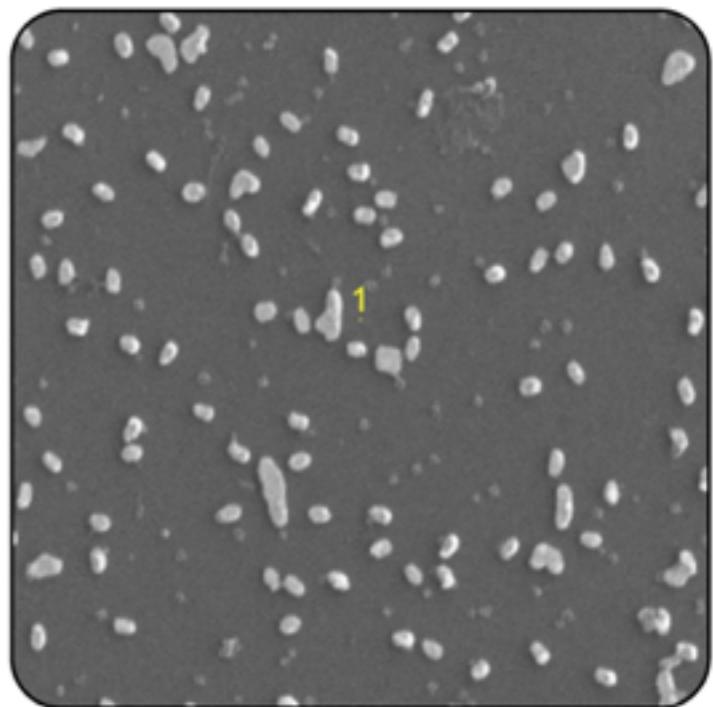
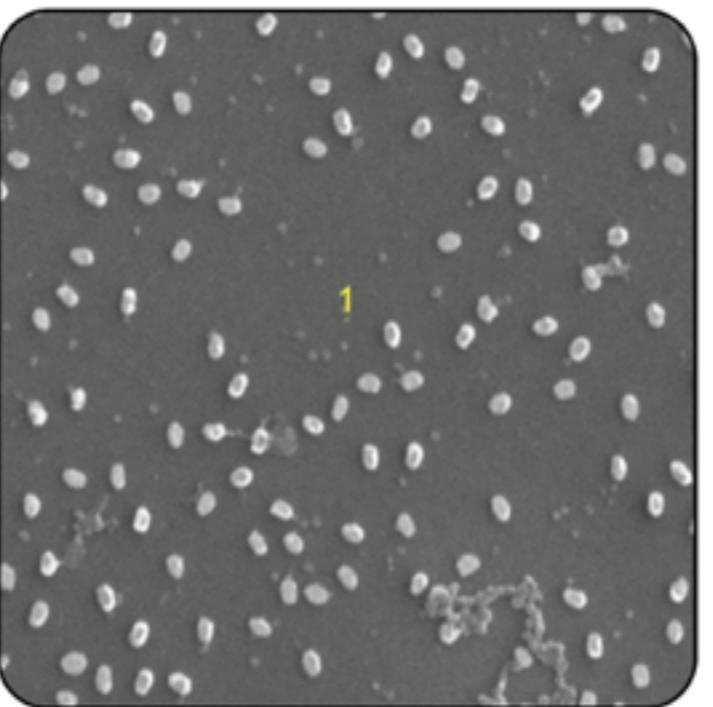
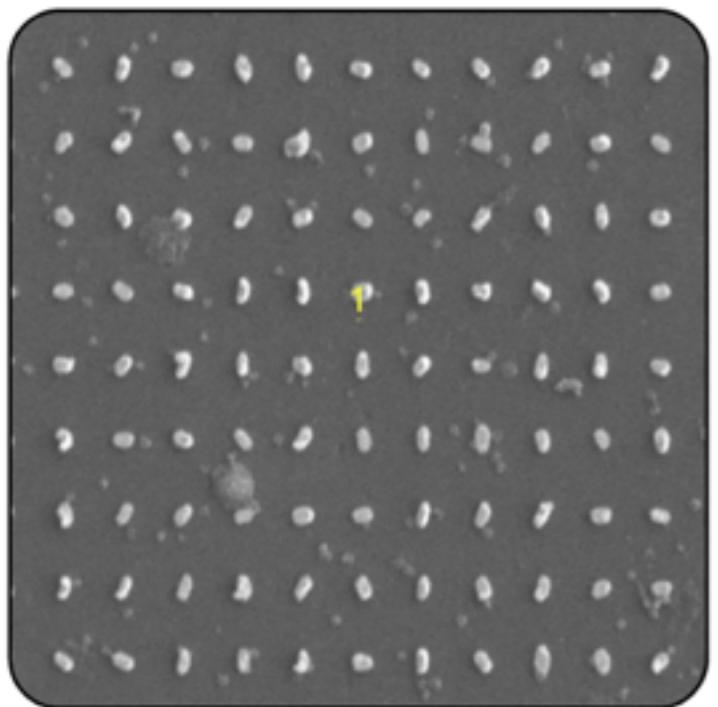
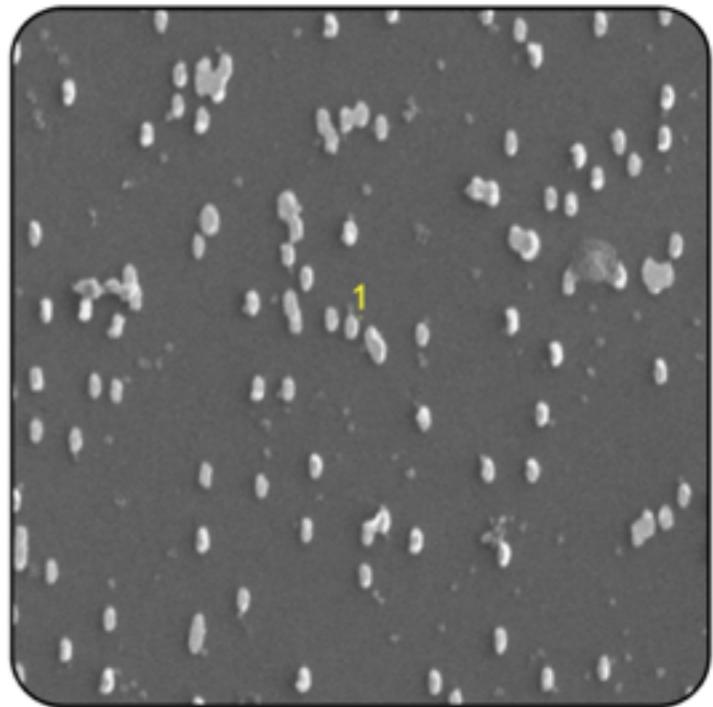
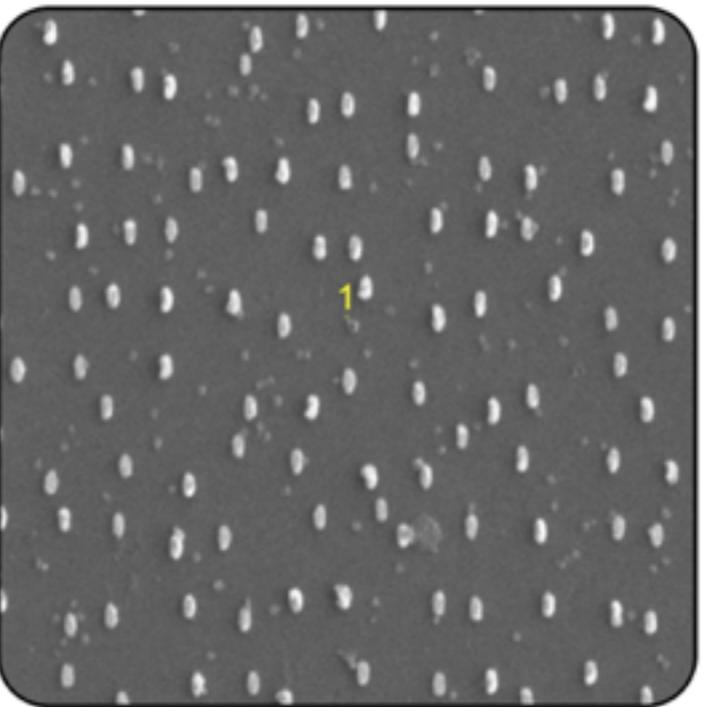
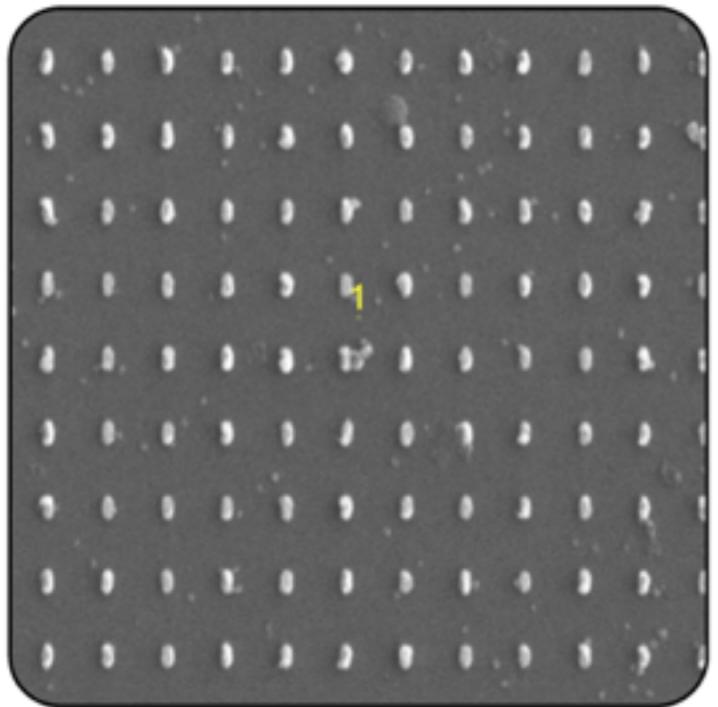




Dipole-dipole interactions, chirality,
... and **plasmonics**

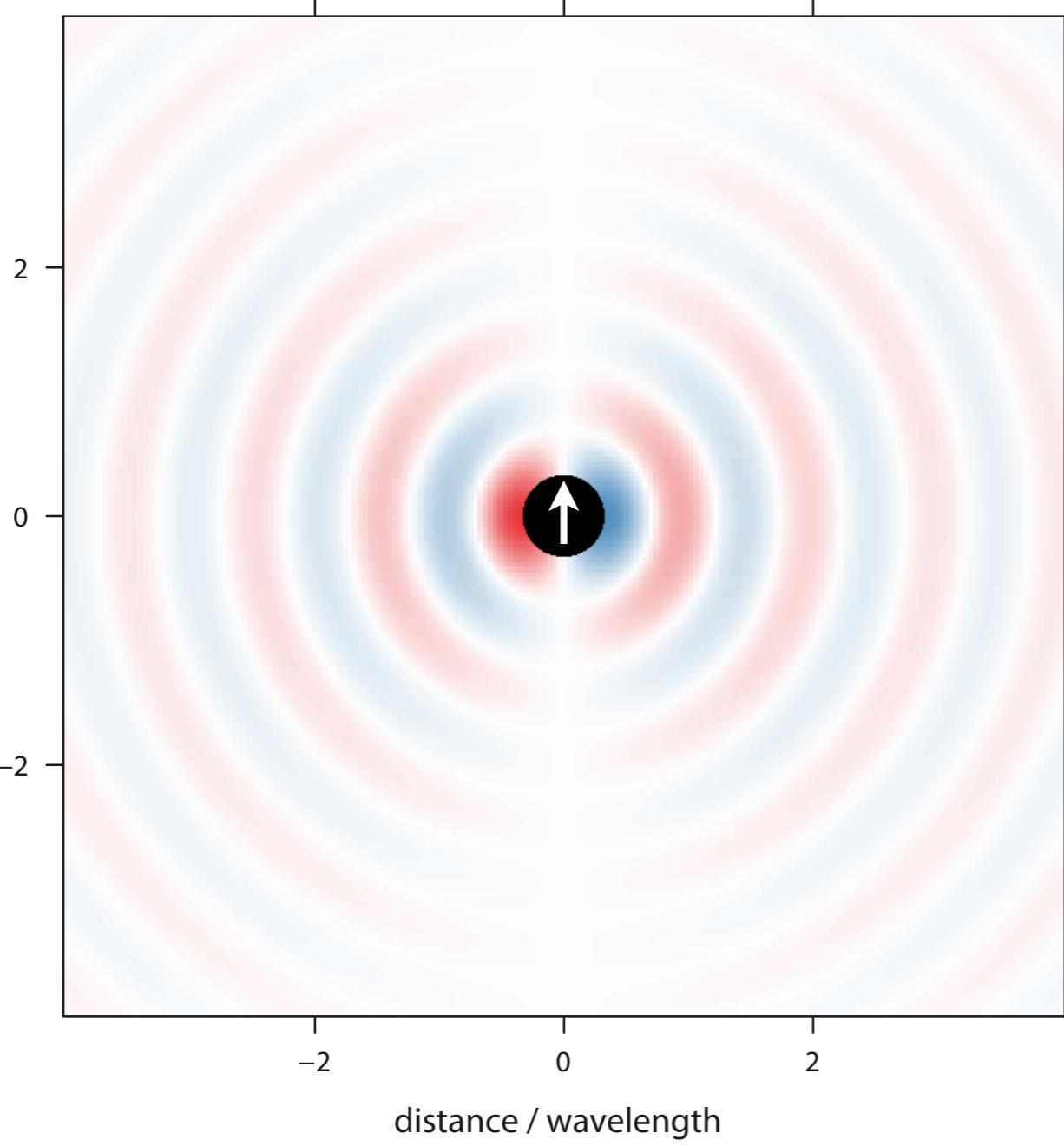


Nano-antennas
what to do with them?

