Multiple scattering and imaging in turbid media

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In order to form an image our eyes rely on the rules of ray optics. The crystalline lens map light coming from different directions to different points on the retina, and together with the knowledge of the lens' accommodation (i.e. the lens' focal length) allows to obtain a reliable picture of our surrounding. Light scattering change the direction of light propagation in a random fashion, so enough scattering effectively wreck our image reconstruction and we are only able to see a shapeless halo. Light scattering is a everyday problem, as anyone who tried to travel in a foggy day knows well, but also has profound implications for biophotonics, where the scattering due to tissues effectively limit our ability to take images only to a shallow depth [1]. If the scattering is not too severe it is still possible to separate the scattered from the unscattered light using gated techniques [2-4], and diffuse wave tomography allows to infer the presence of an object inside a scattering medium from its shadow [5,6], but all the available methods suffer from either limited penetration depth or lack of resolution.

In this talk I will discuss the fundamentals of light scattering and present recent progresses on speckle interferometry techniques, which exploit the correlation present in the laser speckle formed by the scattering of coherent light to reconstruct the shape of an object completely hidden behind a strongly scattering layer [7-9]. Such methods are completely non-invasive and are slowly emerging as a new opportunity for imaging through turbid media.

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