Professor Sir John Pendry will visit the Institute for Optical Sciences from November 6 to 17 2006 as part of the institute’s prestigious Distinguished Visiting Scientist program.

Sir John Pendry is a condensed matter theorist. He has worked at the Blackett Laboratory, Imperial College London, since 1981. He began his career in the Cavendish Laboratory, Cambridge, followed by six years at the Daresbury Laboratory where he headed the theoretical group. He has worked extensively on electronic and structural properties of surfaces, developing the theory of low energy diffraction and of electronic surface states. In 1992, he turned his attention to photonics materials. This interest led to his present research which concerns the remarkable electromagnetic properties of materials where the normal response to electromagnetic fields is reversed leading to negative values for the refractive index.

Grand Public Lecture

The Perfect Lens: Resolution Beyond the Limits of Wavelength

Friday, November 10, 2 p.m. – 3 p.m.

Sandford Fleming Building, Room 1105, 10 King's College Road

Click here for a campus map with the lecture location highlighted in purple.

Public Lecture Poster (pdf format)

Today we use lenses for many tasks. In microscopes they allow us to observe things that are too small to see otherwise. In telescopes, they reveal large stars and planets that are too far to see with the unaided eye. In CD and DVD players and recorders, lenses focus beams of light to very small areas, allowing us to store increasing amounts of data onto a small surface. There is a limit, however, for the smallest things that can be seen by even the best microscopes, a limit beyond which no conventional lens can help. With the introduction of nanotechnology, and the resulting miniaturization of many components, conventional lenses are insufficient. A completely new type of lens is needed.

In 1968 a new sort of lens was proposed, a lens that does not use curved surfaces, and is not made of glass. It is based on an entirely different material, which bends light rays in a strange manner, and allows light to travel backwards. Many years later in 2000 Sir John Pendry showed that this lens is not subject to the limitations of ordinary lenses. It allows us to see objects no matter how small, limited only by the perfection to which it can be manufactured. The materials needed for such a lens cannot be found in nature, yet they have recently been fabricated, and are called metamaterials. The first lenses to take advantage of this were made here in Toronto and later in Los Angeles.

Prof. Pendry will also give three technical seminars aimed at university students

Lecture 1:

Metamaterials: a New Design Paradigm for Electromagnetism

Monday, November 6, 3 p.m. – 4 p.m.
We control electromagnetic radiation in general and light in particular by exploiting the properties of materials and their response to electric and magnetic fields. Glass refracts light because of its response to electric fields and can be used to focus light – hence much of the optics industry. However nature has provided us with a limited palette of properties, much more restricted than allowed in principle by the laws of physics. The response of conventional materials to electromagnetic fields is determined by their constituent molecules. In contrast metamaterials owe their properties to much larger units, though still less than the wavelength of radiation. These large structural units, or ‘metamolecules’ can be designed to give a much wider spectrum of properties. In fact almost any property allowed by physical laws can in principle be engineered in this way. The development of these new materials will be traced and examples given.

Lecture 2:

A Cloak of Invisibility: Harry Potter Does Electromagnetism

Monday, November 13, 3 p.m. – 4 p.m.

Sandford Fleming Building, Room 1105, 10 King’s College Road

Refractive materials gives us some limited control of light: we can fashion lenses, and construct waveguides, but complete control of light is beyond simple refracting materials. Ideally we might wish to channel and direct light as we please just as we might divert the flow of a fluid. Manipulation of Maxwell’s equation shows that we can achieve just that provided we have access to some highly unusual material properties. Metamaterials open the door to this new design paradigm for optics and provide the properties required to give complete control of light. One potential application would be to steer light around a hidden region, returning it to its original path on the far side. Not only would observers be unaware of the contents of the hidden region, they would not even be aware that something was hidden. The object would have no shadow.

Lecture 3:

What is Wrong with the Planck Radiation Law?

Wednesday, November 15, 1 p.m. – 2 p.m.

Note different location: Bahen Building, Room 1160, 40 St. George Street

More than a century ago Planck showed that two bodies separated by vacuum exchange heat at a rate limited by his quantum radiation formula. The law holds good provided that bodies are separated by much more than the wavelength of the emitted radiation, but at shorter distances the law breaks down. Near the surface of a hot body there are strongly fluctuating electric near-fields and these can heat a second body placed in close proximity. The effect is not small and radiative heat exchange between nanostructures can be many orders of magnitude greater than predicted by the conventional far field formula.