Mapping the Plasmon Resonances of Metallic Nanoantennas

Garnett W. Bryant, F. Javier Garcia de Abajo, Javier Aizpurua

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Liane Slaughter
LaNP
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Happy Mardi Gras

Motivation

Gans theory found that plasmon resonance depends only on aspect ratio in quasistatic limit

$$\lambda \propto \frac{L_{Tot}}{2R}$$

Subsequently, many theoretical studies ignore explicit relationship to length or radius

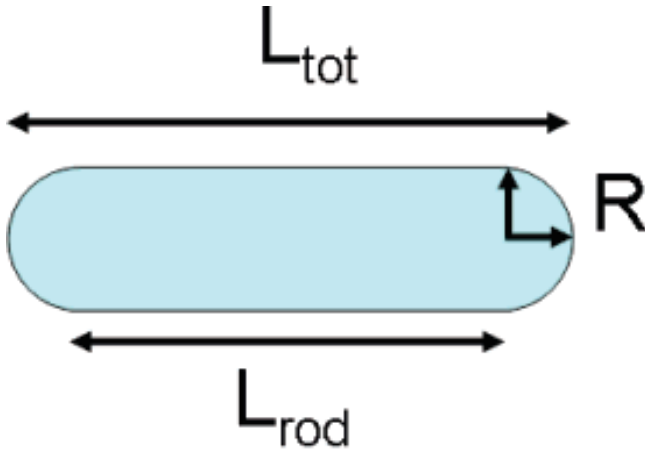
Aizpurua et al use exact electromagnetic calculations to fully map dipole resonance over

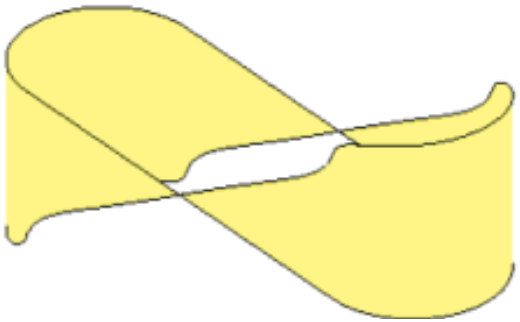
L < 2000nm and R <100nm

Calculations

L ≡ LTot = Lrod + 2R

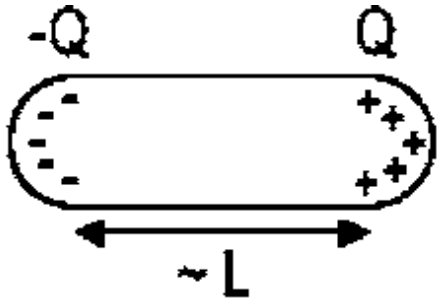
Aspect ratio = LTot / 2R





Solve Maxwell's equations for nanostructures with sharp boundaries for effective surface charges and currents

