Experimental Investigation of Statistical Prediction in Wave-Chaotic Enclosures with Aperture Excitation

Hong Soo Park* and Sun K. Hong
School of Electronic Engineering, Soongsil University, Seoul 06978, Republic of Korea, e-mail: hosu0202@soongsil.ac.kr; shong215@ssu.ac.kr

In this presentation, we experimentally investigate the effectiveness of the Random Coupling Model (RCM) on statistical predictions for a wave-chaotic cavity in which incident power enters through an aperture.

Recent studies have demonstrated that the RCM allows predicting statistical properties of waves inside electrically large enclosures in the short-wavelength regime based on wave chaos [1]. Since the statistical prediction through RCM utilizes the impedance parameters of enclosures and ports, it is also possible to calculate the statistics of the induced voltage on ports, which can lead to predictions of electromagnetic (EM) coupling effects on the target of interest [2]. In particular, it is desirable to predict coupling effects in a more practical environment where the input power is incident through the aperture. Although a statistical model for the coupling of incident power entered through an aperture has been theoretically developed [3], experimental verification of the prediction of EM coupling based on the aperture excitation remains a challenge.

Here, we experimentally demonstrate the prediction of the statistical properties and induced voltage in a wave-chaotic enclosure due to an incident EM wave from external radiation through an aperture. The experiment setup consists of a three-dimensional cavity (1.2 m × 1.2 m × 0.7 m) containing a rectangular aperture (0.2 m × 0.15 m), a receiving antenna (Rx), and a mode-stirrer (which generates 200 different sets of ray trajectories), as shown in Fig. 1. Our experimental investigation involves two-stages, namely 1) the free-space propagation stage where the wave is incident on the aperture of the cavity, and 2) the cavity propagation stage where the incident wave undergoes ray-chaotic and couples to Rx with loss parameter α. To obtain the loss parameter representing the statistics on the universal properties of the cavity, the two stages are considered as a cascade system, and the measured aperture impedance and port coupling are converted into a 2×2 impedance matrix. The overall results indicate that prediction using RCM can be achieved even for incident power transmitted through the aperture externally, validating the utility of RCM for various practical scenarios where aperture excitation exists.

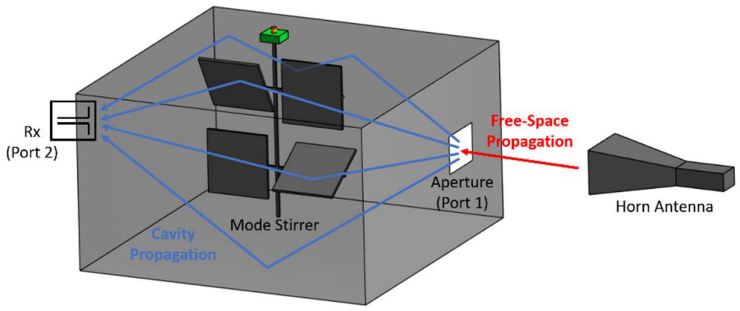

Figure 1. An illustrated view of the two-port cavity with the experimental setup.

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2. J. G. Gil, Z. B. Drikas, T. D. Andreadis, and S. M. Anlage, "Prediction of induced voltages on ports in complex, three-dimensional enclosures with apertures, using the random coupling model," *IEEE Trans. Electromagn. Compat.*, **58**, 5, October 2016, pp. 1535-1540, doi: 10.1109/TEMC.2016.2580301.
3. G. Gradoni, T. M. Antonsen, S. M. Anlage, and E. Ott, "A statistical model for the excitation of cavities through apertures," *IEEE Trans. Electromagn. Compat.*, **57**, 5, October 2015, pp. 1049-1061, doi: 10.1109/TEMC.2015.2421346