Abstract Submitted
for the DAMOP10 Meeting of
The American Physical Society

Propagation of quantized fields through negative-index media
MARTIN LIGARE, Bucknell University — Materials in which both the relative permittivity ϵ and the relative permeability μ are negative exhibit striking optical properties, many of which are the consequence of the fact that the effective index of refraction in these media is negative. Most studies of the propagation of electromagnetic fields in these media have concentrated on classical fields. In contrast, I use simple fully-quantized models to illustrate how some of the striking properties of negative-index media are manifested in the propagation of single photons. The photons in these models originate in the spontaneous emission of idealized two-level atoms, and I follow the spatial and temporal evolution of the intensity expectation value as the field propagates across vacuum-dielectric interfaces and through negative-index media. I also calculate the time-dependent excitation of atoms used as field detectors. The results illustrate the one-photon quantum analogs of the classical group velocity, the classical phase velocity (directed opposite to the direction of propagation), and the focusing properties of negative-index slabs.

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Date submitted: 22 Jan 2010 Electronic form version 1.4