Predicting the Nature of Electromagnetic Field Fluctuations in Random Interconnections of Large Complicated Cavities

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Predicting the statistical description of short-wavelength electromagnetic (EM) field scattering within interconnected networks of large complicated cavities is a topic of great interest in wireless communications, electromagnetic compatibility engineering and optical engineering. It can be shown that the ray dynamics of short-wavelength EM scattering within large complicated enclosures is chaotic in nature. In this ray-chaotic regime, predicting the statistics of induced EM field quantities within a large complicated cavity does not require an intimate knowledge of the shape of the cavity or the orientation of its internal scattering features. Rather, the shape and scales of the internal EM field distributions depend on the value of a single, dimensionless, experimentally-tractable, cavity loss-parameter. The existence of this cavity loss-parameter and its use to predict the shape and scales of induced EM field quantities within a large complicated cavity has been documented in previous literature on the Random Coupling Model (RCM). In this presentation, we showcase our ongoing research in fusing the RCM with the Baum-Liu-Tesche (BLT) EM topology approach. The BLT EM Topology is a hierarchical framework based on the multiconductor transmission line (MTL) model for describing the flow of energy between different nodes on a network of MTL segments. In this manner, we extend the predictions of the RCM to span random interconnections of several large complicated cavities. We present experimental results demonstrating the existence of wave-chaotic fluctuations in large mode stirred chambers (MSC) and show its agreement with predictions from RCM. We then present how these fluctuations are affected when considering random interconnections of MSCs (Figure 1). We also present how these fluctuations are modified due to the presence of non-reciprocal media within the cavities. Finally, we present a software tool, which incorporates the RCM and BLT formalisms, and which can be used for predicting the shape and scale of induced EM field distributions within user-specified interconnected networks of large complicated cavities. This research is sponsored by the Office of Naval Research (ONR), the Air Force Office of Scientific Research (AFOSR) and the Air Force Research Laboratories (AFRL) through grants N00014-14-1-0794, FA9550-15-1-0171 and FA9550-15-1-0379.

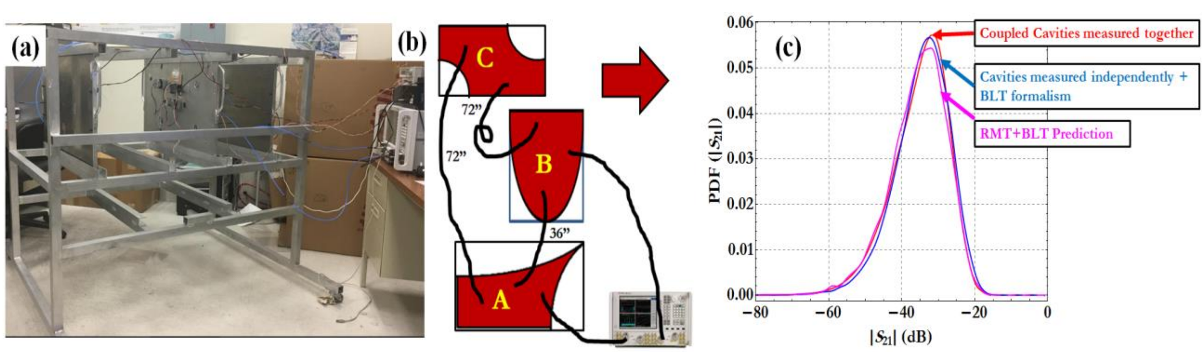

Figure 1: (a) Experimental setup for random interconnection of MSCs (b) Schematic showing one configuration of a network of MSCs. (c) Predictions from RCM+BLT (magenta) in comparison with measured experimental data (blue and black).