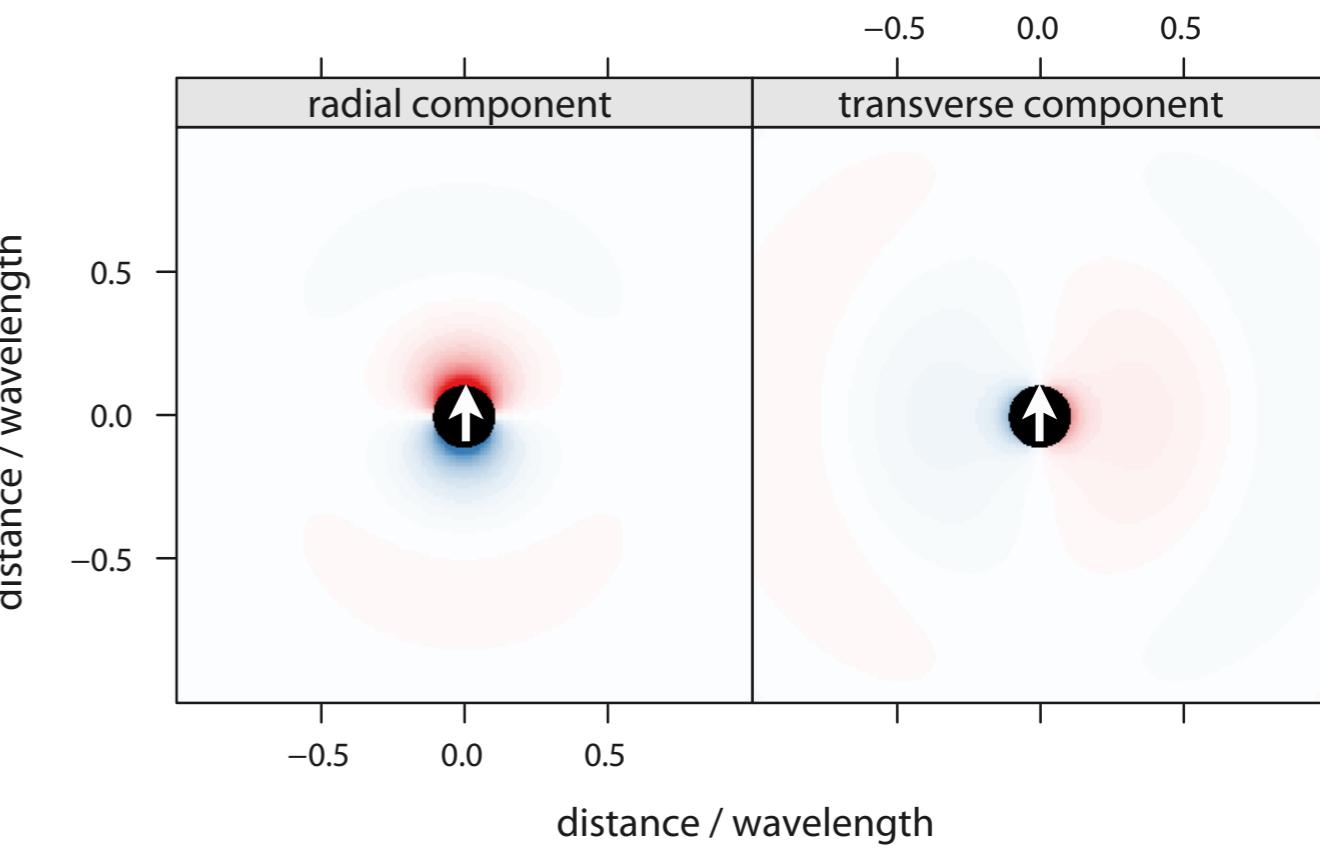
Multiple scattering: electromagnetic coupling



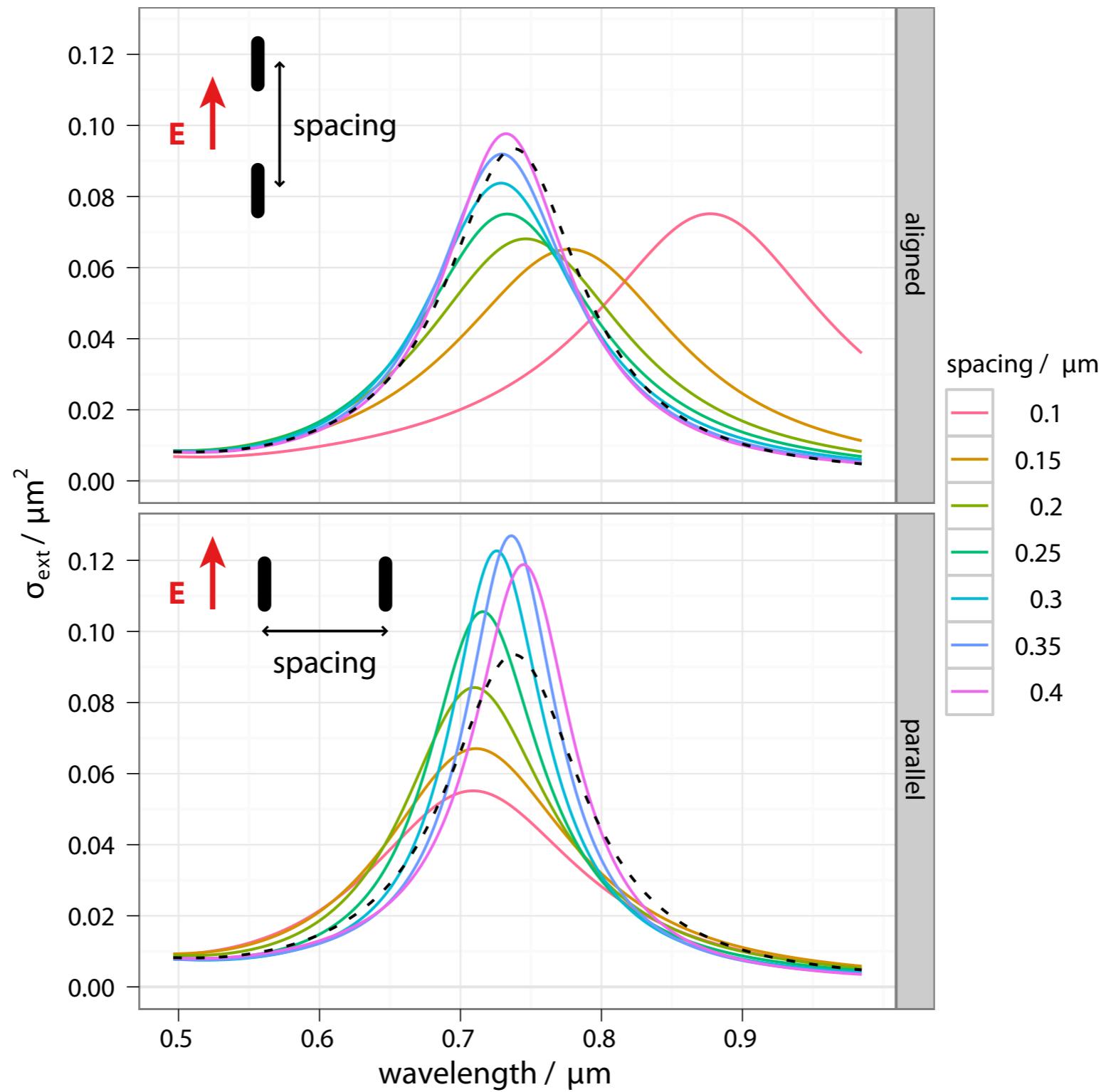
Structure of the dipolar field

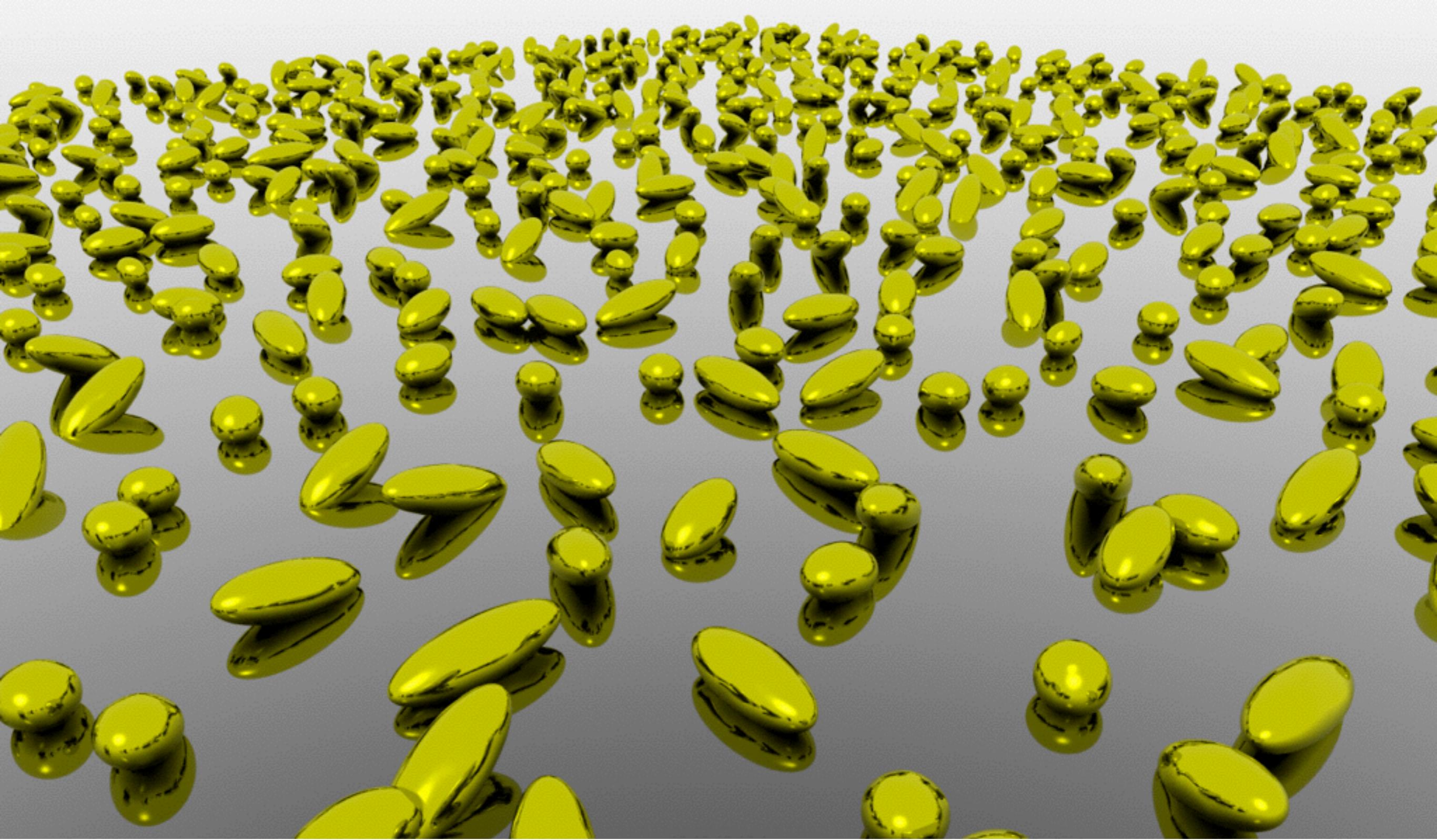


$$\mathbf{E}^{\text{dipole}} = \frac{e^{i\omega r/c}}{4\pi\epsilon_0} \left\{ \frac{\omega^2}{c^2 r} \hat{\mathbf{r}} \times \mathbf{p} \times \hat{\mathbf{r}} + \left(\frac{1}{r^3} - \frac{i\omega}{cr^2} \right) [3(\hat{\mathbf{r}} \cdot \mathbf{p})\hat{\mathbf{r}} - \mathbf{p}] \right\}$$

