13. ABSTRACT (Maximum 200 words)
1) A hybrid method has been developed which efficiently models a large cavity constructed of a waveguide with a flanged opening at one end that couples it to free space. This method uses adiabatic mode theory to describe the electromagnetic fields in the waveguide (single mode) which is slowly changing and shorted at the far end. A finite difference scheme is used to describe the scattered electromagnetic fields in the exterior. This infinite region is truncated using a non-absorbing boundary condition. 2) A methodology has been developed to extend the above results to more realistic applications. Specifically S-Matrix theory is used to take into account discontinuities in the guide, such as an iris or another flanged outlet. This methodology holds for multi-mode waveguides. 3) Analysis of numerical errors for the FDTD method for pulse propagation in a dispersive media have been substantially refined and extended to the appended integral equation approach. 4) A substantially more efficient alternative to the FDTD method for dispersive media has been developed in one spatial dimension for homogeneous materials. Preliminary exploration of extensions to inhomogeneous materials (including material interfaces) and higher dimensions has begun.

14. SUBJECT TERMS
- electromagnetic fields, dispersive media, waveguide
OBJECTIVES

Our program was involved with the investigation of three classes of electromagnetic problems, which require a blend of asymptotic and numerical methods. The problems we considered arise in
* Microwave Heating of Dispersive Materials; e.g., ceramics and biological tissues,

* Pulse Propagation in Highly Dispersive Media, e.g., biological tissue,

* Scattering by electrically large structures with local fine structure, e.g., periodic coatings and slowly changing ducts,

* Pulse propagation in long distance optical fiber communication systems,

RESULTS OF EFFORT

A hybrid method has been developed which efficiently models a large cavity constructed of a waveguide with a flanged opening at one end that couples it to free space. This method uses adiabatic mode theory to describe the electromagnetic fields in the waveguide (single mode) which is slowly changing and shorted at the far end. A finite difference scheme is used to describe the scattered electromagnetic fields in the exterior. This infinite region is truncated using a non-absorbing boundary condition.

A methodology has been developed to extend the above results to more realistic applications. Specifically S-Matrix theory is used to take into account discontinuities in the guide, such as an iris or another flanged outlet. This methodology holds for multi-mode waveguides.

A new theory for the development of hot spots in microwave heated ceramic fibers has been developed. It incorporates the effects of cavity detuning and higher mode generation. A non-local reaction-diffusion equation governs the temperature along the rod and predicts localized thermal structures.

Analysis of numerical errors for the FDTD method for pulse propagation in a dispersive media have been substantially refined and extended to the appended integral equation approach.

A substantially more efficient alternative to the FDTD method for
dispersive media has been developed in one spatial dimension for homogeneous materials. Preliminary exploration of extensions to inhomogeneous materials (including material interfaces) and higher dimensions has begun.

ACCOMPLISHMENTS/NEW FINDINGS
see above

PERSONNEL SUPPORTED
* Faculty

* Post-Docs
  S. Booker

* Graduate Students

* Other (please list role)

PUBLICATIONS
* SUBMITTED
* Journals


"The Flanged Waveguide Antenna: Discrete Reciprocity and Conservation, Wave Motion, submitted.

* ACCEPTED
* Journals


* Conferences


Series, 1996.

INTERACTIONS/TRANSITIONS
* Participation/Presentations At Meetings, Conferences, Seminars, Etc

AFOSR Nonlinear Optics Workshop, Tuscon, AZ, October 1995,
"Comparisons Between Maxwell's Equations and an Extended NLS Equation."

AFOSR Electromagnetics Workshop, San Antonio, TX, January, 1996,
"Cavity Effects and Hot Spot Formulation in Microwave Heated Ceramic Fibers", G. A. Kriegsmann.

Materials Research Society Spring Meeting, San Francisco, CA, April 1996,
"A Hybrid Numerical Method for Modeling Microwave Sintering Experiments",
C. V. Hile.

Grantees' and Contractors' Meeting: Computational and Physical Mathematics,
WPAFB, Dayton, June 24-26, 1996, "A Finite Difference Method for Highly Dispersive Linear Wave Equations".

Conference on Ordinary Differential Equations, Dundee, Scotland, June 1996,
"A Hybrid Numerical Method for Modeling Microwave Sintering Experiments",
C. V. Hile.


* Consultative And Advisory Functions To Other Laboratories And Agencies

* Transitions

NEW DISCOVERIES, INVENTIONS, OR PATENT DISCLOSURES
None

HONORS/AWARDS