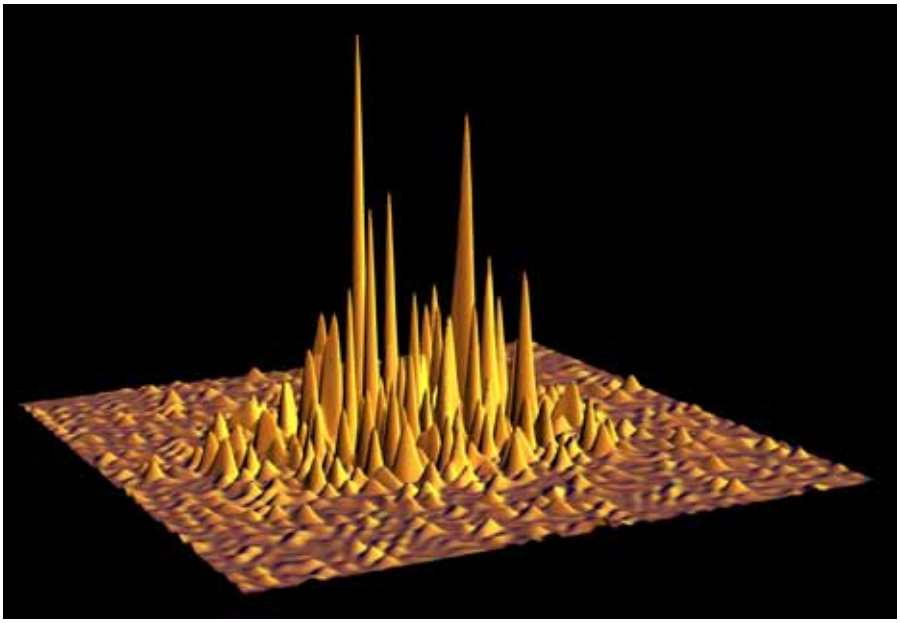
MAKING LASERS FROM DUST: *THE PHYSICS AND APPLICATIONS OF RANDOM LASERS*

Diederik S. Wiersma
European Laboratory for Non-linear Spectroscopy and INFM-BEC
Via Nello Carrara 1
50019 Sesto Fiorentino (Florence)
Italy
www.lens.unifi.it/cs/



The transport of light in complex dielectric structures, ranging from photonic crystals to disordered dielectrics, exhibits a fascinating and sometimes unexpected behaviour. Disordered systems come in many forms like colloidal suspensions and various powders. In these materials, light waves follow a diffusive type of propagation in analogy to the diffusion of electrons in a resistor. Interference effects can survive this diffusive propagation, giving rise to, only recently observed, interference phenomena like weak and strong (Anderson) localization. If optical gain is added to a random material, a unique light source can be obtained called a random laser. Such random laser sources combine the emission properties of a regular light bulb with that of a normal laser and use multiple scattering of light to reach a laser threshold. A random laser can be realized in practice by grinding a laser crystal into a fine powder.

In this seminar we will give an overview of the recent developments in this rapidly growing field of research. In particular, we will discuss the possibility of observing coherent effects from random laser sources and make the connection between interference effects, like Anderson localization, and random lasing. Also we will discuss possible applications of random laser materials obtained by infiltrating a liquid crystal – laser dye solution into porous random systems and by synthesis of optically active polymer dispersed liquid crystals. In the latter case we observe that, due to extremely anisotropic light transport, a fascinating anomalous transport regime can be reached for light waves.

1. *P. Sheng, Introduction to Wave Scattering, Localization and Mesoscopic Phenomena (Academic San Diego, 1995).*
2. *V.S. Letokhov, Zh. Eksp. Teor. Fiz. 53, 1442 (1967) [Sov. Phys. JETP 26, 835 (1968)]; V.M. Markushev, V.F. Zolin, Ch.M. Briskina, Zh. Prikl. Spektrosk. 45, 847 (1986); D.S. Wiersma and A. Lagendijk, Phys. Rev. E 54, 4256 (1996); N.M. Lawandy, et al., Nature (London) 368, 436 (1994); H. Cao, et al., Phys. Rev. Lett. 82, 2278 (1999); D.S. Wiersma and S. Cavalieri, Nature 414, 708 (2001).*
3. *Gottardo, S. Cavalieri, O. Yaroschuck and D.S. Wiersma, Phys. Rev. Lett. 93, 263901 (2004); Mujumdar, M. Ricci, R. Torre, and D.S. Wiersma, Phys. Rev. Lett. 93, 053903 (2004).*