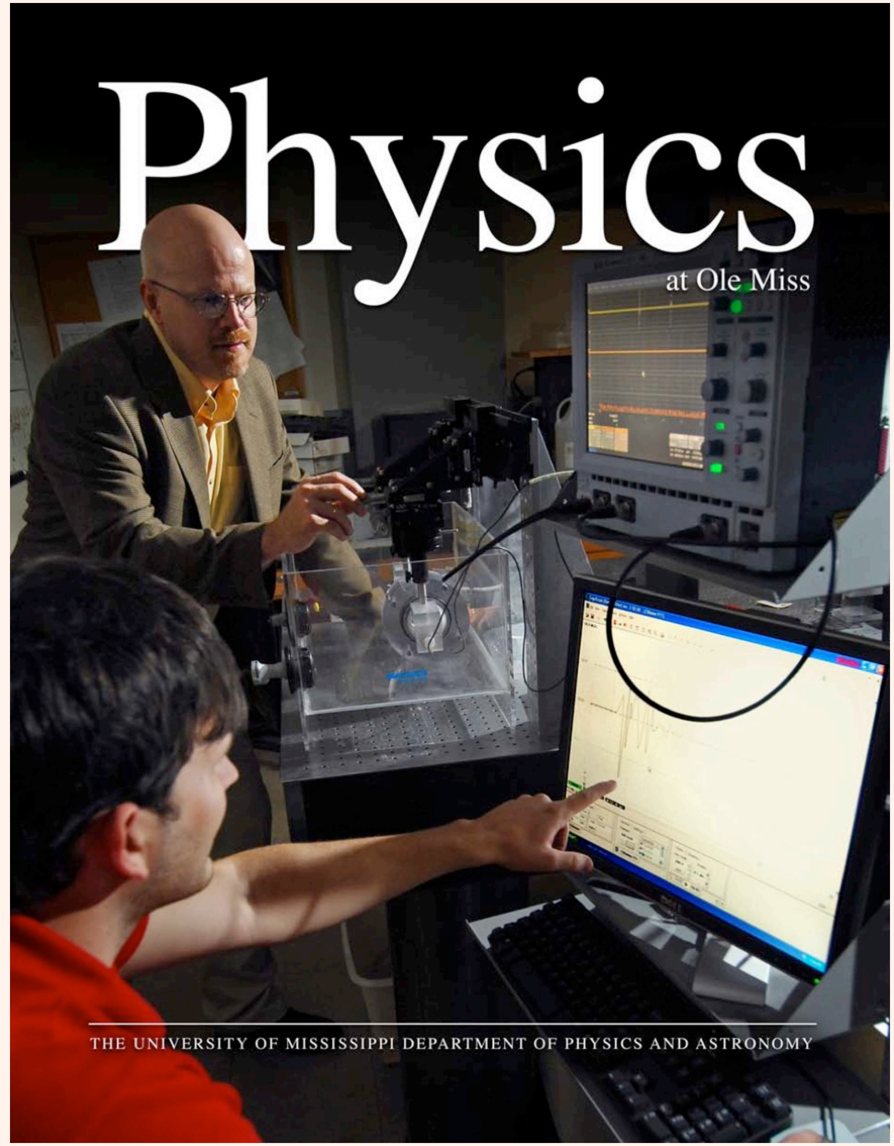
Graduate Studies in Physics at the University of Mississippi

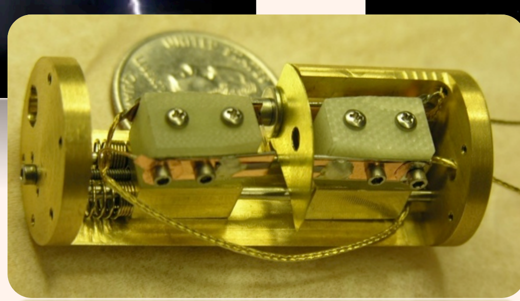
- Faculty: 14
- Including Research Faculty: 35
- Graduate students: 23
- Major Research Areas
    - Physical Acoustics
    - Gravity
    - Condensed Matter
    - High Energy
    - Atmospheric

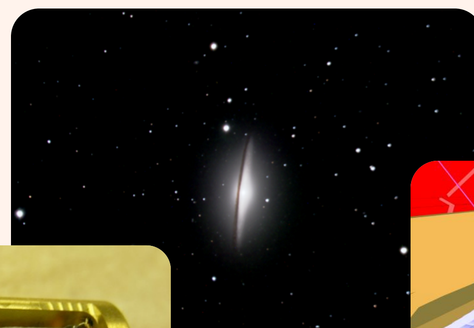


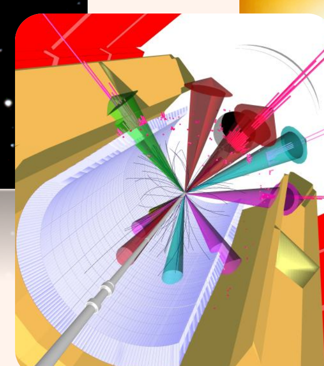
Physics Research at U of M

Research Area	Number of Faculty	Number of Active Grants	2009 Expenditures
Atmospheric	2	1	$108k
Gravity (LIGO)	3	5	$750k
High Energy	4	6	$1,880k
Condensed Matter/ Physical Acoustics	11	3	$440k
	25	40	$10,000k **

** includes all of NCPA research







THE UNIVERSITY OF MISSISSIPPI

Path to a Ph.D.

- 54 credit hours
  (3 out of dept.)
- Preliminary exam (1st year)
- Defense of a Prospectus
  (thesis proposal)
- Defense of a Thesis
- Typical time:
  - ~ 5 years for theory
  - ~ 6 years for experiment

U of M Physics Facilities

- National Center for Physical Acoustics
- 2 machine shops with 5 machinists.
- Computing Farm
  - 160 compute nodes
  - 320 GB memory + 8 TB storage
- Kennon Observatory
- Electronics shop (NCPA).

How to contact us

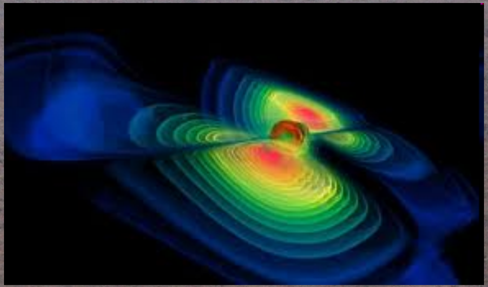
- Website:
  www.phy.olemiss.edu
- Facebook:
  search for
  "mississippi physics"
- Phone: 662-915-7046
- Email:
  - Josh Gladden (Recruiting)
    jgladden@olemiss.edu
  - Luca Bombelli (Graduate Coordinator):
    luca@phy.olemiss.edu

Web Links to Research Groups

- **High Energy**
  http://www.phy.olemiss.edu/HEP/
- **Gravity**
  http://www.phy.olemiss.edu/GR/
- **Condensed Matter**
  http://www.phy.olemiss.edu/CMP/
- **Atmospheric**
  http://www.olemiss.edu/research/atmospheric_physics/
- **National Center for Physical Acoustics**
  http://ncpa.olemiss.edu/

Experimental gravitational astrophysics

Ole Miss is an institutional member of the Laser Interferometer Gravitational-wave Observatory (LIGO) Scientific Collaboration.



