Surface Plasmon Resonance

General Introduction

Steffen Jockusch 07/15/07

Plasmons:

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Surface Plasmon Resonance:

- light (λ) in resonance with surface plasmon oscillation

Requirements:

- Material with free electrons:

Metals	***plasma frequency***
Pb, In, Hg, Sn, Cd	UV
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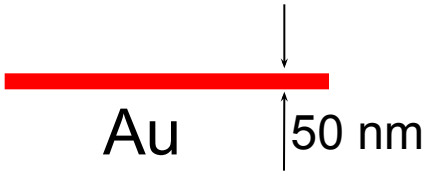
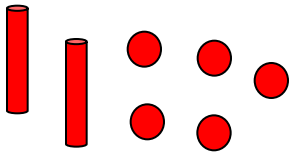
- Surface (interface):

flat surfaces



nanoparticles



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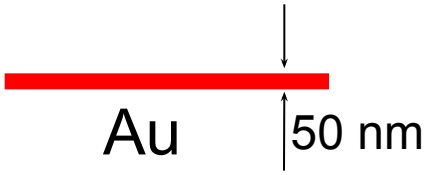

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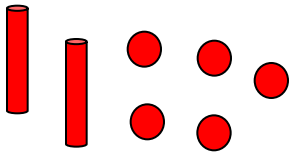
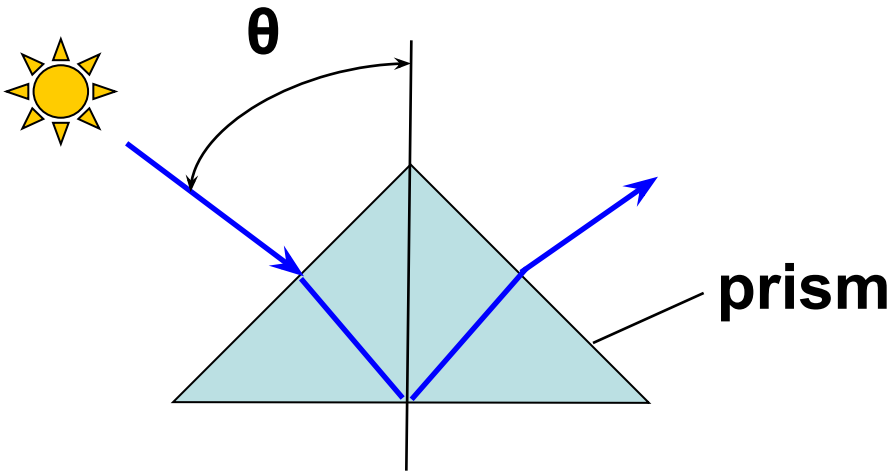
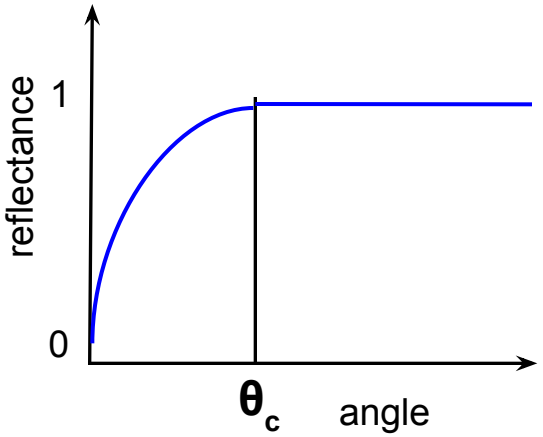
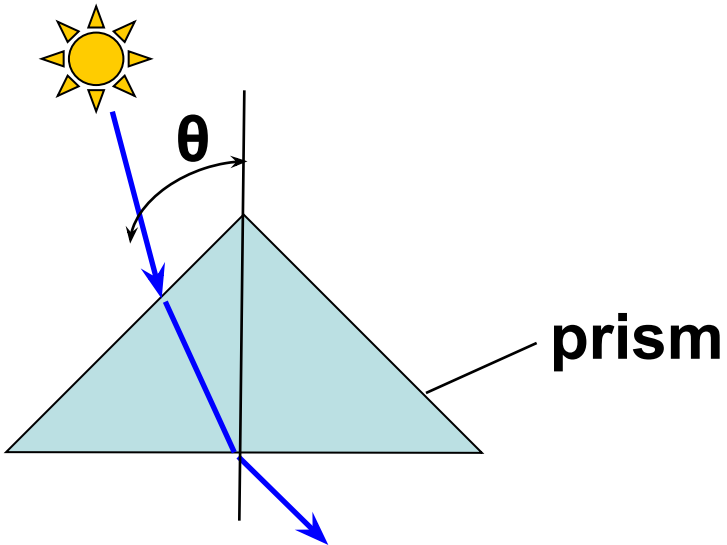


- Light: How to couple the photons to the surface?

