Laboratory Experiments on Sound Propagation in a Continuously Stratified Ocean Containing Internal Gravity Waves

Friday, January 30, 2015 4:00 p.m. in ETC 4.150

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The speed of sound in the ocean varies with temperature, salinity, and pressure over the entire ocean depth. This variation results in a sound speed profile that supports a sound channel for transmitting information over great distances in the ocean. The transmission is strongly affected by local water column oscillations that result from gravity wave motions internal to the ocean. Internal gravity waves can propagate in any density-stratified fluid; in the oceans the increase of density with depth is due to decreasing temperature and increasing salinity. We present results from a laboratory tank experiment that models sound propagation in a stratified ocean containing internal gravity waves. The experiment determines (1) the refraction of acoustic wavefronts due to sound speed gradients and (2) sound speed fluctuations arising from the internal gravity waves. This research provides a data set for comparison with modeling of sound propagation in the oceans.

Generation and Refraction of the Microbarom Signal by Hurricanes over the Atlantic Ocean

Friday, February 6, 2015 4:00 p.m. in ETC 4.150

Dr. Roger Waxler
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www.olemiss.edu/depts/physics_and_astronomy/faculty/waxler.html

It is well known that both acoustic and seismic noise spectra show an increased band of spatially coherent noise around 0.2 Hz, the so-called microbarom and microseism signals. It has been appreciated for over a half of a century that hurricanes over the open ocean are a source of microbaroms and microseisms. While the mechanism for microseism generation has been understood since the early 1960's, a complete theory of the generation of microbaroms did not appear until 2006. It has been shown that microbaroms and microseisms are two manifestations of the same phenomenon: a radiating harmonic of the ocean surface wave field produced by the head-on collision of ocean surface waves of the same period. In 2008 it was conjectured that, for a deep ocean hurricane, the source of the colliding waves is the interaction of the hurricane generated waves with the background ocean swell. The region in which this interaction takes place, the microbarom source region, is generally several hundred kilometers from the eye of the storm. This source region's position with respect to the eye of the storm changes slowly as the storm moves across the ocean so that it can be considered to be more or less static with respect to the storm. As the microbarom signal propagates away from the source region, propagation

paths that pass through the storm are strongly refracted by the storm winds. Thus, hurricanes carry a sound source with them which might be used to probe the interior of the storm itself. To study this effect, a temporary network of infrasound stations was deployed along the US eastern seaboard during the 2010 and 2011 hurricane seasons. The underlying theory will be presented and results from the deployments will be shown.

Large-Scale Acoustic Array Processing

Friday, February 13, 2015 4:00 p.m. in ETC 4.150

Dr. Mark Lai
The Institute for Computational Engineering and Sciences
The University of Texas at Austin

Consider a sensing system using a large number of N microphones placed in multiple dimensions to monitor an acoustic field. Using all the microphones at once is impractical because of the amount data generated. Instead, we choose a subset of D microphones to be active. Specifically, we wish to find the D set of microphones that minimizes the largest interference gain at multiple frequencies while monitoring a target of interest. A direct, combinatorial approach testing all N choose D subsets of microphones is impractical because of problem size. Instead, we use a convex optimization technique that induces sparsity. Our work investigates not only the optimal placement (space) of microphones but also how to process the output of each microphone (time/frequency). We explore this problem for both single and multi-frequency sources, optimizing both microphone weights and positions simultaneously. In addition, we explore this problem for random sources where the output of each of the N microphones is processed by an individual multirate filterbank. The N processed filterbank outputs are then combined to form one final signal. In this case, we fix all the analysis filters and optimize over all the synthesis filters. In this random source/multirate filterbank case, we once again optimize over space-time-frequency simultaneously.

