
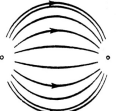
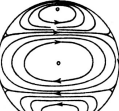
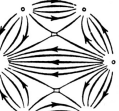


Mie scattering – partial waves

Multipole excitations. Resonances are at $\epsilon_1(\omega) = -\epsilon_2 \cdot \frac{l+1}{l}$; $l = 1, 2, 3, \dots$

First electric partial wave

Second electric partial wave


Third electric partial wave

Fourth electric partial wave

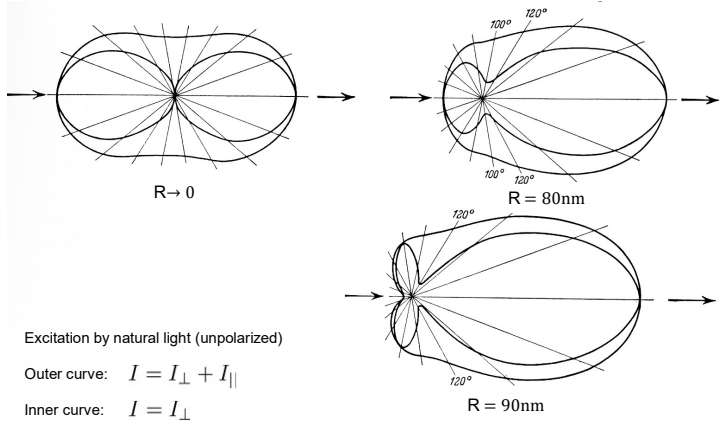
(a) Magnetic lines of force (b) Electric lines of force (a) Magnetic lines of force (b) Electric lines of force

Nanooptics 7/1

Born & Wolf, Principles of Optics



Radiation Pattern of a Au particle




Excitation by natural light (unpolarized)

Outer curve: $I = I_{\perp} + I_{\parallel}$

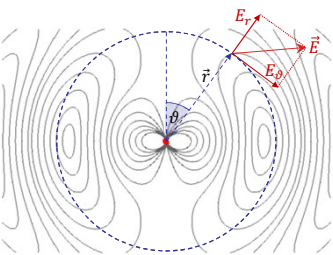
Inner curve: $I = I_{\perp}$

Nanooptics 7/2

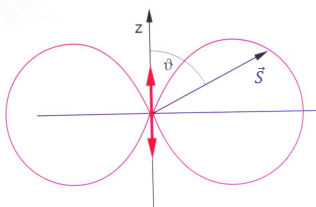
Born, Optik




Electric field



Emission to far-field (polar diagram)



Nanooptics 7/3



Far- and Near-Field of a Point Dipole

Dipole moment

$$p(t) = p_0 \cos(\omega t)$$

creates time-dependent electric field (spherical coordinates!)

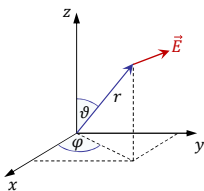
Far-field

Near-field

$$\vec{E}(r, \vartheta, \varphi, t) = \begin{pmatrix} E_r \\ E_{\vartheta} \\ E_{\varphi} \end{pmatrix} = \frac{p_0 k^3}{4\pi\epsilon_0} \begin{pmatrix} \left(\frac{2i}{(kr)^2} + \frac{2}{(kr)^3} \right) \cos \vartheta \\ \left(-\frac{1}{kr} - \frac{i}{(kr)^2} + \frac{1}{(kr)^3} \right) \sin \vartheta \\ 0 \end{pmatrix} \cos(kr - \omega t)$$

Emission to far-field

$$\langle |\vec{S}| \rangle = \frac{\omega^4 p_0^2}{32\pi^2 \epsilon_0 c^3} \frac{\sin^2 \vartheta}{r^2}$$



Nanooptics 7/4

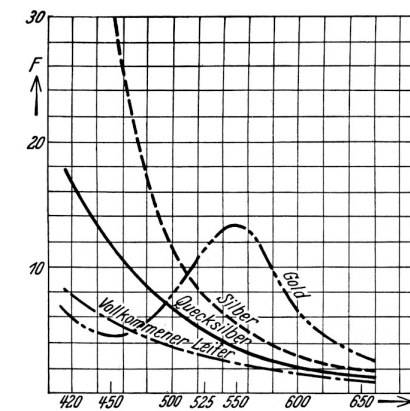
Near-fields

Comparison of far- and near-fields:

$$\left| \frac{E_{\text{Nearfield}}}{E_{\text{Farfield}}} \right|^2 \sim \left| \frac{kr}{(kr)^3} \right|^2 \sim \frac{1}{(kr)^4} \sim \left(\frac{\lambda}{r} \right)^4$$

The intensity in the near-field ($kr \ll 1 \Rightarrow r \ll \lambda$) of an antenna (or, e.g., a molecule) is very large as compared to the far-field!

Total scattering cross section



Translation

Gold = Gold

Silber = Silver

Quecksilber = Mercury

Vollkommener Leiter =
Ideal Conductor



Glasfenster in der
Evang. Peter und
Paul-Kirche Leinfelden