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A Random Matrix Approach for Understanding Wave Statistics from Wireless Communications to Quantum Dots¹ JEN-HAO YEH, EDWARD OTT, THOMAS ANTONSEN, STEVEN ANLAGE, University of Maryland — Complexity of a wave propagation environment is advantageous from the perspective of wave chaos theory because, in the semiclassical limit, the corresponding ray trajectories of the wave propagation have chaotic dynamical behavior, and a statistical description is most appropriate. Random matrix theory (RMT) successfully describes universal properties of the system. We combine RMT with our random coupling model that includes non-universal effects, such as the radiation impedance of the ports and the effect of short ray trajectories in the system, and we establish a first-principles model for wave statistical properties such as the fading amplitude in wireless communications, the scattering matrix, the impedance matrix, and the thermopower of quantum dots. We also report experimental tests on two ray-chaotic microwave cavities with different degrees of loss. In the high loss regime the results demonstrate that our RMT model agrees with traditional fading models (Rayleigh fading and Rice fading) and provides a more general understanding of the models and a detailed physical basis for their parameters. Moreover, in the low loss regime the RMT approach describes the data better.

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