

Plasmonic – all-dielectric dimer: linear and nonlinear effects

August 18, 2016

Background

We consider a hybrid dimer, formed by two nanoparticles: plasmonic (**gold nanoparticle**) and all-dielectric (**BaTiO₃ nanoparticle**). The optical parameters are taken according to Ref. [1].

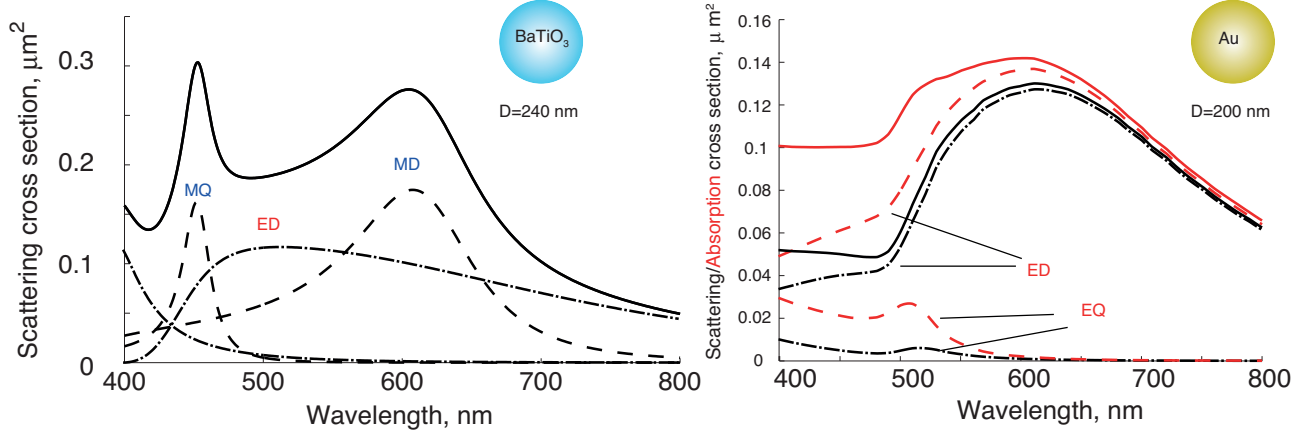


Figure 1: The scattering cross section of (a) BaTiO₃ (BT) and (b) gold (Au) nanoparticles of diameters 240 nm and 200 nm correspondingly. The absorption cross section is also shown in (b).

Linear scattering: dipole model

As a first step we consider simple dipole model consider nanoparticles in dipole approximation leaving only magnetic and electric dipoles in the Mie model. Moreover, the magnetic dipole can be neglected in Au nanoparticle and only electric dipole gives significant contribution. The extinction cross sections of dimers for different geometries and inter particle distances are shown in Fig. 2.

The hybridization model

To reveal the hybridization mechanism we decomposed the extinction into electrical and magnetic components. The results are shown in Fig. 3.