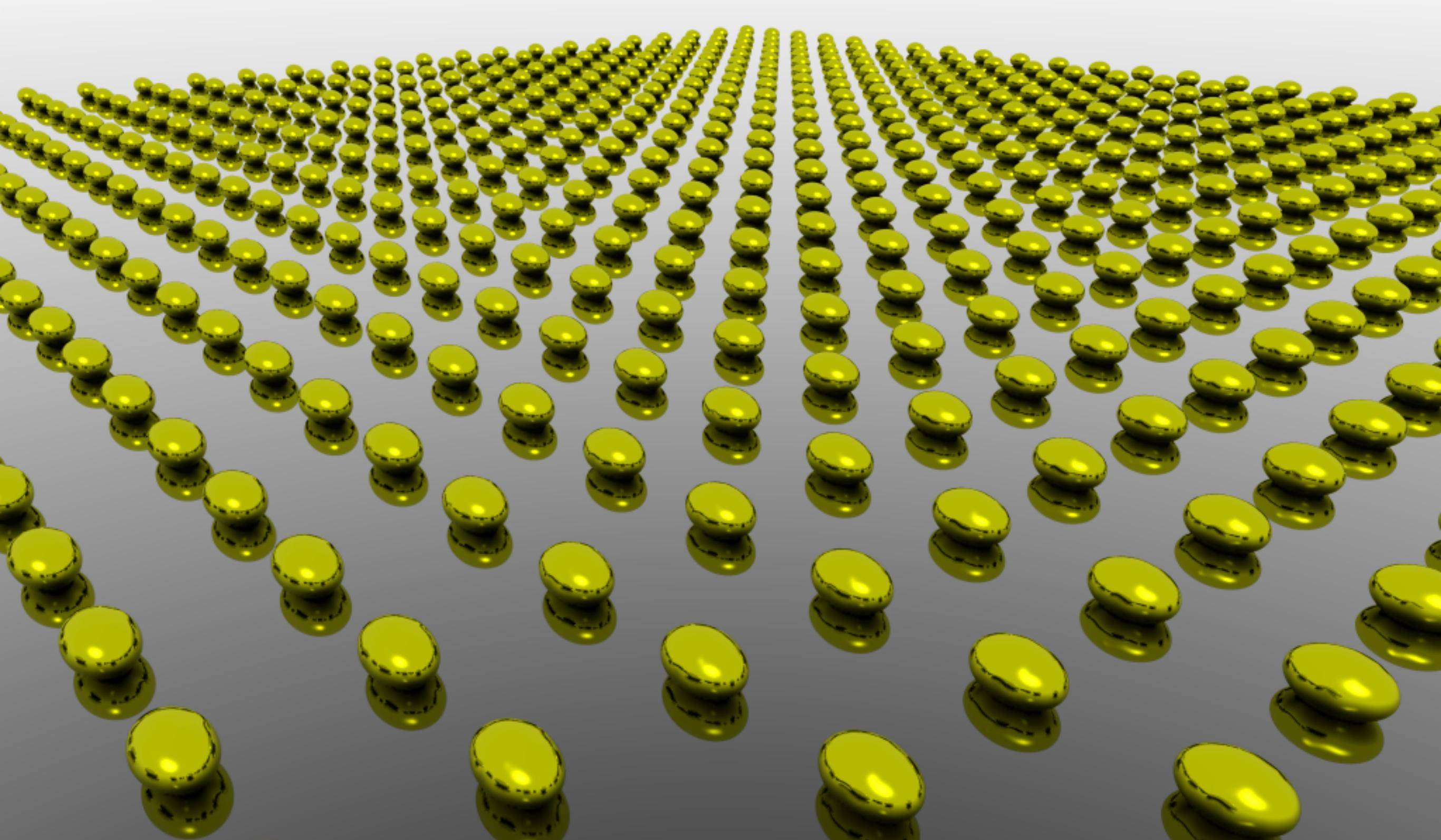


A dimer of nano-rods

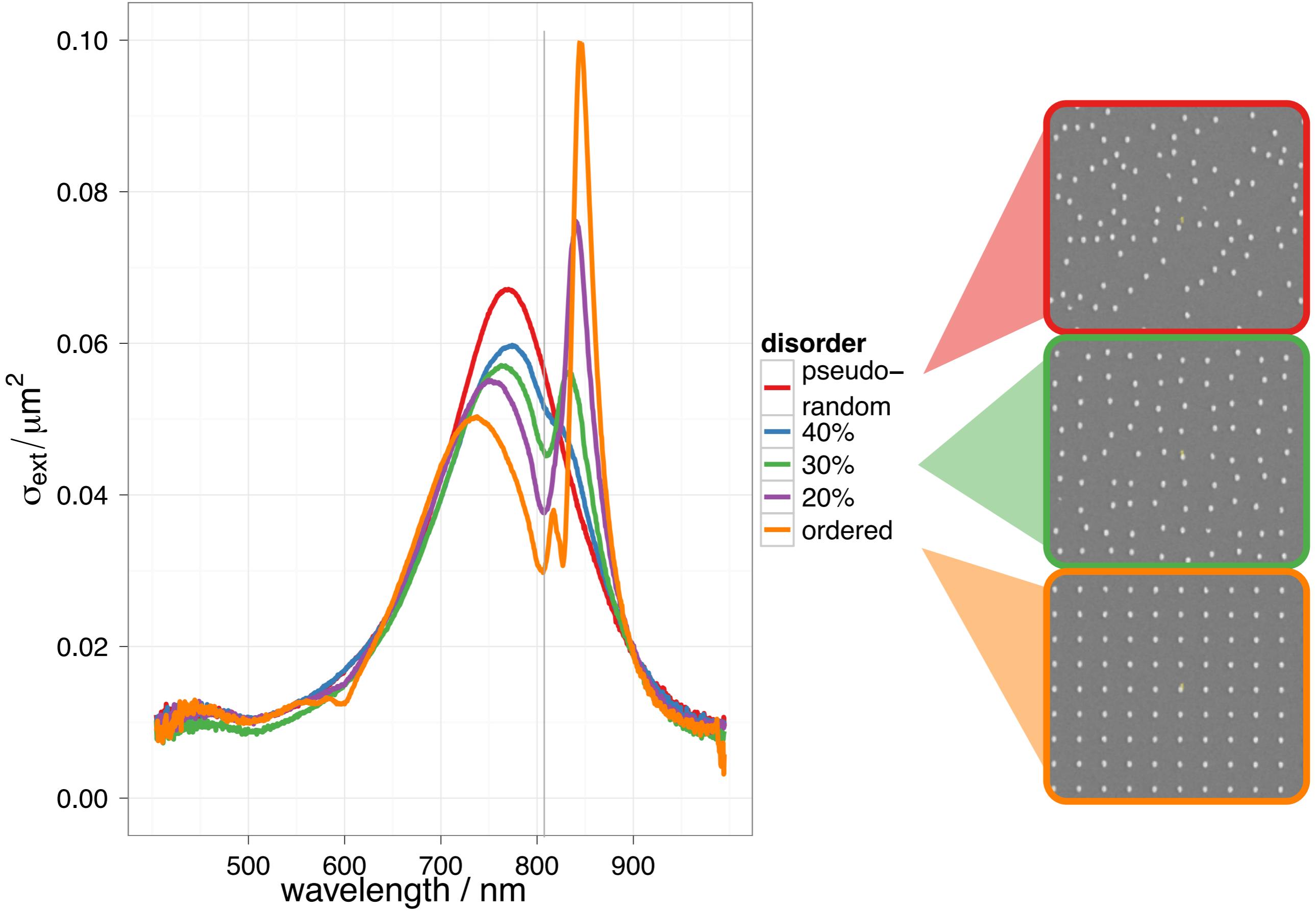




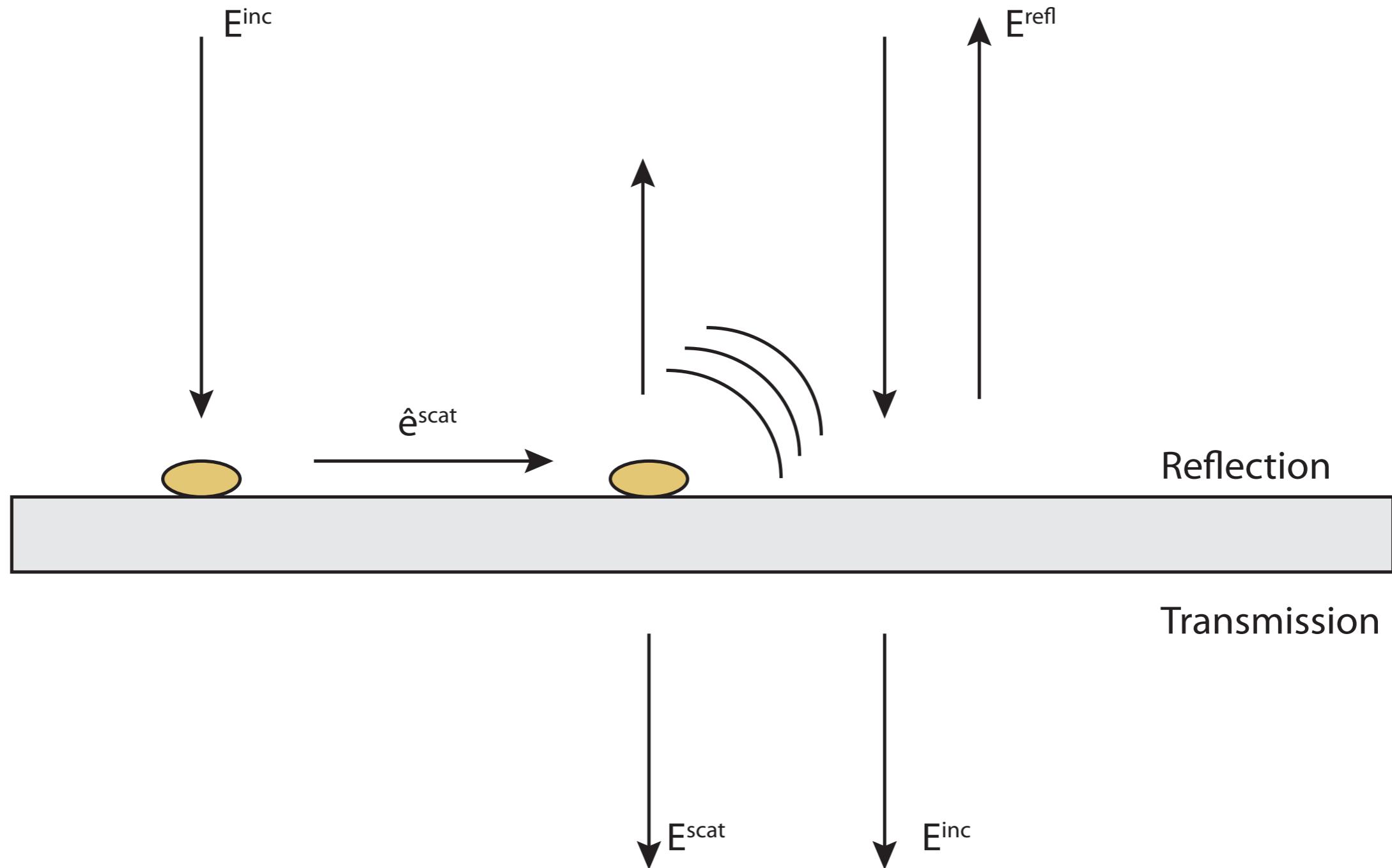
2D random



2D ordered:
Diffractive Coupling



Coherent multiple scattering = diffraction



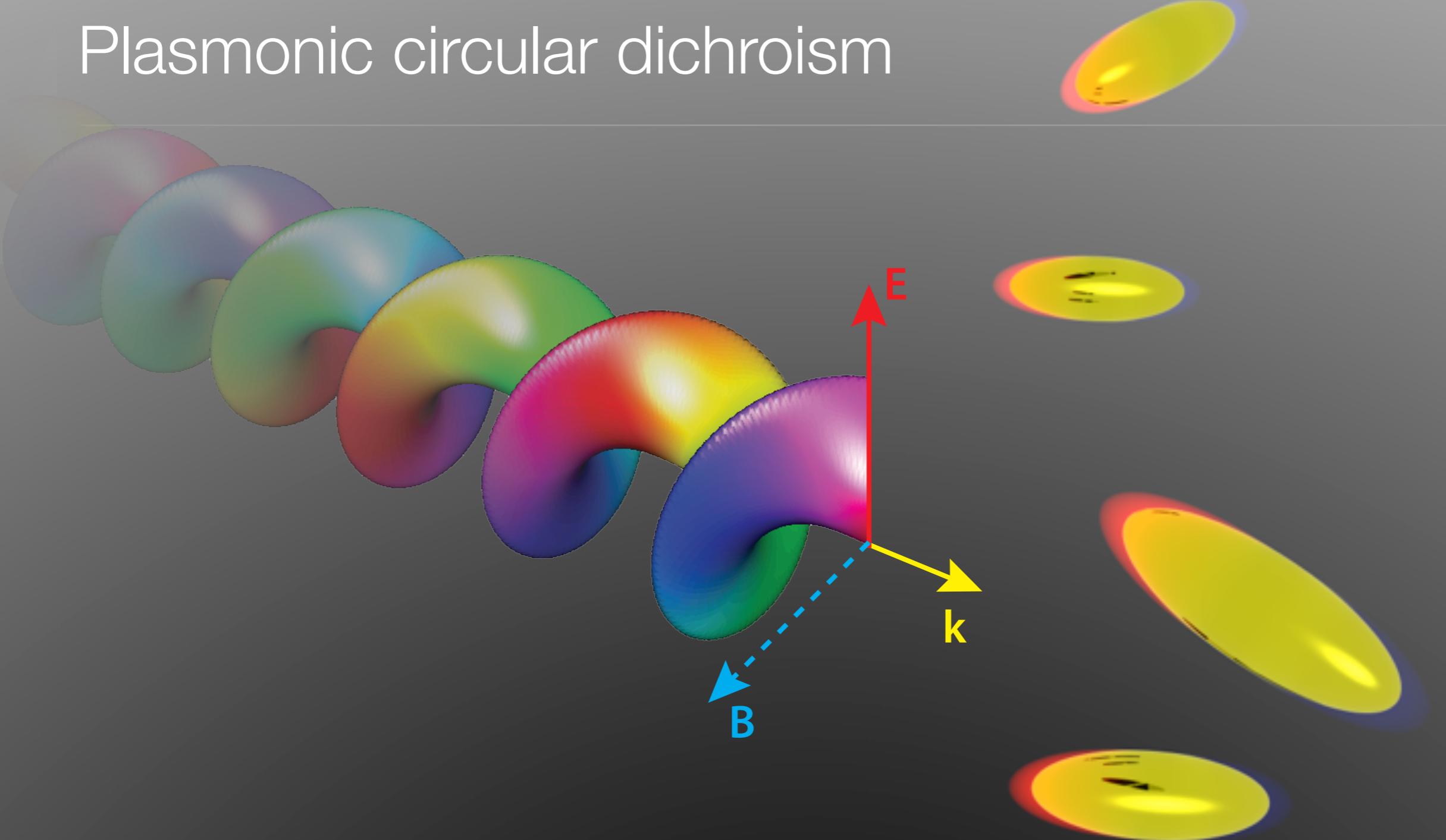


3D chiral structures
optical activity

3D chiral structures
optical activity



Plasmonic circular dichroism



chiral cluster

electromagnetic coupling

New surprises in EM!

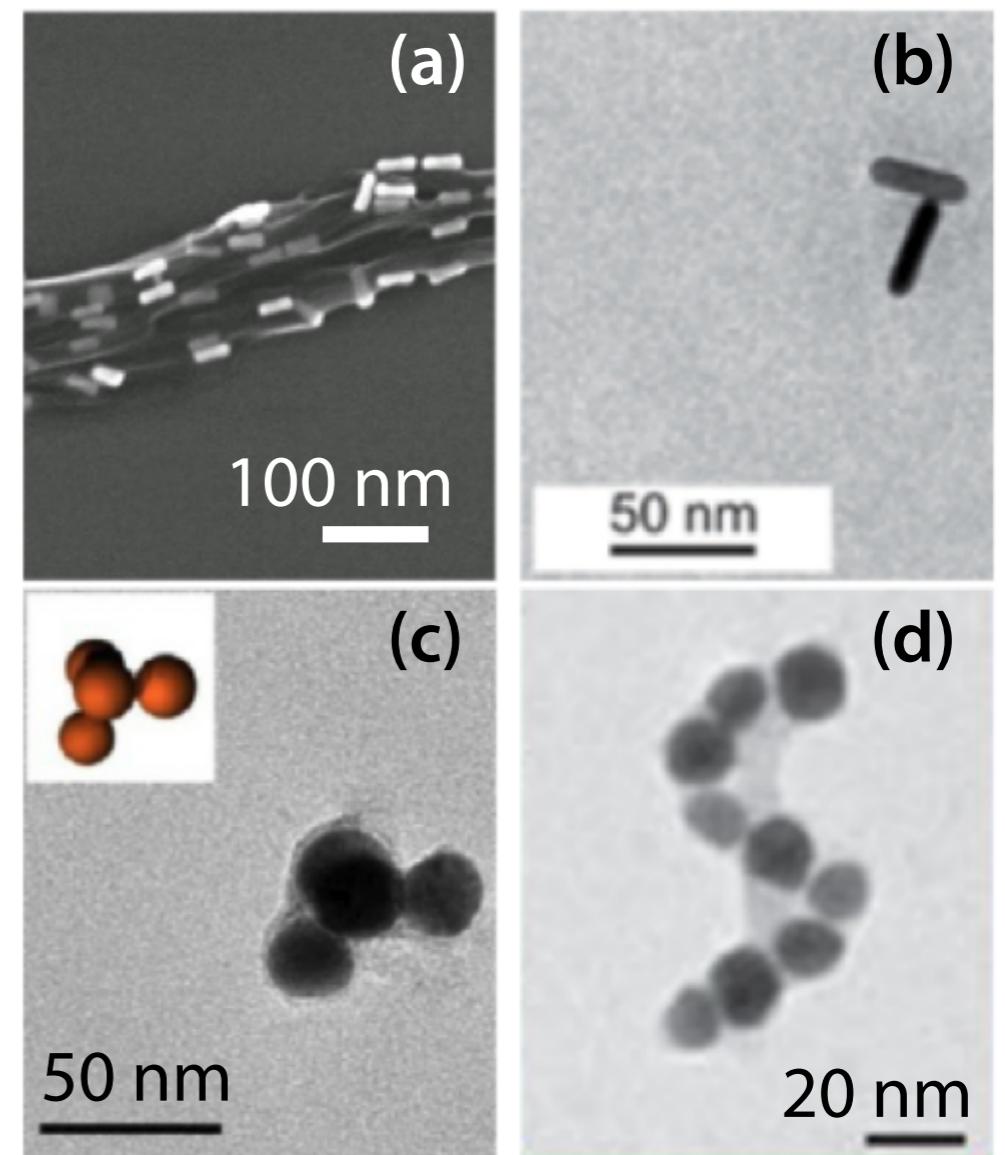
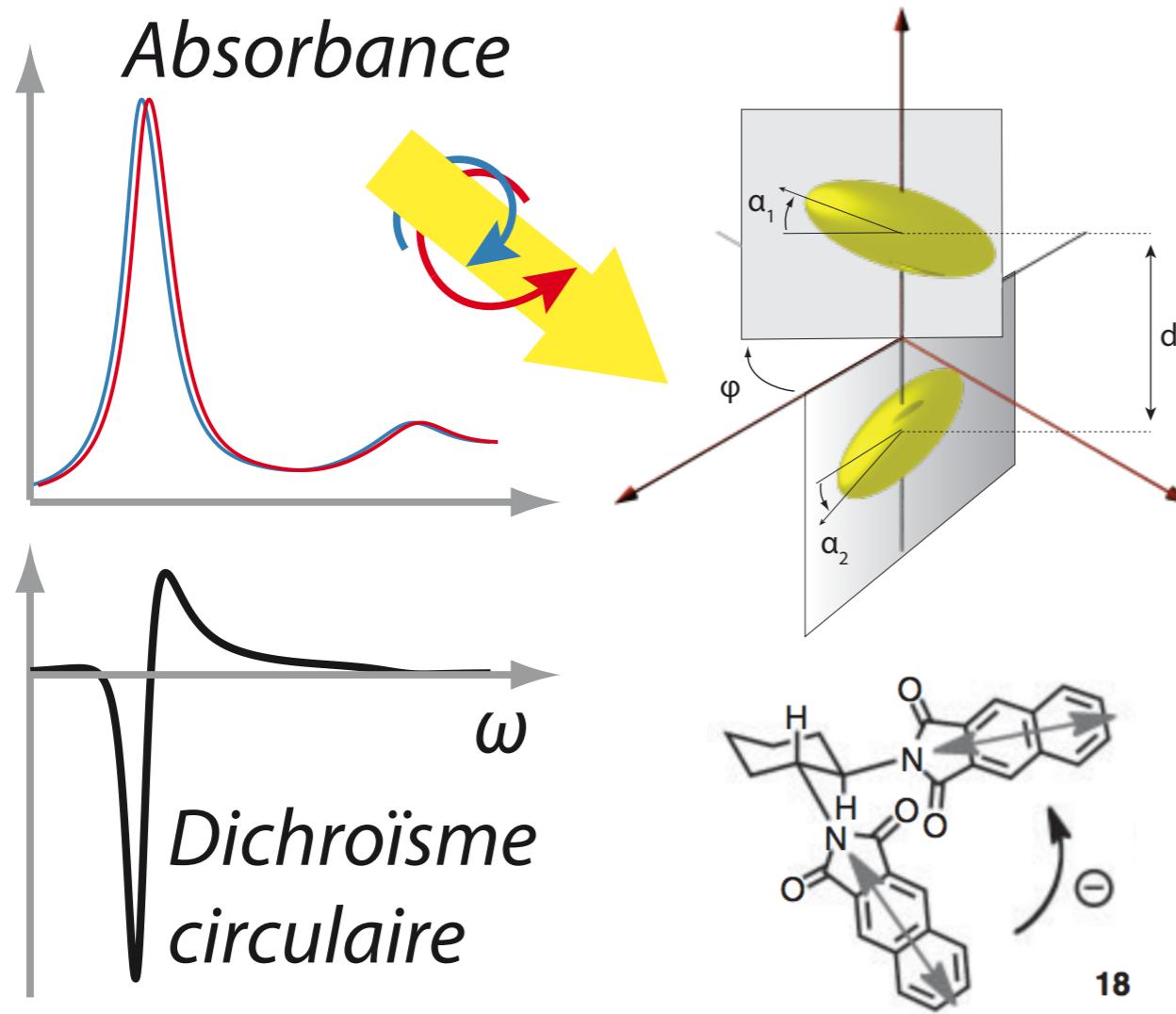
		Symmetry under mirror reflection	
		+	-
