The 9th Meeting of the MidSouth Chapter of the Acoustical Society of America

The University of Central Arkansas Conway, AR 72034

October 7-8, 2011

Meeting Proceedings

Meeting Schedule:

Friday, October 7

2:30-3:00PM	:	Meeting Registration & Welcome
3:00-5:00PM	:	Opening Session
6:00-8:30PM	:	Dinner & Socializing downtown at Mike's Place

Saturday, October 8

7:30-8:00AM	:	Registration, Coffee & Donuts
8:00-9:30AM	:	Morning Session
9:30-10:00AM	:	Poster Session & Break
10:00-11:45PM	:	Closing Session
12:00-1:30PM	:	Exec. Comm. Meeting

Meeting Location: The meeting will be held in Lewis Science Center located on Bruce Street on the University of Central Arkansas campus in Conway, AR. Parking is available in the lots on the east side of the building. Sessions will be held in the south end of the building in room 101 with posters displayed in the atrium. Check the Chapter website for building and campus maps.

Announcements: The next meeting of the MidSouth Chapter of the Acoustical Society of America will be in the spring of 2012.

Check the chapter website:

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

for more details about the upcoming meeting in the months ahead.

Oral Abstracts

FRIDAY AFTERNOON, 7 OCTOBER 2011

3:00-3:30 PM

Cosmic acoustics to earthquakes: A review of some hot topics in Physical Acoustics. Josh Gladden (University of Mississippi and the National Center for Physical Acoustics, 108 Lewis Hall, Dept. of Physics, Univ. of Mississippi, University, MS 38677, jgladden@olemiss.edu)

The field of physical acoustics touches a broad range of technical areas important to fundamental science and society. This "Hot Topics" presentation will reflect the breadth of this impact by discussing the following three topics: sound waves in the early cosmos, acoustics in slip-stick friction systems, and acoustic metamaterials. The early universe, composed of hot ionized matter, was able to support acoustic waves until the temperature cooled enough to allow the formation of neutral atoms. The imprint of these relic acoustic waves is still evident in the cosmic microwave background and is yielding new information about key cosmological constants and dark matter. Earthquakes are perhaps the most destructive of natural disasters. Studies on the effects of acoustic vibrations in slip-stick friction systems have begun to shed light on triggering mechanisms for earthquakes and may lead to better early warning systems. Metamaterials are man made materials in which precise geometric arrays of structures are engineered to produce coherent scattering effects on scales much larger than the structures themselves. These systems can exhibit such exotic properties as a negative index of refraction, band gaps, and a negative effective elastic modulus.

3:30-4:15 PM

Eastern and Western free reed mouth organs: Acoustics and history. James Cottingham (Coe College, 1220 First Ave. NE, Cedar Rapids, IA 52402, jcotting@coe.edu)

This paper presents some episodes in the history of the Eastern and Western free reed instruments as well as a summary of their important acoustical properties. The Asian mouth-blown free reed instruments are of ancient origin and typically employ a free reed strongly coupled to a pipe resonator. In these reed-pipes the same reed often operates on both directions of airflow and behaves as a blown-open or outward striking reed, with playing frequency above both the resonant frequency of the pipe and the natural frequency of the reed. Although the Asian instruments were known in Europe when the Western free reed family originated about 200 years ago, the Western free reed instruments use a different mechanism in which the reed tongue is offset from the opening in the frame, permitting operation on only one direction of air flow. Pipe resonators are not required and generally not used. These free reeds and behave as blown-closed or inward striking reeds, with playing frequency below the natural frequency of the reed. The role of resonators in determining tone quality as well as pitch in free reed instruments will be discussed, along with the possibilities for player-controlled pitch bending. The presentation will include a number of audio, video, and live demonstrations.