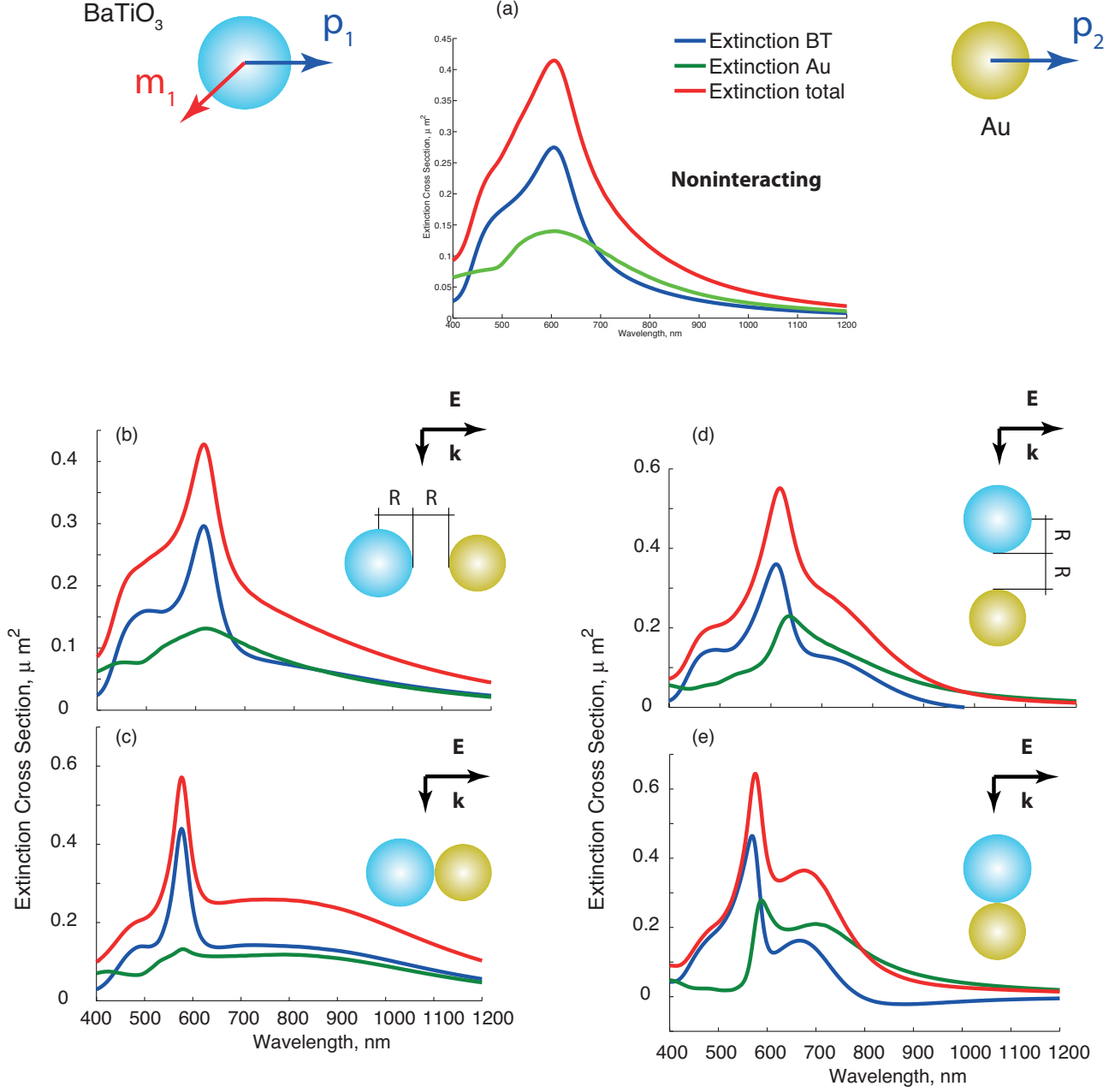


Figure 2: (a) The extinction cross section of nanoparticles in dipole approximation. (b,c) The extinction cross section of a hybrid dimer under **perpendicular** incidence for 120 nm spacing (b) and in case of touching (c). (d,e) The extinction cross section of a hybrid dimer under **parallel** incidence for 120 nm spacing (d) and in case of touching (e).

