



OPN Talks with ...

Sir John Pendry

Metamaterials Expert

Sir John Pendry was among the first to demonstrate the remarkable electromagnetic properties of metamaterials—materials in which light can be made to bend, or refract, backwards. Since then, scientific interest in metamaterials has exploded, due in part to their exciting possible applications, which include cloaking devices and a “super-lens” that could offer sub-wavelength, high-resolution imaging. OPN recently spoke with Pendry about his work, his scientific influences and the potential of the field.

>> What was the focus of your plenary talk for the recent Quantum Electronics and Laser Science (QELS) conference?

I provided an overview of the history of metamaterials research and explored current progress and applications.

In 1968, Victor Veselago introduced the idea that materials could exist for which both $\epsilon < 0$ and $\mu < 0$. For a long time after that, progress was stalled due to the absence of any known material with this property.

The field moved forward with the advent of artificially structured metamaterials with $\epsilon < 0$ and $\mu < 0$. In 2000, Smith et al. were the first to create a single structure through which they could demonstrate negative refraction. In the same year, I introduced the then-controversial concept of a perfect lens—which has now been experimentally verified.

Since then, progress has been rapid. Our ability to make negatively refracting metamaterials function at radio frequencies is now well developed. Researchers are just beginning to explore applications for negative refraction at optical frequencies.

>> Which research efforts would you characterize as having had the greatest impact in your field?

Victor Veselago’s early work on negative refraction was a great inspiration. More recently, David Smith and Shelly Schultz in San Diego have moved the field forward by using metamaterials to confirm the existence of negative refraction. Then there was the vital experimental evidence that superlensing could work, which came first in the radio frequencies from George Eleftheriades in Toronto and subsequently at visible frequencies by Xiang Zhang’s group at the University

of California, Berkeley, and Richard Blaikie’s group in Canterbury, New Zealand.

Roberto Merlin was also very influential in clarifying some aspects of the theory. Finally, there was the spectacular experimental confirmation of our ideas on cloaking made by David Smith and his team, who are now at Duke. The really impressive aspect of this field is the breadth and diversity of those who have contributed to it.

>> How will your findings change the field in 10 years? 20 years? What are the lasting implications of your discoveries?

In short: I don’t know. The signature of a really productive field is that you cannot tell where it will wind up next. I have helped light a fuse, but it is up to others to determine where the rocket will ultimately head.

>> Can you share with us the research for which you received the Royal Medal in 2006 and were knighted in 2004?

The citation was for my sustained contributions over many years. I was first active in the field of surface science, in which I worked on the theory of low-energy electron diffraction. This theory was essential to unraveling diffraction data and discovering atomic arrangements at surfaces.

Then, I moved into synchrotron radiation experiments. (In the 1970s, I worked at Daresbury for a time, the U.K. synchrotron center.) In the 1980s, I was into the theory of transport in disordered systems: Anderson localization. Finally, in the early 1990s, I worked on quantum friction and nanoscale heat transport. During this time, my interest in the electromagnetic near field developed—which provided the backdrop to my theory of the perfect lens.

>> How do you work with other research teams to translate your theories into experiments and eventually applications?

Mostly my experimental collaborators are in another lab remote from London. E-mail is vital. These days we use teleconferencing quite a lot.

>> What one person was most influential in your career?

I had an uncle who helped me enormously. He was a teacher of electronics. He recommended books and answered the myriad questions posed by a young child who was very interested in science.

>> What one anecdote or conversation can you recall that is reflective of your career or accomplishments thus far?

I happened to be visiting a medical specialist recently. When I entered his office, he said “You must be THE John Pendry.” I was surprised that he knew of me at all. But his next words were: “You’re the famous urologist!” This served as a good reminder that fame is fleeting

and confined to one’s own narrow area of specialization.

>> What has been your proudest career moment?

That has to be my Knighthood. It is the only one of my achievements that my aunty has heard about.

>> What advice would you give to students working in metamaterials now?

It is a field that draws inspiration from many areas of science, so keep your interests broad and interdisciplinary. That way, you will have more good ideas and find more applications for your work.

>> What are some of the more exciting recent developments in the metamaterials field?

First, the work at radio frequencies, which I believe will very soon lead to products. Secondly, the research at optical frequencies on sub-wavelength resolution. Although this work is at a much earlier stage, it has enormous potential.

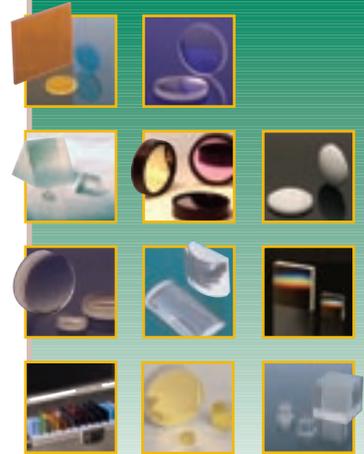
About Sir John Pendry

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.

Pendry is also interested in transport in disordered systems. He produced a complete theory of the statistics of transport in one-dimensional systems. In 1992, he turned his attention to photonic materials and developed some of the first computer codes capable of handling these novel materials. This interest led to his current research on metamaterials. ▲

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