# The $5^{th}$ Meeting of the MidSouth Chapter of the Acoustical Society of America

# The University of Mississippi Oxford, MS 38677

# October 30-31, 2009

# Meeting Proceedings

**Meeting Schedule:**

| **Friday, October 30** | | **Location: Lewis Hall** |
|---|---|---|
| 1:00-2:00PM | : | Registration |
| 2:00-5:00PM | : | Afternoon Session |
| 5:00-7:00PM | : | Dinner on your own |
| 7:00-10:00PM | : | Physics Dept "Spooky Demos" |

| **Saturday, October 31** | | **Location: NCPA** |
|---|---|---|
| 7:30-8:30AM | : | Registration Coffee & Donuts |
| 8:00-10:00AM | : | Morning Session |
| 10:00-10:45AM | : | Break & Poster Sessions |
| 10:45-11:30AM | : | Morning Session |
| 11:30-12:30AM | : | Lunch & Business Meetings |
| 12:30-3:00PM | : | Afternoon Sessions |

**Meeting Location:** The Friday sessions will be at Lewis Hall, Room 100, and Saturday sessions will be in the National Center for Physical Acoustics' auditorium both located on the University of Mississippi campus. Check the Chapter website for campus maps.

**Announcements:** The next meeting of the MidSouth Chapter of the Acoustical Society of America will be in the Spring of 2010 in Conway, AR at the University of Central Arkansas.

Check the chapter website:

`http://www.acosoc.org/RegChapters/MidSouth/`

for more details about the upcoming meeting in the months ahead. Special thanks to Jim Sabatier and Jim Chambers at NCPA for organizing this meeting.

# Oral Abstracts

**Friday, October 30** at Lewis Hall.

**2:00-2:15PM**

**Our Physics Department.** Lucien Cremaldi (Dept. of Physics & Astronomy, The University of Mississippi, Oxford MS 38677, cremaldi@phy.olemiss.edu)

The Department of Physics and Astronomy is housed in Lewis Hall (1939) and in the Lewis Research wing (1995). A primary function of the department is to provide instruction to hundreds of undergraduate students in basic courses in physics and astronomy. We also have our physics degree program, offering two undergraduate degrees, a Bachelor of Science and Bachelor of Arts Degree. We graduate 5-10 majors each year. We have a close connection to the Honors College on campus, teaching five honors physics and honors astronomy each year. Many of our students are involved in senior research projects on campus. Physics majors are eligible for a number of departmental scholarships. We are proud of our long history in astronomy and hold public viewing nights and also special labs in observational astronomy involving astro-photography from the Kennon Observatory, located near Lewis Hall. An equally important function of the department is to perform cutting edge research, addressing fundamental questions about the nature of matter and the Universe. We offer both M.S. and Ph.D. advanced degrees in a variety of fields including. Atmospheric Physics, Gravitational and Particle Physics Theory, Nuclear and Particle Physics, Physical Acoustics, and Solid State Physics. We have close ties to the National Center for Physical Acoustics where a number of our faculty and students perform research, Much of our research takes place off campus for example at the Fermi National Accelerator (FNAL), the Stanford Linear Accelerator (SLAC), the European Organization for Nuclear Research (CERN), and the Laser Interferometer Gravitational Wave Observatory (LIGO), A brief history of the physics department from its origins in 1848 leading up to our current programs will be presented.

**2:15-5:00PM**

**Concepts in Architectural Acoustics.** Lee Bolen (Dept. of Physics & Astronomy, The University of Mississippi, Oxford MS 38677, bolenleen@bellsouth.net)

When sound energy is produced, the propagation and reception of the sound is modified by the environment in which in which the sound is transmitted, absorbed, reflected, and diffused. In this paper the effects of the environment on sound produced indoors will be examined. The spoken word and popular and music of a variety of types are generated in classrooms, auditoriums, and lecture halls. The varieties of sounds produced and the complexities of the human ear make it difficult to build a one size fits all hall space with appropriate acoustic properties. It is necessary to start with the perception of sound and to describe some of the characteristics of the human ear. Sound produced in an auditorium is greatly modified by the characteristics of the room. The size, shape, and types of reflective and absorptive surfaces in the room can enhance or reduce the character of the sound for the listener. We will discuss these three characteristics of a room in some detail and discuss how each parameter modifies the sound for the listener and performer. With knowledge of the types of speech or music for which an auditorium is intended, we can discuss the important variables for good acoustic design in new auditoriums and for modifications to existing spaces. We will also describe the principles for appropriate sound reinforcement systems and illustrate examples of good design. Finally we will visit and discuss the characteristics of several auditoriums on

campus that were designed and intended for different uses.