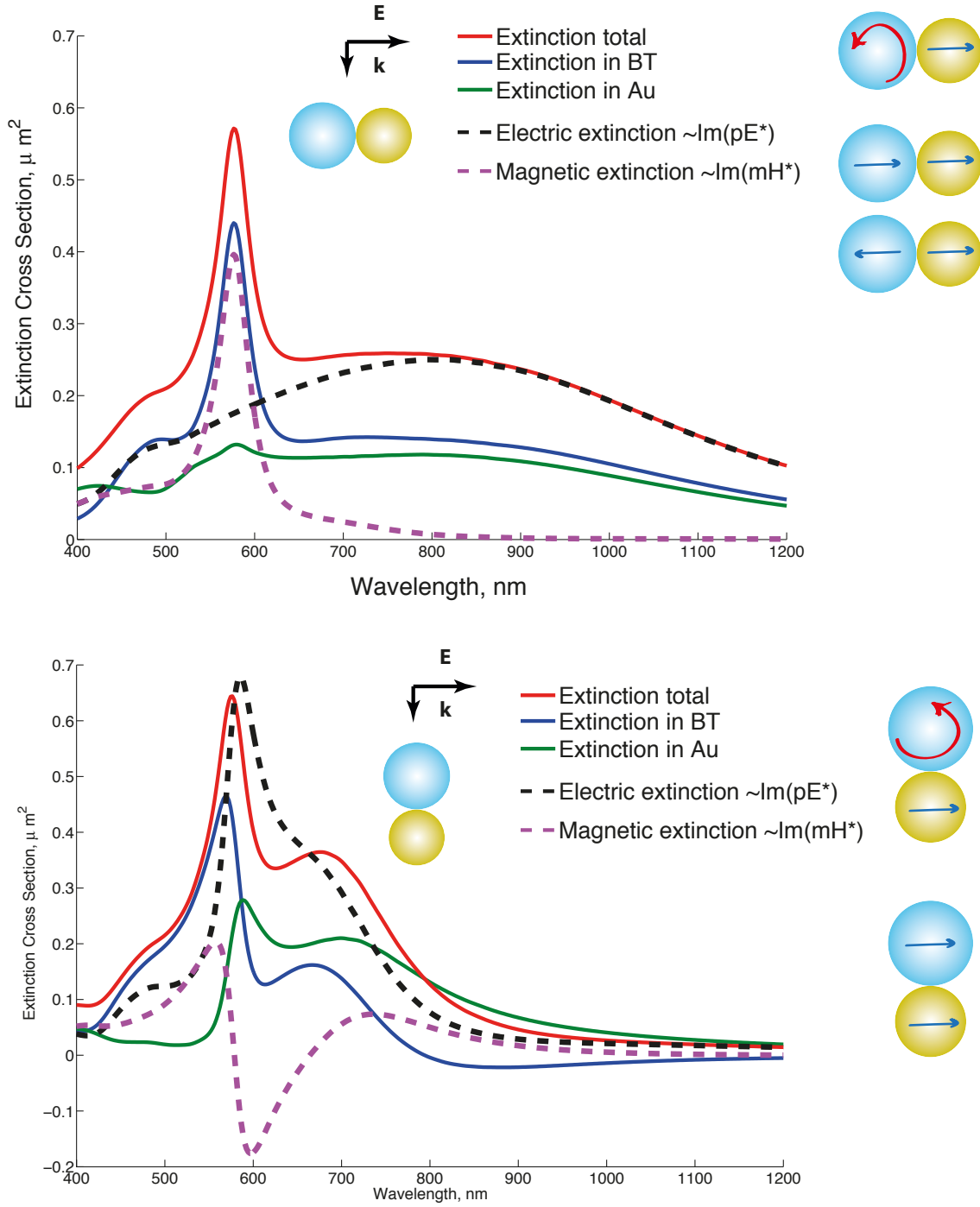


Figure 3: (a) The extinction cross section of a hybrid dimer under **perpendicular** (a) and **parallel** (b) incidence in touching geometry along with electrical and magnetically components of the extinction.

Numerical simulations

We have employed numerical simulations in Comsol Multiphysics package to plot field distribution of fields scattered by dimer. The results are shown in Fig. 4.

