Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Modeling Transmission Line Networks Using Quantum Graphs[1]
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Quantum graphs—one dimensional edges, connecting nodes, that support propagating Schrödinger wavefunctions—have been studied extensively as tractable models of wave chaotic behavior (Smilansky and Gnutzmann 2006, Berkolaiko and Kuchment 2013). Here we consider the electrical analog, in which the graph represents an electrical network where the edges are transmission lines (Hul et. al. 2004) and the nodes contain either discrete circuit elements or intricate circuit elements best represented by arbitrary scattering matrices. Including these extra degrees of freedom at the nodes leads to phenomena that do not arise in simpler graph models. We investigate the properties of eigenfrequencies and eigenfunctions on these graphs, and relate these to the statistical description of voltages on the transmission lines when driving the network externally. The study of electromagnetic compatibility, the effect of external radiation on complicated systems with numerous interconnected cables, motivates our research into this extension of the graph model.

[1]Work supported by the Office of Naval Research (N0014130474) and the Air Force Office of Scientific Research.

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Date submitted: 06 Nov 2015 Electronic form version 1.4