

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

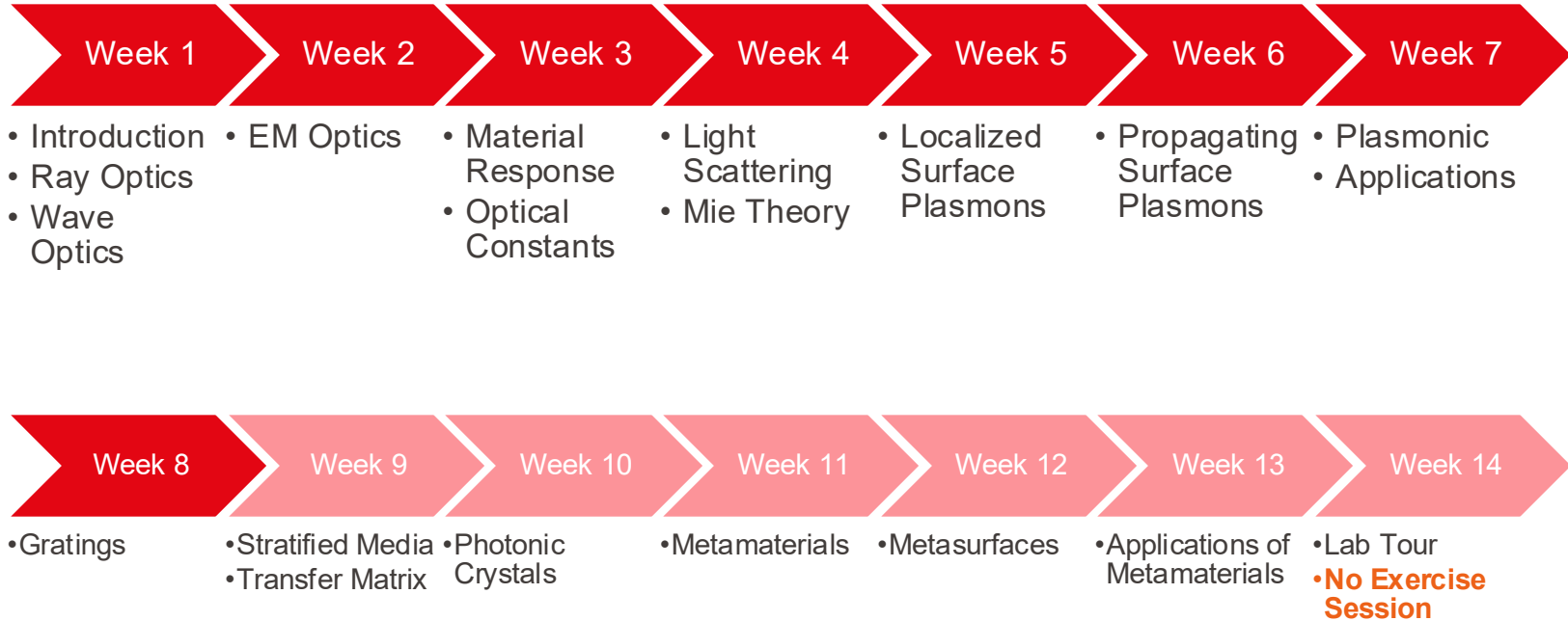
$$\nabla \times \mathbf{B} = \mu_0 \left( \mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$