LIGO searches for gravitational waves, the “ripples in space-time” predicted by Einstein’s theory of relativity.

LIGO is the major experiment funded by the National Science Foundation. The Ole Miss LIGO group was awarded over $1.2M in the past three years to support students and do research on gravitational astrophysics.

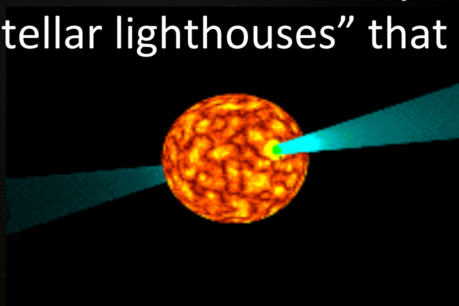
More information at http://ligo.phy.olemiss.edu or email cavaglia@olemiss.edu

Background image: Aerial view of the LIGO Laboratory in Hanford, WA

Theoretical gravitational astrophysics

http://www.phy.olemiss.edu/GR/

When massive stars die, they become black holes or “neutron stars”:
small “stellar lighthouses” that we observe as pulsars



We also see gigantic black holes in galaxies
When galaxies merge, so do these black holes!

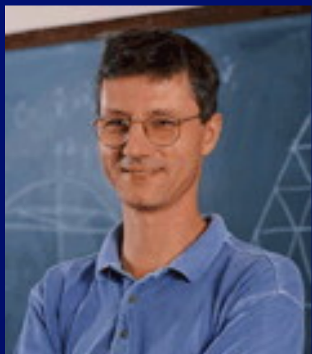
According to Einstein’s theory, the strongest gravitational waves will come from the “death cry” of merging black holes and neutron stars

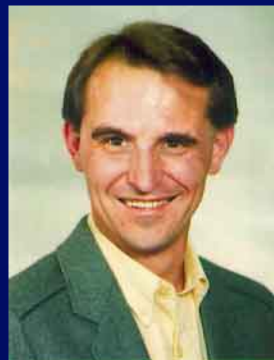
These “death cries” will tell us a lot about the Universe:

1) Was Einstein right?
2) What is the state of matter inside a neutron star?
3) How were black holes born? How did they grow?
4) How did the Universe become what it is today?

For more information: **http://www.phy.olemiss.edu/~berti**
or email: **berti@olemiss.edu**

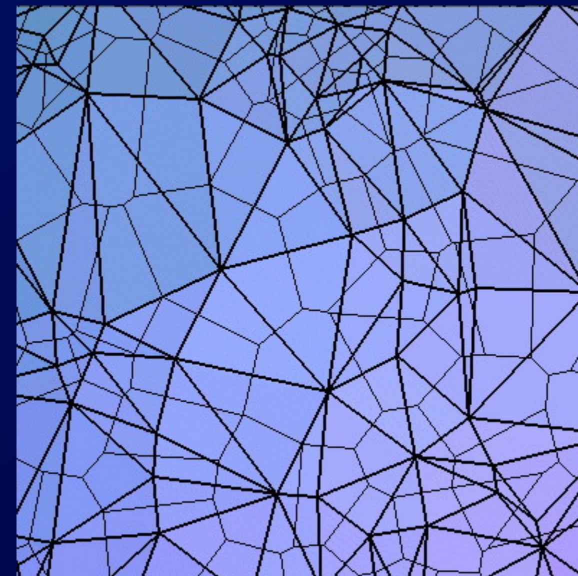
Gravitational Physics: Quantum Gravity and Other Theoretical Aspects


Luca Bombelli


Tibor Torma


Caixia Gao

main activities: loop quantum gravity and quantum gravity in the causal set approach



other projects: black-hole entropy, star clusters and star formation

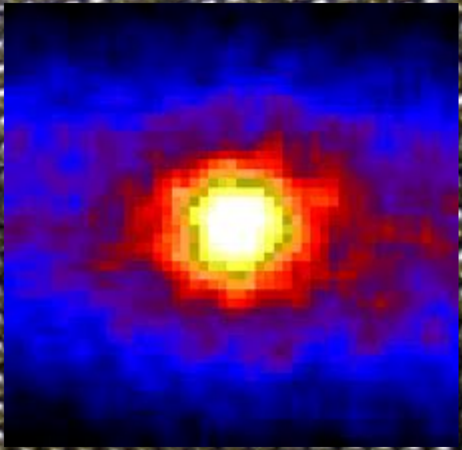
Arif


Brian Mazur

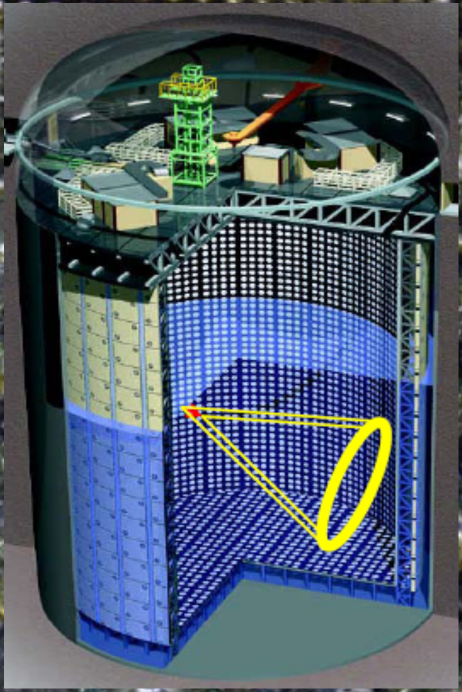

The University of Mississippi

Neutrino Physics

- A neutrino is an elementary particle that is electrically neutral, and has a nonzero tiny mass. There are many sources of neutrinos such as solar, atmospheric, supernova, and reactor neutrinos. Here, the Sun as seen in neutrinos by the Super Kamiokande expt. Trillions of neutrinos pass through our body every second because neutrinos are weakly interacting.



- Neutrino detectors all around the world are trying to study the neutrino properties. In 1998, research results at the Super-Kamiokande neutrino detector determined that neutrinos do indeed flavor oscillate, and therefore have mass.



B meson

- CP violation: All matter have anti-matter. CP violation causes differences in matter anti matter properties.