Calculated near-field and far-field optical response of longitudinal mode

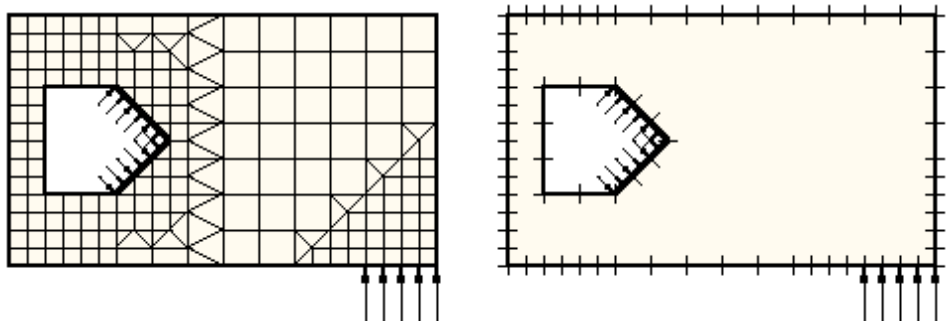


Aizpurua et al. *Phys. Rev. B* **2005**

Boundary Element Method

Integral method

Requires only discretization of surface instead of volume



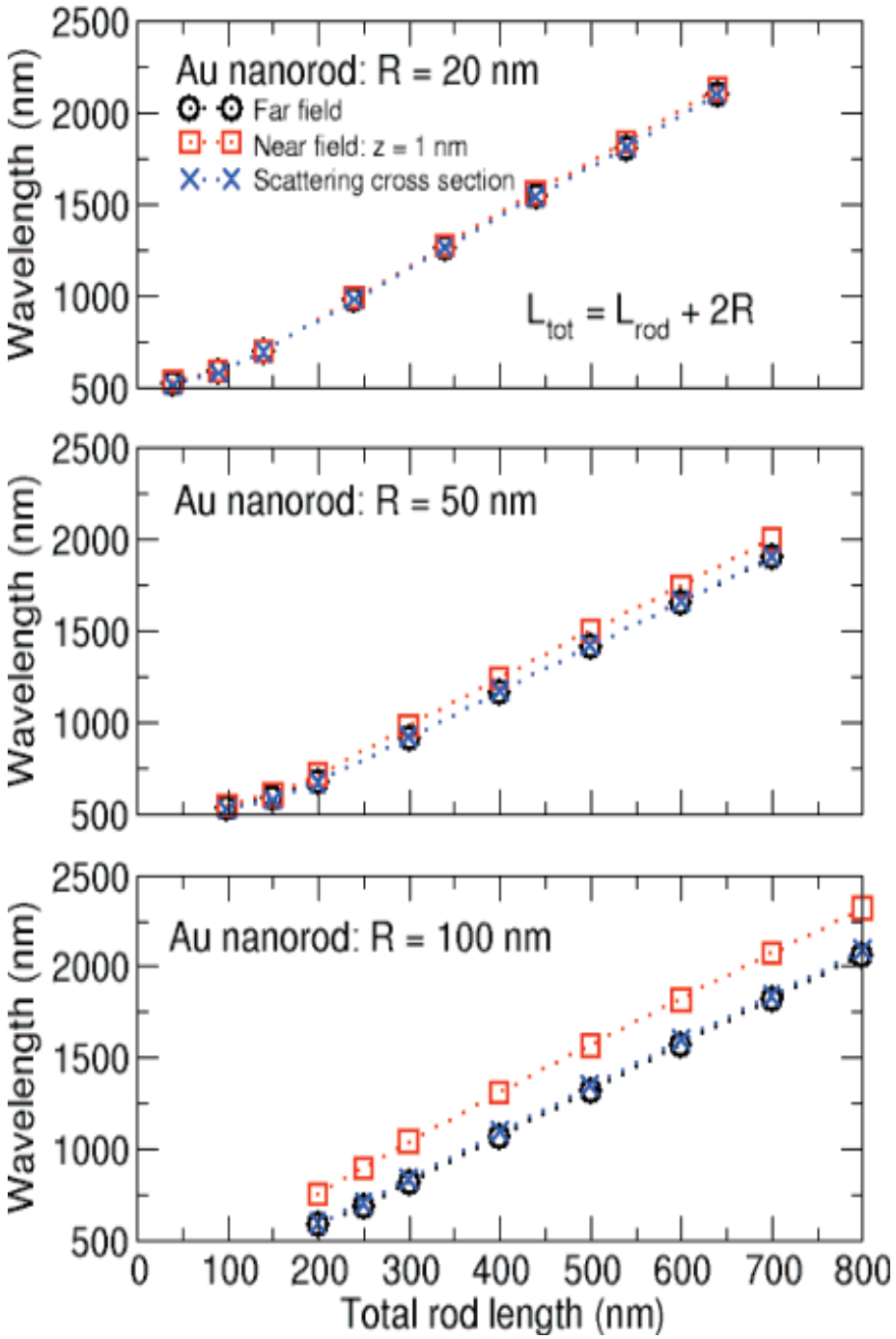