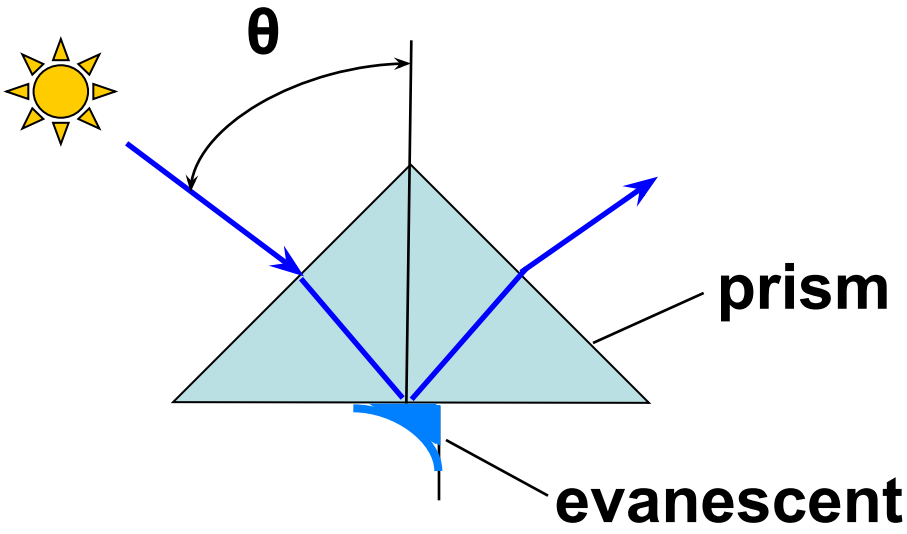
Total reflection on a prism

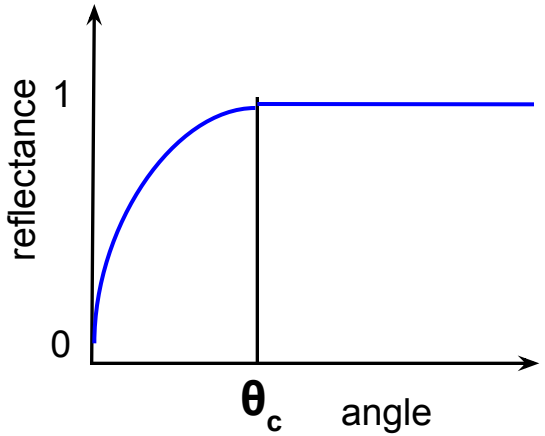






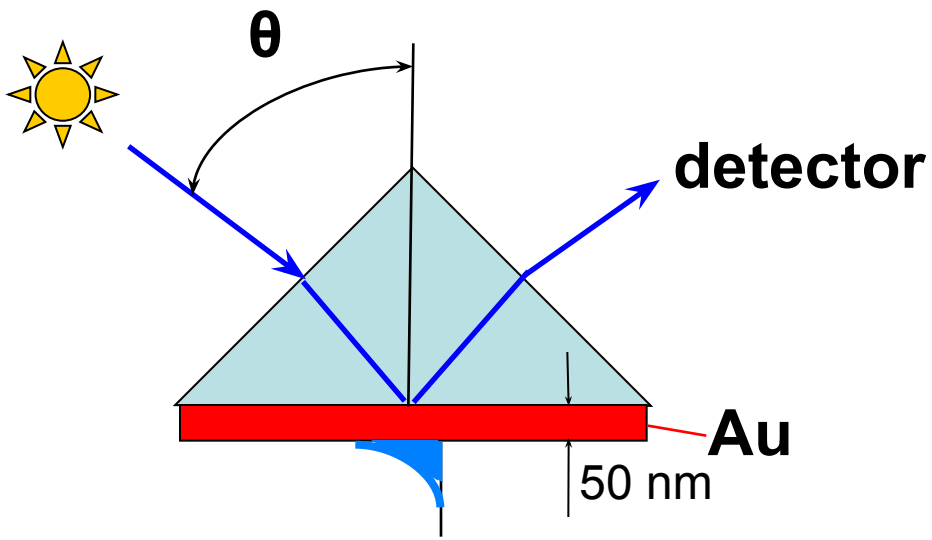
Evanescent Wave

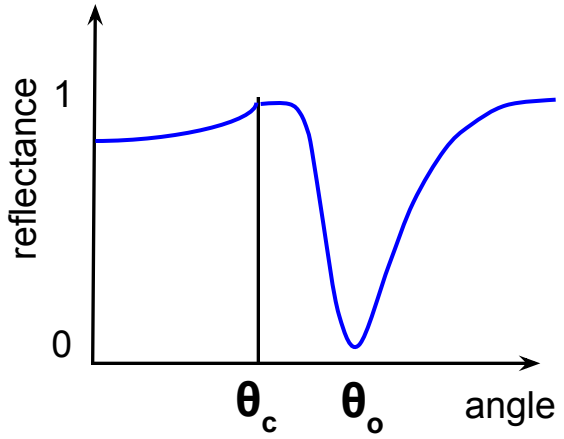




