Controlling Waves Through Disorder in microwaves: From Inverse Design to Anderson Localization

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Abstract

I will first demonstrate that wave control in disordered media can be achieved not only through wavefront shaping, but also by directly optimizing the disorder itself. Unlike wavefront shaping, inverse design approaches offer a far greater number of degrees of freedom, enabling simultaneous control over multiple modes (1,2). Then, in a second part, I will address the challenge of three-dimensional localization of electromagnetic waves. Previous efforts to observe Anderson localization of light in disordered dielectric media have been hindered by experimental artifacts (3). Recent numerical studies, however, suggest that metallic disorder could support localization. I will present conclusive experimental evidence of three-dimensional Anderson localization of microwaves in disordered metallic aggregates.
(1) Horodynski, M., Kühmayer, M., Ferise, C., Rotter, S., & Davy, M. (2022). Anti-reflection structure for perfect transmission through complex media. *Nature*, *607*(7918), 281-286.

(2) Zhumabay, Z., Ferise, C., Pagneux, V., Rotter, S., & Davy, M. (2025). Inverse design of mirror-symmetric disordered systems for broadband perfect transmission. *arXiv preprint arXiv:2505.01220*.

(3) Skipetrov, S. E., & Page, J. H. (2016). Red light for Anderson localization. *New Journal of Physics*, *18*(2), 021001.
(4) Yamilov, A., et al. (2023). Anderson localization of electromagnetic waves in three dimensions. *Nature physics*, *19*(9), 1308-1313.

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