Finite Element Method BEM

http://www.iam.uni-stuttgart.de/bem/home_bem_introduc.html

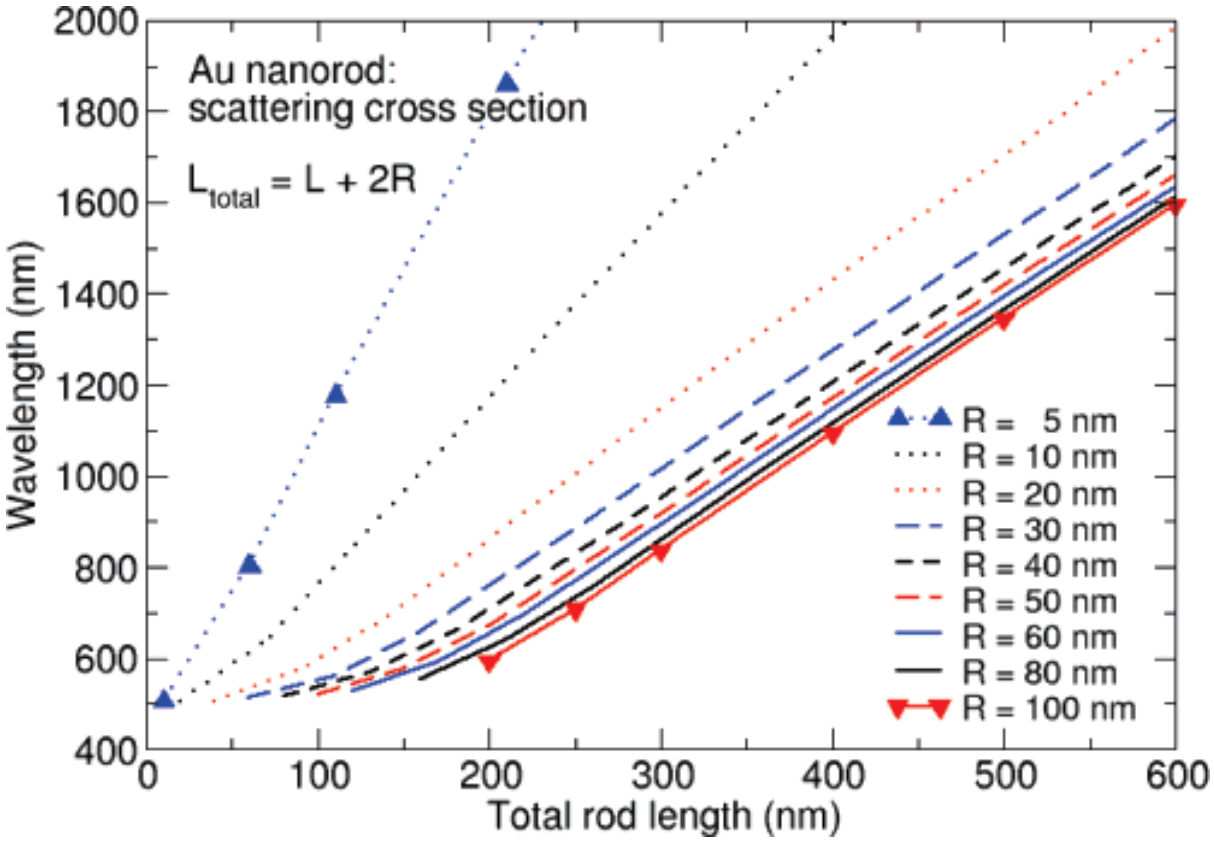
Discretized surface integrals of surface charges and currents and solved resulting matrix equations

Dependence of the dipolar resonance wavelength on nanorod length.