**Saturday, October 31** at NCPA.

**8:00-8:30AM**

**Research Overview of National Center for Physical Acoustics.** John Seiner (National Center for Physical Acoustics, University of Mississippi, 1 Coliseum Drive, University, MS 38677, jseiner@olemiss.edu)

The National Center for Physical Acoustics (NCPA) opened its door for research 20 years ago in 1989. Its primary charter was to develop acoustic technology that would provide a competitive advantage for U.S. and Mississippi business and at the same time provide a pool of well trained professionals in Physical Acoustics. The objective of this paper is to provide a brief overview of the research currently being conducted at the NCPA. Research at the NCPA is divided into four groups: Basic Research led by Dr. Ken Gilbert who manages efforts concerning the Army Center of Excellence in Acoustics and the Global Infrasound Network for detecting violators of the Comprehensive Nuclear Test Ban Treaty; Applied Research led by Dr. Jack Seiner who manages the Jet Noise & Mach 5 Wind Tunnel Facilities which are currently developing noise reduction concepts for the Navys F-18 Super Hornet and the Modern Air Force weapons bay; The Soil/Porous Media Group led by Dr. Jim Sabatier who has developed the most advanced Laser Doppler Vibrometer in the world and was successfully used for land mine detection; Physical Science Applications group led by Dr. Rich Raspet who deals with advanced cavitation power technology, resonant ultrasound spectroscopy for materials characterization of advanced materials, and medical ultrasound. All four of these areas will be discussed in some detail. The NCPA is also moving into the area of energy conservation with new programs in Wind Turbines, HHO technology for automobiles, and hydrogen storage using palladium.

**8:30-9:00AM**

**Acoustics Research and the Center for Earthquake Research and Information.** Charles Langston (Center for Earthquake Research and Information, University of Memphis, 3876 Central Ave., Suite 1, Memphis, TN 38152, clangst@memphis.edu)

The Center for Earthquake Research and Information (CERI) is a Tennessee state agency and Tennessee Center of Excellence at the University of Memphis. Its mandate includes academic research into the causes and consequences of earthquakes, monitoring regional and local earthquakes under the auspices of the Advanced National Seismic System, and public outreach through K-12 information programs and important partnerships with the US Geological Survey and West Tennessee Seismic Safety Commission. CERI maintains 137 seismic stations in seismic networks that include the New Madrid Seismic Zone region of Arkansas-Missouri-Kentucky-western Tennessee and the East Tennessee Seismic Zone that includes eastern Tennessee-North Carolina-Virginia-Georgia. These seismic networks often record infrasound acoustic events that sometimes generate inquiries from the public who believe they are earthquakes. In November 2003 the New Madrid network recorded infrasound from a large bolide that was studied to determine trajectory information and acoustic/seismic coupling at numerous seismic stations. This network also recorded sonic booms from the reentry of Space Shuttle Discovery in November 2007. Other network acoustic events are more enigmatic and it is difficult to determine the source of acoustic waves. In addition to seismic network studies, an experimental acoustic/seismic array was constructed to examine seismic coupling of thunder infrasound. This array also recorded the demolition of the Baptist Hospital in downtown Memphis, TN, at a surprising long range of over 50km. There are plans to augment the New Madrid seismic network with an array of infrasound sensors to study local earthquake infrasound and to identify anomalous acoustic events.

**9:00-9:15AM**

**Infrasound Detection Using a Large Ring Laser.** Robert Dunn (Hendrix College, Department of Physics, 1600 Washington, Conway, Arkansas 72032, dunn@hendrix.edu)

In the process of using a large ring laser to measure the rotational components of seismic waves, strong signals in the 7.2 mHz regime were detected from hurricanes in the Gulf of Mexico. In addition, infrasound responses from volcanoes have also apparently been detected. Whether the infrasound couples directly into the ring laser or couples into the ground and is detected as ground vibrations is an open question. A review of these results will be presented.