evanescent wave: - nearfield standing wave,
- extends about 1/2 λ,
- decays exponentially with the distance

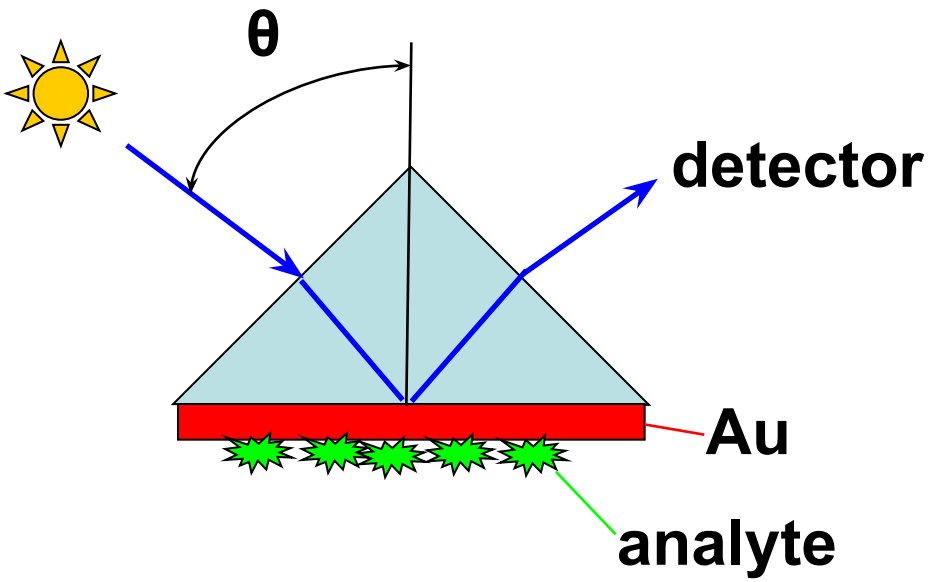
Surface Plasmon Resonance

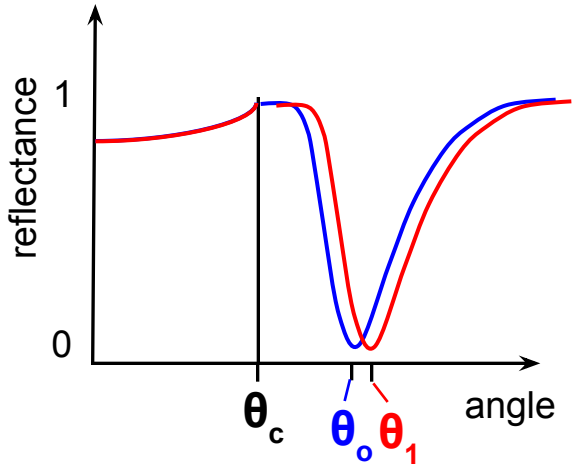




(Kretschmann)