Acoustic Metamaterials

Friday, February 20, 2015 4:00 p.m. in ETC 4.150

Romain Fleury
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Metamaterials are artificially structured materials that are engineered to interact with waves in anomalous or extraordinary ways, leading to unconventional physical phenomena not found in natural materials, such as negative refraction and cloaking. They have been so far almost exclusively based on artificial structures that are inherently symmetric upon time-reversal. This talk will explore the largely uncharted scattering properties of a novel class of acoustic devices, metamaterials and metasurfaces, that are engineered to purposely break time-reversal symmetry. Several examples with strong application potential will be discussed, along with experimental results.

Wind Turbine Noise Regulations

Friday, March 6, 2015 4:00 p.m. in ETC 4.150

David A. Nelson, INCE Bd. Cert., PE
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The common conception of an environmental noise criterion is a lone dB(A) value. It's easy to remember, measure, and litigate. But depending on the type of noise, it might not correlate with community experience. And without instructions for how to make the measurement, it could be essentially worthless. As with product sound quality, the complexity of human perception plays a major role in determining individual reactions to a given sound. Thus a more refined approach to evaluating sound may be required. Finally, each individual has their own perception of the proper balance between the benefit of making the noise and the cost of consuming it. A number of empirical studies reveal the degree of community reaction expected in given situations, allowing something like a cost-benefit analysis. These concepts have been applied for a recent project to develop a criterion for industrial noise in a semi-rural area. We'll discuss the anatomy of that criterion and the importance of the companion measurement protocol. We'll also discuss applications in other environments and/or for music as a noise source.

Experience-Dependent Plasticity in the Subcortical Encoding of Speech Signals

Friday, March 27, 2015 4:00 p.m. in ETC 4.150

Professor Bharath Chandrasekaran
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Speech is the most important acoustic signal for humans. Our brain is able to simultaneously extract "what" is being said (referred to as lexical information) and "who" is speaking (referred to as indexical information) from the speech signal with consummate ease. In this talk, I will focus on recent studies examining experiential influences on the subcortical encoding of speech signals. I will also discuss methods that recover and classify lexical and indexical content in speech signals from the brain of listeners. This is a complex computational problem; the brain response to speech signals is noisy due to several methodological issues. In pilot experiments, we use a combination of electroencephalography (EEG) and machine learning approaches to classify speech signals. We have extensive preliminary data that show that "brain reading" of speech signals is an achievable goal. Using these studies as a scaffold, I will discuss the initial groundwork for the "predictive coding" hypothesis, which explicates how prior experiences affects neural encoding of speech signals.

A Two-Way Coupled Mode Formalism that Satisfies Energy Conservation for Impedance Boundaries in Underwater Acoustics

Friday, April 3, 2015 4:00 p.m. in ETC 4.150

Dr. Steven A. Stotts
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This paper shows that energy conservation and the derivation of the two-way coupled mode range equations can be extended in three dimensions to complex mode functions and eigenvalues. Furthermore, the energy in the coupled mode formulation is conserved for finite thickness ocean waveguides with a penetrable bottom boundary beneath any range dependence. The new derivations rely on completeness and a modified orthonormality statement. The mode coupling coefficients are specified solely and explicitly by the waveguide range dependence. Application of energy conservation to examine the accuracy of a numerical coupled mode calculation is presented.

A New Methodology for Quantifying Acoustic Wavefronts on Clustered Rocket Nozzles

Friday, April 10, 2015 4:00 p.m. in ETC 4.150

Andres Canchero
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A new methodology for quantifying acoustic wavefronts is proposed in the present study. Retroreflective shadowgraphy visualizations during the start-up of a cluster of two high area ratio rockets are being used to analyze particular regions of interest using the Radon Transform. Laboratory scale rocket nozzles are tested in the anechoic chamber and high-speed flow facility at The University of Texas at Austin. Thrust optimized parabolic contour nozzles exhibit different flow states during start-up, free shock separated flow, restricted shock separated flow and end-effects regime; which is the most important acoustic event during the start-up. By way of linking acoustic measurements, wall pressure measurements and RANS simulations with the new methodology using the Radon Transform, the goal of the study resides in understanding the sources of sound. Most sound waves are generated by the interaction of turbulence with shock cells located in the supersonic annular plume, which is shown to behave very unsteadily during the end-effects regime. This new technique using the Radon Transform on shadowgraphy images aims to better characterize the near-field acoustic environment, which means to improve the prediction on the acoustic loads during ignition.