**9:15-9:30AM**

**Elastic Constants of Palladium Hydride at Elevated Temperature and Pressure.** Rasheed Adebisi*, Guangyan Li, Josh Gladden (University of Mississippi National Center for Physical Acoustics , 1 Coliseum Dr., University, MS 38677, raadebis@olemiss.edu)

Hydrogen is known to occupy the octahedral interstices provided by the palladium atoms. Palladium hydride (PdHx) exists in two phases, at low concentration (PdH0.02) the lattice parameter deviates a little from that of pure palladium. Above this concentration the second phase appears and the lattice parameter becomes substantially greater than that of pure palladium. The two phases coexist at certain critical temperature and pressure. Resonant Ultrasound Spectroscopy (RUS) has been used to investigate the elastic constants of palladium hydride up to and around the critical temperature and pressure of the palladium hydride crystal. The investigation includes the design and construction of high temperature and high pressure RUS cell.

**9:30-9:45AM**

**High-temperature Elastic Constant Measurements of Thermoelectric Silicon Germanium Alloys.** Guangyan Li*, Rasheed Adebisi, Josh Gladden (University of Mississippi National Center for Physical Acoustics , 1 Coliseum Dr., University, MS 38677, gyli@phy.olemiss.edu)

The elastic properties of several doped silicon germanium (SiGe) alloys were studied using our in-house high-temperature resonant ultrasound spectroscopy (RUS) system. SiGe alloys are state-of-art high-temperature (near 1000C) thermoelectric (TE) power generation materials. The TE efficiency of SiGe alloys can be improved by doping at varying levels. Consequently, the elastic properties of doped SiGe alloys will differ from undoped ones. The knowledge of the elastic properties of doped SiGe alloys at high temperatures is required for studying material properties and making reliable TE power generation devices. RUS is an acoustic technique that uses the measured resonance modes of a properly prepared sample to infer the elastic constants of the material. Two high-temperature transducer systems, a direct-contact system and a buffer-rod system, were employed in this study. The temperature trends and specific features of the elastic constants of these polycrystalline samples will be presented and discussed. The irreversible annealing effects in some SiGe alloys will be discussed. The advantages and disadvantages of two high-temperature transducer systems will also be briefly addressed.

**9:45-10:00AM**

**Spectral analysis of ultrasonic backscatter from bone.** Brent Hoffmeister (Rhodes College, Department of Physics, 2000 North Parkway, Memphis TN, hoffmeister@rhodes.edu)

Ultrasonic techniques are being developed to detect changes in bone density caused by osteoporosis. We have proposed that ultrasonic backscatter measurements may be a useful approach. Phase cancellation effects and the natural inhomogeneity of bone tissue can cause backscatter signals to vary dramatically from site to site in a measurement region. In addition, the backscatter power spectrum from a single site typically shows a very complicated frequency dependence. In this study we investigate the utility of averaging backscatter spectra acquired from multiple sites in a measurement region. Spatial averaging reveals that the backscattered power decreases smoothly and monotonically with frequency. Simple parameters based on the spatially averaged backscatter spectra are found to correlate well with bone density, suggesting that this approach may be useful for diagnosing osteoporosis.

**10:00-10:45AM**
Break & Poster Sessions

**10:45-11:00AM**

**Speckle noise in laser Doppler vibrometers.** Vyacheslav Aranchuk (National Center for Physical Acoustics, University of Mississippi, University, Mississippi 38677, aranchuk@olemiss.edu)

Laser Doppler Vibrometry has become a common technique for vibration measurements, offering significant advantages due to its non-contact nature over traditional vibration sensors. When a laser Doppler vibrometer (LDV) is used for measurements of a target with optically rough surface, the light scattered from the target and mixed with a reference beam is the speckle field. The in-plane and angular motion of the target causes variation of the intensity and the phase of speckles, thus generating the noise at the vibrometer output. This speckle noise can exceed the instrumental noise of a LDV and often defines the noise floor of measurements, greatly affecting the LDV performance. The speckle noise is caused by the combined effect of spikes in the demodulated velocity signal and the phase fluctuations of speckles. The origins of LDV speckle noise and methods of its reduction are presented.