4:15-4:30 PM

The diatonic harmonica, pipe resonators, and the siren. Casey N. Brock* (Austin Peay State University, Clarksville, TN 37044, casey.brock@hotmail.com) and James P. Cottingham (Coe College, Cedar Rapids, IA 52402)

A number of measurements of reed motion and sound field have been made on a diatonic harmonica mounted on a fixed volume wind chamber. These include variation of sounding frequency with blowing pressure, and the degree to which the sounding frequency and sound spectrum can be altered by attaching external pipe resonators. Differences were observed between the behavior of blow and draw reeds, as well as the dependence of the results on whether the secondary reed in the reed chamber is allowed to vibrate. As noted by Helmholtz, at a simple level of analysis the sound production of a free reed is similar to

that of a siren, in both cases involving an air stream that is periodically interrupted. Our current results are compared with the results of measurements made in an earlier study of a siren in similar experimental configurations. [Work partially supported by National Science Foundation REU Grant PHY-1004860.]

4:30-4:45 PM

Some Hazardous Acoustical Things You and Others Might Not Think of. Dan Scott, Retired professor (P. O. Box 166, Purcell, OK 73080, danwscott@ieee.org)

Some Hazardous Acoustical Things You and Others Might Not Think of: Three Example Scenarios.1, The Acoustics Of Tires And 2. The Case Of The Office That Could Have Had A Bad Medical Condition, 3. What can happen when the driver of a vehicle succeeds in "thinking about exactly what he wants to focus on." What they have in common: "Binaural Beats" effects? How they are caused. Description of the mammalian auditory anatomy: what the little hills do; what the upper little hills do; how do e know this?The likely reasons these mechanisms provided evolutionary advantages for both prey and predator...So, what's new? A very brief summary of my own work with the psycological effects that my new music technology and that similar technologies and fortuitous circumstances may also produce.

4:45-5:00 PM

Rhythm algorithm application for music. Alexander Ekimov (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, aekimov@olemiss.edu)

Rhythm algorithm was developed at the University of Mississippi for periodic broadband signals to find the (signals) period's dependence versus time. A raw periodic signal is processed with a sliding time window from the beginning to the end across a signal. This time window is equal to the periodic broadband and pulse similar signals' part duration time (T1). To increase the signal to noise ratio the time window overlap is applied. Then the narrow Fourier filtration (frequency range corresponds to the most informative part of the signal) is applied for the output of the time window (T1). The broadband signal becomes a set of narrow frequency envelopes of the signal on the output of each filter, then another time window (T2) is applied to these envelopes. This window size (T2) is two times more pulse similar signals' repetition time. Final results of the period dependence with time are presented with Short Term Fourier Transform. This algorithm has application for human/animal footstep signals and for underwater clicks of sperm mammals. Another application of this rhythm algorithm for some music (classic and modern) sound is presented here. Analysis of the music sounds with this algorithm shows the sequences close to the human footsteps rhythms. For the classic music example [Bach "Toccata and Fugue, BWV565" (1740)] a hidden rhythms not hearing from the sound directly were detected.

SATURDAY MORNING, 8 October 2011

8:00-8:30 AM

Catching up with superluminal sound. Joel Mobley (University of Mississippi, One Coliseum Dr., University, MS 38677 jmobley@olemiss.edu)

Of the all the parameters for describing wave propagation, the group velocity is perhaps the most enigmatic. From quantum wavepackets to microwave bursts, the group velocity is said to represent speeds of particles and energy, and yet it is also known to exhibit arbitrarily large and negative values. For electromagnetic waves, the reality of superluminal (i.e., $>$ c, or $<$ 0) group velocities is well-established with observations dating back several decades. More recently, we reported measurements of acoustic group velocities exceeding the speed of light, bridging a gap five orders of magnitude wide between c and ordinary acoustic speeds. To illustrate the physical manifestation of "fast sound" and "fast light", we show how superluminal wavepackets are constructed and detected in the laboratory. We also explain how superluminal group velocities are compatible with relativistic causality.