- CP violation is one of the necessary conditions to explain the matter-antimatter asymmetry in the universe after the Big Bang.

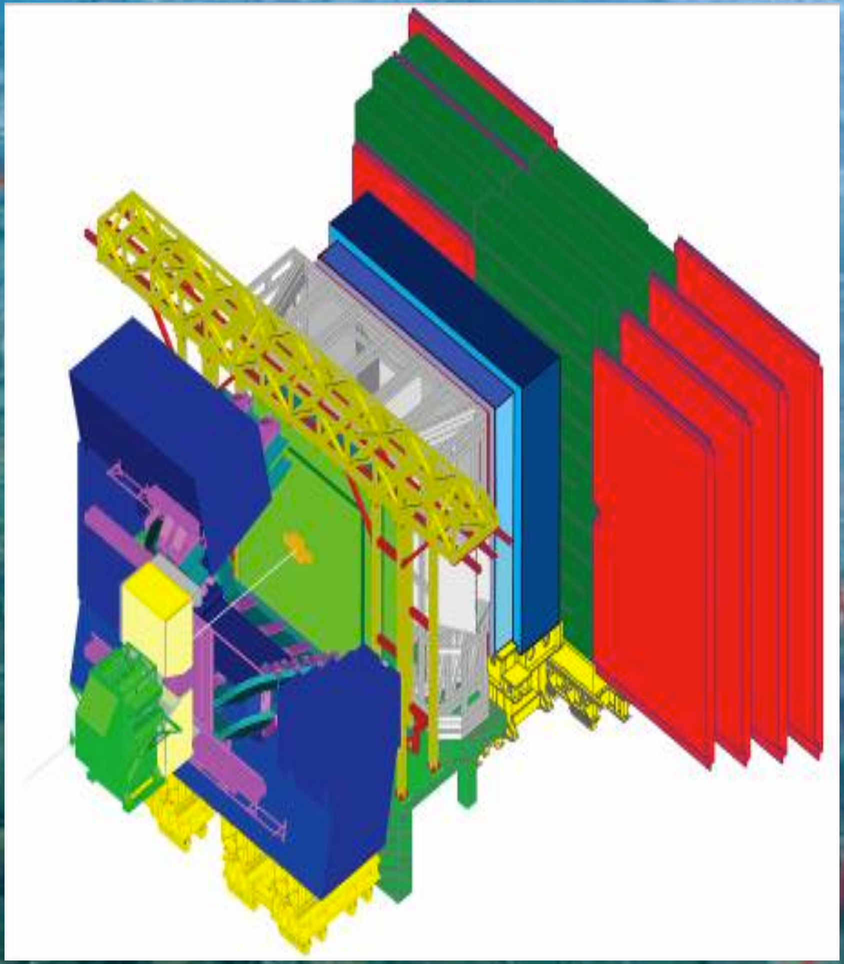
- B mesons are mesons composed of a heavy bottom quark and a light antiquark quark.

- B mesons are excellent source to explore the CP violation.

LHCb @LHC

- A Large Hadron Collider Beauty Experiment is dedicated to the Precision Measurements of CP-Violation and Rare Decays.

- LHCb Collaboration: 14 countries,   47 institutions, ~600 people



<u>Atmospheric Physics</u> at the University of Mississippi

Faculty:

Dr. Thomas Marshall, Professor (marshall@olemiss.edu)
Dr. Maribeth Stolzenburg, Research Associate Professor (mstolzen@olemiss.edu)

Current Graduate Student:

Mr. Sumedhe Karunarathne

Recent Ph.D. Students:

Dr. Baishali Ray, Ph.D. (May 2010). Now teaching at Young Harris College, GA.
Dr. Chris Maggio, Ph.D. (Dec. 2007). Now teaching at Mississippi College, MS.

Current Projects:

- observational studies of lightning initiation and propagation – acquisition and analysis of data from multiple platforms at multiple electromagnetic frequencies, along with high-speed video data, from three field campaigns (2009-2011) at KSC.
- modeling the contribution of thunderstorms and lightning in the Earth's global electric circuit.
- continued data analyses of the electrical evolution, precipitation structure, and lightning development in New Mexico mountain thunderstorms.

Some Recent Media Coverage of our Research:

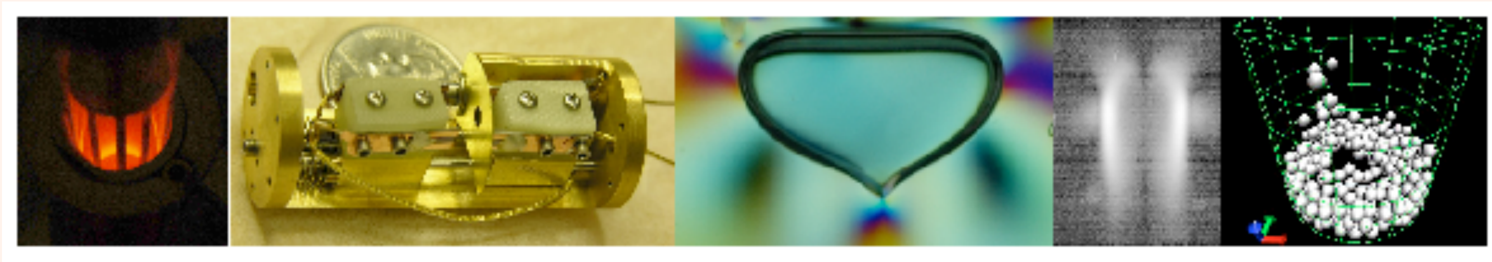
- featured in an upcoming "Field Notes" column by Dava Sobel in *Discover Magazine.*
- interviewed for the "Lightning" portion of *Science Storms,* a new permanent exhibit at The Museum of Science and Industry in Chicago.

Atmospheric Physics at UM *(continued)*

Recent Publications:

- Stolzenburg, M., T.C. Marshall, P.R. Krehbiel (**2010**), Duration and extent of large electric fields in a thunderstorm anvil cloud after the last lightning, *J. Geophys. Res., 115*, D19202, doi:10.1029/2010JD014057.
- Maggio, C. R., T.C. Marshall, M. Stolzenburg (**2009**), Estimations of charge transferred and energy released by lightning flashes, *J. Geophys. Res., 114,* D14203, doi:10.1029/2008JD011506.
- Marshall, T.C., M. Stolzenburg, P.R. Krehbiel, N.R. Lund, C.R. Maggio (**2009**), Electrical evolution during the decay stage of New Mexico thunderstorms, *J. Geophys. Res., 114,* D02209, doi:10.1029/2008JD010637.
- Stolzenburg, M., T.C. Marshall (**2009**), Electric field and charge structure in lightning-producing clouds, *Lightning: Principles, Instruments and Applications*, H.-D. Betz, U. Schumann, P. Laroche (Eds.), 641 pp., Springer, doi: 10.1007/978-1-4020-9079-0_3.
- Davydenko, S.S., T.C. Marshall, M. Stolzenburg (**2009**), Modeling the electric structures of two thunderstorms and their contributions to the global circuit, *Atmos. Res., 91,* 165, doi:10.1016/ j.atmosres.2008.08.006.
- Maggio, C.R., T.C. Marshall, M. Stolzenburg (**2009**), Transient currents in the global electric circuit due to cloud-to-ground and intracloud lightning, *Atmos. Res., 91,* 178,10.1016/j.atmosres.2008.07.008.
- Stolzenburg, M., T.C. Marshall (**2008**), Charge structure and dynamics in thunderstorms, *Space Sci. Rev., 137,* doi: 10.1007/s11214-008-9338-z.
- Betz, H.-D., T.C. Marshall, M. Stolzenburg, K. Schmidt, W.P. Oettinger, E. Defer, J. Konarski, P. Laroche, F. Dombai (**2008**), Detection of in-cloud lightning with VLF/LF and VHF networks for studies of the initial discharge phase, *Geophys. Res. Lett., 35,* L23802, doi:10.1029/2008GL035820.
- Mareev, E.A., S.A. Yashunin, S.S. Davydenko, T.C. Marshall, M. Stolzenburg, C.R. Maggio (**2008**), On the role of transient currents in the global electric circuit, *Geophys. Res. Lett., 35,* L15810, doi: 10.1029/ 2008GL034554.
- Stolzenburg, M., T.C. Marshall (**2008**), Serial profiles of electrostatic potential in five New Mexico thunderstorms, *J. Geophys. Res., 113,* D13207, doi:10.1029/2007JD009495.
- Coleman, L.M., M. Stolzenburg, T.C. Marshall, M. Stanley (**2008**), Horizontal lightning propagation, preliminary breakdown, and electric potential in New Mexico thunderstorms, *J. Geophys. Res., 113,* D09208, doi: 10.1029/2007JD009459.

Condensed Matter Physics



Research

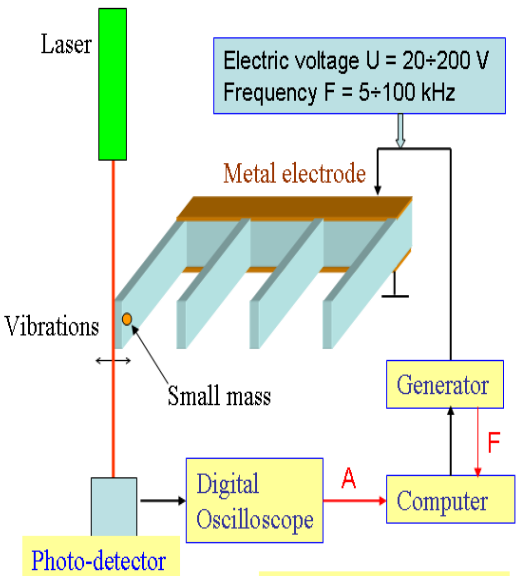
- High temperature and pressure resonant ultrasound spectroscopy (thermoelectrics, metallic hydrides, layered ceramics,…)
- Acoustic and flow properties of viscoelastic fluids
- Granular dynamics in a vortex flow
- Multidomain ferroelectric transducers and cantilevers

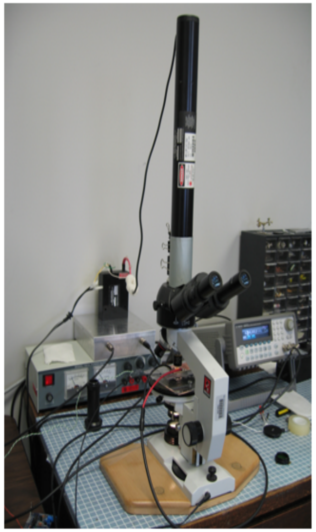
People

- Faculty: J.R. Gladden, I. Ostrovskii, N. Ostrovskaya
- Students: Rasheed Adebisi, Sumudu Tennakoon,
  David Sedarook, Trey Lyons

Nanoscience: Multidomain Ferroelectric Cantilever for Pico-gram mass Detection.
Applications: Detection and Identification of Protein Molecules (including those in air or water).

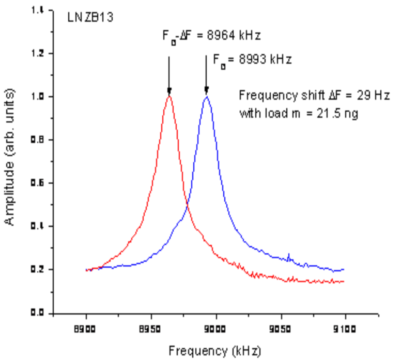
Experimental setup: Excitation and Detection of the Acoustic Vibrations



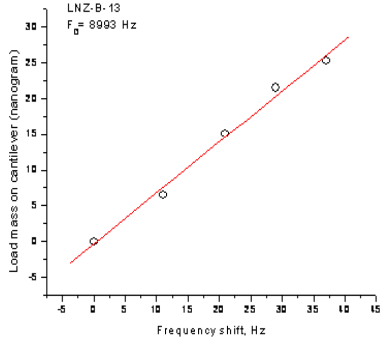


A – vibration amplitude
F – frequency

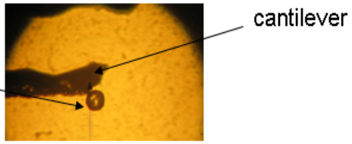
RESULTS: Measurements from fabricated cantilevers