**11:00-11:15AM**

**Modeling the LDV Signal in Photoacoustic Spectroscopic Detection of Explosives.** Logan Marcus (National Center for Physical Acoustics, University of Mississippi, University, Mississippi 38677, LSMarcus@olemiss.edu)

Different techniques for photoacoustic signal detection have been developed since its inception as a spectroscopic method. The authors have proposed a method of detection of the photoacoustic signal from solids using a laser Doppler vibrometer (LDV). The photoacoustic effect and the molecular properties of the explosive sample, 2,4,6-trinitrotoluene (TNT), will be examined through the lens of spectroscopic detection. LDV signal detection will be discussed in the light of the physical processes that are involved in the photoacoustic effect. An analytical model of the phenomena underlying the change in phase of a LDV probe beam resulting from the photoacoustic effect from a condensed sample has been constructed. The model takes into account two phenomena responsible for changing phase of the LDV probe beam.

**11:15-11:30AM**

**Cavitation Threshold Dependence on High Static Pressure.** Kenneth Bader (University of Mississippi National Center for Physical Acoustics , 1 Coliseum Dr., University, MS 38677, kbader@olemiss.edu)

The creation of a bubble in a liquid is energetically favorable when the liquid is subject to a net/ an overall tension less than of its saturated vapor pressure. This gain is offset by the creation of a liquid-vapor/gas interface, and only bubbles larger than some critical size will spontaneously grow. The magnitude of the acoustic pressure required to produce a cavity of the critical size is the termed the cavitation threshold of the liquid. The dependence of the cavitation threshold on hydrostatic pressure has previously been reported up to 130 bar in terms of electrical power applied to the acoustic driving transducer. These measurements used a standing wave set-up in a stainless steel spherical resonator (24.1cm outer diameter, 1.9 cm thick) with a $Q > 10{,}000$ when fluid loaded. This work will extend into higher pressure regimes and will be used to extrapolate the cavitation threshold at 1kbar. Also, a sensor will be incorporated to report the cavitation threshold in terms of pressure instead of electrical power.

**11:30AM-12:30PM**
Lunch & Business Meetings

**12:30-12:45PM**

**Application of FEM Analysis to the Design of Non-Uniform Vibrating Beams with Harmonic Overtones.** William Kirkland* and Sally Anne McInerny (Mechanical Engineering Department, University of Alabama at Birmingham, Birmingham, AL 35294-4461, rocwbk@yahoo.com)

Vibraphones are traditionally three octave instruments of range F3 to F6 (175 to 1403 Hz). Compared with the ranges of the marimba (C2 to C7, 65 to 2093 Hz) and xylophone (C3 to E7, 130 to 2637 Hz), the musical range of the vibraphone can be viewed as severely limited by the musician. Furthermore, vibraphone and other mallet percussion instrument beams are tuned by manually adjusting the undercut using a trial and error process. As such, this method is highly labor and time intensive resulting in a greater monetary cost for the end user. This research seeks to reduce tuning time and labor cost by applying finite element analysis (FEM) to the design, and CNC machining to the manufacture, of vibraphone bars. We also seek to extend the range of the vibraphone to four octaves, F2 to F6 (88 to 1403 Hz). The end result will be a more cost effective instrument which, due to the added base register, is viable as a solo performance instrument. The research to be undertaken builds on the work of Bustamante (1991). Bustamante defined the bar cut by parabolic equations based on Timoshenko Beam theory which were shown to result in beams with harmonic frequencies and overtones. In this research, FEA analysis (including an optimization) and CNC machining will be used to mill Aluminum alloy 6061 beams with the parabolic undercuts defined by Bustamantes equation. These beams will be tested in the laboratory to verify the sound generated is consistent with the design. Reference: Bustamante, F. O. (1991). Nonuniform Beams with Harmonically Related Overtones for use in Percussion Instruments. J. Acoust. Soc. of Am., 90 (6), 2935-2941.

**12:45-1:00PM**

**Musical Acoustics with Smart Phone Applications.** Tom Muir (National Center for Physical Acoustics, University of Mississippi, University, Mississippi 38677, tmuir@olemiss.edu)

Remarkable progress with hardware and software applications for smart phones now enables casual experimental studies on musical instruments, which previously required laboratory facilities. Measurements involving tonal analyses with FFT line spectra, waveforms, pitch and tuning, sound pressure levels and loudness, as well as room reverberation, etc. are now possible with an IPhone and its headset microphone. Some examples are given here, through an experimental study of an American reed "pump" organ, recently restored by the author. These instruments, popular in the 19th and early 20th centuries, have long provided interesting pursuits involving their acquisition, restoration, history and musicology, as well as performance. Some acoustical curiosities of the authors instrument are described, including stop types, reed spectra and intonation.