scalar	Energy	$U \equiv \frac{1}{2} \left\{ \epsilon_0 \mathbf{E} \cdot \mathbf{E} + \frac{1}{\mu_0} \mathbf{B} \cdot \mathbf{B} \right\}$	$C \equiv \frac{1}{2} \left\{ \epsilon_0 \mathbf{E} \cdot (\nabla \times \mathbf{E}) + \frac{1}{\mu_0} \mathbf{B} \cdot (\nabla \times \mathbf{B}) \right\}$
	Angular momentum	$\mathbf{J} \equiv \epsilon_0 \mathbf{r} \times (\mathbf{E} \times \mathbf{B})$	Linear momentum
		$\mathbf{p} \equiv \epsilon_0 \mathbf{E} \times \mathbf{B}$	+ Symmetry under time reversal

Cohen Lab – *Superchiral light*

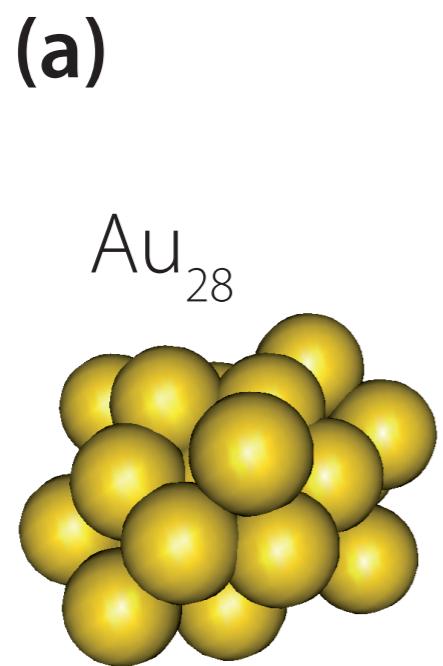
Science, 332, 333, 2011, PRL, 104, 163901, 2010, ...