# Week 8

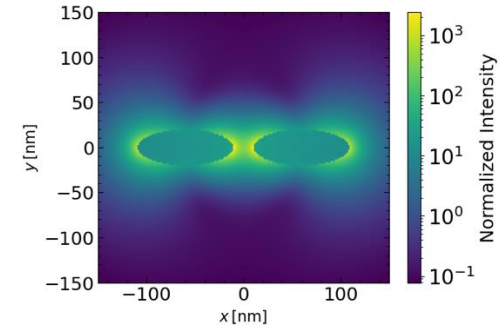
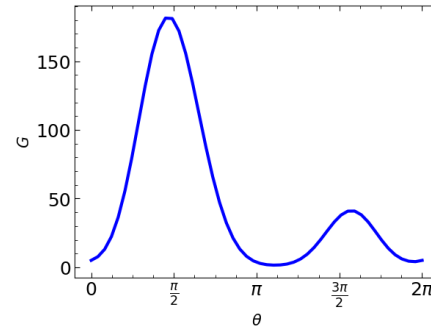
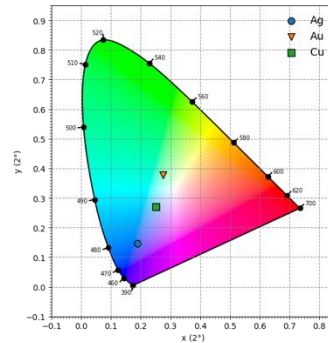
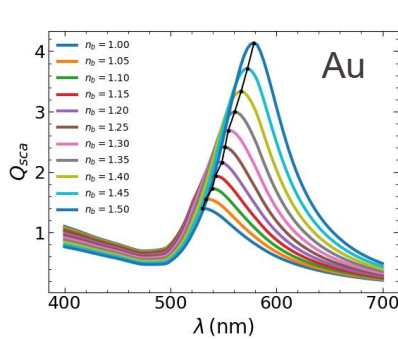
(Gratings)

Stavros Athanasiou

Lausanne, 04 Nov 2025



1. Sensing with Plasmonic Particles
2. Visualization of color with CIE Plot
3. Plasmonic Enhancement of Raman Scattering
4. Electromagnetic Response of Non-spherical particles

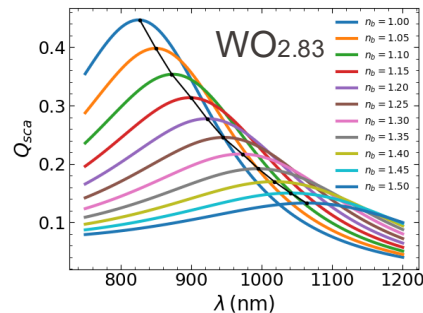
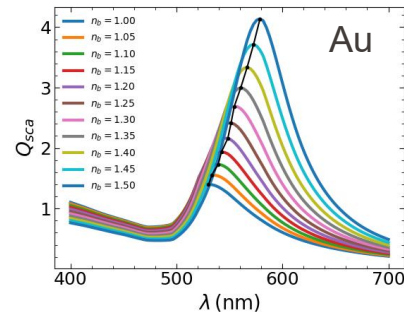
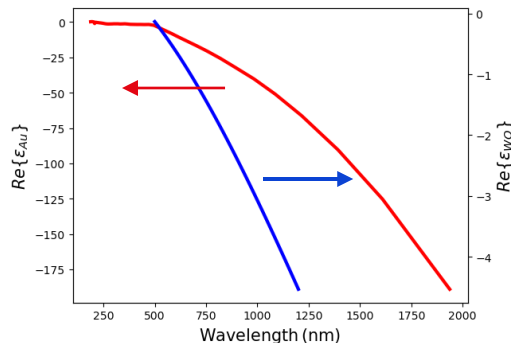


We worked with two particles, and found:

- Gold: **4.85 nm** per 0.05 RI increase.
- Tungsten oxide: **23.63 nm** per 0.05 RI increase.

Recall the resonance condition

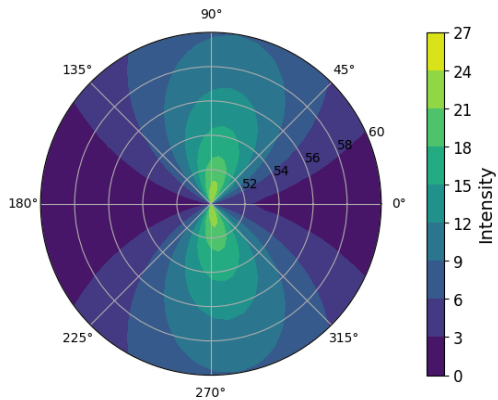
$$\text{Re}\{\varepsilon_1(\omega)\} = -2\varepsilon_2$$