**1:00-1:15PM**

**Inquiry based Physics Labs versus Cookbook Labs.** George Nock (Northeast Mississippi Community College, 101 Cunningham Blvd., Booneville MS 38829, abnock@nemcc.edu)

The purpose of this quasi-experimental study was to determine the effects on community college student physics conceptual achievement due to the use of inquiry-based laboratory activities versus cookbook laboratory activities. An analysis of covariance (ANCOVA) was performed to test for differences in mean post-test Force Concept Inventory (FCI) score for two different types of physics lab instruction (IL versus CBL). Results of the ANCOVA, $F(1, 35) = 0.761$, $p < 0.389$, supported the null hypothesis that no significant difference was found in the post-test FCI scores of the two groups. An ANCOVA was performed to test for differences in mean post-test Mechanics Baseline Test (MBT) score for two different types of physics lab instruction (IL versus CBL)., however, the covariate and the dependent variable were shown to not be linearly related. Therefore, a one-way analysis of variance (ANOVA) was used to compare MBT scores. The results of the ANOVA, $F(1, 36) = 0.066$, $p < 0.798$, supported the null hypothesis that there was no significant difference in MBT scores of the two groups. An independent t-test was used to compare the mean lecture test grades for the lab groups taught using inquiry and cookbook methods. The mean lecture test scores of the inquiry-based lab group ($M = 81.39$, S.D. = 8.15) were found to be significantly higher, $t(36) = -2.021$, $p < 0.0255$, than the cookbook lab group ($M = 75.74$, S.D. = 9.07). The effect size as measured with Cohens d was 0.66.

**1:15-1:30PM**

**Elementary School Physics Outreach Programs at Copiah-Lincoln Community College.** Kevin McKone (Copiah-Lincoln Community College, P.O. Box 649, Wesson, MS 39191, kevin.mckone@colin.edu)

Here at Copiah-Lincoln Community College (Co-Lin), we have initiated some new programs in an effort to bring physics and astronomy to upper elementary and junior high students. As part of Colins lecture series, we present an annual science program geared towards elementary school students. This last year, over 300 students enjoyed Jugglemania, a juggling show that introduced students to the physics and math of juggling. This year, students will be entertained by Bubbleman, and his show about the physics of bubbles. Last summer, Co-Lin started a week long science camp through the physics department, emphasizing robotics and astronomy for upper elementary and junior high students. Students completed three robotic projects and then traveled to Rainwater Observatory and Planetarium for an overnight trip. This fall, Co-Lin will enlist the help of our football players, and host a star party to celebrate the International year of Astronomy. This community event will be geared towards elementary students. This will be an opportunity for some of our athletes to interact with younger students in a positive academic setting. Lastly, I will talk about the MAST project at Jackson State University headed by Dr. Mehri Fadavi. Having been involved with this project for the last four years, I have seen first hand the impact this program has had on our local junior high and high school physics and physical science instructors.

**1:30-1:45PM**

**"Physics of Music" a physics course for non-science majors.** Brent Hoffmeister (Rhodes College, Department of Physics, 2000 North Parkway, Memphis TN, hoffmeister@rhodes.edu)

The curriculum at Rhodes College requires all students to take at least one laboratory based science course. In an effort to offer a physics course appealing to non-science majors we designed a course about the physics of musical instruments. Students learn about mechanical vibrations and waves, and apply these principals to sound production by string, brass, woodwind and percussion instruments. Laboratory experiments range from analysis of simple harmonic motion of a mass on a spring to acoustic characterization of actual instruments. Also, students are required to build their own unique musical instrument which they present at the end of the semester. This talk will provide an overview of the course, a description of some of the laboratory experiments, and examples of instruments designed by the students.