○ Forward far-field
□ Near-field scattering
× Scattering cross section

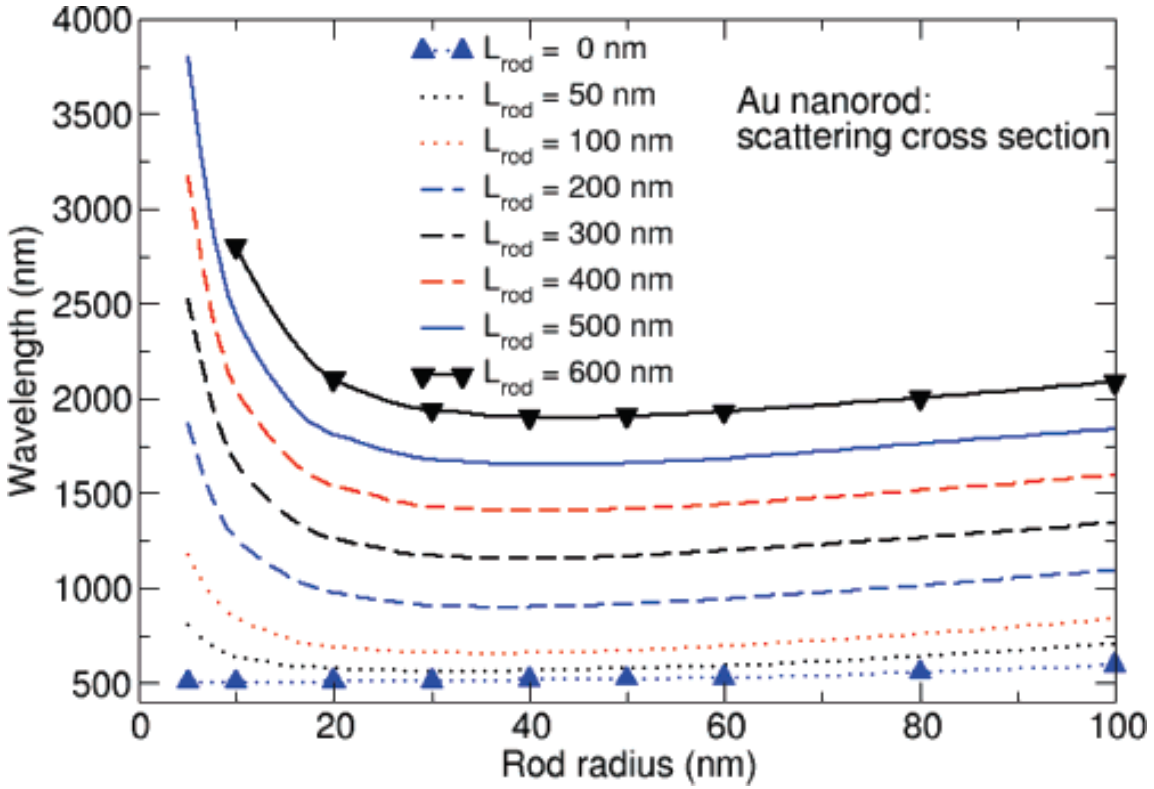


Dependence on length at fixed radius



At certain R, the slope of scattering cross section vs. length does not change

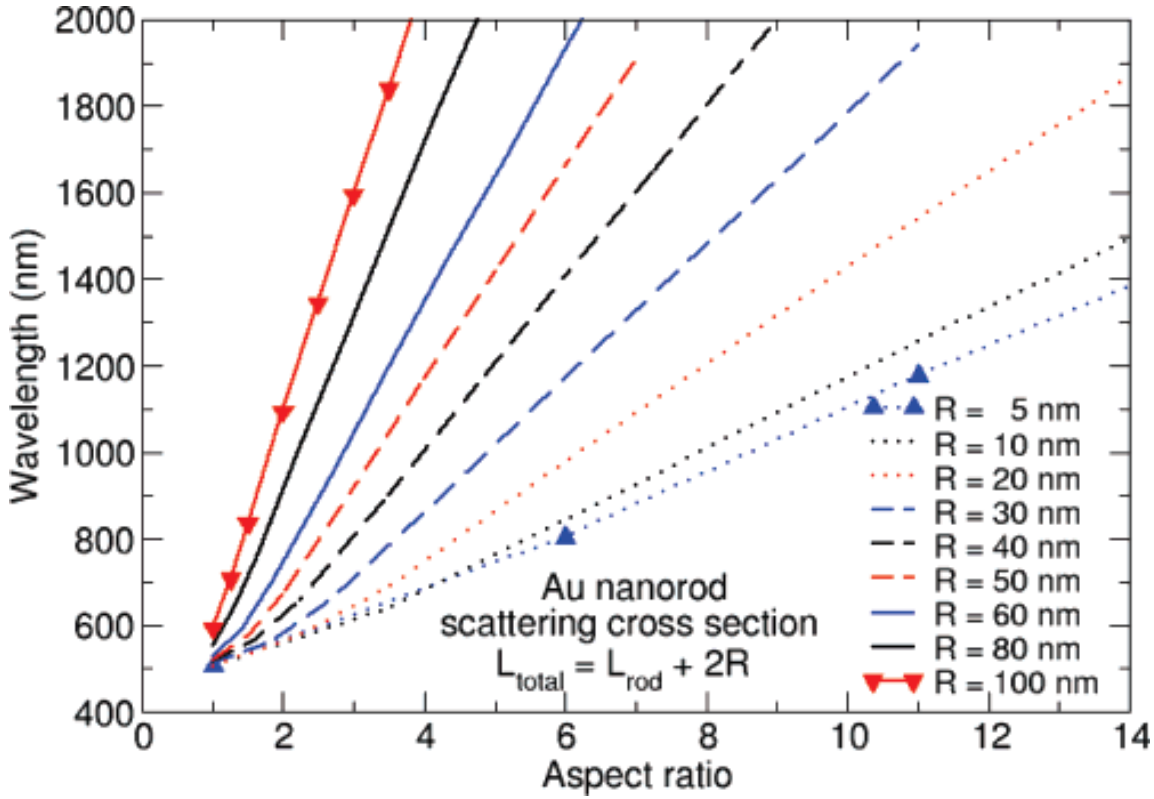
Dependence on radius at fixed length