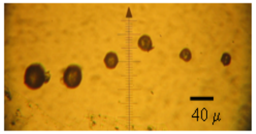


Linearity and calibration of the cantilever



Small masses – paraffin spherical peaces
D = 5÷50 μ and M = 0.1÷60 ng

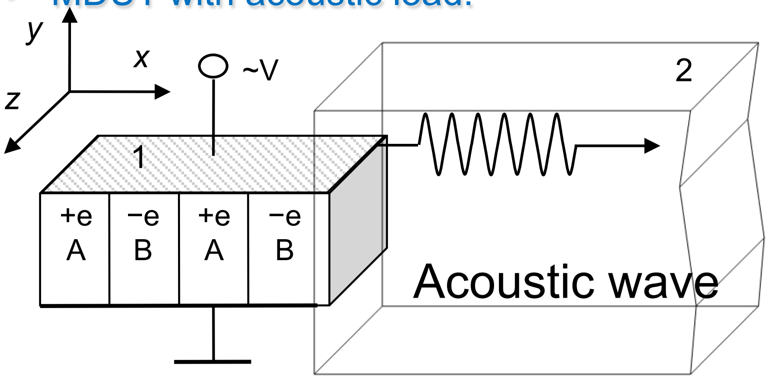


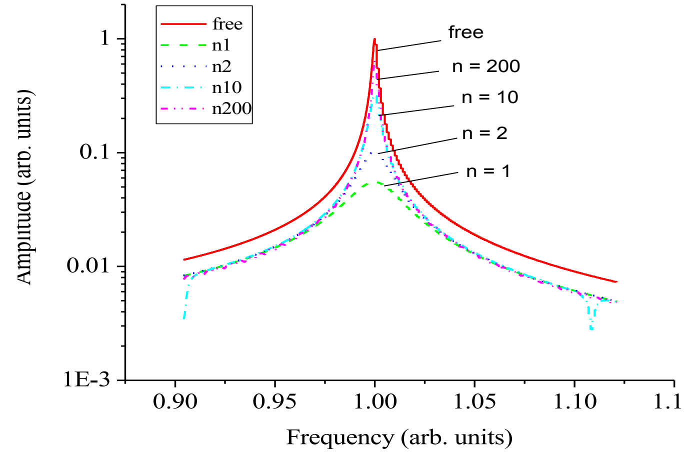


100 pg or 10^{-10} g is the smallest mass measured in our experiments

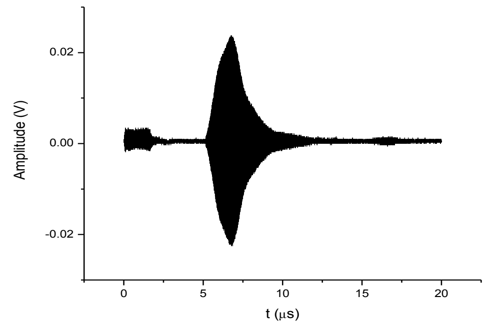
NEW Multi-Domain Ultrasonic Transducers (MDUT)

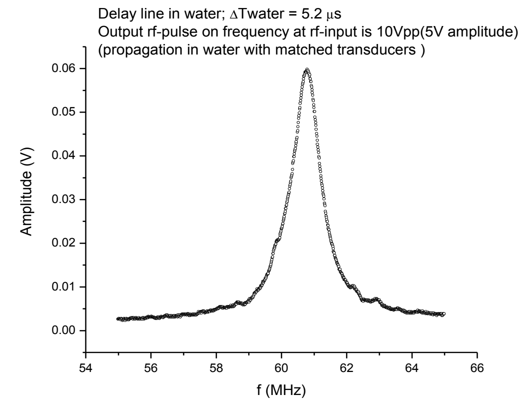
- We fabricated MDUTs based on $LiNbO_3$ and $LiTaO_3$.
- MDUT with acoustic load:





60 MHz MDUT: Lab prototype, LTZA17a, b (98 m domain period)





- Multi-Domain ultrasonic transducer is developed and ***patented***.
- Lab models of $LiNbO_3$ and $LiTaO_3$ MUTs are fabricated
- Analytical theory is developed for 2D MDUT
- Theory is in a good agreement with the experiments
- Applications of MUT are for Ultrasonics and Medicine.

$$U_n(\omega) = V \frac{e_{21}}{c_{11}^E} \frac{d}{h} \frac{1}{\gamma d} \frac{Tanh(\frac{\gamma d}{2})}{1 + Z \cdot Coth(n\,\gamma d)}$$

Wind Noise Program

Richard Raspet—Professor
Jeremy Webster—R&D Engineer
Kevin Dillion—Masters
Jiao Yu—Masters and Ph.D.
JohnPaul Abbott—Masters, current Ph.D. student

Program: - Develop theories for wind noise measured outdoors
- Relate measured wind and wind turbulence to pressure measurements

Anemometers

Microphones

From no quantitative theories in the literature when the University started this research program to theories for:

- Spherical wind screens
- Streamlined probes
- Intrinsic pressure fluctuations above the ground and at the surface

Publications:

R. Raspet, J. Webster, and K. Dillion. "Framework for wind noise studies," *J. Acoust. Soc. Am.* **119**, 834 (2006).

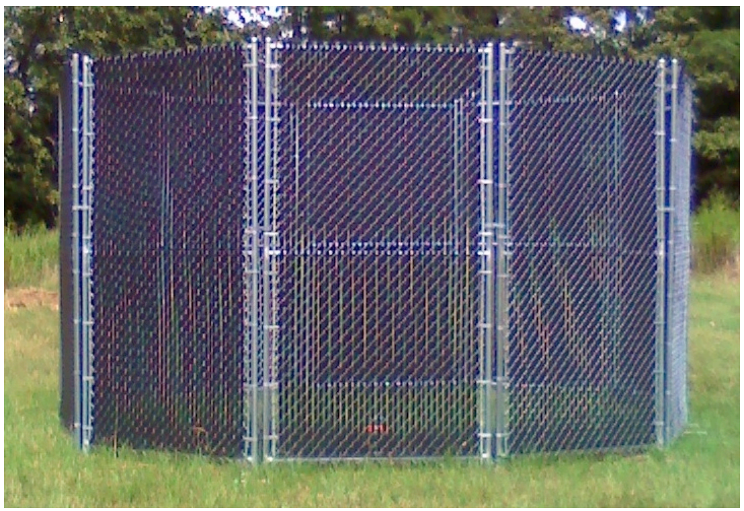
R. Raspet, J. Webster, and J. Yu. "Low frequency wind noise contributions in measurement microphones," *J. Acoust. Soc. Am.* **123**, 1260 (2008).

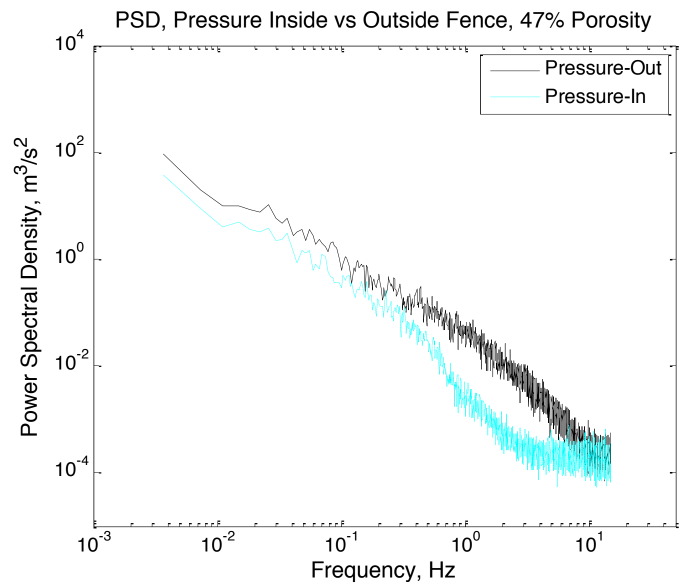
J. Webster, R. Raspet, J. Yu, and W. Prather, "Measurement of wind noise levels in streamlined probes," *J. Acoust. Soc. Am.* **127**, 2764 (2010).