<http://cohenweb.rc.fas.harvard.edu/>

Circular dichroism, ou *dichroïsme circulaire*

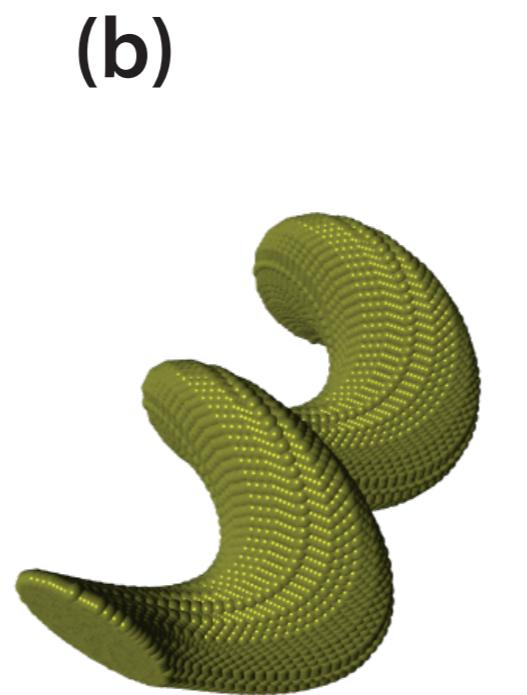


Coupled dipoles at all scales



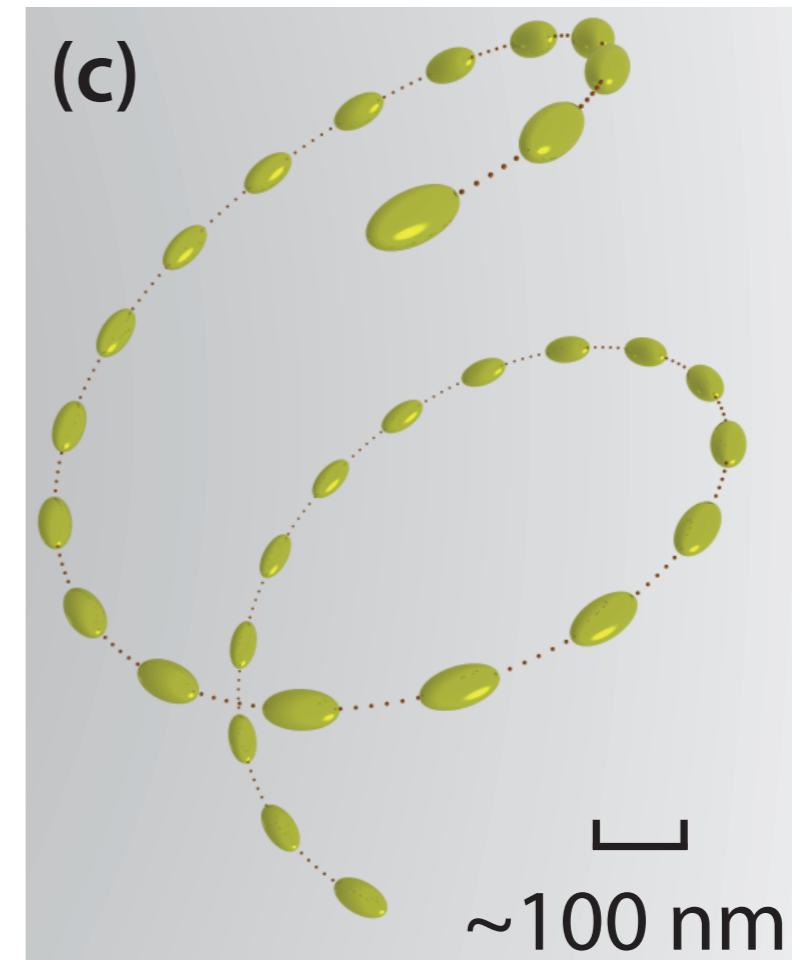
◻
~1 nm

Atomic cluster
Absorption bands



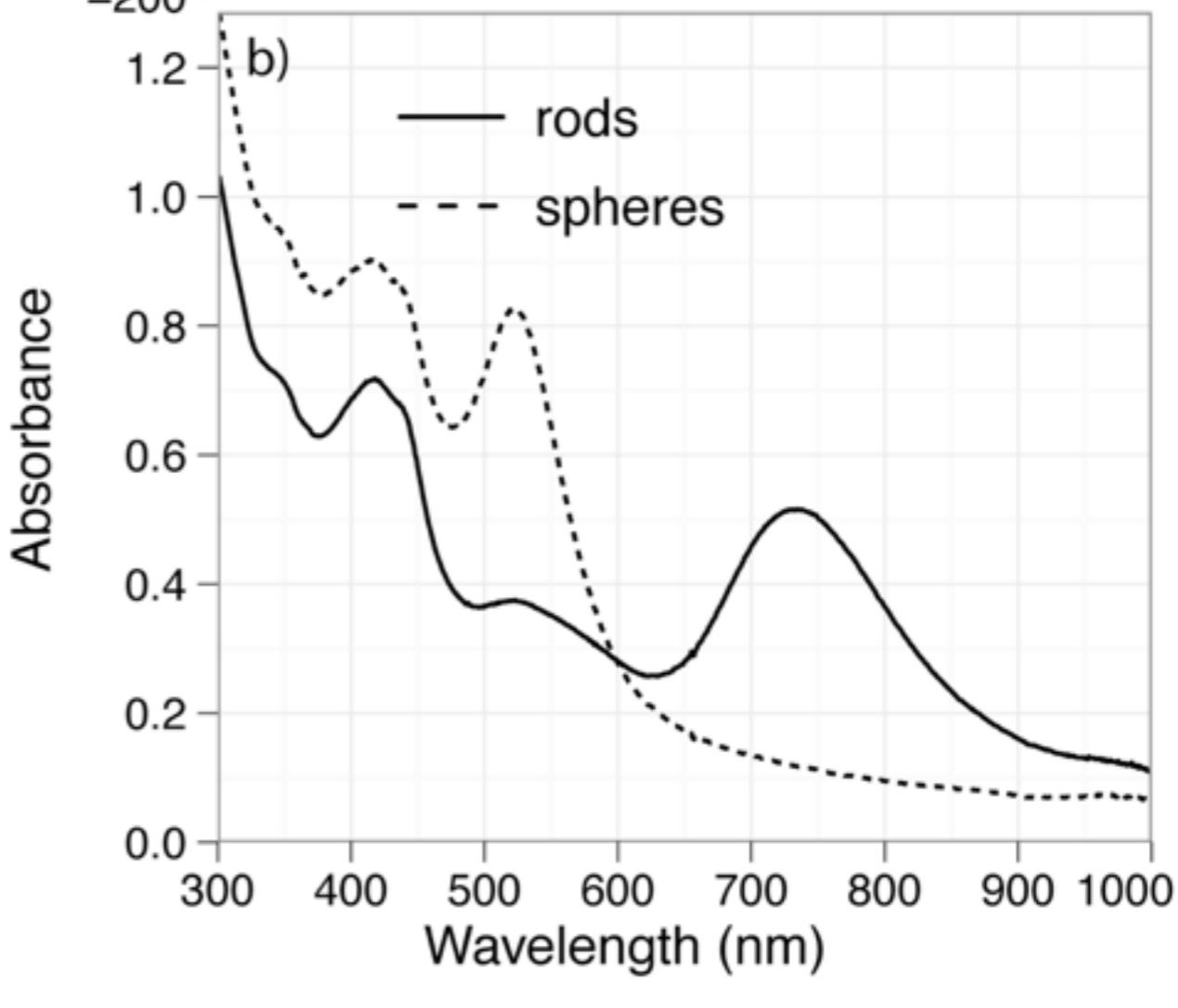
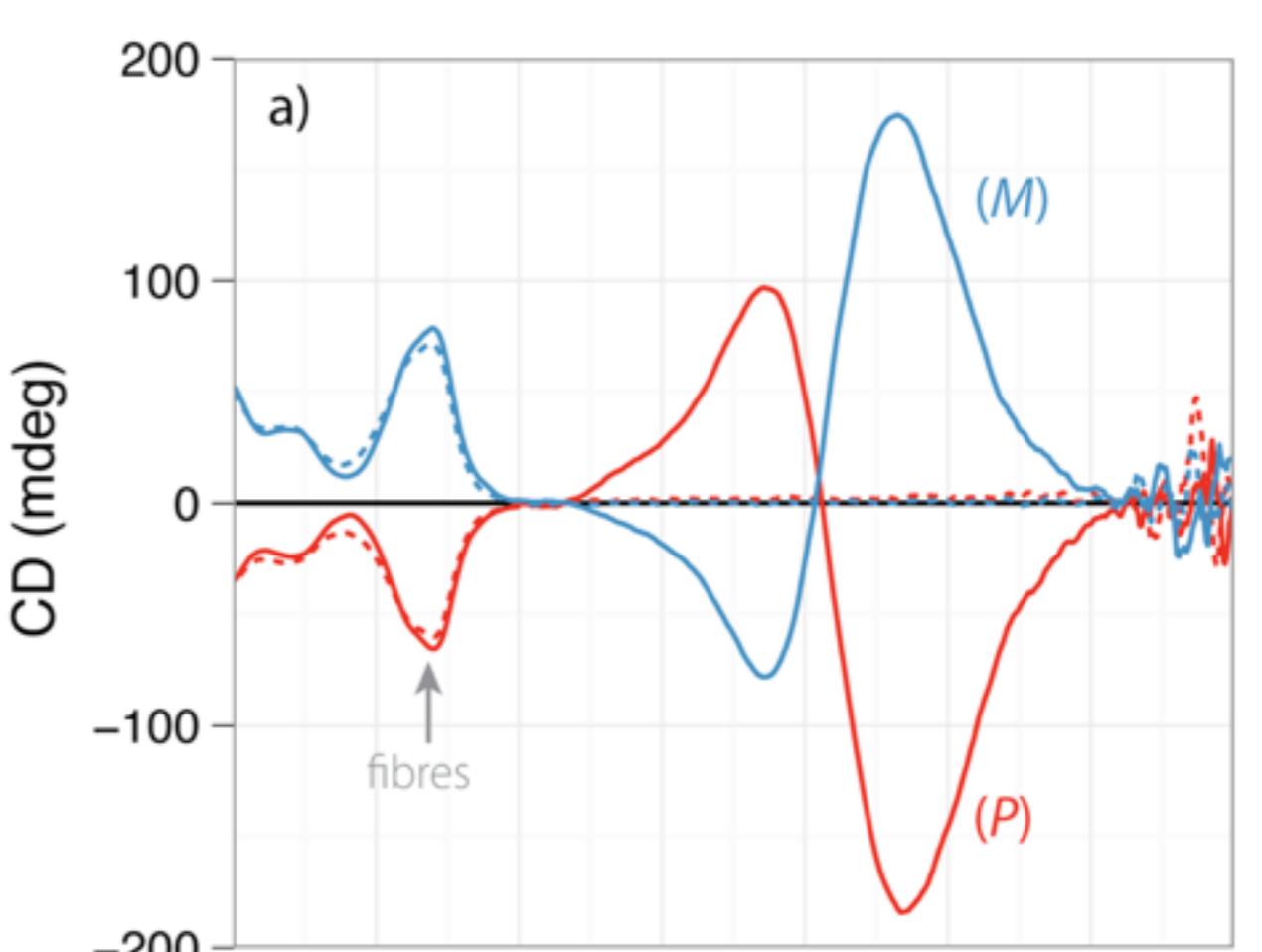
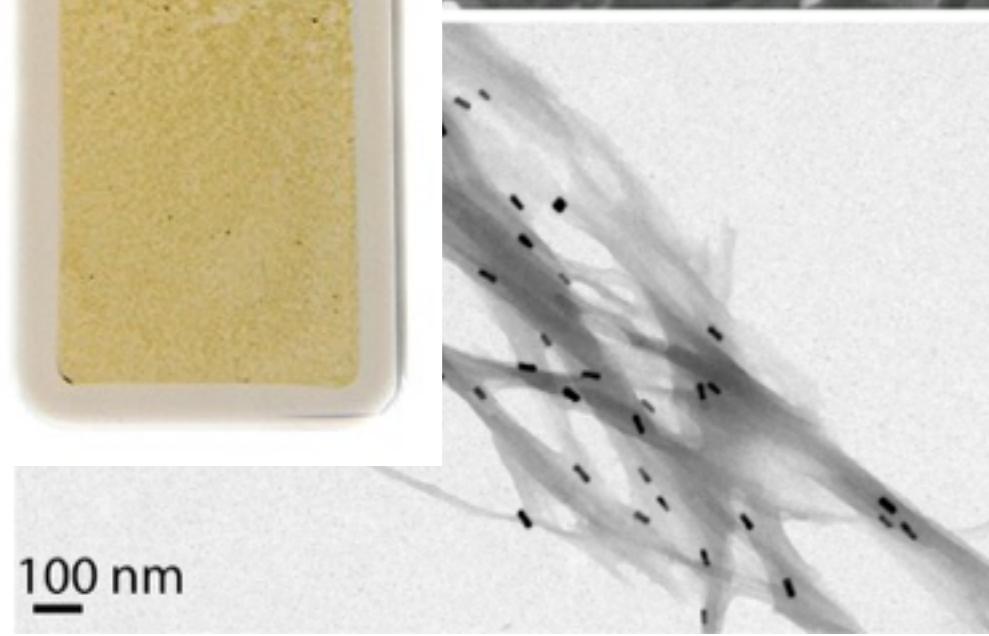
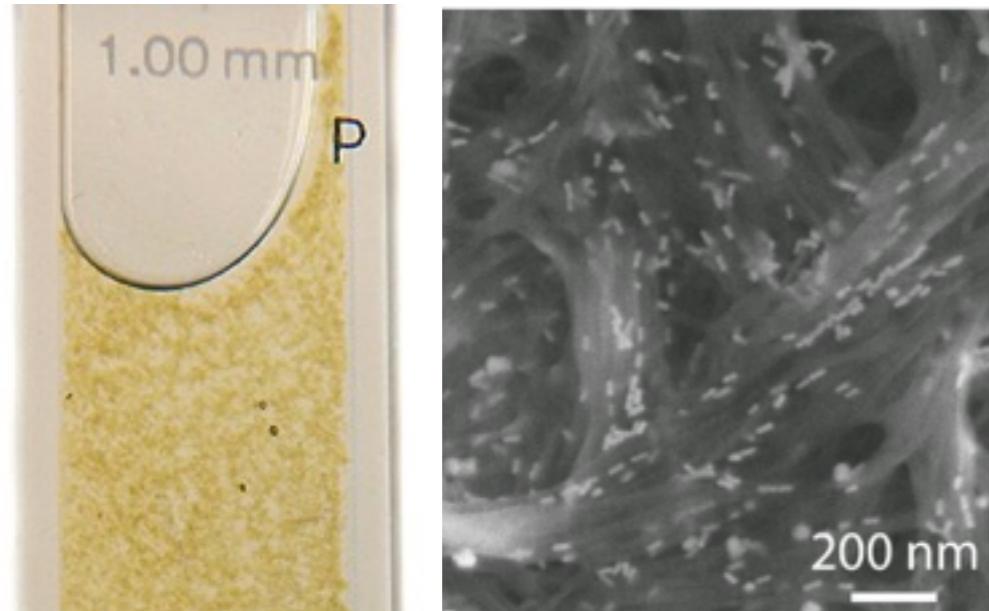
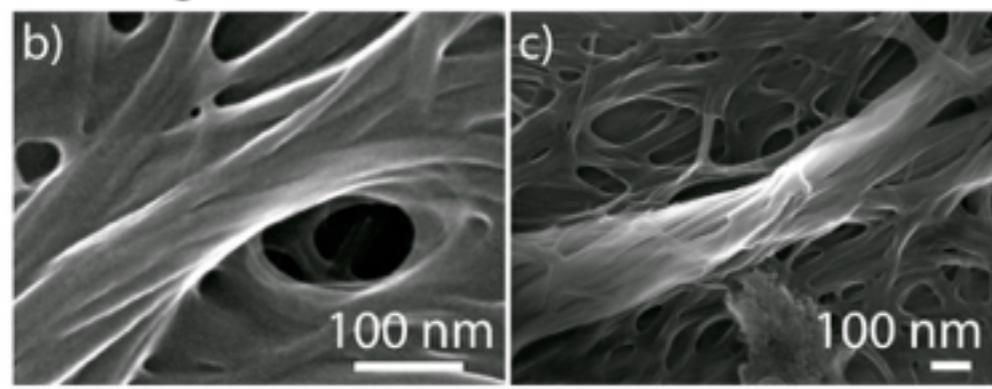
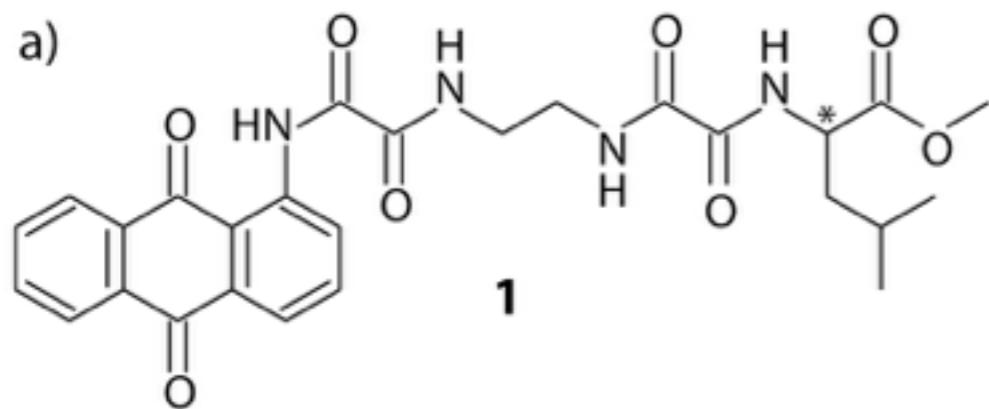
◻
~10 nm

