3D Regular electromagnetic cavity made chaotic through spatial microwave modulators

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1 Extended Abstract

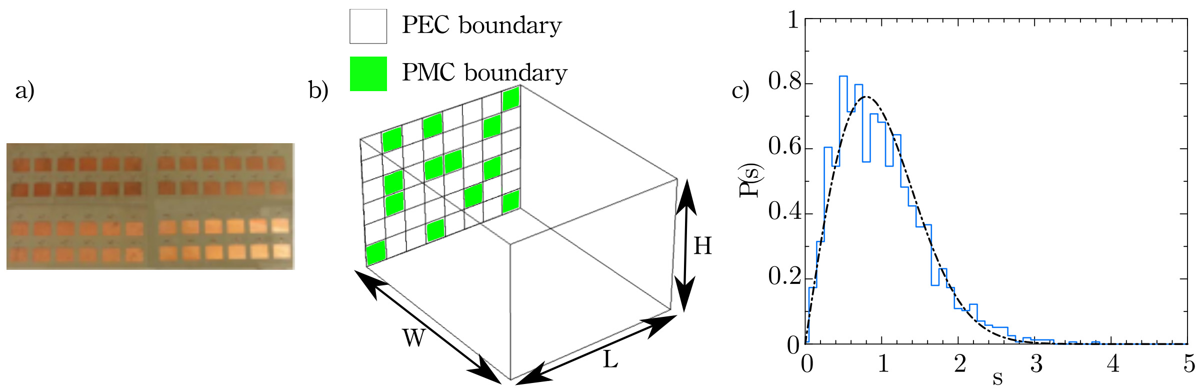

Figure 1. a) Experimental SMM. b) Simulated parallelepipedic cavity made chaotic by means of SMM. Its dimensions are $L = 4c_0/f_0$, $W = 5c_0/f_0$ and $H = 3c_0/f_0$ where c_0 is the speed of light. c) NNSD of 2000 eigenvalues of the cavity b) (blue histogram) compared with the prediction for chaotic systems (black dashed dotted line)

This paper investigates the possibility to transform a regular 3D electromagnetic (EM) cavity into a chaotic one by *only* modifying locally its boundary conditions at several places. This could be carried out experimentally in a parallelepipedic EM cavity whose walls are partially covered with spatial microwave modulators (SMM) [Figure 1.a)]. Indeed, SMM are arrays of resonators that are electronically reconfigurable with simple logical controls and which can switch boundary conditions from quasi perfect electric conductor (PEC) to perfect magnetic conductor (PMC) [1]. In order to study the chaoticity of such a cavity, we follow the approach described in [2] and compare its spatial and spectral statistics with predictions of Gaussian Orthogonal Ensemble of random matrix theory (RMT). Here, we present a numerical simulation of a lossless parallelepipedic cavity, shown in Figure 1.b), where SMM are emulated by an array of square patches among which a fixed number are randomly set to PMC boundary condition. In Figure 1.c), the nearest-neighbor spacing distribution (NNSD) of eigenvalues (blue histogram) of an ensemble of 4 different configurations of the cavity shown in Figure 1.b) is compared with the Wigner surmise (dash dotted line). For each configuration, 500 eigenvalues around $f_0 = 2.4$ GHz are computed by Finite Element Method. A good agreement with RMT prediction for time reversal chaotic systems is observed. For other spectral and spatial statistical quantities, we find again a good agreement with RMT predictions. Therefore, the parallelepipedic cavity of Figure 1.b) displays the universal behavior of wave chaotic systems without any change of its geometry. Due to the non-negligible amount of absorption introduced by the experimental SMM [Figure 1.a)], the experimental validation of this numerical result will be done in the framework of open wave systems, where the statistical predictions are obtained by RMT applied to the effective Hamiltonian formalism [3].

References

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