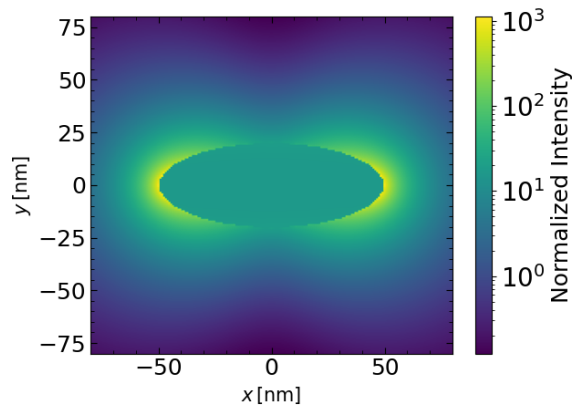
Disclaimer: The results in the notebook were obtained for a relatively larger particle size, where the small particle approximation is expected to fail. However, the above argument provides a very helpful insight (in fact the exact solution for the resonance peak is similar to the one above).

Geometrical features impact field enhancement.

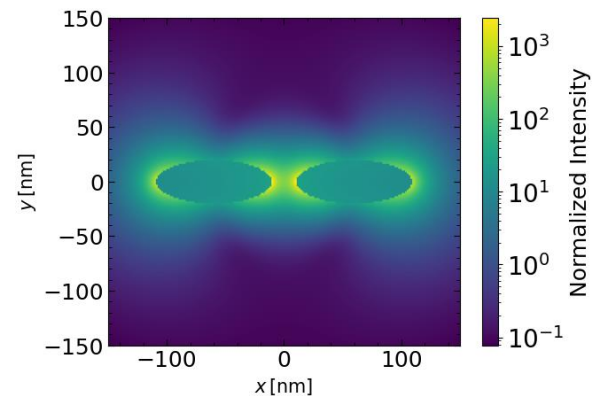
Sphere of  $R = 50$  nm



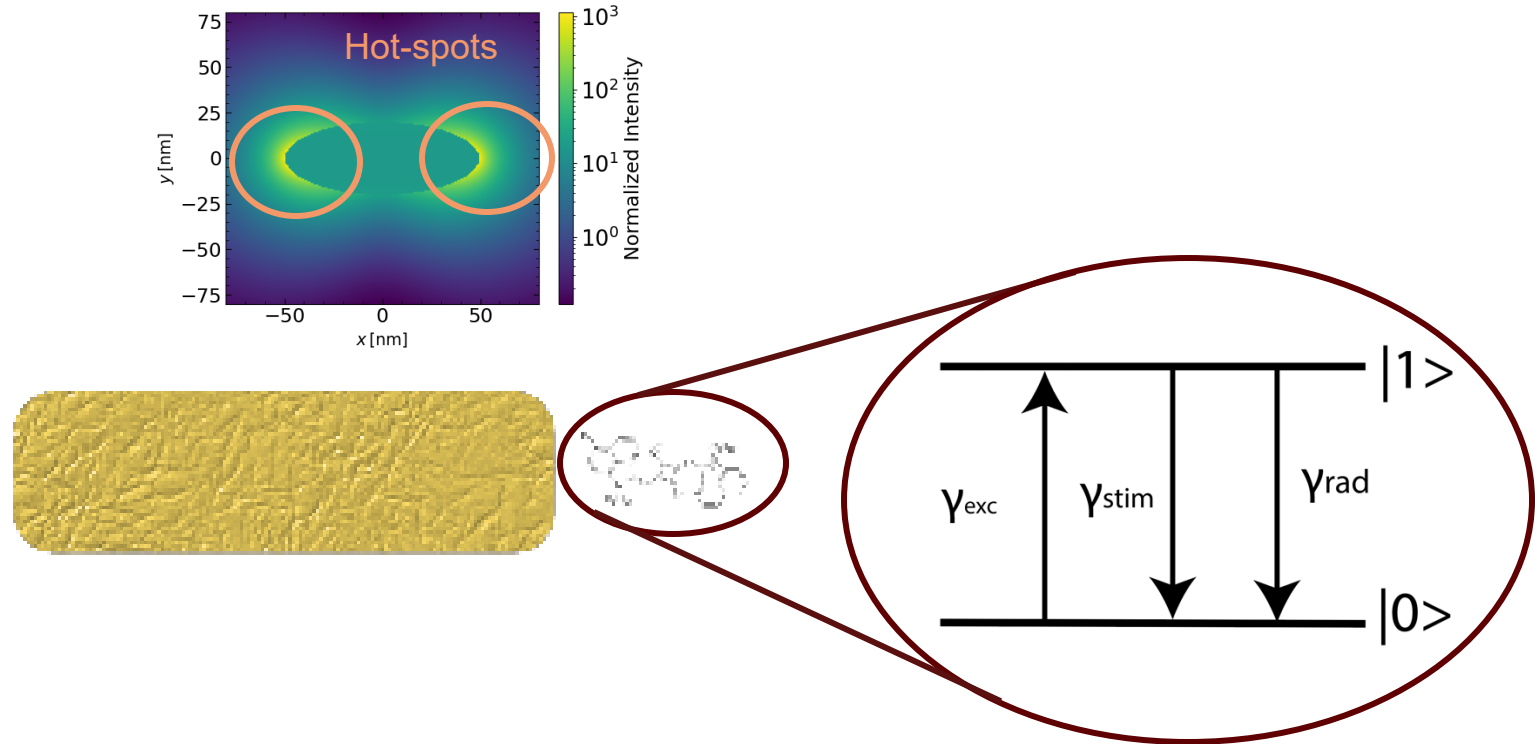
Ellipsoid with  $a = 50$  nm,  
 $b = c = 20$  nm