Phonemic Perception Training in Quiet and Noise of English Speech for Chinese College Students

Friday, April 24, 2015 4:00 p.m. in ETC 4.150

Professor Chang Liu
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The goal of this study is to examine two hypotheses of our previous studies on English speech perception of Chinese college students, who had similar performance in English vowel identification in quiet and stationary noise, but lower scores in multi-talker babble, compared to their peers in the US. The 1-2 year experience of living in the US may promote Chinese-native speakers' capacity to use the temporal cues in noise and get less impact by informational masking of babble. Several experiments of English vowel perception were conducted before and after phonemic perception training. Chinese college students were divided into three training groups: control (no specific phonemic training), training in quiet (TIQ), and training in noise (TIN). Five English back vowels were used as the training stimuli and training was conducted daily for one hour for six consecutive days. Preliminary results showed that English vowel perception in quiet was improved after training for all three groups with the training effect highest for TIN, lowest effect for Control, and TIQ in between. Vowel perception in noise was improved the most for the TIN, followed by TIQ, while no improvement was found for Control. In particular, perceptual weight was shifted after training. That is, the three groups used vowel duration cues similarly before training, whereas TIN and TIQ did not use duration cues, but Control still used it after training, implying that phonemic training improved listeners' use of phonetic cues. Training effect was also extended to new talkers for TIN and TIQ, especially for TIN in noise. In addition, training effect was observed for five front vowels that are not included in the training vowels. Post-training results indicate that TIN had better capacity against informational masking of babble than TIQ, but did not differ in the capacity of using temporal cues of noise. Altogether, English phonemic training may improve non-native listeners' phonetic processing and the ability to resist informational masking.

Measurements of Three-Dimensional Acoustic Propagation over a Translationally Invariant Wedge and in a Scale-Model Canyon

Friday, May 1, 2015 4:00 p.m. in ETC 4.150

Dr. Jason Sagers
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Scale model (1:7500) acoustic propagation experiments were conducted in a laboratory tank to investigate three-dimensional (3D) propagation effects induced by range-dependent bathymetry, with the objective of providing benchmark quality data for comparison with numerical models.

A computer-controlled positioning system accurately moved the receiving hydrophone in 3D space while a stationary source hydrophone emitted pulsed waveforms between 200 kHz and 2 MHz. Acoustic measurements in two model environments are discussed. First, experimental results are shown for a 1.22 x 2.13 m^2 model bathymetric environment possessing a 44.5 mm deep flat bottom with a translationally invariant wedge of 10° slope along one edge. Synthetic vertical line arrays (VLAs) were located on the wedge and mode filtering was performed at each VLA location to infer mode amplitudes. Modal shadow zones are visible in the inferred range-dependent mode amplitudes. Second, experimental results are shown for 1.19 x 2.13 m^2 scale model representation of a portion of the Hudson Canyon. The model was patterned after measured bathymetric data and fabricated from closed-cell polyurethane foam by a computer numerical control (CNC) milling machine. Results are shown for propagation paths along and across the axis of the canyon where the received time series are post-processed to estimate travel times, transmission loss, and horizontal and vertical arrival angles. [Work supported by ONR].

Metastructure-Based Passive Phased Acoustic Array

Friday, September 4, 2015 4:00 p.m. in ETC 4.150

Dr. Likun Zhang
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Many practical applications, including ultrasound engineering and auditorium acoustics, require formation of sound fields with specific wave fronts. Conventional phased source arrays composed of an array of elementary sources with proper relative phases have been a standard way to form the desired wave fields. However, such arrays have the disadvantages of high cost and complexity in the electronics required to operate the individual sources in the array. This seminar will present schemes that avoid the complexity of conventional phased arrays by manipulating the wave front from a single source using acoustic metastructures that do not themselves contain any source of sound, unlike the conventional phased array with its many individual sources. A metastructure-based passive array is therefore appealing for its simplicity and capability. Metastructure-based passive phased arrays thus find applications where conventional active arrays would be too complex and expensive.

