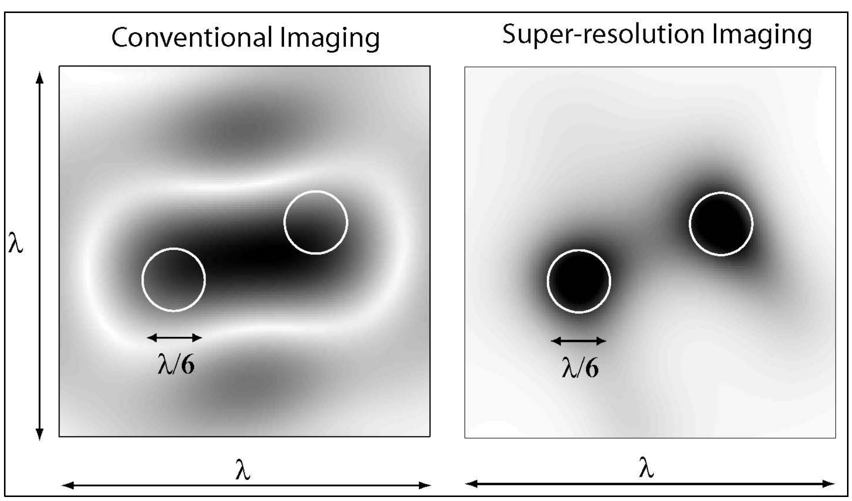
Applied Optics Group Lunchtime Seminar
1pm Wednesday 4 June 2008, B1 Seminar Room, Biology Building

On the encoding of subwavelength information by multiple scattering

Francesco Simonetti

Department of Mechanical Engineering, Imperial College, London SW7 2AZ, UK

Central to the image formation process is the transfer of information from the object to be imaged to the system that displays the information in the form of an image. In order to accomplish this transfer, the information has to be encoded in a form of energy that can be propagated across space by waves. The quality of the image is determined by the amount of information that the imaging system can retrieve from the incoming wave field and depends on the encoding mechanism and the efficiency of the energy transfer through space. The encoding is a key aspect of this process and can be achieved by means of scattering of waves excited by an external source. In this case, the physical phenomena governing the interaction of waves with the object's structure encode information in the energy of the scattered field. The wave-matter interaction also provides the key to unlock the information contained in the wave field captured by the imaging system. This is achieved by solving what effectively is an inverse problem based on the assumption of a particular wave-matter interaction model. The model should be as close as possible to the true physical interaction; however, state-of-the-art imaging technology uses a simplified model known as the Born approximation. This paper reports on recent work showing that the classical diffraction limit, which precludes the possibility of observing the subwavelength features of an object, is a consequence of the Born approximation. Indeed, it is shown that by accounting for multiple scattering a resolution beyond the Rayleigh criterion can be achieved. In order to support this argument, experimental results showing resolution in the order of a sixth of the wavelength are presented.



Experimental demonstration of subwavelength resolution imaging with ultrasound. The resolution of conventional imaging methods is affected by the Rayleigh diffraction limit, super-resolution techniques overcome the limit and resolve two subwavelength cylinders (diameter $\lambda/6$) revealing details smaller than the wavelength, λ. Simonetti et al. PRE 76 2007.