Nanoparticle
Plasmonic response

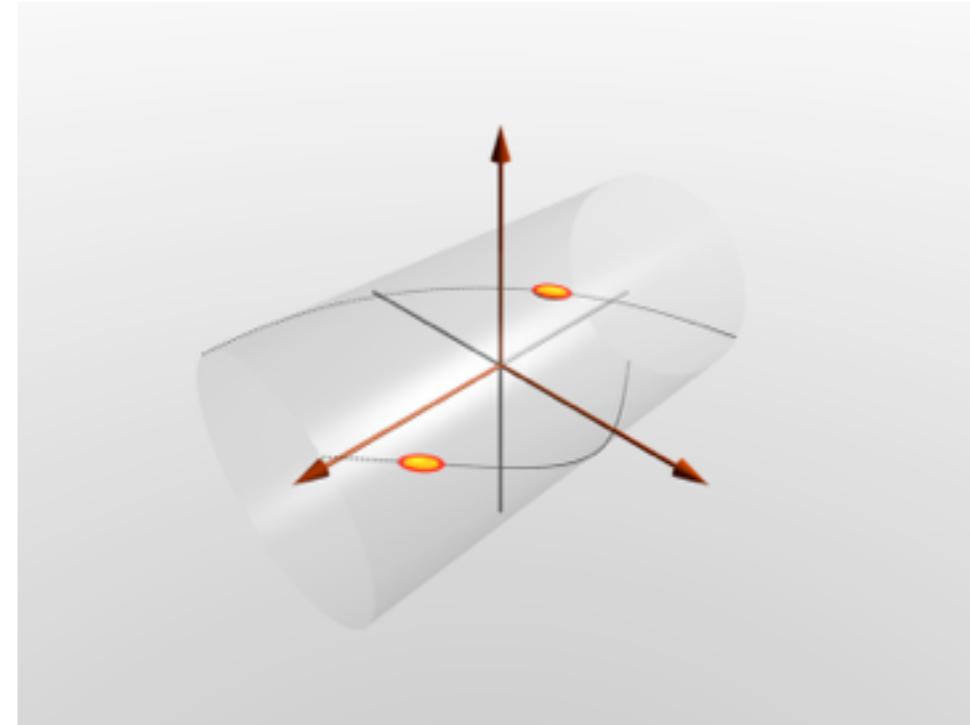
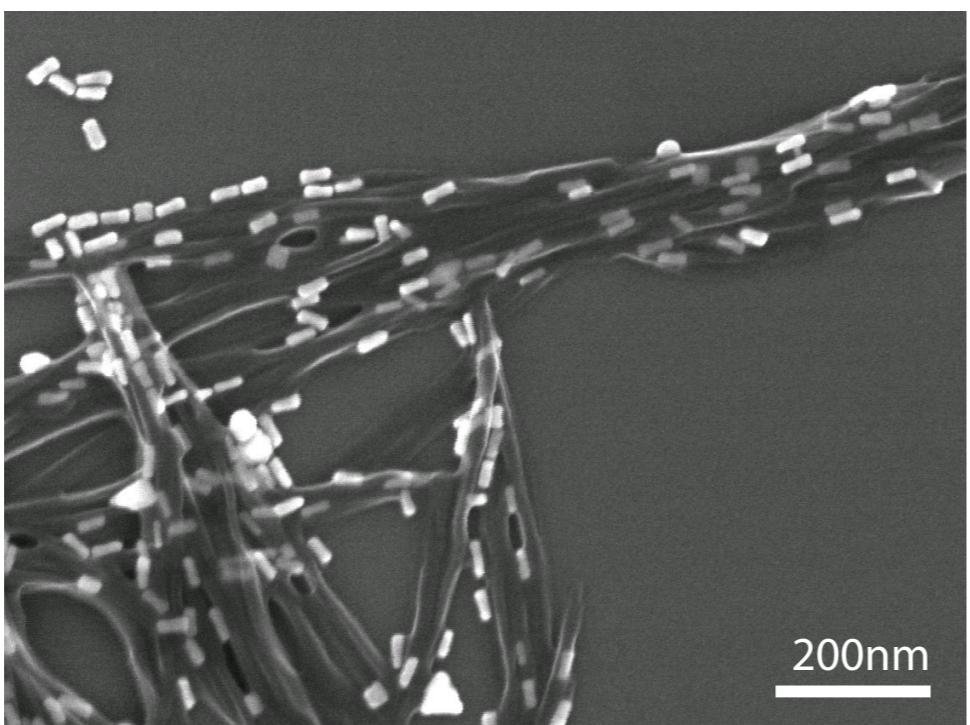
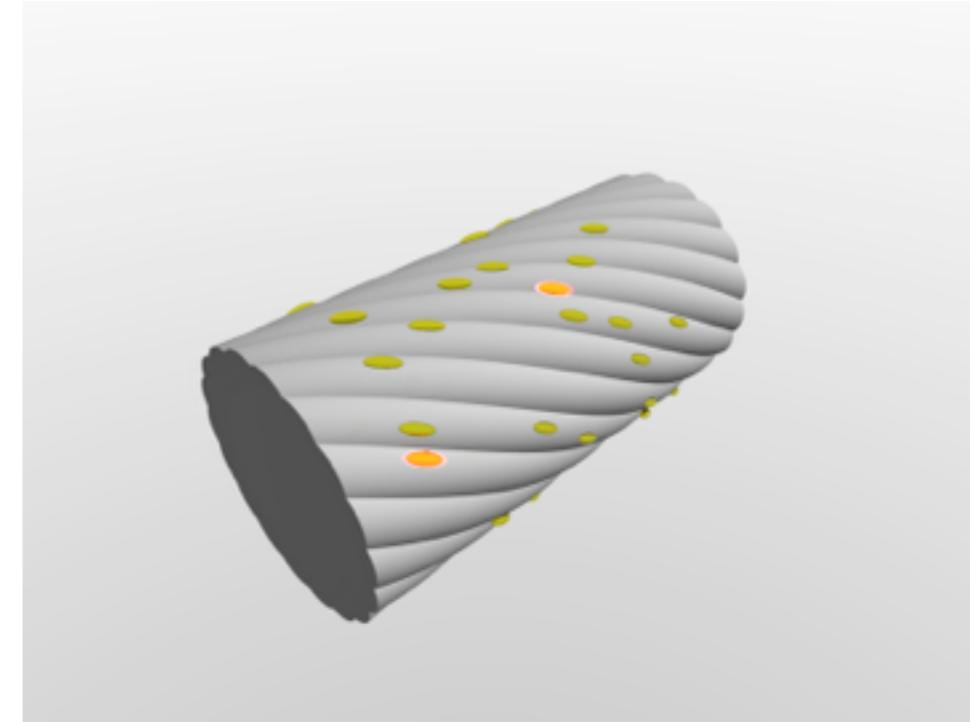
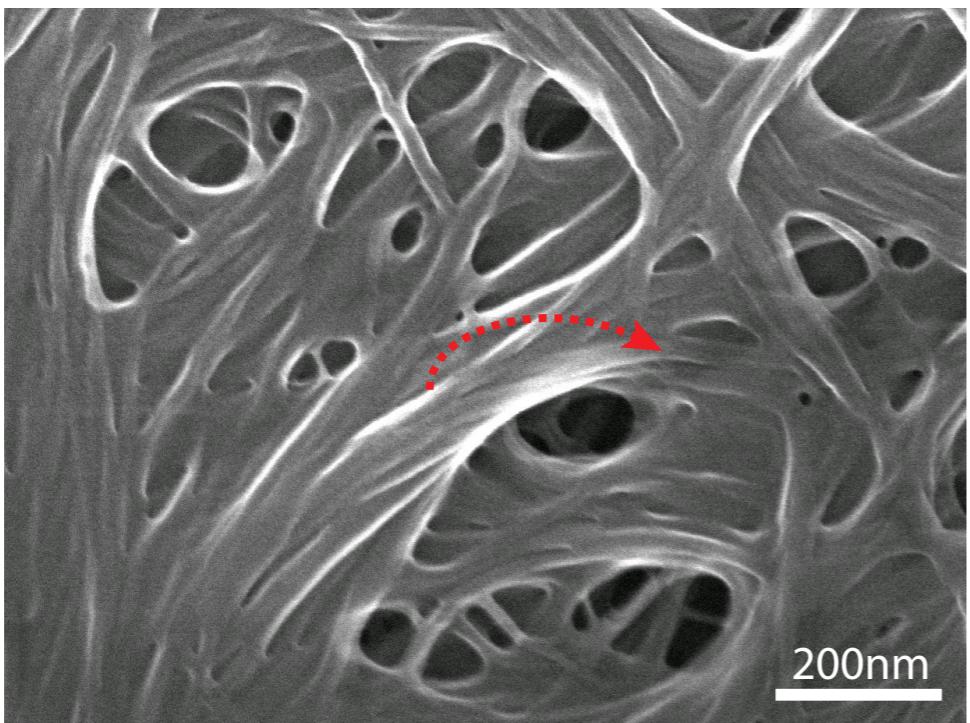


