Focussing light with surface plasmons – how low can we go?

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Abstract
Nanoscience presents optics with a problem: we cannot see objects smaller than the wavelength using conventional optics. However metals have an unusual property that allows us to get around this problem: when the electric field of a light beam pushes in one direction, the electrons in the metal move in the opposite direction giving a negative value to the permittivity. This gives rise to the phenomenon of surface plasmons, excitations on the metal surface that can be excited by light. Here we show how light can be focussed into length scales much smaller than the wavelength and explore the ultimate limits imposed by the metal. It turns out that a beam of light can be concentrated into less than a nanometre leading to intense interactions between the energy of the light and individual atoms and molecules.

In this talk I explore how the new technique of transformation optics can give physical insight into the problem of light focussing by plasmons [1]. I shall explore the material properties that limit the extent of the focussing and show a few examples of structures that we propose for this purpose. In most cases analytic solutions can be found and this gives us an understanding of the process that goes far beyond computer simulations. Recent experimental data confirm the validity of our models [2].

References

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