Noise Control in the Energy Industry

Friday, September 11, 2015 4:00 p.m. in ETC 4.150

Benjamin J. Copenhaver
ATCO Emissions Management
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While natural gas and coal fired power plants are responsible for generating a significant portion of the energy consumed in the U.S., they can also generate a significant amount of noise. Firms specializing in industrial acoustics, such as ATCO Emissions Management, are often called upon by energy companies to deliver solutions for noise mitigation that are practical and cost effective, while satisfying environmental noise regulations and complaints from nearby communities. This seminar will use examples from past projects, including power plants and pipeline compressor stations, to provide a high-level overview of the field of industrial acoustics. The steps of a typical noise control project will be examined, including noise measurement, propagation modeling, and mitigation strategies, as well as the tools used for each.

Analysis of Acoustic Scattering from Large Fish Schools Using Bloch Wave Formalism

Friday, September 18, 2015 4:00 p.m. in ETC 4.150

Dr. Jason A. Kulpe
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In the open ocean, scattering of sonar signals in the 1-10 kHz frequency range is dominated by large fish schools, where multiple scattering effects between the air-filled swim bladders of the fishes within the school are strong. These schools are typically large in comparison to the acoustic wavelength, and the fish typically swim in nearly-periodic arrangements with a separation distance of approximately one body length. Analysis of the periodic school is performed using the Bloch theorem, which reduces the study of the entire school to the study of a unit cell containing a single fish's swim bladder. Acoustic reflection from the school is considered, using a finite element discretization of the unit cell, via an expansion of Bloch waves for the transmitted wave field. Next, acoustic scattering from a large finite school is studied using the Helmholtz-Kirchhoff integral theorem, with the Bloch solution used as inputs to the integral. A general model using the Bloch formalism that encompasses the internal structure, fish biologic properties, and realistic school effects such as disorder and geometry, will be explored. Transient analysis of the frequency dependent scattering, using the proposed model, may assist sonar operators to better classify large fish schools.

Twenty-four Days, Twenty-three Scientists, One Research Vessel and the New England Mud Patch: An Ocean Acoustics Travelogue

Friday, September 25, 2015 4:00 p.m. in ETC 4.150

Dr. Kevin M. Lee and Professor Preston S. Wilson
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In July and August of 2015, twenty-three scientists conducted a series of measurements and scientific data collection operations on the research vessel Hugh R. Sharp, about 6o miles south of Martha's Vineyard, in an area known as the New England Mud Patch. The overall scientific goal of the project is to study inverse techniques for the acoustic characterization of muddy ocean bottom sediments. Absolute evaluation of inversion results requires direct knowledge of the acoustic properties themselves. The work conducted this summer sought to obtain that ground truth, in preparation for the main acoustics experiment next year. A travelogue on the work and life aboard a research vessel dedicated to such an endeavor will be presented.

Technology; Process; People: Generating Engineering Solutions to Wicked Problems and Accommodating Complex Construction Realities of Performance Venue Projects

Friday, October 9, 2015 4:00 p.m. in ETC 4.150

Craig Janssen, Managing Director
Idibri
Dallas, Texas
www.idibri.com

Projects can be separated into phases of needs analysis, engineered solution and implementation. These simple phases belie the tremendous difficulty experienced in design and construction projects for performance venue facilities, and undersell the complexity of human dynamics required for the successful delivery of these projects. Case studies of performance venues will be presented, accompanied by discussion of the technical, process and people challenges implicit in each. Also discussed will be the common characteristics of engineers who successfully deliver these projects.

