Spatiospectral Shaping of Pulse Propagation Through Diffusive Media

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The transmission of short pulses through random media is impeded by multiple-scattering, which distorts the pulse's spatiotemporal profile and reduces the peak transmitted power. We have achieved unprecedented control of pulse propagation through a diffusive system by exploring both spatial and spectral degrees of freedom. With spatiospectral shaping of an incident pulse, its diffusion is stopped temporally and then quickly transitions to ballistic-like transport for enhancement of peak transmitted power. Our approach is based on the spatiospectral transmission matrix, which is constructed from frequency-resolved transmission matrices. We obtain a 35-fold enhancement in peak power of transmitted pulse, by controlling 971 spatial and spectral degrees of freedom in a two-dimensional diffusive waveguide. We illustrate the power of spatiospectral shaping by comparing it to spatial-only, spectral-only, sequential spatial and spectral control. Supported by analytic theory and numerical simulations, our results establish the physical limits of manipulating pulse propagation in diffusive media.