8:30-8:45 AM

High temperature elastic moduli trends of lanthanum telluride and lead telluride thermoelectric alloys. Rasheed Adebisi* and Joseph Gladden (University of Mississippi, National Center for Physical Acoustics, Room 1077, RUS LAB, NCPA, University of Mississippi, University, MS 38677, raadebis@olemiss.edu)

Thermoelectric materials are used to convert thermal energy into electricity using the Seebeck effect. Thermoelectric devices are known for their contributions in the powering of spacecrafts for decades. The efficiency of thermoelectric material is a function of figure-of-merit and the temperature gradient between its ends. Researchers at JPL are currently using nanotechnology to enhance the figure of merit of new nanostructured thermoelectric materials. These materials will be used in devices for high temperature applications. So there is a need to determine the structural stability of these materials in the temperature range of applications. This can be achieved by the characterization of their mechanical properties. The elastic moduli of several nanostructured polycrystalline lanthanum telluride and an n-type lead telluride alloys were measured over a wide temperature range from room temperature to 1000 °C using a high-temperature resonant ultrasound spectroscopy (RUS) device. The temperature trends of the elastic moduli of all the samples decrease with an increase in temperature. A subtle deviation from linearity was noticed in the LaTe plots near 300 °C. Linear fit models were used to get the slope of the plots. Similar model fit was done for the PbTe plot as well.

8:45-9:00 AM

Polymer based acoustic emission sensors and sensor characterization. Sumudu Tennakoon*, Joseph Gladden, Nathan Murray and Qin Zhang (Department of Physics and Astronomy, National Center for Physical Acoustics, University of Mississippi, University, MS 38677, sptennak@olemiss.edu)

Acoustic Emission (AE) is the phenomenon of producing elastic waves by sudden deformations in a material due to external effects such as mechanical loading, thermal expansion or contraction, etc. Acoustic sensors embedded into structures can be used to monitor and record AE events. Careful analysis of AE signals over a time period can predict structure failures before possible collapse. This method is highly useful for structural health monitoring (SHM) applications in aerospace and other mission critical structures.Polymer based piezoelectric materials such as PVDF can be considered as a good candidate for assembling AE sensors due to their flexibility and comfortably bond with different geometries. Studying sensor characteristics such as frequency response, sensitivity and effects of packaging materials are important in accurate AE signal analysis.In the present study, prototype PVDF sensors were assembled. Three types of experiments for characterizing sensors will be discussed (1) Drop test: dropping known mass repeatedly from constant height to impact on nylon sheet where sensors were attached. (2) Shock tube: generating shock wave from a ruptured diaphragm separating two different pressure regions inside closed tube provides a step function of pressure vs. time at the end plate. (3) Loading test: generating elastic waves from compressing plexiglass block and bending of a tin bar.

9:00-9:15 AM

Optimal gate delay for ultrasonic backscatter measurements of bone. Morgan Smathers* and Brent Hoffmeister (Rhodes College, 2000 North Pkwy, Memphis, TN 38112, smamr@rhodes.edu)

Osteoporosis is a disease that affects 10 million Americans. Our study seeks to develop a method for measuring bone density using ultrasonic

backscatter. Ultrasonic pulses from a 5MHz transducer were propagated into regions of porous bone. The returned signal was analyzed to determine Apparent Integrated Backscatter (AIB) which is a measure of the frequency averaged backscatter power. Measurements were performed on 36 cube shaped specimens of bone prepared from 5 human femurs and one bovine femur. AIB was determined from 14 different gated regions of the backscatter signal. All gated regions had a duration of 2 microseconds. The gates differed according to their delay from the start of the backscatter signal, ranging from 0 to 6 microseconds in 0.5 microsecond increments. For each choice of gate delay the correlation between AIB and bone density was determined. For small delays (0 and 0.5 microseconds) we observed a positive correlation between AIB and density. For larger delays, the correlation became negative. Delays of greater than 2.0 microseconds did not significantly change the correlation of AIB with density. We conclude that choice of gate delay has an important affect on how well AIB correlates with bone density. Gate delays of 2 microseconds or greater appear optimal.

9:15-9:30 AM

An investigation of the use of ultrasound to control nuisance species in commercial aquaculture settings. Bradley Goodwiller and Jim Chambers (National Center for Physical Acoustics, University of Mississippi, 1 Coliseum Drive, University, MS 38677, btgoodwi@olemiss.edu)

As one step in the investigation of using acoustics to improve aquaculture production, work was pursued on the possible use of ultrasound to control the Bolbophorus trematode in commercial catfish ponds. By eliminating the host ram's horn snail via exposure to high amplitude ultrasound, the trematode population can be controlled. Initial laboratory tests indicated that a commercially available sonicator (operating at 20 kHz) is capable of killing individual snails in fish tanks nearly instantaneously. More thorough testing indicated efficiency rates of approximately 50% on batches of 10 snails in fish tanks surrounded by air. The experimental setup of these initial tests provided nearly 20 dB of gain in sound levels compared to what is expected in ponds due to reverberation from the air surrounding the tank walls. The work presented here constitutes the basic research behind the design and development of a field deployable system capable of killing a significant percentage of a snail population.