◻
~100 nm

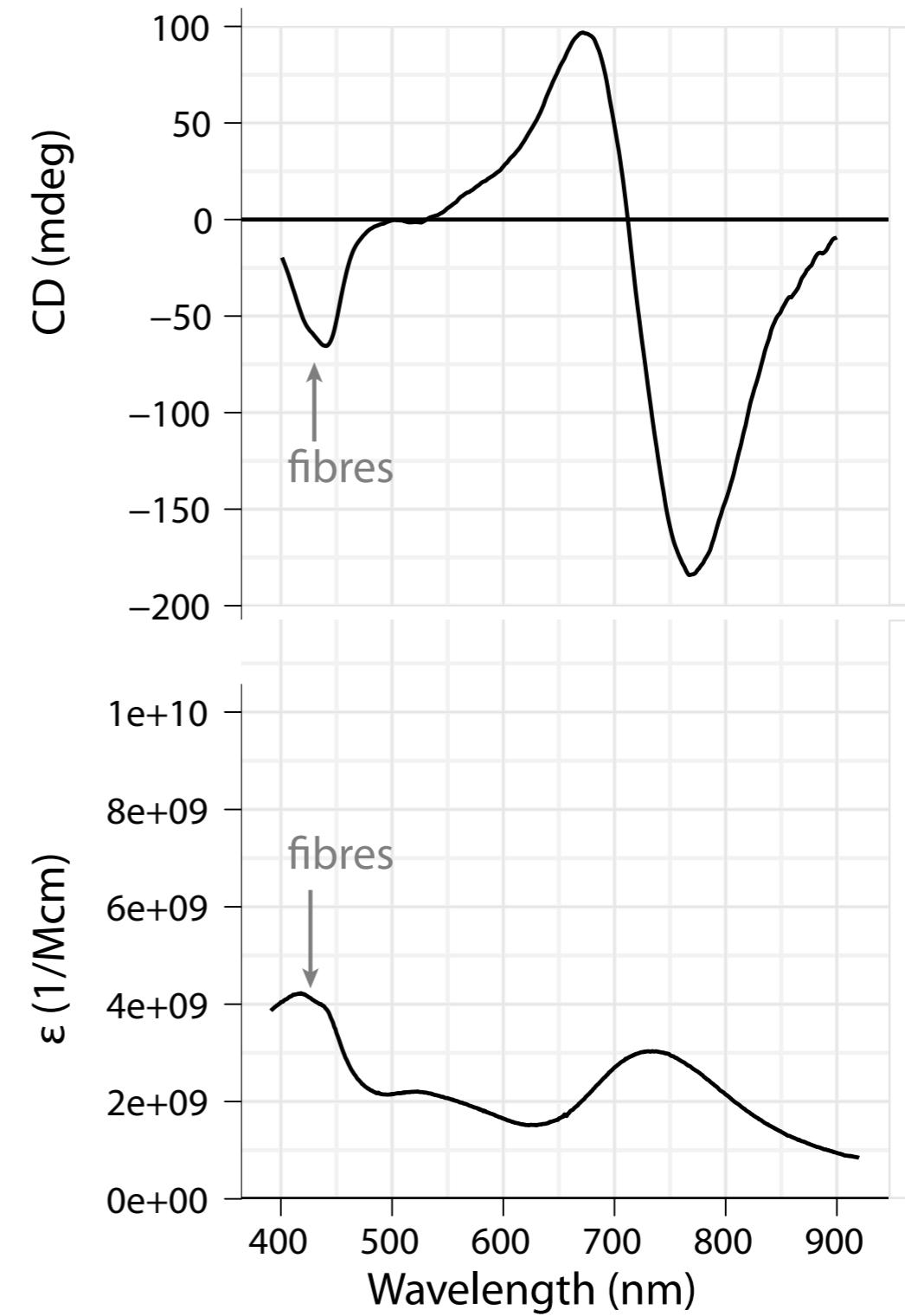
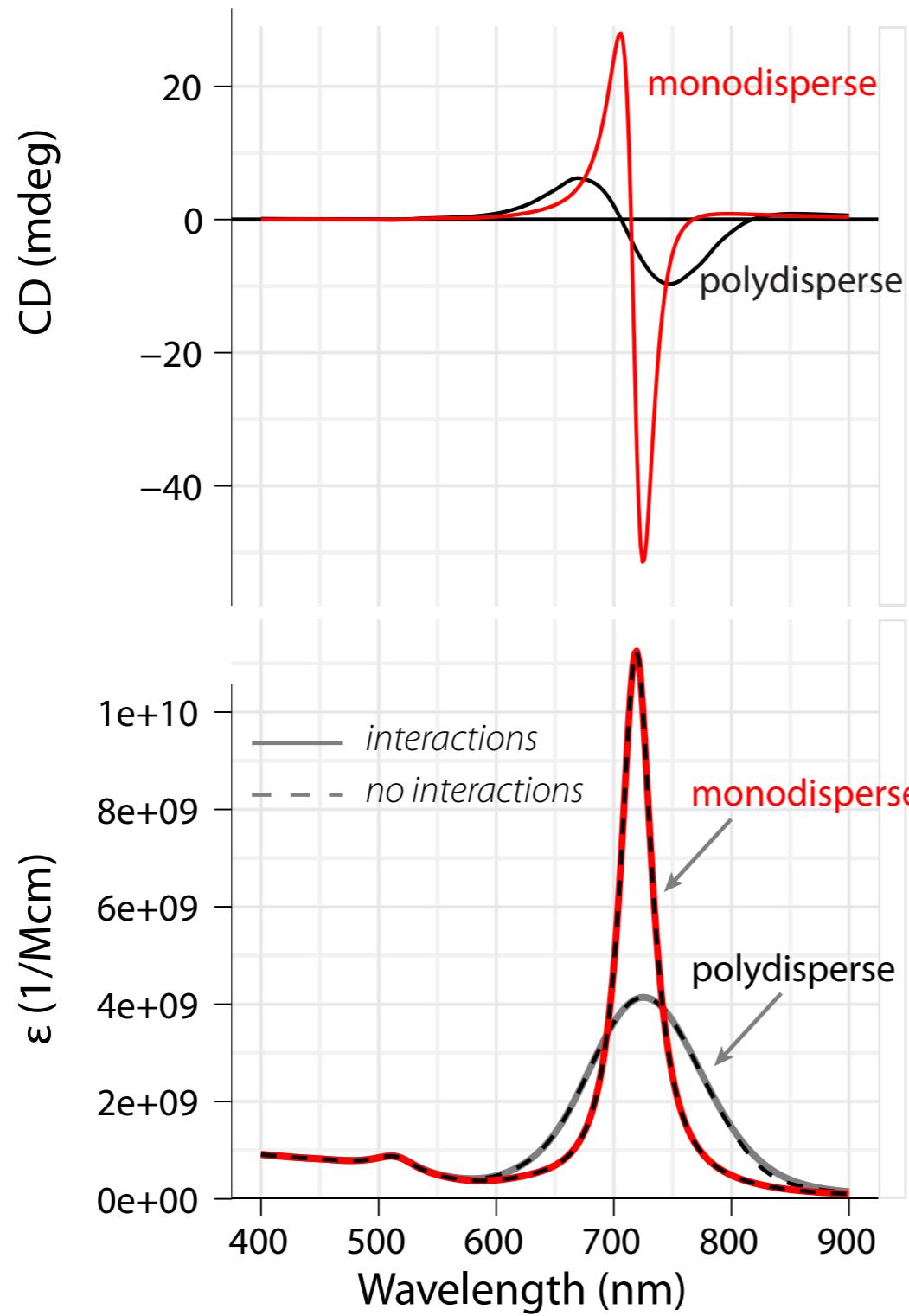
Collection of NPs
Plasmon hybridisation

