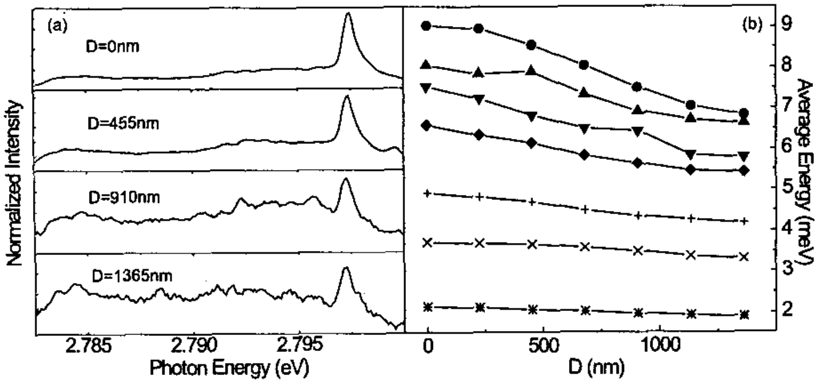
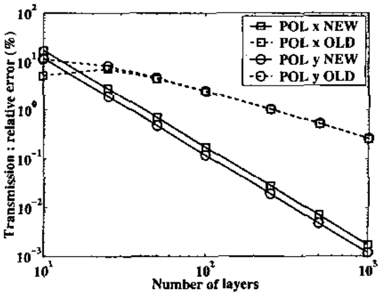


QWA5 **Fig. 2.** Part(a): LO-phonon sidebands measured at different positions. The D represents the distance between the center of the laser spot and the center of the detected area. Part(b): The average energy of excitons as function of D. The initial energy of excitons are (from top to bottom) 21 meV, 18 meV, 15 meV, 12 meV, 9 meV, 6 meV and 3 meV, respectively.



QWA6 **Fig. 1.** Relative error for the transmission of a 50 nm thick aluminum slab ($\epsilon_{Al} = -34.5 + i8.5$) illuminated at 488 nm by a plane wave at a 50° angle. The incident wavevector lies in the (x, z) plane. The error curves are given for the two states of polarization.

shown in Fig. 1(c) as the diamonds. By Gaussian fit, we obtain the transport length as the FWHM of the Gaussian function. Figure 1(d) shows the laser excess energy dependence of the transport length measured by this method. We find a pronounced periodic feature with a period of E_{LO}, the LO-phonon energy.

In ZnSe quantum wells, after the optical excitation, the electron-hole pairs created in continuum states form excitons rapidly by emission of LO-phonons. These hot excitons relax rapidly by LO-phonon emissions (few ps), then slowly by acoustic phonon emissions (some 100 ps).[1] Thus, the initial energy of the excitons for the latter slow relaxation process is a periodic function of E_{excess}, with a period of E_{LO}. The importance of this initial energy on the transport process is proved by the strong periodic feature observed in Fig. 1(d). In the cases of small initial energy (The E_{excess} corresponds to multiples of E_{LO}), we observe pronounced quenching of the transport length in Fig. 1(d).

The LO-phonon sideband observed in Fig. 1(b) reflects the energy distribution of the excitons. The peak in this sideband corresponds to the excitons before the first acoustic phonon scattering event. Thus, the spatial profile of this peak (squares in Fig. 1(c)) reflects the quasi-ballistic transport of excitons, which is free of acoustic phonon scattering. The measured profiles coincide well with the results of a Monte Carlo simulation. Both the experiment and the simulation show that the transport length of this quasi-ballistic transport is independent of the energy of excitons. This behavior can be attributed to the cancellation between the increase of the velocity and the decrease of the free-flight time with increasing energy.

In Fig. 2(a), we show the LO-phonon sideband detected at different spatial positions with respect to the excitation spot. From these spectra, we calculate the average energy of excitons at different positions by taking into account the LO-phonon assisted recombination rate,[2] as shown in Fig. 2(b) for several initial energies. We find the excitons remain hot during their transport within few μm, which confirms the dominant role of the exciton velocity on the transport process in this regime.

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QWA6 **1:00 pm**

Modeling Nano-optics: Towards a More Physical Formulation of the Coupled Dipole Method

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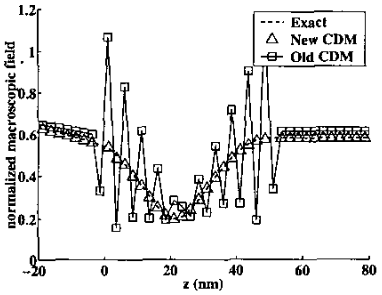
The coupled dipole method (CDM) is a well known and widely used method to study the scattering of light by objects with arbitrary shape.[1,2,3,4] In the CDM the scatterer is described as a collection of N subunits. Each subunit has to be small enough compared to the local spatial variations of the electromagnetic field to satisfy the dipole approximation. In principle the accuracy of the calculation of the fields (internal or scattered) can always be made higher by making the subunits smaller. There are however some intrinsic limitations. As Draine first pointed out in the case of homogeneous spheres,[2] the macroscopic field computed with the CDM agrees well with the macroscopic field computed with the theory of Mie only near the center of the sphere. As one gets closer to the surface of the sphere, discrepancies start to appear, no matter how small the discretization. As a consequence, the CDM is only an approximate theory, even in the long wavelength limit. This could be a problem especially when dealing with nanostructures for which interfaces cannot be ignored.