9:30-10:00 AM

Poster introductions (5 min each) followed by poster session & break.

10:00-10:15 AM

Principles, concepts and tricks for wind noise studies. Richard Raspet (National Center for Physical Acoustics, University of Mississippi, 1 Coliseum Drive, University, MS 38677, raspet@olemiss.edu)

A group at the University of Mississippi has been studying the basic physics of wind noise in measurement microphones. Since wind noise is not propagated acoustically, we have had to develop new methods of prediction. We have applied methods developed for aerodynamic studies and for atmospheric studies of turbulence to our unique problem with some success. In this talk we introduce the basic ideas of wind noise generations and describe some of the methods and calculation tricks used to predict different contributions to wind noise near the earth's surface.

10:15 AM - 10:30 AM

The Design and Fabrication of a Sensor Array for Aeroacoustic Measurements. Skipper Thurman (University of Central Arkansas, Department of Physics & Astronomy, Conway, AR 72034, slthurman01@gmail.com)

Modern directional sensor arrays are capable of measuring noise with unprecedented resolution, precision, and versatility. Pre-fabricated sensor arrays can be prohibitively expensive but have unique applications in localizing and characterizing noise sources. A less costly array can still be a useful tool for making acoustical measurements. A description is given of the design, construction, and preliminary testing of a low-cost sensor array, consisting of 30 microphones, for measuring jet noise in the National Center for Physical Acoustics jet lab anechoic chamber, located at the University of Mississippi. A computational model of the array is presented giving the theoretical response of the array to a monopole point source. It is shown how this response is used to design the physical array. Details are given on the fabrication of the sensor array and its components. Noise source measurements are then taken and the data compared to the theoretical prediction. The modularity of the design is described along with how it may be fully utilized to improve or modify the array for specific applications.

10:30 AM - 10:45 AM

Preliminary suggestions for limitation of pulsing low frequency content in noise ordinances. Dave S. Woolworth (Oxford Acoustics, Inc., 356 CR 102, Oxford, MS 38655, dave@oxfordacoustics.com)

Current noise ordinances use single number A-weighted sound levels to delineate limits; The weighting effectively eliminates low frequency content from consideration in measurements. The advent of low frequency or "boom" music and "boom cars" in the last 20 years has changed the soundscape to be contended with relative to noise ordinances developed previously. Predictable and repeatable sources such as transportation, and industrial sources are regulated through well funded studies (private and public) to protect citizens health and safety. The "boom" sources, however, are transient, unpredictable to some degree, and can be reduced when alerted to monitoring; currently there is no central source for funding studies of this nature. This paper investigates some of the issues surrounding low frequency pulse noise from these sources and suggests a potential direction for making regulations.

10:45 AM - 11:00 AM

Seepage Monitoring of Embankments Using Passive Seismic Method. Binyam D. Tadese*, Craig J. Hickey and Alexander E. Ekimov (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, bdtadese@olemiss.edu)

Earthen levees and dams are critical infrastructures that require continuous monitoring because their failure can cause a catastrophic human life loss, environmental and socioeconomic impact on the society. Among the main causes of failures in embankments, internal erosion is one of the largest of all causes worldwide. Even though embankments are designed to be impervious as much as possible, most embankments exhibit internal seepage. Typical safety inspection of embankments involves visual inspection supported with limited instrumentation. However, internal erosion can get quite advanced before it can be detected by this means. Recently, a number of non-intrusive geophysical investigation methods have been utilized for assessing the integrity of embankments and for monitoring the formation of internal piping. In this research, a non-intrusive passive seismic method is used to study the progressive evolution of internal seepage on scaled experiment embankments at the USDA-HERU in Stillwater, OK. A model embankment with known soil composition and compromised zones is monitored for progressive buildup of internal seepage/piping with accelerometers placed at different locations on the embankment surface. Vibration caused by internal seepage that is above the ground vibration noise is the source of passive seismic energy recorded and analyzed. Multi orthogonal analysis techniques are used to process the records. Wind, temperature and precipitation measurements are also collected to study the environmental influence on passive results. Experimental results are presented and discussed. [This research is sponsored by the Department of Homeland Security-sponsored Southeast Region Research Initiative (SERRI) at the Department of Energy's Oak Ridge National Laboratory].

