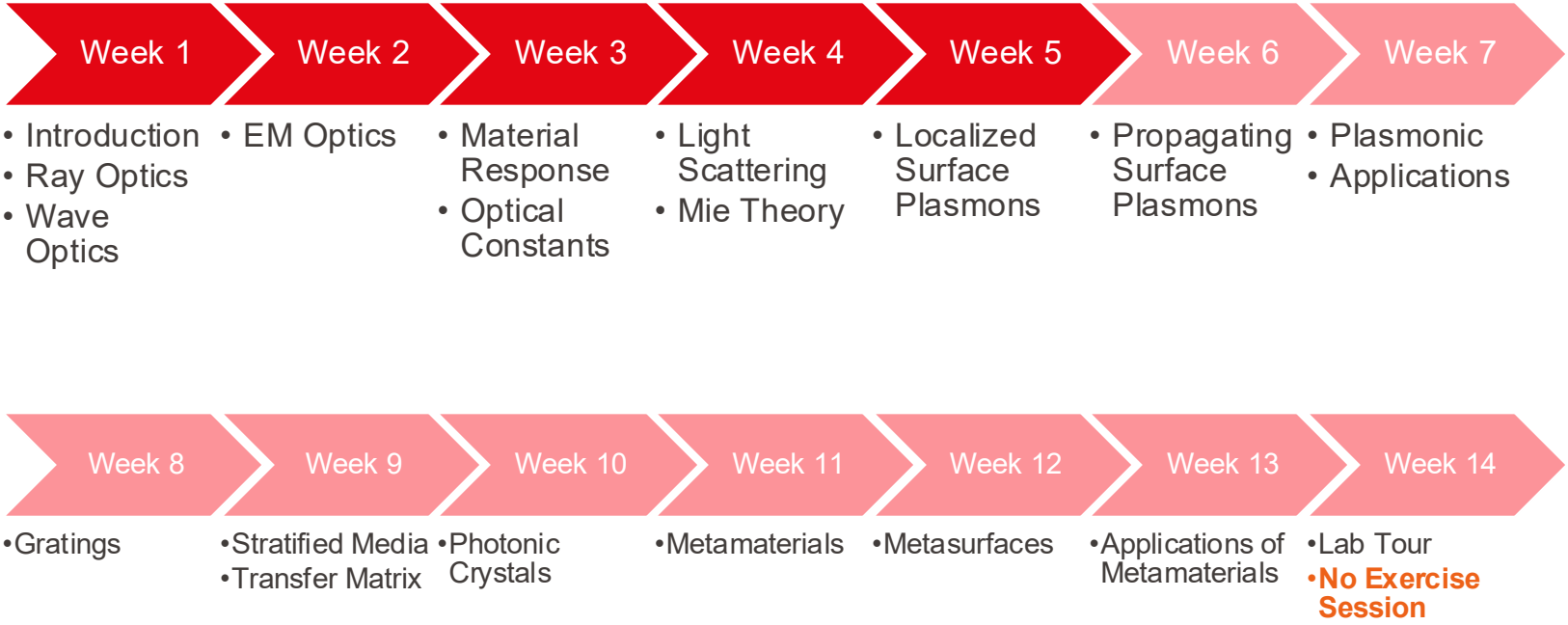
Week 5

(Localized Surface Plasmons)

Stavros Athanasiou

Lausanne, 07 Oct 2025

Course Timeline



Last Week : Light Scattering

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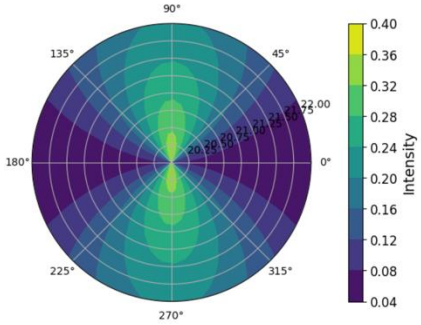
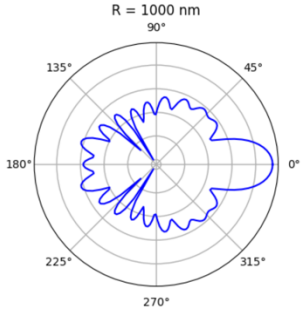
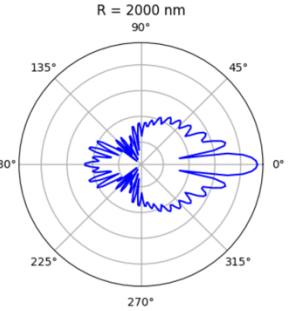
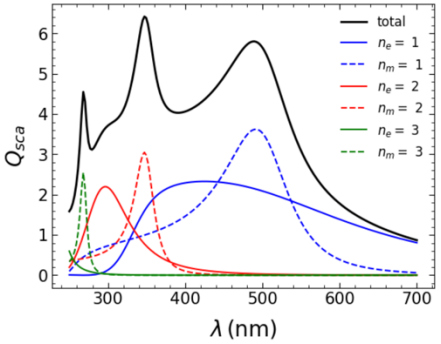
1. The near- and far- fields
2. Modes of the Radiation Pattern
3. The Response of Dielectric Particles and Multipole Analysis
4. The Response of Metal Particles