The reason for this limitation is neither mathematical nor numerical. It stems from a flawed physical assumption. It is often argued that the local-field correction infered from the Clausius-Mossotti polarizability (which is the long wavelength limit of any of the usual forms of polarizability used in the CDM) is exact in the static limit. This only true in the bulk. In the CDM one should not neglect the local-field correction due to the geometry of the environment of the dipole. This neglect leads to an incorrect definition of the local-field factor and hence a wrong macroscopic field.

We show how to obtain for some geometries a form of the CDM that accounts for the environment of each dipole and leads to a formulation of the CDM that is exact in the long wavelength limit. We also show how this new form of the CDM can improve the performance of the



QWA6 **Fig. 2.** Electric field inside and outside a 50 nm thick dielectric slab ($\epsilon = 20$) illuminated at 600 nm by a plane wave (incident from the left) at a 50° angle. The incident wavevector lies in the (x, z) plane. We plot the x component of the electric field. The slab occupies the region 0 nm $> z >$ 50 nm.

method when computing internal or scattered fields.

To illustrate how the interface problem is dealt with, we present in Fig. 1 the relative error in the calculation of the intensity transmitted through a 50 nm thick aluminum slab. The slab is treated as a three-dimensional structure using a generalization of the CDM to periodic structures.[5] As shown on Fig. 1 for the transmitted light, the new form of the CDM leads to a better convergence than the conventional form of the CDM. Figure 2 shows that the calculation of the internal macroscopic field is also greatly improved.

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QWA7 1:00 pm

Radiative Transfer in the Near Field

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The behaviour of systems that are supposed to be very well-known may reveal surprises when we look at them on a nanometric length scale. This is the case of light emission by a body at temperature T. A thermal source such as a blackbody or the incandescent filament of a light bulb is often presented as the typical example of an incoherent source as opposed to a laser. Indeed, whereas a laser is monochromatic and very directional, a thermal source has a broad spectrum and is usually quasi-isotropic. However, it has been shown recently by Carminati et al. (1999) and Shchegrov et al. (2000) that the field emitted by a thermal source made of a polar material at a distance of the order of 10 to 100 nm is enhanced by more than four orders of magnitude and is partially coherent. The purpose of this paper is to discuss the implications of these effects for the radiative heat transfer between objects separated by distances in the range of the nanometer.

The extraordinary enhancement of the density of energy is due to the excitation of surface modes by random currents due to thermal motion of charges. These modes produce an additional contribution to the local density of electromagnetic states which is confined close to the interface. It turns out that this density of states almot diverges for some well defined frequencies. We consider in this paper the implications for the radiative heat transfer due to the coupling between these surface modes (Mulet, 2001).

We will consider two different geometries. First, we study the heat transfer between two half spaces as a function of the distance. We show how the flux varies with the distance. It will also be shown that most of the radiative flux is exchanged at some particular frequency. A behaviour completely different from what happens in far field. The second application is the study of the heat transfer between a small spherical particle and an interface in the presence of surface phonon-polaritons. This can be viewed as a first model describing the radiative flux between a near-field probe tip and an interface. We examine the distance dependence of the power exchanged between the sphere and the interface. We also analyse how the power is distributed below the interface in order to discuss the possibility of a local radiative heating.

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QWA8 1:00 pm

Plasmon Coupled Tip-enhanced Near-field Optical Microscopy

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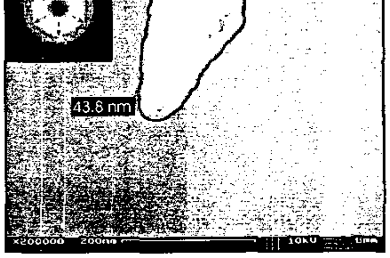
Scanning near-field optical microscopy[1] aims at optically resolving subwavelength structures. The most common technique relies on the local excitation of the sample surface by the optical fields near a nano-aperture which is commonly produced at the end of a glass fiber tip.[2] Alternatively, high resolution microscopy can also be achieved by using the local field enhancement produced at the end of a sharp metal tip when illuminated by a highly focused laser beam.[3,4]

By combinging these techniques in the form of a sharp metal tip at the end of an overcoated fiber, we propose a new method that does not require the delicate technologies to produce nano-apertures,[5,6] nor require the intense external focused beam responsible for the field enhancement. Fabrication of these probes is similar to the fabrication of nano-apertures, with the difference that the end of the probe is overcoated (see Fig. 1).



QWA8 Fig. 1. Silver coated fiber glass tip. Inset: radial mode.

The mode injected into the fiber is guided until it reaches its cut-off frequency due to the decreasing core diameter in the taper region.[7] Past the cut-off point, the mode no longer propagates, and an evanescent field is created. The large wavevectors of this evanescent field match the resonance conditions for surface plasmon excitation on the surrounding silver layer. The surface plasmons then travel along the metal coating towards the tip apex. For a linearly polarized mode, we expect a minimum of the field at the apex. However if the probe is excited by a radially polarized mode (see inset in Fig. 1) a strongly enhanced field is expected at the tip apex.

The electromagnetic field associated with surface plasmons can be used as a local optical near-field source to investigate fluorescence samples such as single molecules. Fluorescence quenching can be avoided by keeping the tip-sample distance larger than ≈5 nm.

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QWA9 1:00 pm

Quantum Dots for Off-on Biological Labeling

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Quantum dots (QDs) possess discrete energy states within the conductance band (CB) and va-