**1:45-2:15PM**

**Alien Soundscapes: From Toccatas to Thunder.** Andi Petculescu (Dept. of Physics, The University of Louisiana at Lafayette, Lafayette, LA 70504, andi@louisiana.edu)

In the effort to bring physical acoustics (back) to planetary science, one must persuade the relevant decision makers of the benefits that acoustic sensing can bring to the study of alien environments. To this end, we have simulated the atmospheric effects on the production and propagation of sound on Mars, Venus, and Titan. We'll present these effects on human voices and a musical piece. We then show simulations of thunder on Titan and Venus. Once in a planet's atmosphere, omnidirectional microphones can corroborate the existence of lightning via thunder, working in tandem with electromagnetic sensors. We discuss the potential impact of thunder studies on advancing our knowledge of extraterrestrial atmospheres.

**2:15-3:00PM**

**Challenges in Vehicle Noise and Vibration.** Mohamad Qatu (Mechanical Engineering Department, Mississippi State University, Box 9552, Mississippi State, MS 39762, qatu@me.msstate.edu)

This presentation is focusing on the noise and vibration attribute in the product development of commercial vehicles. It emphasizes the current issues and challenges that product development engineers face in the three main categories of noise vibration and harshness (NVH):(powertrain, road and wind. The presenter will speak about the usual or expected NVH and the unexpected or unusual NVH. Challenges covered include the need for CAE tools at various stages of development with limited information available

at times, the need for detailed design standards and verification methods. Challenges related to product variability and assessment will also be overviewed. The presenter will review key progress areas and status of current technologies.

# Poster Abstracts

**Bessel's Flames of Glory.** Shane McNew and William V. Slaton* (Department of Physics, The University of Central Arkansas, Conway AR 72035, wvslaton@uca.edu)

The Ruben's Tube is a popular physics demonstration that dramatically illustrates one-dimensional standing waves. The demo consists of a long tube closed on one end and the other driven with a speaker. The tube is filled with natural gas that exits through small evenly spaced holes along the top of the tube. The gas exiting the holes is ignited and the heights and color of the flames are an indication of the speaker-driven standing wave that appears in the tube. Regions where the standing wave acoustic velocity is large are illustrated by tall yellow flames, whereas regions with low acoustic velocity have short bright blue flames. This variation in flame height is due to the Bernoulli effect. This research project explored the theoretical and experimental design, construction and testing of two-dimensional flame pans: square and circular. The square geometry should support standing waves similar to the Ruben's tube in both directions and so the flame patterns will be lines of yellow flames in a grid pattern. The circular geometry should support standing waves that have a radial and polar dependence with corresponding flame patterns. Theoretical predictions of the resonance modes in the two-dimensional flame pans will be compared to photographs of the flame pans in operation.

**Doppler ultrasound measurements of the motion of a physical pendulum.** Joshua Lieblong* and Carl Frederickson (Department of Physics, The University of Central Arkansas, Conway AR 72035, jal121387@yahoo.com)

Doppler ultrasound is being evaluated as a tool for characterizing human motion. A high frequency sound wave is transmitted toward a moving object, which then reflects frequencies shifted from the transmitted frequency due to the velocity of the object. Measurements using a physical pendulum to model the behavior of a leg will be reported. After the interaction between the acoustic signal and a simple physical pendulum is understood, a double physical pendulum will be studied. The double pendulum will be able to bend in the middle similar to a leg bending at the knee. The comparison can be used to model an individual's walk to distinguish that person's mood, mass, or even as part of an identification system using oscillatory human motion.

**Volcanic infrasound to study atmospheric ducts.** J.D. Assink* and R. Waxler National Center for Physical Acoustics, University of Mississippi, University, Mississippi 38677, jdassink@olemiss.edu), D. Drob (Naval Research Laboratory, Washington, DC, USA), D. Fee (Infrasound Laboratory, University of Hawaii, Kailua-Kona, HI, USA), and A. Aydin (Geology and Geological Engineering, University of Mississippi, University, MS, USA)

The Tungurahua volcano in Ecuador has been extremely active since the second quarter of 2006. Activity levels rose to a maximum in July 2006 when Tungurahua was most explosive. As it happens, two infrasound arrays are situated at 37 km (RIOE, SW) and at 250 km (LITE, N) distance. This setup of source capture and far-field station is used to assess the regional atmospheric ducts as modeled by current G2S models. Detection statistics are presented and compared to ray theory simulations.