Discrepant transport characteristics under Anderson localization at the two limits of disorder

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We report on the experimental and numerical studies on Anderson localization in two-dimensional disordered systems. Our structures are based on photonic crystal templates with introduced disorder, and systematically range from nearly-periodic to completely amorphous disorder. In the amorphous systems, we investigated spectral statistics over an ultrabroad wavelength range of ~600 nm, averaged over numerous configurations. The spectra provided access to several quasimodes, whose widths and separations allowed us to directly estimate the optical Thouless conductance g_{Th}, consistently observed to be below unity, and following a log-normal distribution. Despite being in the Anderson localization regime, the level- spacings were seen to follow an approximate Wigner-Dyson function. We carried out theoretical calculations based on the tight-binding model, modified to include coupling to a bath. The theoretical results were in excellent agreement with experiments, suggesting that the level-spacing behavior arose from the degree of localization in the system[1]. Next, we measured the generalized conductance g' over all disorder strengths. Anderson localization was identified also in the near-periodic disorder. Statistical measurements revealed a discrepant behavior in the fluctuations of g' in the two disorder regimes. Under amorphous disorder, the g' is log-normally distributed. At near-periodic disorder, the distribution is heavy-tailed towards large conductance values. The theoretical model is in excellent agreement with the experiments, and also endorses the results over much larger ensembles[2]. These results quantify the differences in the two disorder regimes, and advance the studies of disorder into actual consequences of Anderson localization in light transport within open mesoscopic systems.

[1] Optical Thouless conductance and level-spacing statistics in two-dimensional Anderson localizing systems
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[2] Discrepant transport characteristics under Anderson localization at the two limits of disorder
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