J. Yu, R. Raspet, J. Webster, and J. Abbott, "Wind noise measured at the ground surface," (accepted for publication, *J. Acoust. Soc. Am*)

New Work

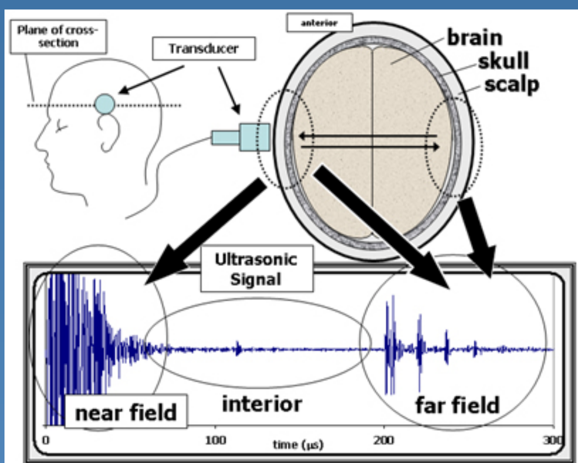
Large screens for infrasound and long range sound propagation



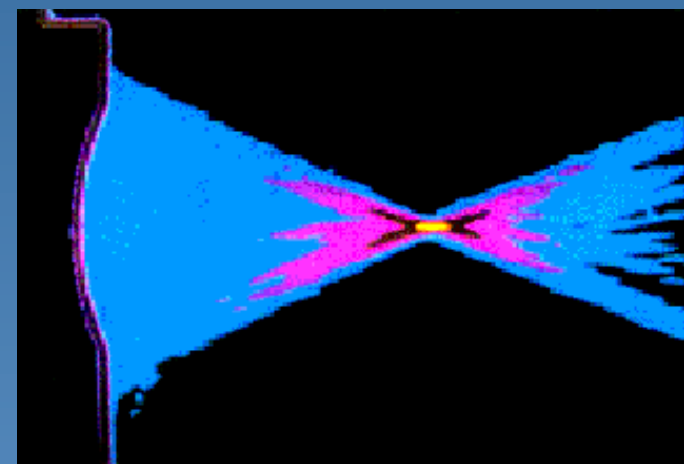


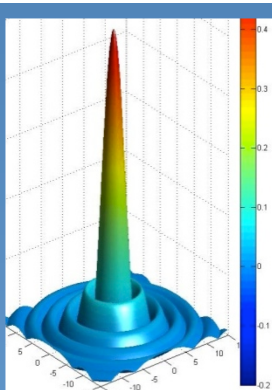
Next: - Wind noise under trees
- Radiation

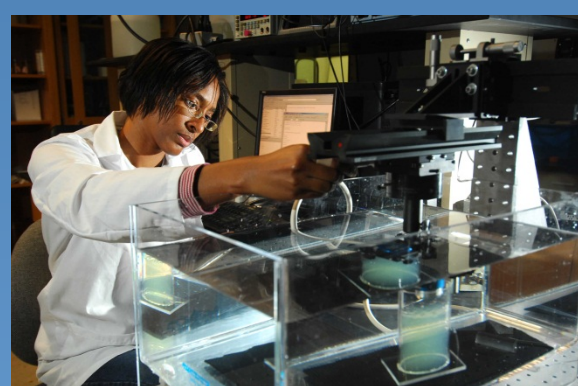
Biomedical Ultrasound

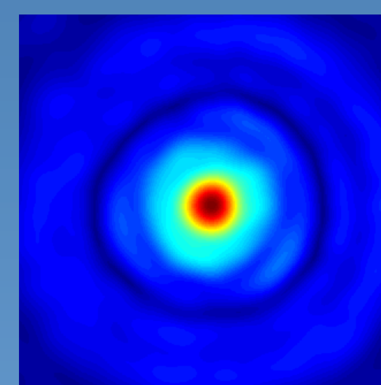


- Detection of brain trauma
- Remote ultrasonic surgery
- High-intensity fields
- Diagnostic applications



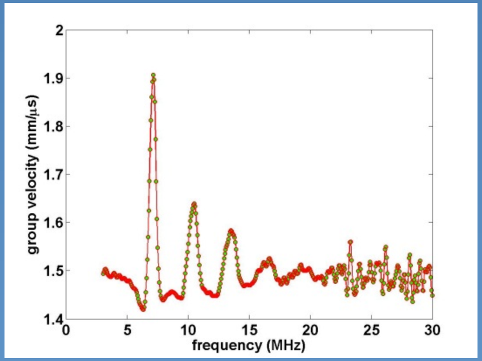


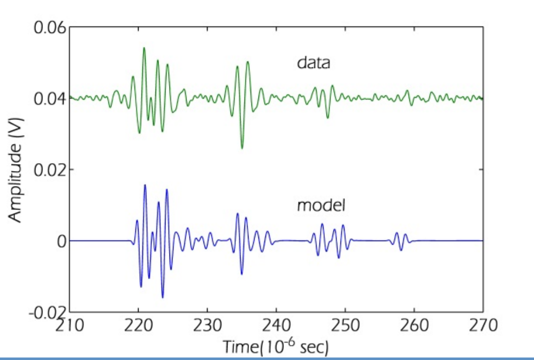


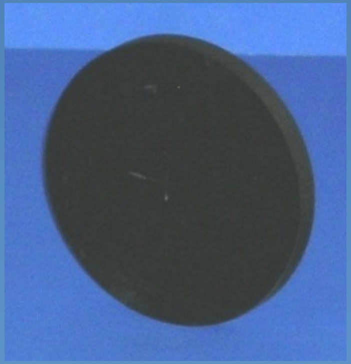


Physical Ultrasonics

- Disordered Media
- Phononic Metamaterials
- High Power Cavitation
- Causal Methods
- Materials Characterization







