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A phase-space approach to the propagation of stochastic fields: from EMC to holography and wireless communications

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In nature and technology, there are many complex sources, such as printed circuit boards (PCBs) that emit electromagnetic radiation that is stochastic. The modeling of such radiation is challenging and a long-standing research issue. We have developed theoretical methods to propagate noisy electromagnetic (EM) fields in free space. In our approach, we use the Wigner distribution function (WDF) to analyze radiation from complex sources in phase space. Our model helps characterize wave propagation both in the near field and far field. This is done by exploiting the relationship between the WDF and correlation function (CF). We also see that the Wigner function approach helps account for the evanescent components and their decay as we propagate the source CF [1]. Our model is validated through experimental results obtained using an Arduino microcontroller printed circuit board (PCB) as the source of stochastic fields. We have extended our model from 2D to 3D and proposed an improved near-field holography method [2].

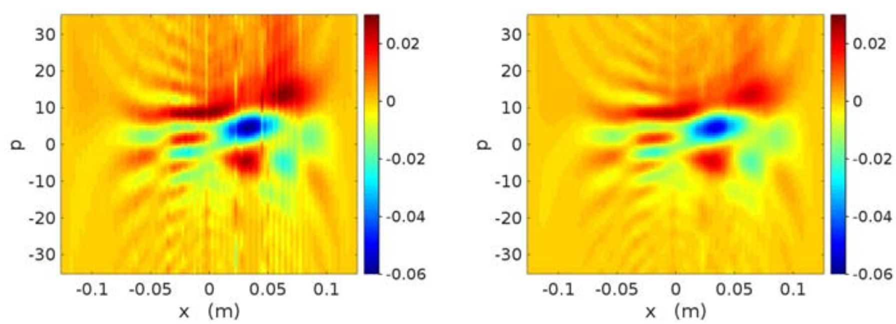

Fig: The WF obtained from measured data at 250 MHz is shown on left and WF obtained using the propagator model on right for z = 0:02 m.

The theoretical framework used for analyzing noisy EM emissions has some formal similarity to the formulation of the channel matrix of multiple input multiple output (MIMO) systems. We therefore propose that the WDF propagation technique may be adapted to be used as a means of providing information on the maximum achievable channel capacity in a given physical environment. A 2D rectangular waveguide is considered as an example for our analysis in this context.

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References

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