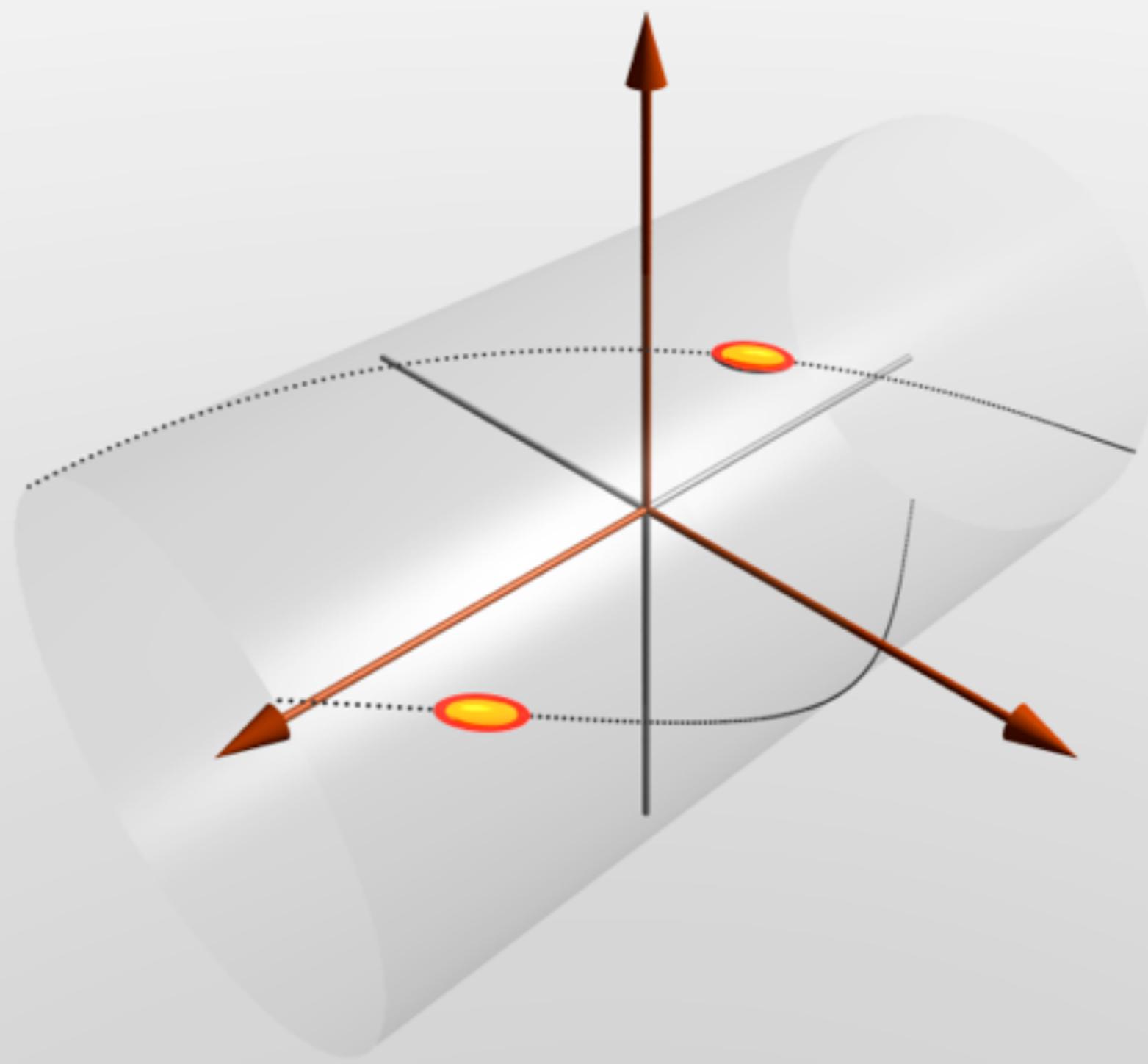


Minimal model – distribution of chiral dimers

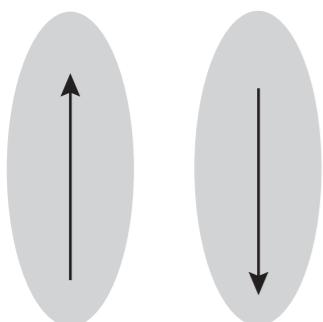


Results

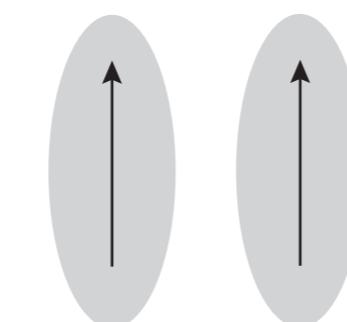




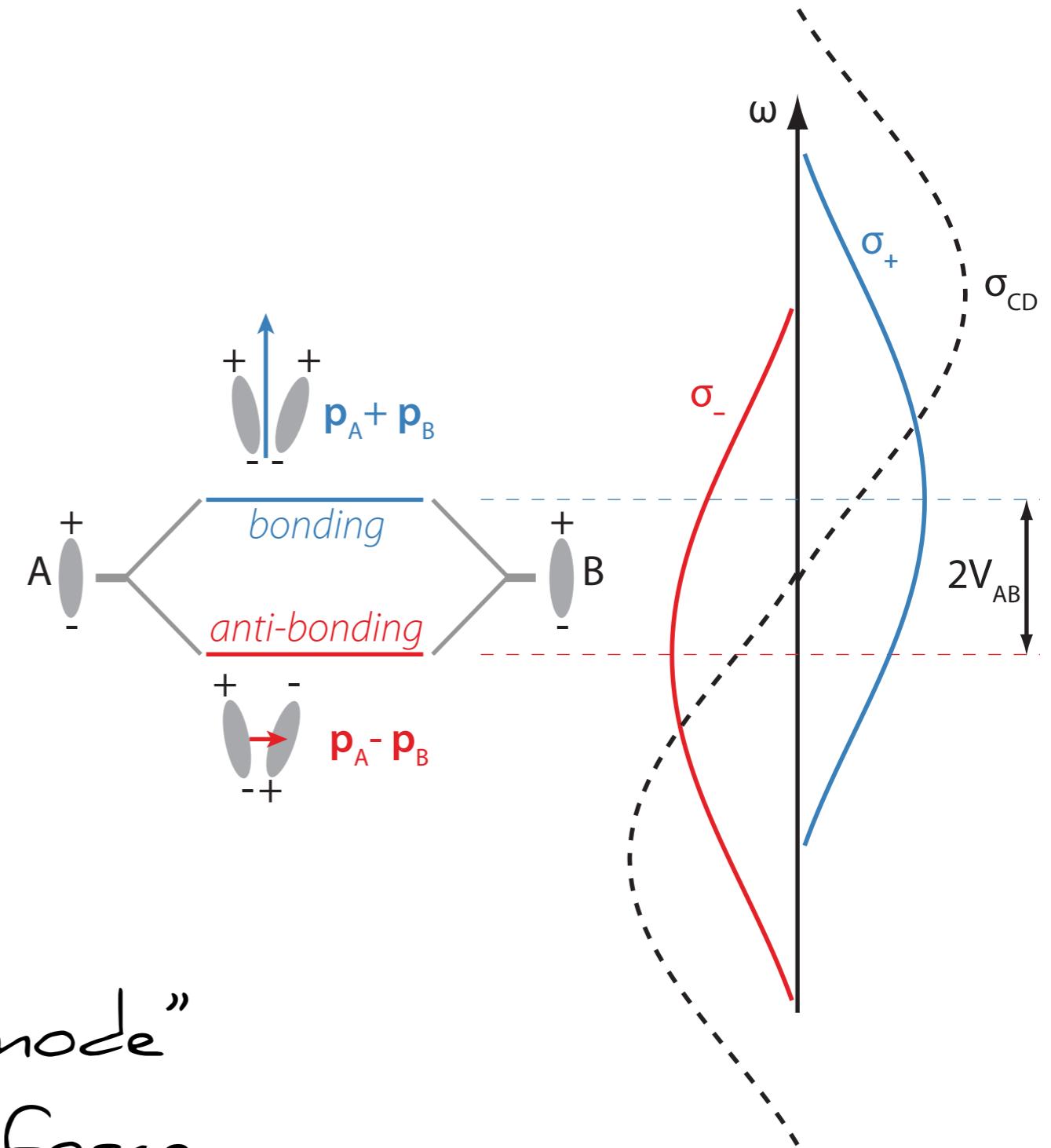
Chiral plasmon hybridisation – exciton coupling



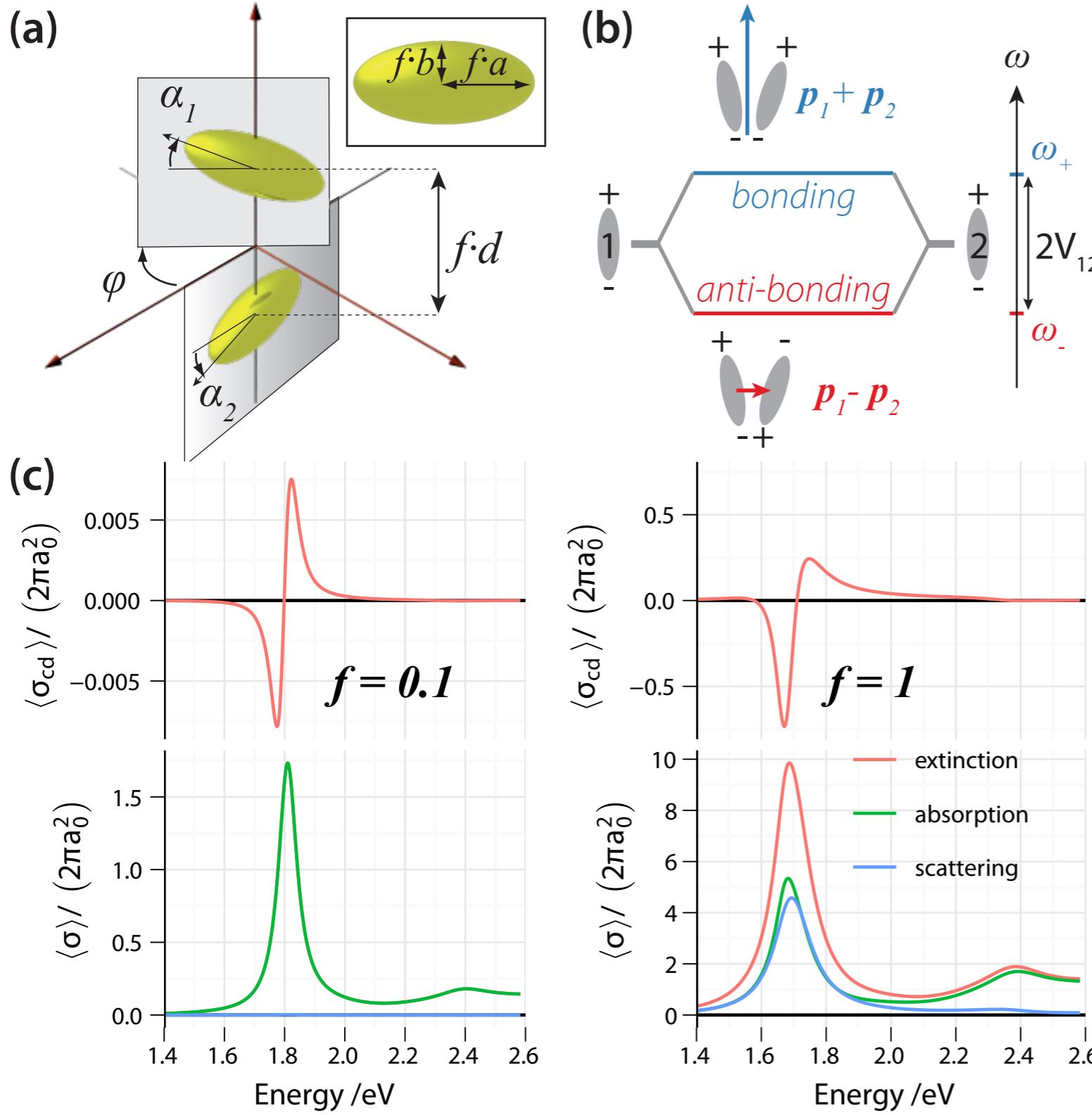
“Dark node”
Negative force



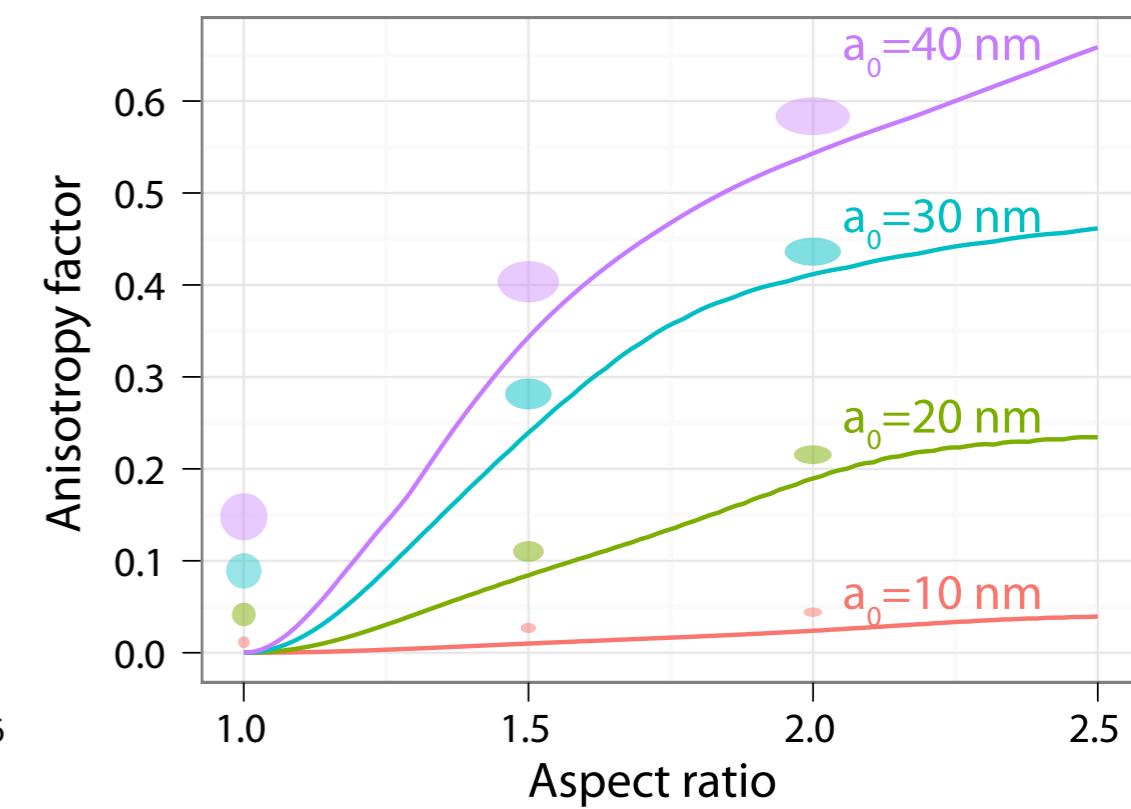
“Bright node”
Positive force



Fingers crossed: a plasmonic chiral dimer



New effects
with plasmonics!



Helix of nanoparticles