Surface Plasmon Resonance Spectroscopy

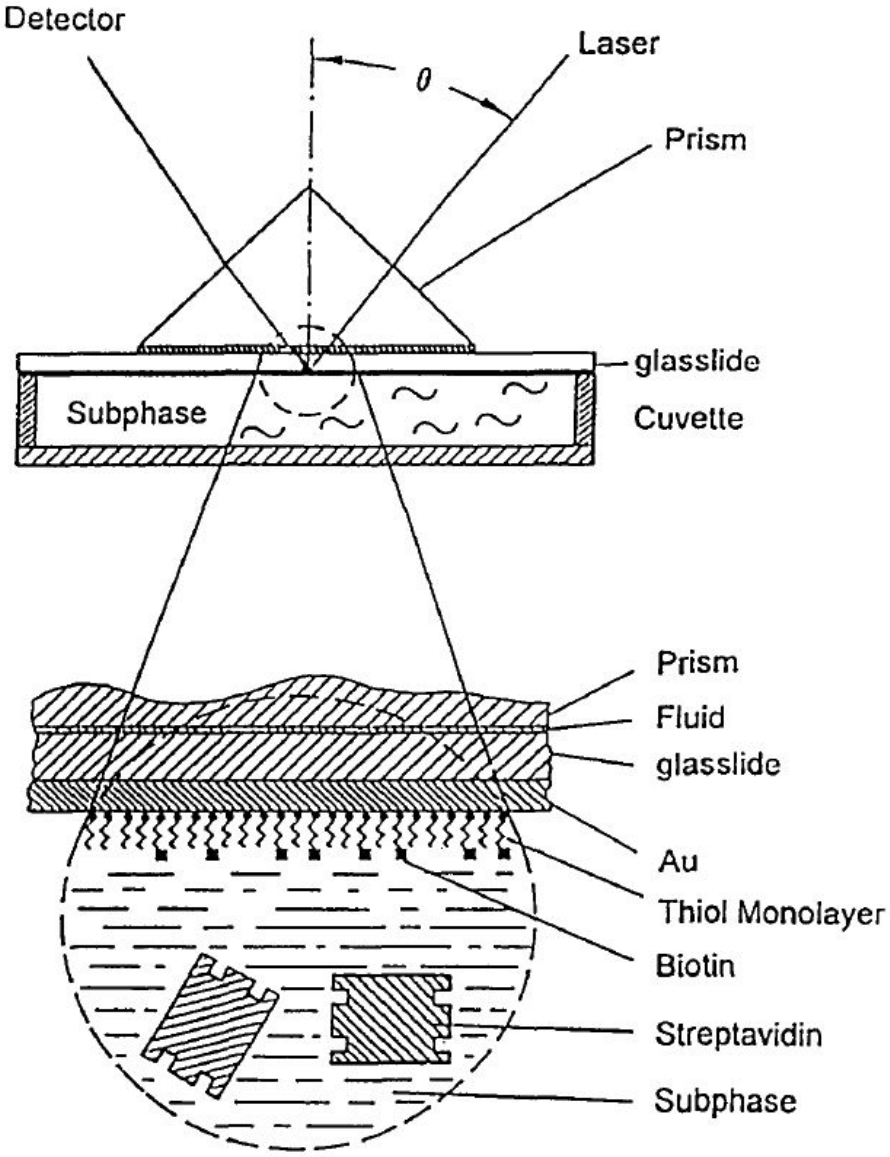


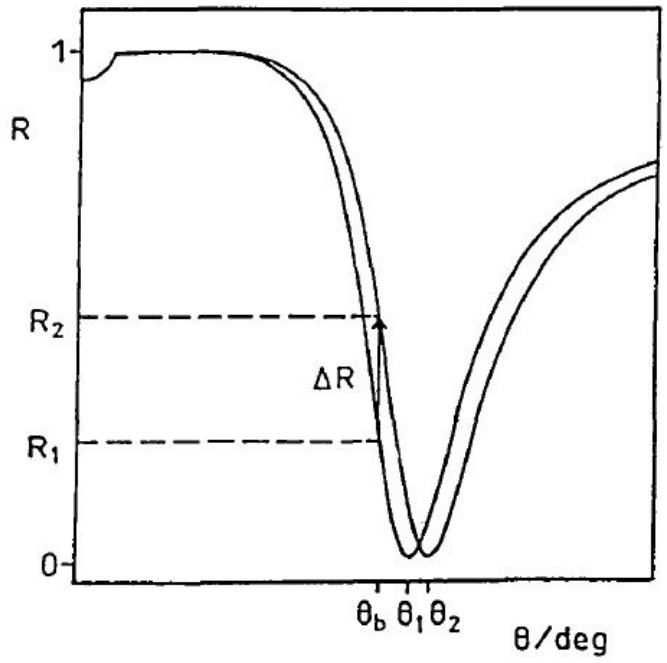


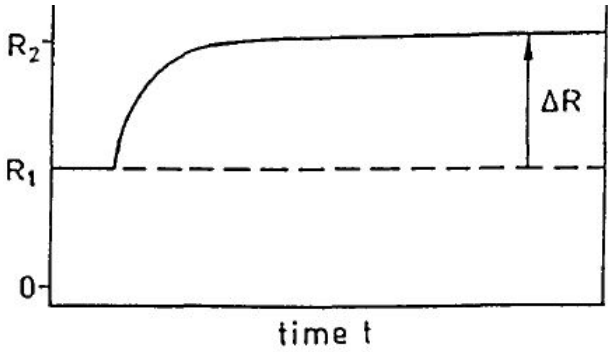
To measure: - thickness changes,

- density fluctuation,
- molecular adsorption

Surface Plasmon Resonance Spectroscopy in Sensors

