

EMERGING RESEARCH FRONTS - 2009

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Emil Wolf talks with *ScienceWatch.com* and answers a few questions about this month's Emerging Research Front Paper in the field of Physics.



Article: Unified theory of coherence and polarization of random electromagnetic beams

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SW: Why do you think your paper is highly cited?

Because the theory presented in that paper makes it possible to provide solutions to a number of scientific, technological, and medical problems which could not have been done previously.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

The discovery reported in the paper provides a synthesis of two branches of optics, known as the theory of coherence and the theory of polarization of light. Until the publication of my paper, these two subjects had always been treated independently of each other. Prior to the invention of the laser, almost 50 years ago, the available sources which generate light, such as a light bulb and the sun, may be shown to have, on a short time scale, irregularities (called fluctuations) which make it impossible to use such light for some applications. Light of this kind is said to be incoherent.

On the other hand, laser light is said to be coherent, has a much more regular behavior and also is very intense. This makes it possible to utilize it for many different purposes. For example, it is used in ophthalmology for treating some eye disorders such as detached retinas and cataracts; it is used to record and play music; and it has an important role in the operation of computers and supermarket barcode readers at the checkout counters. Roughly speaking, coherence theory is concerned with analyzing the effects of fluctuations.

Another aspect of these fluctuations is known as polarization, a phenomenon utilized, for example, in certain kinds of eyeglasses and in automobile headlights to reduce glare.

SW: Would you summarize the significance of your paper in layman's terms?

Until the publication of my paper, coherence and polarization were treated

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independently of each other. I showed that they are actually intimately related. This discovery makes it possible to solve many problems which were not solvable before.

than 50
years."

SW: How did you become involved in this research and were any particular problems encountered along the way?

I have carried out research regarding coherence for most of my scientific career which now extends over more than 50 years. About six years ago, I started writing a book on the coherence properties of light. In the process of writing it, I had to examine some features of polarization, and after researching it, I discovered the intimate relation between these two areas of optics that has led to the publication of this highly cited paper and also to many papers published on the subject since then. The book, which was published by Cambridge University Press in 2007, and is entitled *Introduction to the Theory of Coherence and Polarization of Light*, presents an account of the new theory and discusses some of its applications.

SW: Where do you see your research leading in the future?

I expect that many applications of the theory will be forthcoming. Some have already been made; they answer questions to some old problems, such as an elucidation of the effects of atmospheric turbulence on the propagation of light through the atmosphere, a subject which is of importance in communications via GPS guidance systems. Another application may well be found in medical diagnostics, particularly in connection with abnormalities in biological tissues. Clarification of some aspects of the propagation of light through optical fibers, which are also used for communication, are also likely to be forthcoming.

SW: Do you foresee any social or political implications for your research?

This research has been supported by the Air Force Office of Scientific Research (AFOSR), located in Arlington, Virginia. I presume that they may be interested in some of the applications I've mentioned; and possibly even in some which might still be forthcoming. As regards social implications, I think that in a broad sense the technological and medical applications which I've already mentioned touch upon this subject.

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