Optical response of strongly coupled metal nanoparticles

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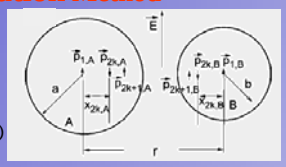
Motivation

- The studies have been developed into many new applications in nanostructure optical devices.
- Relatively little is known about the nature and the properties of the near-field interactions of closely spaced metal nanoparticles.

Calculation Method

颗粒间耦合作用：
多镜象相互作用。
两大小不等金属颗粒
在纵向场情况（右图）

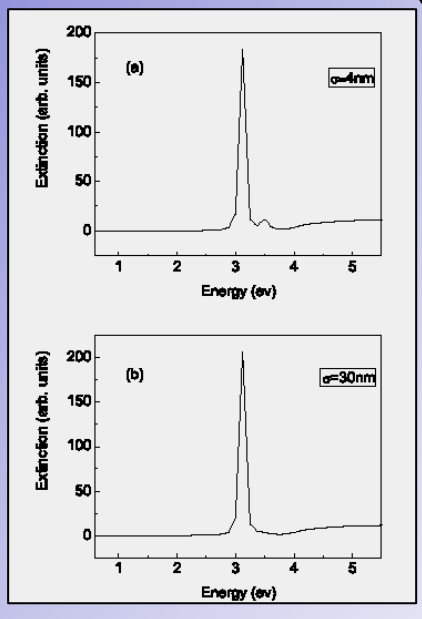


$$p_{n,\mathrm{A}}^{\mathrm{o}} = p_{1,\mathrm{A}}\gamma^{n-1}\left(\frac{b\sinh 2\vartheta}{a\sinh(n-1)\vartheta + b\sinh(n+1)\vartheta}\right)^3$$

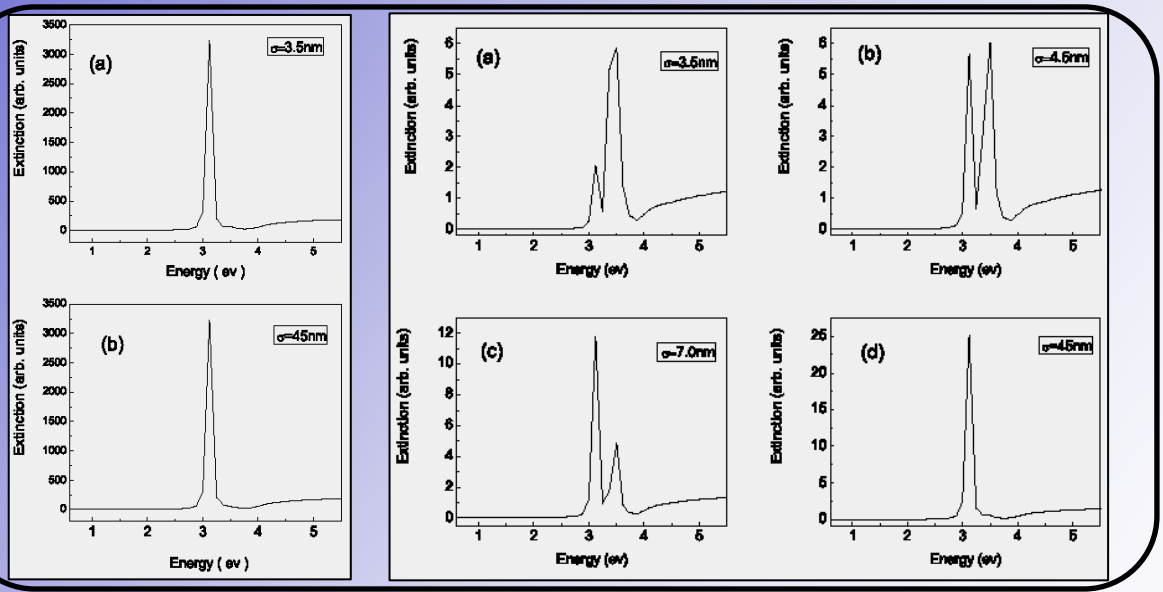
$$p_{n,\mathrm{A}}^{\mathrm{e}} = p_{1,\mathrm{B}}\gamma^{n-1}\left(\frac{a\sinh 2\vartheta}{r\sinh n\vartheta}\right)^3$$

$$p_{\mathrm{A}}^{\mathrm{T}} = \sum_{n=1}^{\infty}(p_{n,\mathrm{A}}^{\mathrm{o}} - p_{n,\mathrm{A}}^{\mathrm{e}}) = \sum_{k=1}^{\infty}(p_{2k-1,\mathrm{A}} - p_{2k,\mathrm{A}})$$

颗粒的消光部分正比于 $\omega Im(\tilde{\beta})$



两大小相同银颗粒，直径为10nm。



银颗粒的消光光谱。两银颗粒的大小不同。大颗粒的直径是25nm，小颗粒的直径是5nm。颗粒间的相互耦合对大颗粒（左图）的等离激元共振峰无大的影响，但对小颗粒（右图）具有重大的影响。处在3.5ev的等离激元共振峰随着颗粒间耦合强度的减弱而逐渐减弱并直至消失。

Conclusion

The optical responses of coupled metal nanoparticles are studied. For two unequal nanoparticles, the small particles can have a much shift of plasmon resonant frequency, which depends on the mutual interaction between two particles. The results exhibit that the plasmon resonance can be tuned by the electromagnetic coupling between neighboring particles.

•***References***

[1] Y, Ju and J. P. Huang, The Journal of Physical Chemistry B, 112, 7865 (2008)