Chez Pierre

Presents ...

Monday, October 24, 2016
12:00pm Noon
MIT Room 4-331

Chez Pierre Seminar

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"Mesoscopic Correlations of Diffusing Light: Controlling Transmission of Radiation in Strong Scattering Media"

A key discovery of the 1980's was the unexpected fluctuation properties of the transmission matrix for disordered electrons in mesoscopic conductors, determined through low-temperature transport measurements. This led to the theoretical prediction of Universal Conductance Fluctuations in the metallic (diffusive) regime: the standard deviation of the conductance was found to be independent of the mean free path and order e^2/h. This result implied the existence of previously unknown correlations in the transmission matrix of any diffusing classical wave system, including electromagnetic waves. In the language of optics, the diffusive speckle pattern is not uncorrelated beyond the speckle size, as believed since Lord Rayleigh; these correlations were later verified by various experimental and numerical studies. A related and also surprising discovery was that for purely elastic scattering there always exist certain input states known as "open channels" which allow transmission with probability unity through a disordered medium with average transmission <T> <<1. This result was not testable with electronic transport due to the inability to control the input electronic state. Moreover if open channels might be accessible in optics was an unresolved question until recently. However the invention of the spatial light modulator about a decade ago made it possible to exert a high degree of control over the wavefront of incident light and search for optimal inputs, renewing interest in these questions. I will review recent theoretical and experimental work at Yale related to this topic [1-3]. The theoretical work provides a random matrix description of coherent control of transmission of diffusive light and predicts the maximum transmission enhancement possible for a given experimental geometry. The experiments demonstrate order of magnitude coherent control of diffusive transmission and very recently have confirmed in detail the predictions of the random matrix theory for the geometry-dependent eigenvalue density. The mesoscopic correlations of diffusing waves are found to play a critical role in enhancing the dynamic range of control via an SLM.

[1] "Filtering random matrices: The effect of imperfect channel control in multiple-scattering", A. Goetschy and A. D. Stone, Physical Review Letters, 111, 063901 (2013).
[2] "Coherent control of transmission of light through disordered media", S. M. Popoff, A. Goetschy, S. F. Liew, A. D. Stone, and H. Cao, Physical Review Letters, 112, 133903 (2014).
[3] "Correlation effects in focused transmission through disordered media", C. W. Hsu, S.-F. Liew, A. Goetschy, H. Cao and A. D. Stone, arXiv 1607.06403 (2016).