

# Advanced Research in High Performance Scientific Computing

Jun Zhang

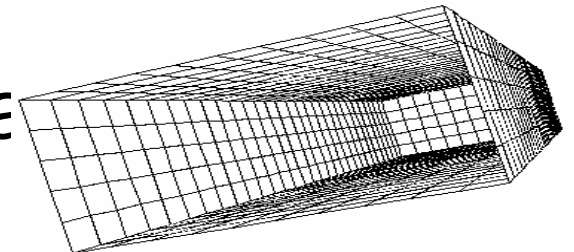
**Laboratory for High Performance Scientific Computing and Computer Simulation**

**Laboratory for Computational Medical Imaging and Data Analysis**

**Department of Computer Science  
University of Kentucky  
Lexington, KY**

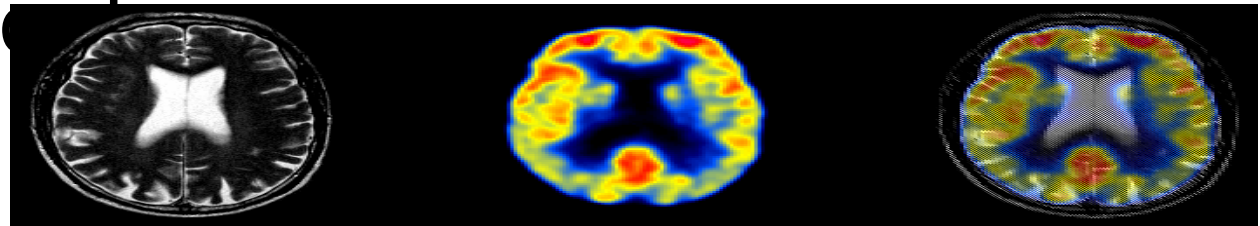
# Laboratory for High Performance Scientific Computing and Computer Simulation


- Director: Dr. Jun Zhang
- National and international visibility
- Parallel scientific and parallel computing
- Computational sciences
- Modeling and simulations in bioinformatics
- Knowledge discovery and data analysis in scientific computing



# Laboratory for Computational Medical Imaging and Data Analysis

- Director: Dr. Jun Zhang
- Computational techniques for medical image analysis and visualization
- Data mining and information system for brain image analysis
- Non-invasive early detection of certain brain diseases





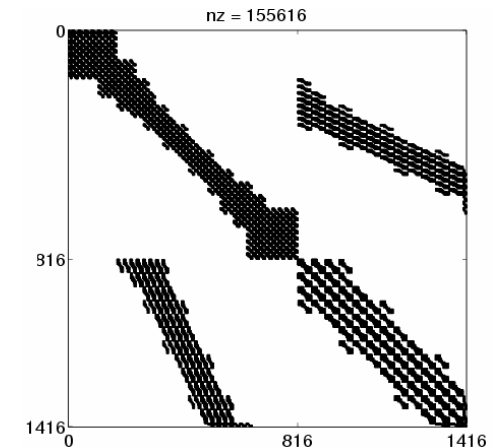
# Mission Statement and Research in CMIDA and HiPSCCS Labs

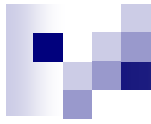
- Study and design robust and efficient numerical algorithms and software packages for solving large scale scientific and engineering problems on high performance computers
- Develop and evaluate software tools and problem solving environments for facilitating parallel and distributed simulation and visualization
- Develop highly accurate and highly efficient computational methods and numerical schemes for simulating physical and engineering processes with a focus on applications in computational fluid dynamics
- Develop efficient algorithms and software for large scale data mining and information retrieval
- Develop efficient computational algorithms for bioinformatics and medical imaging applications
- Promote and popularize high performance scientific computing techniques and practice in general science and engineering research, industrial and medical practices

# Application Areas

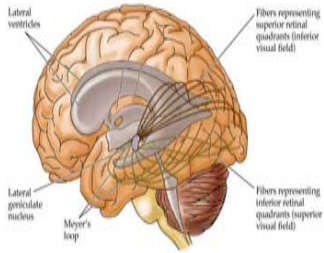


- Medical imaging analysis
  - Fiber tracking in the human brain for early detection of Alzheimer's disease
- Biosimulations
  - Skin burn
  - Diffusion flame
- Computational electromagnetics
  - Electromagnetic scattering problems
- Data mining and information retrieval
  - Terrorism analysis system

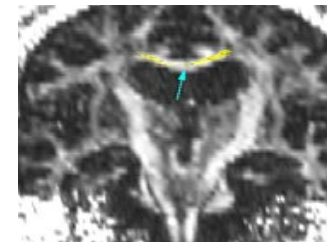
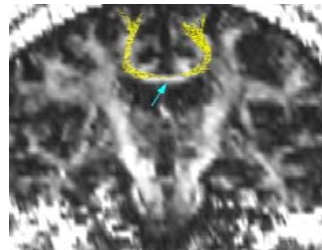