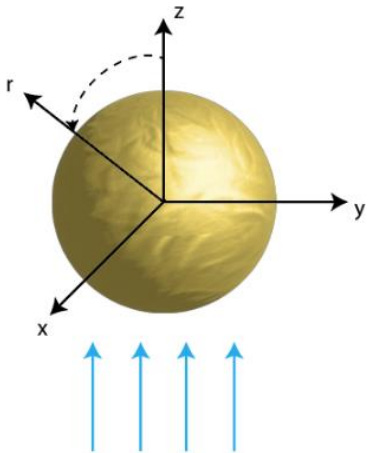




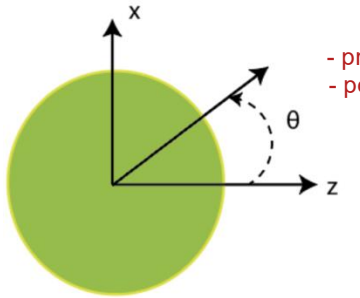


What have we learned?

1. Use Mie theory to study light scattering from spherical particle
2. Far-field pattern can be influenced from size and dielectric functions of the particle and medium
3. Scattering spectrum : electromagnetic response of the spherical scatterer → multipole analysis



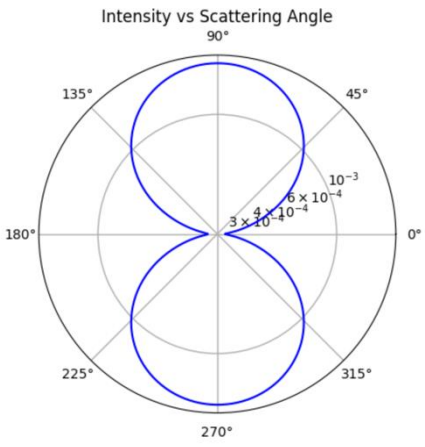
Near-field vs Far-field



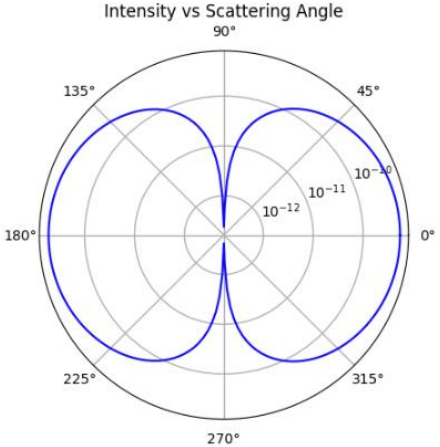
Incident wave :
- propagation along z
- polarization along x

$r \ll \lambda$

$r \gg \lambda$



Near field



Far field

This Week: Localized Surface Plasmons / 1

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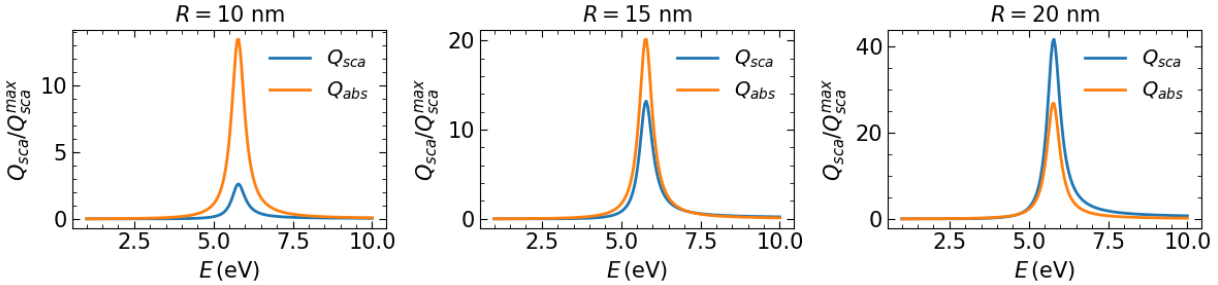
- Scattering from Small Particles and the Drude Model

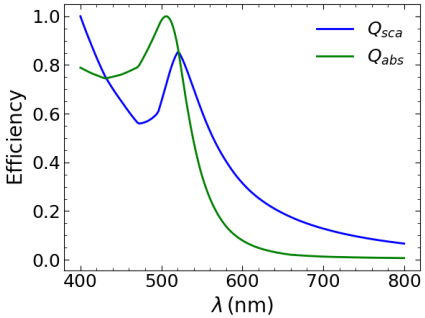
$$Q_{sca}(\omega) = \frac{8}{3}x^4\left|\frac{\varepsilon_r(\omega)-\varepsilon_b}{\varepsilon_r(\omega)+2\varepsilon_b}\right|^2 \qquad \tilde{\omega}_{sp} = \frac{\omega_p}{\sqrt{1+2\varepsilon_b}}\sqrt{1-\frac{(2\varepsilon_b+1)\gamma^2}{4\omega_p^2}} - i\frac{\gamma}{2}.$$

