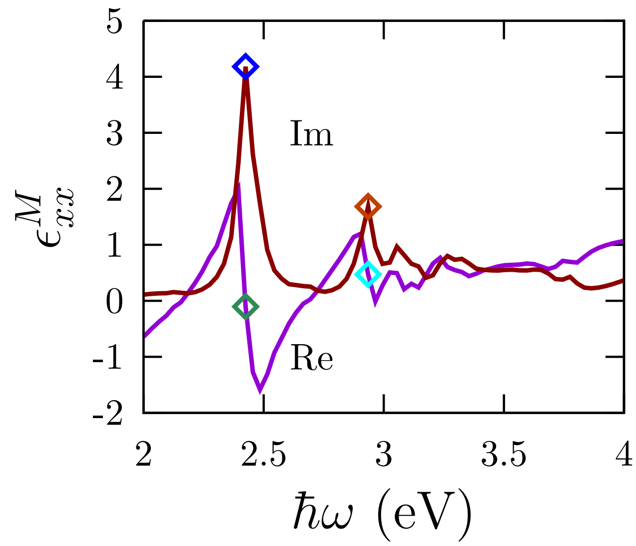

Figure 3: The real and the imaginary parts of macroscopic dielectric function ϵ_{xx}^{M} component versus photon energy $\hbar\omega$. Two points are indicated on curves at $\hbar\omega_2 = 2.42$ and $\hbar\omega_3 = 2.94$

.

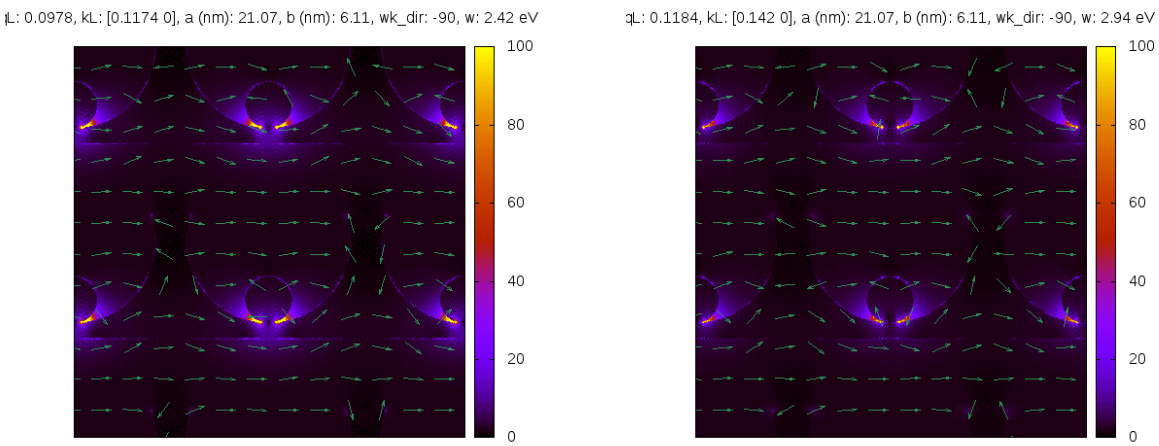

Figure 4: . Image for the microscopic electric fields at the two reference points of Fig.3 for $\hbar\omega_2 = 2.42$ (left panel) and $\hbar\omega_3 = 2.94$ (right panel). The microscopic electric field video coded in `mp4` format can be visualized with a click on figure.

Bibliography

[1] Fu Min Huang, Dean Wilding, Jonathon D. Speed, Andrea E. Russell, Philip N. Bartlett, and Jeremy J. Baumberg. Dressing plasmons in particle-in-cavity architectures. *Nano Letters*, 11(3):1221–1226, 2011. PMID: 21284375.

[2] P. B. Johnson and R. M. Christy. Optical constant of noble metals. *Phys. Rev. B*, 6:4370, 1972.