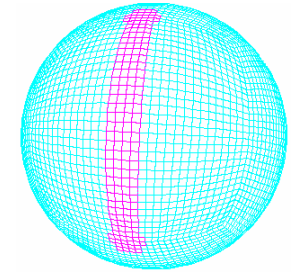
# Function and Connectivity of Human Brain



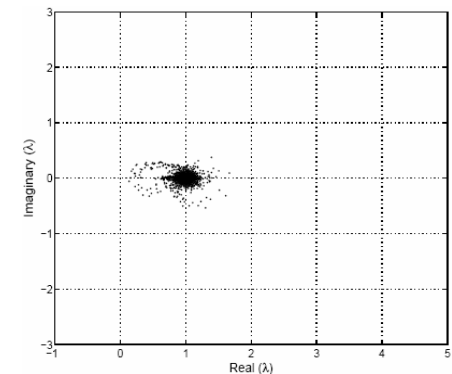
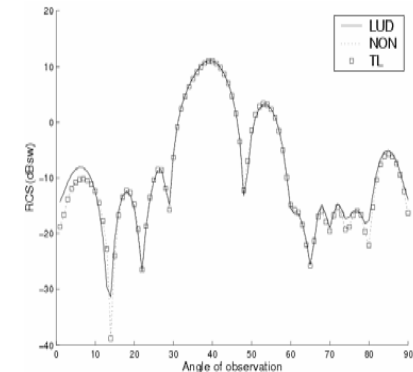
- Magnetic resonance imaging (MRI)
- Tracking brain white matter fiber
- White matter fibers – the connecting wires
- Use of DT-MRI data for fiber tractography
- Diffusion-based tracking technique
- Comparison of healthy & diseased brains



# Computational Electromagnetics

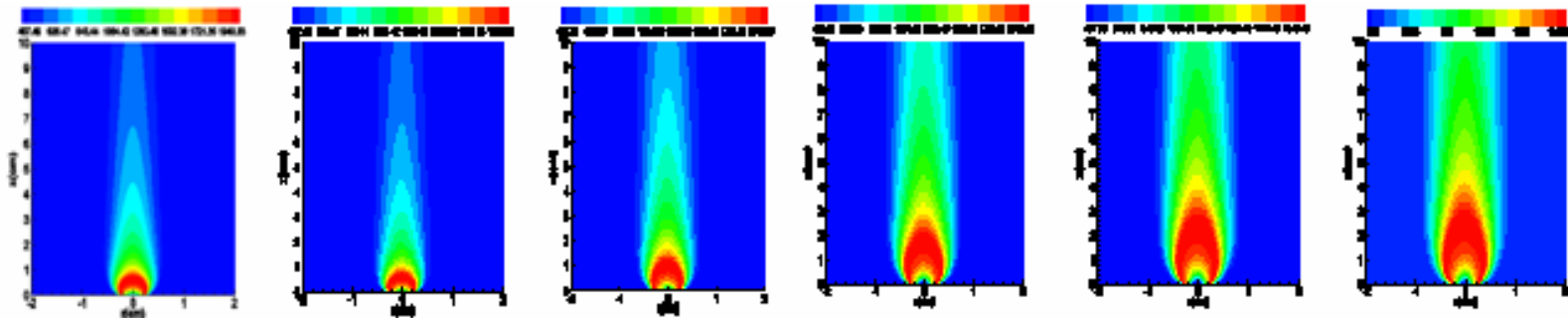


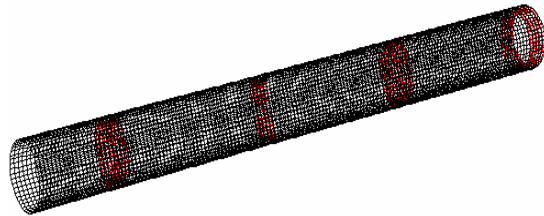
- Electromagnetic scattering problems
- Hybrid integral equations
- Method of moment (MoM)
- Linear systems  $A x = b$
- Fast iterative solvers
- Fast multipole method (FMM)
- Preconditioning techniques



# Steady and Unsteady Laminar Diffusion Flame Simulation

- Computer simulation of laminar diffusion flame
- Applications to bioheat transfer in skin
- Human and firefighter protection
- Biomedical applications





# Personnel and Grants

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- U.S. Department of Energy Office of Science
- Kentucky Science & Engineering Foundation
- Alzheimer's Association
- Research Organization for Information Science & Technology, Japan
- University of Kentucky Research Committee
- University of Kentucky Center for Computational Sciences