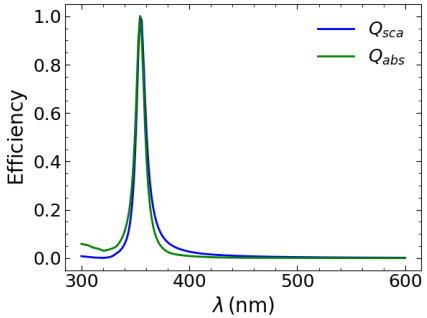
- Comparing Scattering and Absorption in Small Particles



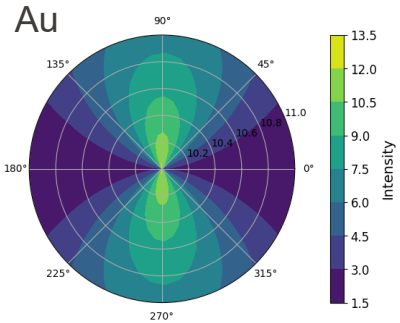
This Week: Localized Surface Plasmons / 2

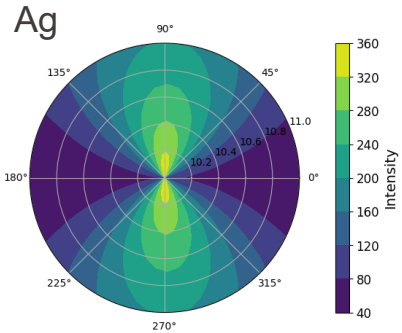
- Small Gold and Silver Particles





- Near-Field Enhancement of Metallic Particles

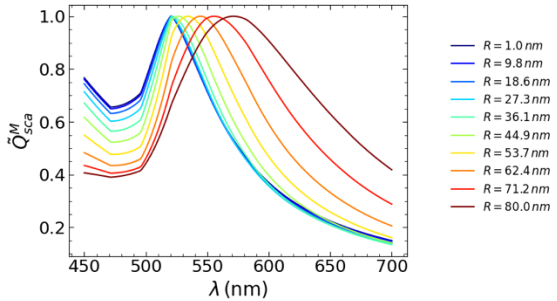




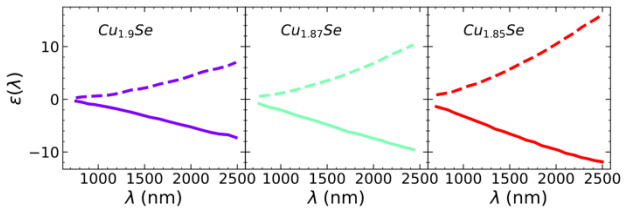
This Week: Localized Surface Plasmons / 3

- Breakdown of the Small-Particle Approximation

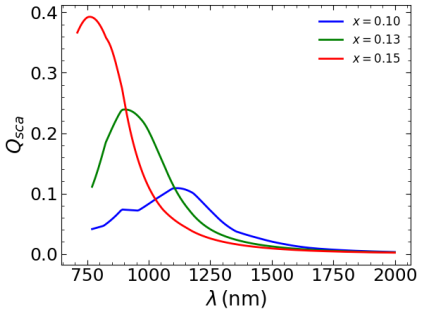
Exact solution: From Mie theory!



- Tuning Plasmon Resonance with Doping



Adapted from Athanasiou S. and Martin O.J.F., J. Chem. Phys C, 128 (43), 18574-18581 (2024)



Nobel Prize Week

PHYSIOLOGY OR MEDICINE – Monday, 6 October, 11:30 CEST at the earliest
The Nobel Assembly at Karolinska Institutet, Wallenbergsalen, Nobel Forum, Nobels väg 1, Solna
Press accreditation

Today!

PHYSICS – Tuesday, 7 October, 11:45 CEST at the earliest
The Royal Swedish Academy of Sciences (Kungl. Vetenskapsakademien), Session Hall, Lilla Frescativägen 4A, Stockholm
Press accreditation

CHEMISTRY – Wednesday, 8 October, 11:45 CEST at the earliest
The Royal Swedish Academy of Sciences, Session Hall, Lilla Frescativägen 4A, Stockholm
Press accreditation

LITERATURE – Thursday, 9 October, 13:00 CEST at the earliest
The Swedish Academy (Svenska Akademien), Börssalen, Källargränd 4, Stockholm
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PEACE – Friday, 10 October, 11:00 CEST
The Norwegian Nobel Committee, The Norwegian Nobel Institute (Norska Nobelinstitutet), Store Sal, Henrik Ibsens gate 51, Oslo
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THE SVERIGES RIKSBANK PRIZE IN ECONOMIC SCIENCES IN MEMORY OF ALFRED NOBEL – Monday, 13 October, 11:45 CEST at the earliest
The Royal Swedish Academy of Sciences, Session Hall, Lilla Frescativägen 4A, Stockholm
Press accreditation