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This grant was used to continue support of our graduate level research program into the complete asymptotic description of ultrawideband signal, ultrashort pulse electromagnetic wave propagation in causally dispersive media and waveguiding systems. Our long-term research goal in this important area is to develop a rigorous, uniform asymptotic description of ultrawideband electromagnetic pulsed beam propagation, reflection, and transmission phenomena in both lossy dielectric and conducting dispersive media that is valid for aritrarily sort rise-time spatial and temporal dynamics of the field as it propagates through the dispersive material.

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A Research Program on The Asymptotic Theory of Ultrawideband Pulse Propagation In Dispersive Media

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This grant was used to continue support of our graduate level research program into the complete asymptotic description of ultrawideband signal, ultrashort pulse electromagnetic wave propagation in causally dispersive media and waveguiding systems. Our long-term research goal in this important area is to develop a rigorous, uniform asymptotic description of ultrawideband electromagnetic pulsed beam propagation, reflection, and transmission phenomena in both lossy dielectric and conducting dispersive media that is valid for arbitrarily short rise-time pulses. A critical aspect of this research is the coupling between the spatial and temporal dynamics of the field as it propagates through the dispersive material.

Three of my students whose research was partially supported by this grant have successfully defended their Ph.D. dissertations. They are John A. Marozas, *Angular Spectrum Representation of Ultrawideband Electromagnetic Pulse Propagation in Lossy, Dispersive Slab Waveguides (1997)*, Hong Xiao, *Ultrawideband Pulse Propagation in Complex Dispersive Media (1998)*, and Chris C. Khamnei, *Open Unstable Optical Resonator Mode Field Theory (1998)*. The results of their research is contained in my publication record for this funding period (reprints attached, if available):

1. J. A. Marozas and K. E. Oughstun, "Electromagnetic Pulse Propagation Across a Planar Interface Separating Two Lossy, Dispersive Dielectrics," in *Ultra-Wideband, Short-Pulse Electromagnetics 3*, C. Baum et al, eds., pp. 217-230 (Plenum Press, New York, 1997).
2. C. M. Balictsis and K. E. Oughstun, "Generalized Asymptotic Description of the Propagated Field Dynamics in Gaussian Pulse Propagation in a Linear, Causally Dispersive Medium," Physical Review E 55, 2, 1910-1921 (1997).
3. K. E. Oughstun and H. Xiao, "Failure of the Quasimonochromatic Approximation for Ultrashort Pulse Propagation in a Dispersive, Attenuative Medium," Physical Review Letters 78, 4, 642-645 (1997).

4. H. Xiao and K. E. Oughstun, "Hybrid Numerical-Asymptotic Code for Dispersive Pulse Propagation Calculations," Journal of the Optical Society of America A 15, 5, 1256-1267 (1998).
5. J. A. Solhaug, K. E. Oughstun, J. J. Stamnes, and P. D. Smith, "Uniform Asymptotic Description of the Brillouin Precursor in a Lorentz Model Dielectric," Journal of the European Optical Society A, Pure and Applied Optics 7, 3, 575-602 (1998).
6. K. E. Oughstun, "The Angular Spectrum Representation and the Sherman Expansion of Pulsed Electromagnetic Beam Fields in Dispersive, Attenuative Media," Journal of the European Optical Society A, Pure and Applied Optics 7, 5, 1059-1078 (1998).
7. J. A. Solhaug, J. J. Stamnes, and K. E. Oughstun, "Diffraction of Electromagnetic Pulses in a Single-Resonance Lorentz Model Dielectric," Journal of the European Optical Society A, Pure and Applied Optics 7, 5, 1079-1101 (1998).
8. P. D. Smith and K. E. Oughstun, "Electromagnetic Energy Dissipation and Propagation of an Ultrawideband Plane Wave Pulse in a Causally Dispersive Dielectric," Radio Science 33, 6, 1489-1504 (1998).
9. K. E. Oughstun and C. C. Khamnei, "Three-Dimensional Field Structure in Open Unstable Resonators. Part I: Passive Cavity Results," Optics Express 4, 10, 388-399 (1999).
10. C. C. Khamnei and K. E. Oughstun, "Three-Dimensional Field Structure in Open Unstable Resonators. Part II: Active Cavity Results," Optics Express 4, 10, 400-410 (1999).
11. J. E. K. Laurens and K. E. Oughstun, "Electromagnetic Impulse Response of Triply-Distilled Water," in *Ultra-Wideband, Short-Pulse Electromagnetics 4*, E. Heyman, B. Mandelbaum and J. Shiloh, eds., pp. 243-264 (Plenum Press, New York, 1999).
12. P. D. Smith and K. E. Oughstun, "Ultrawideband Electromagnetic Pulse Propagation in Triply-Distilled Water," in *Ultra-Wideband, Short-Pulse Electromagnetics 4*, E. Heyman, B. Mandelbaum and J. Shiloh, eds., pp. 265-276 (Plenum Press, New York, 1999).
13. H. Xiao and K. E. Oughstun, "Failure of the Group Velocity Description for Ultrawideband Pulse Propagation in a Double Resonance Lorentz Model Dielectric," Journal of the Optical Society of America B 16, 10, 1773-1785 (1999).
14. K. E. Oughstun, "Asymptotic Description of Ultrawideband, Ultrashort Pulsed Electromagnetic Beam Field Propagation in a Dispersive, Attenuative Medium," to appear in *Ultra-Wideband, Short-Pulse Electromagnetics 5*.
15. K. E. Oughstun and H. Xiao, "Influence of the Precursor Fields on Ultrashort Pulse Measurements," to appear in *Ultra-Wideband, Short-Pulse Electromagnetics 5*.

In addition, our most recent research will be presented as invited papers at two conferences this summer. The first is on the "Asymptotic Description of Pulsed Ultrawideband Electromagnetic Beam Field Propagation in Complex

Dispersive Media," which will be presented in the Special Session on Free and Guided Optical Beams at the Progress in Electromagnetics Research Symposium (PIERS2000) in Cambridge, Massachusetts. The second is "On the Accuracy of Asymptotic Approximations in Ultrawideband Signal, Ultrashort Pulse, Time-Domain Electromagnetics," which will be presented at the joint AP-S/URSI-B special session on Recent Developments in Theoretical Electromagnetics at the 2000 IEEE International Symposium on Antennas and Propagation and USNC/URSI National Radio Science Meeting in Salt Lake City, Utah.