Undergraduate Summer Research: **Basic Acoustics Summer School**

at the
National Center for Physical Acoustics

University of Mississippi

Summer 2011

National Center for Physical Acoustics

Established 1986, facility construction 1989

$13.5M in research funding

57 Full-time employees

21 Graduate Students

8 Undergraduate Students

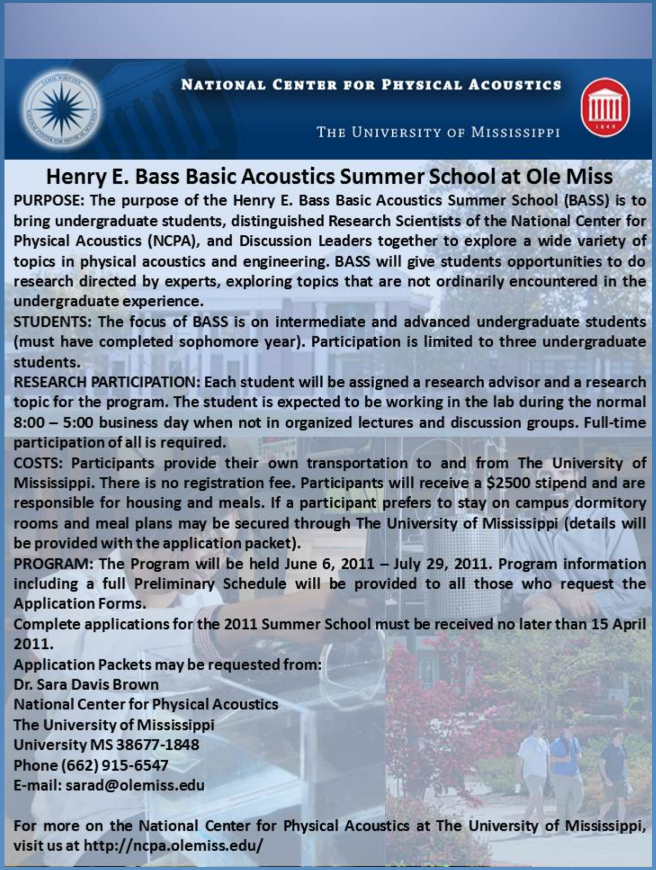
<u>Research areas include:</u>
aeroacoustics, infrasound, materials science, biomedical ultrasonics, atmospheric propagation, laser vibrometry, underwater acoustics

Physics, Chemistry, Biology, Engineering, …

BASS Program

- Eight week summer research program for undergraduates

- Work directly with staff scientists and engineers at NCPA



NATIONAL CENTER FOR PHYSICAL ACOUSTICS

THE UNIVERSITY OF MISSISSIPPI

Henry E. Bass Basic Acoustics Summer School at Ole Miss

PURPOSE: The purpose of the Henry E. Bass Basic Acoustics Summer School (BASS) is to bring undergraduate students, distinguished Research Scientists of the National Center for Physical Acoustics (NCPA), and Discussion Leaders together to explore a wide variety of topics in physical acoustics and engineering. BASS will give students opportunities to do research directed by experts, exploring topics that are not ordinarily encountered in the undergraduate experience.

STUDENTS: The focus of BASS is on intermediate and advanced undergraduate students (must have completed sophomore year). Participation is limited to three undergraduate students.

RESEARCH PARTICIPATION: Each student will be assigned a research advisor and a research topic for the program. The student is expected to be working in the lab during the normal 8:00 – 5:00 business day when not in organized lectures and discussion groups. Full-time participation of all is required.

COSTS: Participants provide their own transportation to and from The University of Mississippi. There is no registration fee. Participants will receive a $2500 stipend and are responsible for housing and meals. If a participant prefers to stay on campus dormitory rooms and meal plans may be secured through The University of Mississippi (details will be provided with the application packet).

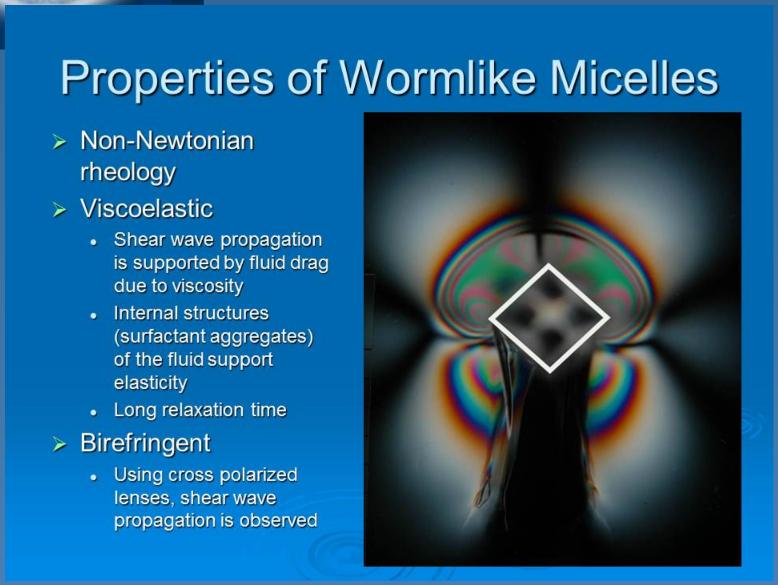
PROGRAM: The Program will be held June 6, 2011 – July 29, 2011. Program information including a full Preliminary Schedule will be provided to all those who request the Application Forms.

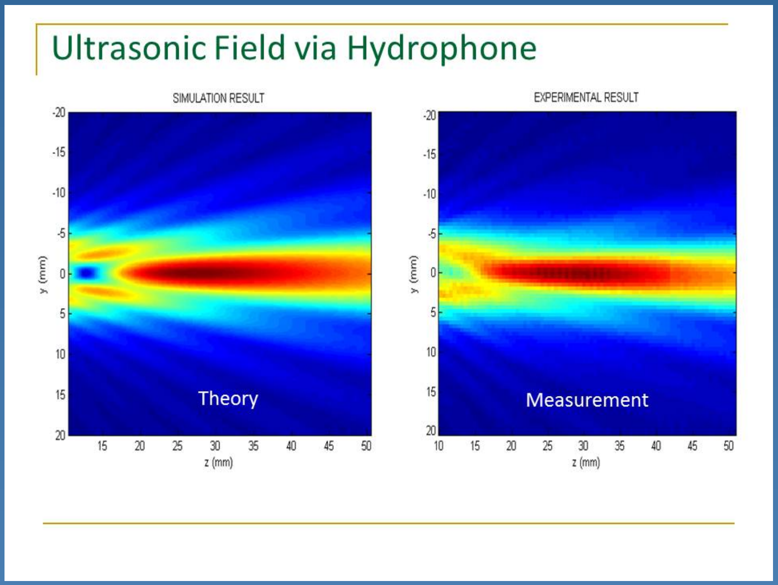
Complete applications for the 2011 Summer School must be received no later than 15 April 2011.