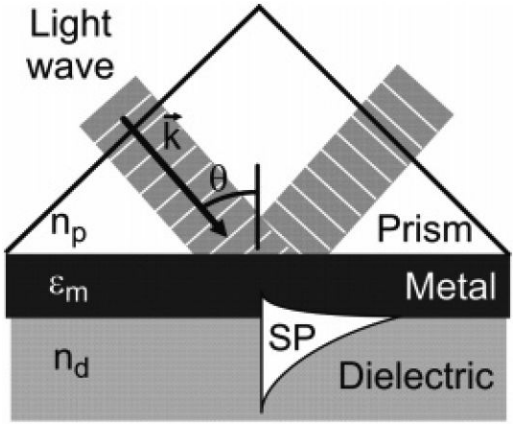




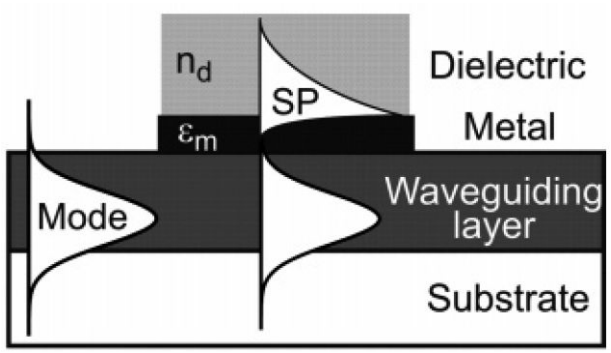


Knoll, et.al. *Biosensors & Bioelectronics*, **1995**, *10*, 903

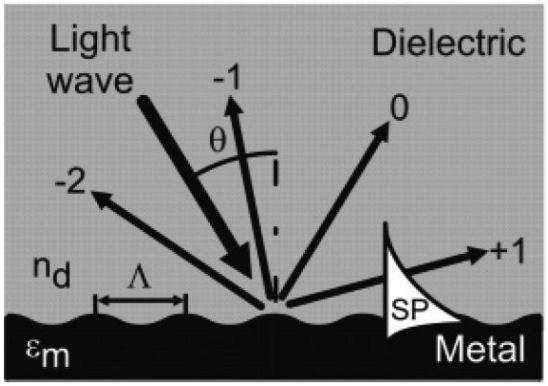
Coupling of Light to Surface Plasmon



Prism coupler (Kretschmann)