11:00 AM - 11:15 AM

Laboratory measurements of acoustic, electrical resistivity, and erodability of soils as a function of compaction. Cameron Ehn[1]*, Gregory J. Hanson[1] and Craig J. Hickey[2] ([1]USDA-ARS, Hydraulic Engineering Research Unit (HERU), Stillwater, OK, 74075, cameron.ehn@okstate.edu, and [2]National Center for Physical Acoustics (NCPA), University of Mississippi, Oxford, MS 38677)

Catastrophic floods resulting from the failure of dam and levee infrastructures can paralyze the economy and social life of large populations for long periods of time. The United States has over 100,000 miles of levees and the National Inventory of Dams lists approximately 79,000 U.S. dams. The development of rapid assessment techniques to determine the integrity of levee systems and earthen dams is essential in managing such structures. These assessment techniques require advanced screening tools to delineate, classify, and prioritize compromised locations within levees and dams. Although overtopping is the primary cause of dam and levee failure, internal erosion, seepage, and piping are also among the major causes of failure in earthen embankments. Current geophysical techniques used in the assessment of the interior of earthen embankments include: acoustic/seismic, electro-magnetic and resistivity, gravity, optical sensing, and radar. The advantage associated with using geophysical techniques is that the measurements are sensitive to the distribution of the bulk, or geophysical, properties in the subsurface such as: elasticity, electrical resistivity, dielectric constant, etc.Relationships between these physical properties and the more "basic" properties (bulk density, water content, porosity, mineralogy, etc) used by engineers must be determined. In this presentation, laboratory measurements of seismic velocity, electrical resistivity, erodability, and the standard Proctor test are discussed. It is anticipated that relationships based upon these measurements will provide the bridge for practitioners to more fully utilize the information in geophysical maps. (This research is sponsored by the Department of Homeland Security-sponsored Southeast Region Research Initiative (SERRI) at the Department of Energy's Oak Ridge National Laboratory)

11:15 AM - 11:30 AM

The Use of Seismic Tomograms for the Identification of Internal Problems with Earthen Dams and Levees. Leti T. Wodajo[1]*, Craig J. Hickey[1], Gregory J. Hanson[1], and Chung R. Song[3] ([1]National Center for Physical Acoustics, University of Mississippi, Oxford, MS 38677, ltwodajo@olemiss.edu, [2]USDA-ARS, Hydraulic Engineering Research Unit (HERU), Stillwater, OK, 74075, and [3]Department of Civil Engineering, University of Mississippi, Oxford, MS 38677)

According to the National Inventory of dams (NID,2009), out of the 84,134 dams in the US, more than 87% (73,423) are earthen dams. The majority of these earthen dams are past or approaching their design life expectancy of 50 years. According to the National committee on Levee Safety (NCLS, 2009), there are an estimated 122,000 miles (¿196M meters) of levees currently in use in the US. These levees protect cities and other infrastructures from fluctuating water levels of rivers and oceans. These infrastructures are therefore a vital part of a nation?s infrastructure and require regular monitoring and rehabilitation programs to function properly. This study examines the use of a non-invasive geophysical seismic method known as seismic refraction, multi-channel analysis of surface waves (MASW) and shear wave surveys to provide additional information where the usual visual inspection is not sufficient and the common boring investigation is not an option. These methods are used to identify erosion, seepage, and piping through the body of the dam and levee. Results from different surveys will show the distribution of seismic velocities in an earthen dam and how tomography images from different surveys are used to identify known dam structures as well as the presence of problematic areas due to erosion, seepage, and piping. [This work is funded under USDA-ARS Specific Cooperative Agreement: 58-6408-7-234].

