Controlling coherent light propagation through opaque media

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Transmission channels are building blocks of coherent light transport in opaque media such as white paint, paper, and biological tissue. Wavefront shaping techniques have been developed to selectively couple light into such channels to enhance light transmittance through multiple-scattering media [1,2].

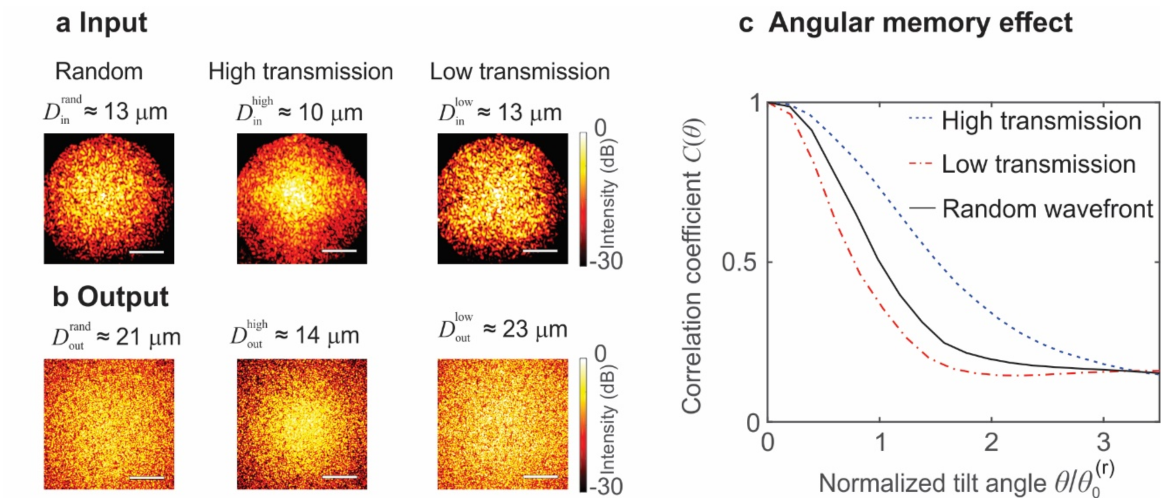

Figure 1: (a), Experimentally measured spatial intensity distribution incident on the front surface of a diffusive sample for random wavefront (left), high-transmission channel (center), and low-transmission channel (right). (b), Corresponding transmitted intensity profiles on the sample back surface. (c) Experimentally measured intensity correlation function $C(\theta)$ of the transmitted speckle patterns as a function of the normalized tilt angle $\theta/\theta_0^{(r)}$ for a high-transmission channel (blue dashed line), a low-transmission channel (red dot-dash line), and a random incident wavefront (black solid line). $\theta_0^{(r)}$ denotes the width of $C(\theta)$ for the random wavefronts where $C(\theta_0^{(r)}) = C(0)/2$, and its value is about 1°.

Here we demonstrate that the transmission channels of a wide diffusive slab exhibit transversely localized incident and outgoing intensity profiles, even in the diffusive regime far from Anderson localization [3]. Transverse localization of high-transmission channels enhances optical energy densities inside and on the back surface of multiple-scattering media, which will be important for imaging and sensing applications.

We further demonstrate that selective coupling of light into a single transmission channel modifies the angular memory effect correlation range [4]. High-transmission channels have a broader range of memory effect than a plane wave or a Gaussian beam, thus will provide a wider field of view for memory-effect-based imaging through opaque media.

Reference

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[3] H. Yılmaz, C. W. Hsu, A. Yamilov, and H. Cao, *Nat. Photonics* **13**, 352-358 (2019).
[4] H. Yılmaz, C. W. Hsu, S. Rotter, A. Yamilov, and H. Cao, *arXiv:1906.06460* (2019).