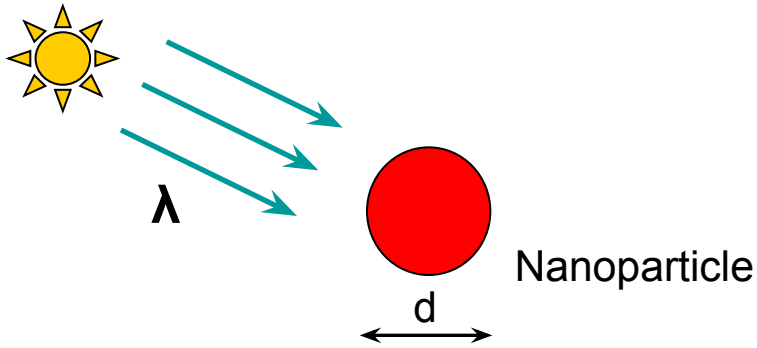
Waveguide coupler



Grating coupler

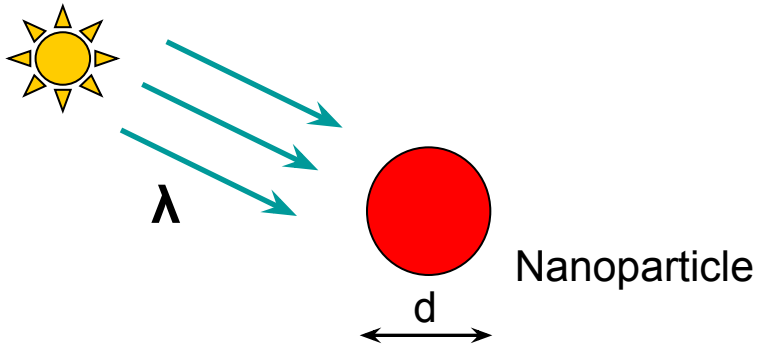
Homola, *Chem. Rev.* **2008**, *108*, 462

Nanoparticle Surface Plasmon



$d \ll \lambda$

Nanoparticle Surface Plasmon



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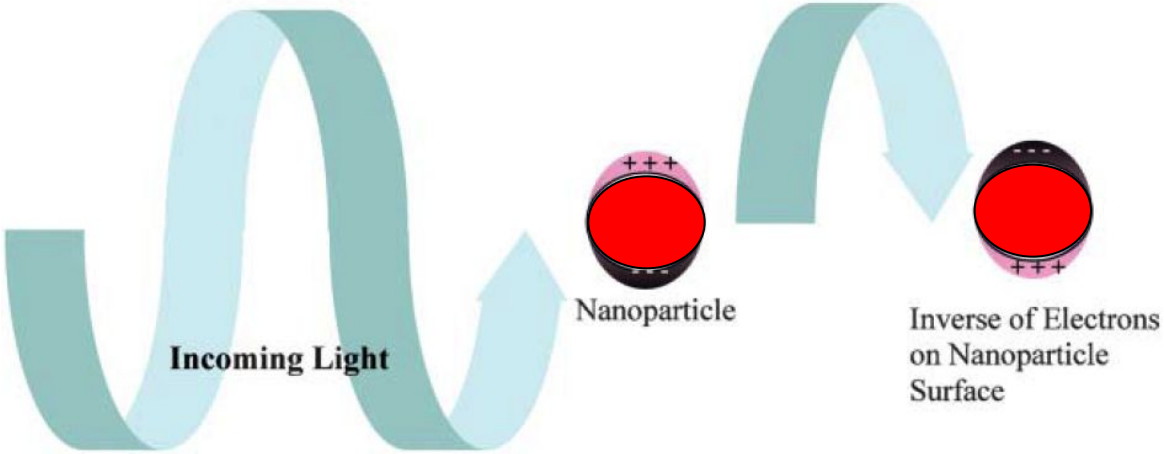

Light resonance with the surface plasmon oscillation
causes the free electrons in the metal to

Eustis and El-Sayed, *Chem. Soc. Rev.*, **2006**, *35*, 209

Surface Plasmon-assisted Spectroscopy

Technique	*Largest enhancement factor*
Surface enhanced raman **SERS**	10^{14} Nie and Emery, *Science*, **1997**, *275*, 1102.
Surface enhanced IR **SEIRA**	10^{4} Tsang, et.al., *Phys. Rev. Lett.*, **1980**, *45*, 201.
Sum frequency generation **SESFG**	10^{4} Baldelli, et.al., *J. Chem.Phys.*, **2000**, *113*, 5432.
Second harmonic generation **SESHG**	10^{4} Chen, et.al., *Phys. Rev. Lett.*, **1981**, *46*, 145.
Surface enhanced fluorescence **SEF**	~100