11:30 AM - 11:45 AM

Hurricane Generated Infrasound. Bob Dunn (Hendrix College, Department of Physics, Conway, AR, dunn@hendrix.edu)

In this presentation the results from using ring lasers to detect the infrasound from hurricanes in the Atlantic and the Gulf of Mexico will be discussed. The apparent travel times for emissions from Hurricanes Dean and Wilma, while they were in the Caribbean, indicate acoustic rather than seismic propagation. No distinct millihertz infrasound peaks were detected from hurricanes when they were beyond the continental shelf and over deep water; while in the Caribbean several distinct infrasound peaks were detected from Hurricane Wilma when it was over shallow water. The consistency of the $\sim$7.2 mHz infrasound frequency emitted by different hurricanes as they move ashore suggests the possibility of a frequency dependent coupling between hurricane generated infrasound and atmospheric acoustic modes. Eight frequencies have been calculated that couple energy between the atmosphere and spheroidal ground modes: 3.681, 4.405, 4.696, 5.076, 6.104, 7.067, 8.118, and 9.171 mHz; the ring lasers have recorded six of these frequencies. We propose the following speculative model for the detection of distinct hurricane generated responses detected by the ring laser. Hurricane infrasound is generated by radial oscillations at a frequency inversely proportional to the core vortex radius of the storm. The hurricane infrasound energy preferentially couples into atmospheric acoustic modes. In the vicinity of the ring laser, the atmospheric acoustic energy couples into the ground and creates ground vibrations that frequency modulates the ring laser output. The acoustic-seismic coupling is enhanced when the coupling takes place in unconsolidated soil.

Poster Abstracts

A Trigger for a Helmholtz Resonator. John Lahmann*, and Stephen R. Addison (Department of Physics, The University of Central Arkansas, Conway AR 72035, lahmannjohn@yahoo.com)

With the use of a Helmholtz Resonator, our objective is to investigate wave coupling mechanisms at low frequencies. The resonator will work as an impulsive sound source which will be used to calibrate low frequency detectors. Acting as the resonator is a 2.5-foot long stainless steel pipe, 4-in in diameter, closed at both ends. Using a different assortment of flanges, we have securely closed off one end of the pipe. To close off the other end we use different thickness's of sheet aluminium which acts as a diaphragm held on by one of the flanges. To create the pulse, we pull a vacuum in the pipe to the desired pressure and trigger the resonator by puncturing the diaphragm causing it to rupture. For the pulse to be used as a calibration source, the diaphragm must be punctured so that we receive a consistent pulse each time. We have recently developed an automated triggering mechanism that gives this reliable puncture. Work to date is concentrated on developing a resonator with a larger cavity volume that will create a more intense pulse.

Effect of gate delay on the frequency dependence of ultrasonic backscatter measurements of bone. Joseph A. McPherson*, Morgan R. Smathers, and Brent K. Hoffmeister (Rhodes College, Department of Physics, 2000 North Parkway, Memphis, TN, 38112, mcpja@rhodes.edu)

Osteoporosis is a degenerative bone disease that causes normally porous bone tissue, called cancellous bone, to become even more porous and weak. We have proposed that ultrasonic backscatter measurements may be sensitive to these changes in bone porosity. Backscatter signals were analyzed by computing the power spectrum of a gated region of the signal. The gate was delayed by an amount Td from the start of the signal. The goal of this study is to determine how the gate delay Td affects the measured frequency dependence of the backscatter power. Measurements were performed on 36 cube shaped specimens of human and bovine bone using a 5 MHz transducer. The gate delay Td ranged from 0 to 6 μs, and the gated region had a fixed length of 2 μs. Backscatter signals were analyzed to determine the slope of the frequency dependence of the power in the gated region of the backscatter signal. This parameter is called FSAB. Measured values of FSAB were plotted as function of specimen density and a linear regression was performed to determine the correlation of FSAB with density. The correlation coefficient, r, ranged between -0.96 to -0.86, improving with gate delay up to a delay of 1 μs. Delays greater than 1μs did not improve the correlation.