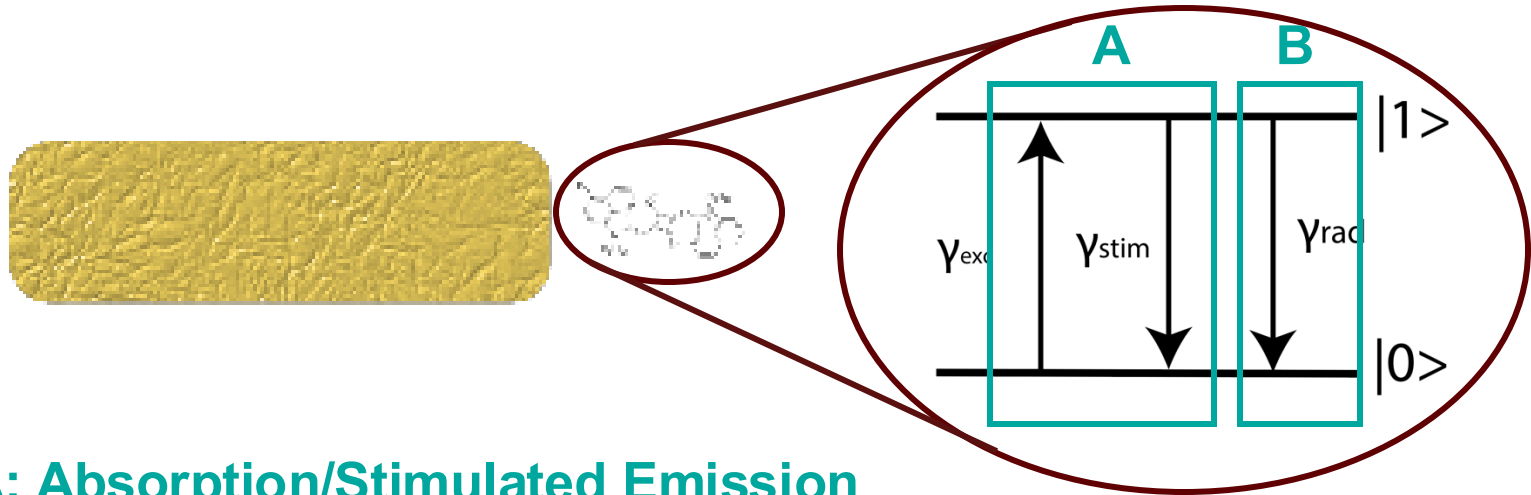
Dipole Antenna with two ellipsoids  
of  $a = 50$  nm,  $b = c = 20$  nm



Plasmonic Nanoparticles can boost light-matter interaction.