At certain L_{rod}, the slope of scattering cross section vs. length does not change

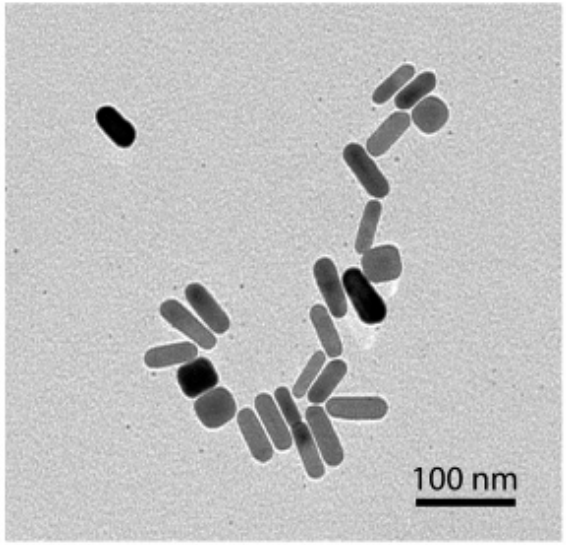
Aspect Ratio!

λ vs. $\frac{L_{Tot}}{2R}$

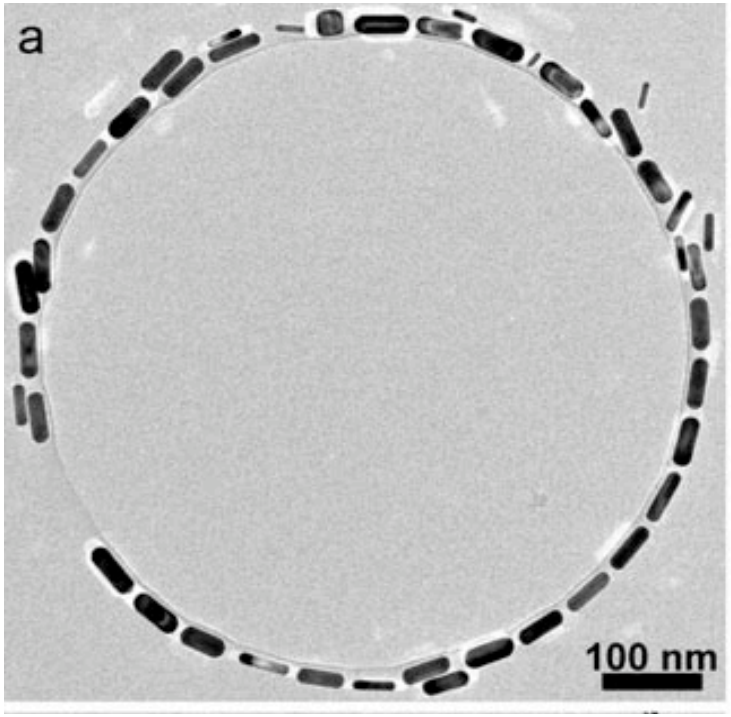


Quasistatic limit applies only over very narrow size regime

Where are we experimentally?



Hafner et al. *J. Phys. Chem. B* **2006**



Zubarev et al, *Angewandte* **2007**