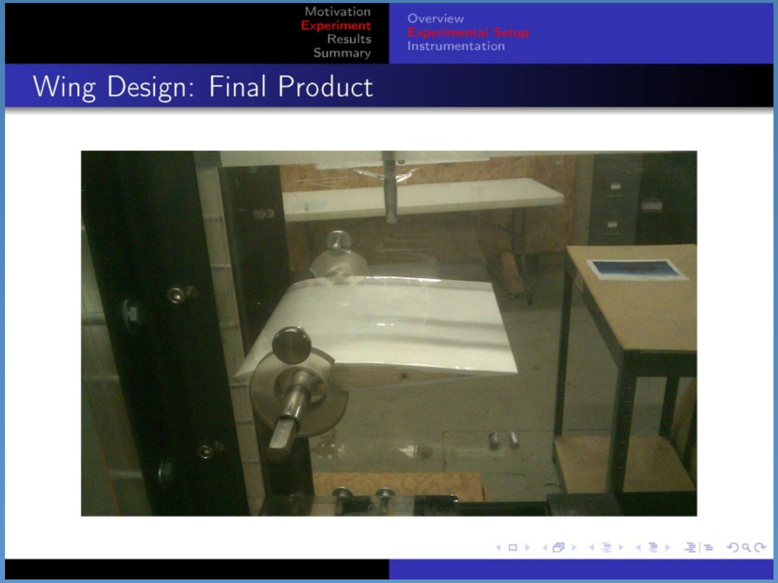
Application Packets may be requested from:
Dr. Sara Davis Brown
National Center for Physical Acoustics
The University of Mississippi
University MS 38677-1848
Phone (662) 915-6547
E-mail: sarad@olemiss.edu

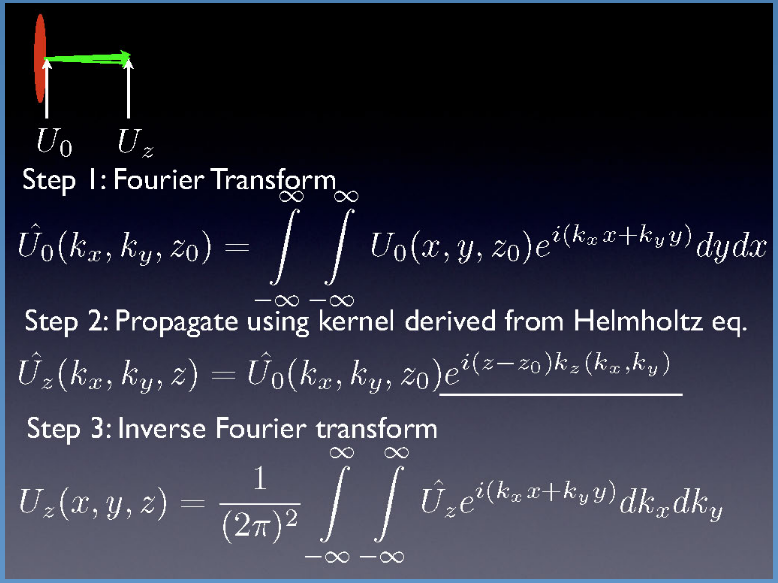
For more on the National Center for Physical Acoustics at The University of Mississippi, visit us at http://ncpa.olemiss.edu/

2010 Student Projects



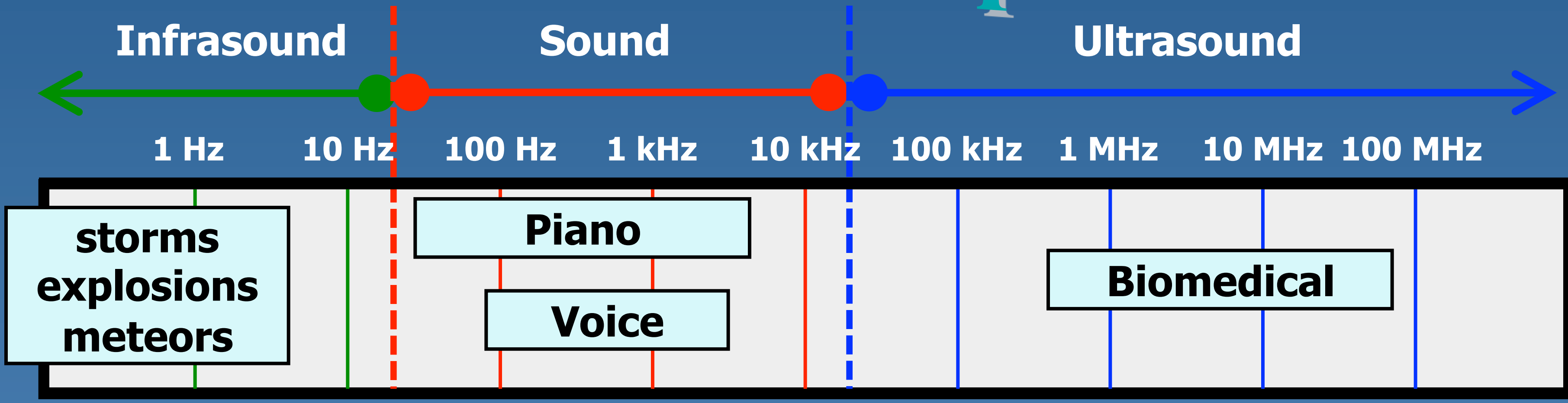






Inaugural Class 2010

The Acoustic Spectrum



Research at NCPA

Infrasound

Remote detection of high energy atmospheric events

Wind filters for infrasonic transducers

Sound

Vibrations in aerospace structures

Jet noise

Aquaculture

Laser vibrometry

Atmospheric propagation

Ultrasound

Materials characterization

Resonant spectroscopy

Highly dispersive structures

Biomedical applications

Condensed Matter/Soft materials

Faculty Emails by Research

- **High Energy**
  - Lucien Cremalid: cremaldi@phy.olemiss.edu
  - Don Summers: summers@phy.olemiss.edu
  - Rob Kroeger: kroeger@phy.olemiss.edu
  - Breese Quinn: quinn@phy.olemiss.edu
  - Alakabha Datta: dattav@phy.olemiss.edu
- **Gravity**
  - Luca Bombelli: luca@phy.olemiss.edu
  - Marco Cavaglia: cavaglia@phy.olemiss.edu
  - Emanuele Berti: berti@phy.olemiss.edu
- **Atmospheric**
  - Tom Marshall: marshall@phy.olemiss.edu
  - Maribeth Stolzenburg: mstolzen@phy.olemiss.edu
- **Condensed Matter / Solid State**
  - Igor Ostrovskii: iostrov@phy.olemiss.edu
  - Josh Gladden: jgladden@olemiss.edu
  - Viktor Klymko: vick@olemiss.edu
- **Physical Acoustics**
  - Rich Raspet: raspet@olemiss.edu
  - Jim Sabatier: sabatier@olemiss.edu
  - Roger Waxler:rwax@olemiss.edu
  - Joel Mobley: mobley@olemiss.edu
  - Cecille Labuda: cecille@phy.olemiss.edu
  - Craig Hickey: chickey@olemiss.edu
  - Charlie Church: cchurch@olemiss.edu
  - Ken Gilbert: kgilbert@phy.olemiss.edu
  - Zhiqu Lu: zhiqulu@olemiss.edu