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Title: Anomalous light diffusion in strongly heterogeneous disordered materials

Abstract:
Strongly heterogeneous optical materials are very common in nature, from clouds to powders and foams, to biological tissues. Large-scale non-scattering regions can lead to a modified step length distribution in the random walk trajectory followed by light, which in turn may strongly affect the macroscopic transport process in the material. In this seminar, I will give an overview of our recent theoretical and experimental work on light transport in strongly heterogeneous disordered materials. The first part will be dedicated to systems containing a fractal-type heterogeneity - the so-called Lévy glasses - in which the light transport can be superdiffusive [1]. We will see in particular that important quantities, such as the steady-state light intensity distribution in finite systems, can be predicted semi-analytically by a fractional diffusion approach [2]. The second part of this seminar will be devoted to random media containing non-scattering spherical regions with an arbitrary size distribution. We will see that asymptotic diffusion constant, step length distributions and void-crossing statistics can be analytically predicted via remarkably simple and intuitive formulas [3]. The influence of step correlations due to quenched disorder on transport will finally be discussed.

[1] K. Vynck, J. Bertolotti, P. Barthelemy and D. S. Wiersma, "Superdiffusion of Light in Lévy glasses", in "Optical Properties of Photonic Structures", eds. M. Limonov and R. De La Rue (Taylor & Francis, 2012).
[2] J. Bertolotti, K. Vynck and D. S. Wiersma, Multiple scattering of light in superdiffusive media, Phys. Rev. Lett. 105, 163902 (2010).
[3] T. Svensson, K. Vynck, M. Grisi, R. Savo, M. Burresi and D. S. Wiersma, "Holey random walks: Optics of heterogeneous turbid composites", Phys. Rev. E 87, 022120 (2013).