# Deterministic Models of Randomness in Electromagnetic Systems

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Many types of stochastic phenomena play an important role in electromagnetic phenomena: manufacturing disorder, spontaneous emission, thermal radiation and fluctuations, and even van der Waals or Casimir forces. Directly modeling such effects by an ensemble of random simulations, however, quickly becomes computationally prohibitive. Instead, because normally one is only interested in some form of average effect, there are often methods to directly find the average effect by coupling deterministic simulations with analytical methods. This talk reviews several such techniques, both new and old. A familiar example of this is the use of the local density of states (LDOS) to capture the mean spontaneous emission power of a single particle, but even this method becomes too costly when applied to an ensemble of emitters continuously distributed throughout a fluorescent medium. Instead, there is a class of analytical transformations that can be used to efficiently model the net effect of emitters everywhere in a material, which can be used to accurately calculate fluorescence, near-field thermal radiation, and even fluctuational forces like the Casimir effect. Yet another example of a random effect is computing scattering from manufacturing disorder such as surface roughness in a waveguide, which poses a challenge for direct modeling because of the vast disparity of scales. Perturbative methods such as Born approximations can be used to separate the scales and formulate deterministic calculations of waveguide loss, but standard methods break down at interfaces between high-contrast materials because of field discontinuities that complicate perturbative analysis. Recent approaches have solved this challenge, however, and can be used to predict loss figures of merit for competing waveguide structures and cavity designs. In general, we often find that there are indirect ways to utilize computational modeling tools that are dramatically faster than brute-force replication of reality without sacrificing accuracy.