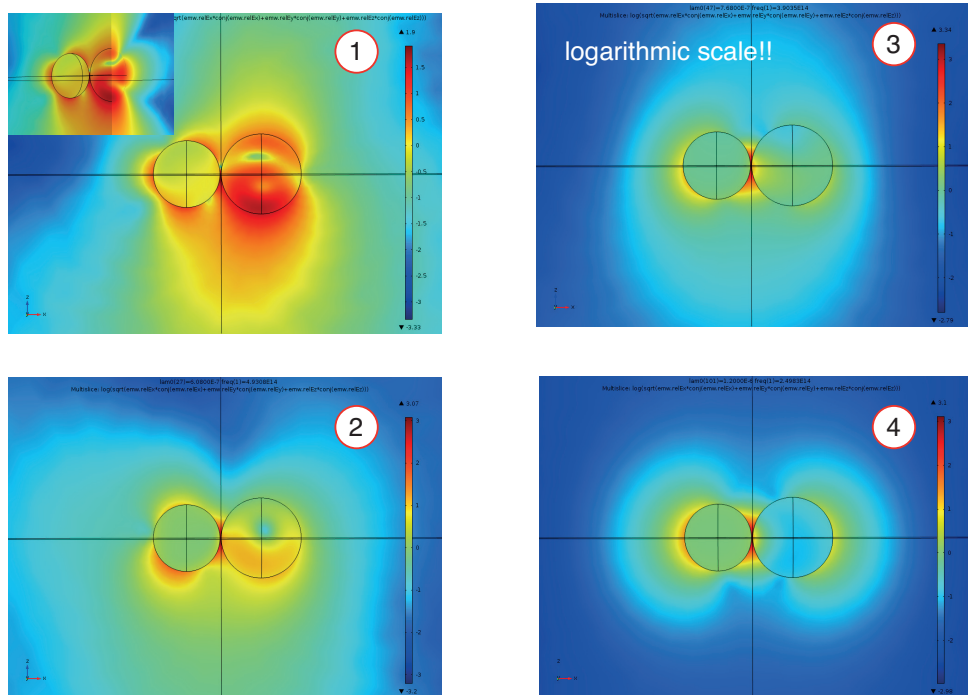
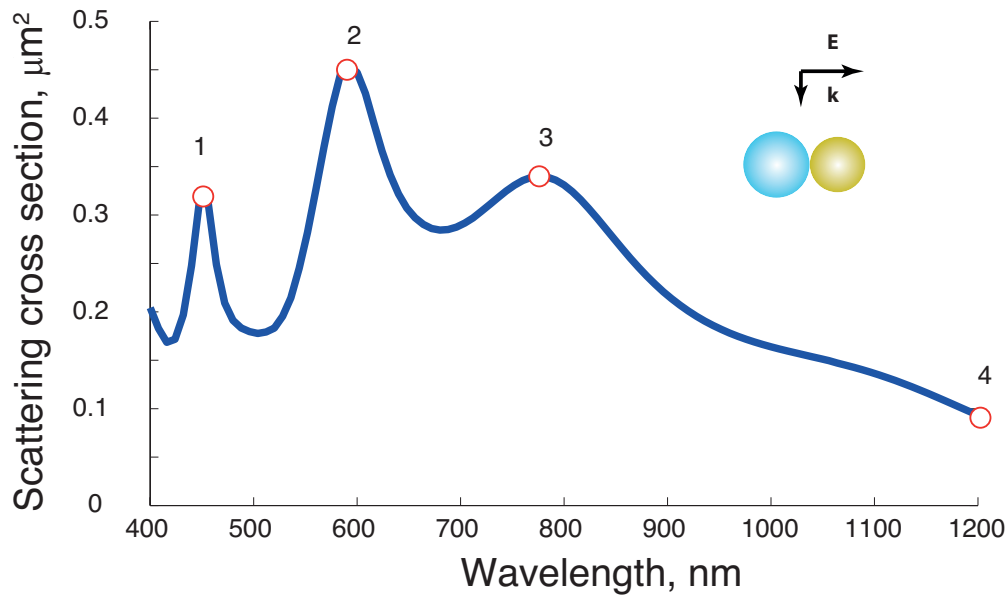


Figure 4: The scattering cross section of the hybrid dimer under **perpendicular** illumination. The field intensity distributions are plotted for fixed wavelengths labeled in the spectra. The colormap has logarithmic scale. The mode types in BT/Au dimer can be labeled as follows : 1 – MQ/ED mode, 2 – MD/ED, 3 – ED/ED, 4 – ED/ED.

References

- [1] <http://refractiveindex.info/?shelf=main&book=BaTiO3&page=Wemple-e>
- [2] R. W. Boyd, Nonlinear optics. San Diego: Academic Press, 2003.