Plasmonic Nanoparticles can boost light-matter interaction.



## A: Absorption/Stimulated Emission

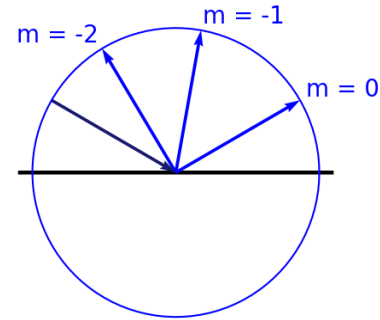
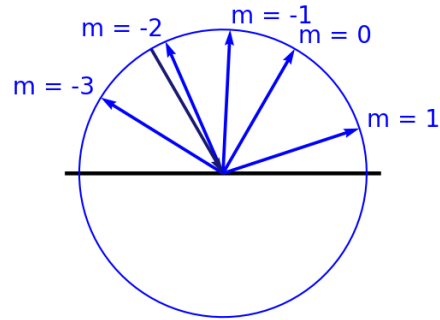
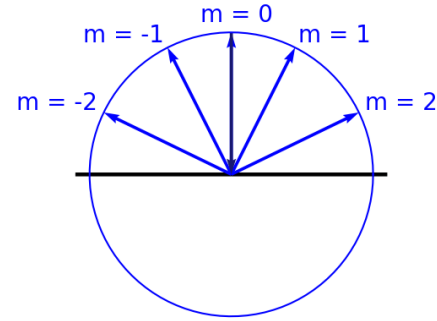
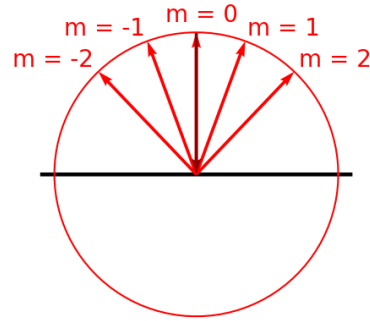
$$\gamma_{exc} = \gamma_{stim} \propto |\hat{p} \cdot \vec{E}|^2$$

## B: Spontaneous Emission

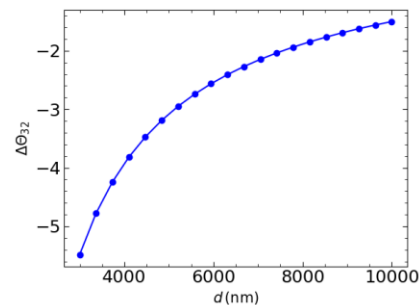
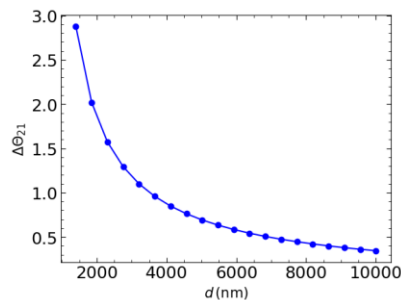
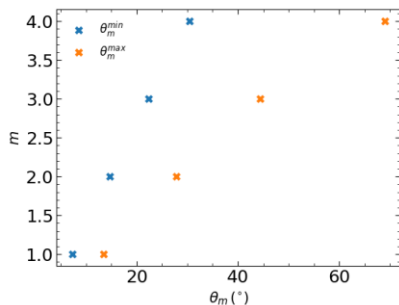
$$\gamma_{rad} \propto \text{Im}\{\hat{p} \cdot G \cdot \hat{p}\}$$

(Purcell effect)

- Visualizing the Diffraction Orders



## Overlap of Diffraction Orders



## Propagating and Evanescent Modes

