Strong- and weak-damping limits of the response of enclosures to complex driving.

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At high frequencies, full-wave modelling of the propagation of electromagnetic (EM) radiation within the physical environment, originating, for example, as stray emissions from electronic circuitry or in wireless communication, becomes infeasible. Furthermore, the sources of such radiation may themselves be very complex and therefore by necessity statistically characterized: in the context of EM emissions, for example, it has been found that measurements of two-point field-field correlation functions, rather than of the fields themselves, provide the appropriate vehicle for quantifying stray radiation from electronic circuits [1,2]. Such complexity is further compounded when one must take account of the physical environment, which is especially the case when such radiation takes place in strongly reverberant enclosures.

In this paper, we exploit an approach to modelling the response of such electrically large, driven enclosures that is based on Random Matrix Theory (RMT). It is related to the Random Coupling Model (RCM) [5] in taking advantage of the deep connections that exist between the spectra and eigenvectors of random matrices and those of ray-chaotic cavities, but differs by treating the sources themselves as being independently complex, as they are in problems such as those of electromagnetic compatibility (EMC). As mentioned above, the appropriate vehicle for characterizing the response of such systems is the two-point field-field correlation function (CF) rather than the fields themselves. Treating the CF furthermore allows a direct connection to be made to ray tracing simulations by taking advantage of the relationship between CF's and the Wigner distributions function (WDF), which provides a wave analog of ray-dynamical phase-space densities and approximates them in the average [3,4].

In particular, we provide analytical descriptions of the statistics of fluctuation, about this mean, of CF's in two limits. First, in the high-damping limit where individual resonant frequencies of the cavity are closer than individual resonance widths, there is a simple Gaussian-distributed response which can be entirely described following an estimation of the variance of fluctuation, which is achieved using standard assumptions of RMT: this is the Ericson regime. Second, in the weak-damping limit, we can provide a relatively simple analytical description of the statistics of the response by assuming that correlation between the effect of individual resonances may be neglected. The intermediate regime separating these limits is also successfully described by RMT (in the case of simply ray-chaotic enclosures) although in that case simple analytical descriptions are not available, and some numerical simulation of RMT ensembles has been used.

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