Call of the Wild Tiger: Exploring Acoustic Monitoring of Wild Tiger Populations

Friday, October 16, 2015 4:00 p.m. in ETC 4.150

Courtney Dunn, Director
The Prusten Project
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Development of new methods of remote monitoring is essential for more efficient as well as minimally disruptive census of species where dense jungle prohibits visual confirmation. This is particularly important for Panthera tigris, whose populations have plummeted by over 50% within the past century and whose ranges have been reduced to 7% of their historic lands. With the population decline of many other forest-dwelling species following that of this flagship species, it is important now more than ever to establish an efficient, all-encompassing census method for such landscapes. We sought to determine what makes an individual tiger's call unique in hopes of developing a non-invasive acoustic monitoring system within rangeland countries. To answer this question, spectrogram outputs of 265 bouts from approximately 1,618 hours of recording were analyzed to determine vocal characteristics from eight female and nine male adult Bengal tigers residing in controlled, ex-situ conditions. Volunteers extracted data on minimum and maximum fundamental frequencies, duration of bouts, inter-call intervals, average call duration, first call duration, and the time of day a vocalization occurred. Comparison of acoustic parameters among the 17 individuals revealed a significant difference existed between sexes as well as among individuals.

Tour of the Knicker Carillon atop the UT Tower

Fri, Oct 23, 2015 3:30 p.m. to 4:30 p.m.

Samuel K. Hord
Department of Mechanical Engineering
The University of Texas at Austin
https://www.utexas.edu/tours/mainbuilding/carillon
www.dailytexanonline.com/news/2013/04/16/tower-carillon-bells-ring-after-months-of-silence

A carillon is a set of at least 23 bells that are sounded by clappers controlled by a keyboard and foot pedals. The Kniker Carillon atop the UT Tower was installed in 1936, at which time the university could afford only 17 bells. Additional bells were added in the 1980s, bringing the current total to 56. The largest bell in the carillon rings at B flat, weighs 7,350 pounds, and is big enough to take a bath in. A guided tour of the Kniker Carillon in the Tower belfry, located four flights up from the observation deck, will be led by the seminar speaker, a carillonneur since his undergraduate days at BYU. The speaker will touch on the dynamics of bell vibration and acoustic radiation from the Tower, and will both explain how the carillon works and demonstrate how it is played. The tour will start at 3:30 p.m. on the 8th floor of the Tower. Use one of the entrances on the north, east, or west side of the Main Building, which will bring you in on the ground floor, and then take the Tower elevator to the 8th floor, where the carillon practice room is located. The group will be escorted by elevator up to the 27th floor and then taken up several flights of stairs to the

room in which the carillon is played. To actually see the bells one must continue on up a ladder and climb through a trapdoor, so viewing may be limited by time and size of the group. There will be no access to the Tower observation deck during the tour.

Transmission Matrices: Introduction and Application

Friday, October 30, 2015 4:00 p.m. in ETC 4.150

David A. Nelson, INCE Bd. Cert., PE
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Layered systems present both challenge and opportunity in noise control. The equations for a handful of basic situations are worked out in engineering texts, but the number of situations encountered in practice drives a need for a straightforward method of assessing them. Transmission matrices simplify the evaluation of structures as diverse as foil-covered absorbers, multi-leaf partitions, lined ducts, side-branch resonators, and chambered mufflers. We'll demonstrate the theoretical basis, introduce a handful of basic matrices, and use them to address a real-life noise control problem. A “spin class” uses bass-saturated dance music to encourage people exercising on stationary bicycles. The throbbing easily penetrates generic walls between commercial spaces because of the low-frequency partition resonance. When the developer's architect helpfully specifies an added wall that doesn't get the job done, the acoustical consultant dusts off his knowledge of transmission matrices to both explain the failure and to propose a solution.

Nonlinear Internal Waves and Coastal Ocean Acoustics: Are We There Yet?

Monday, November 9, 2015 1:00 p.m. in RLM 11.204

Dr. James F. Lynch
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www.whoi.edu

Chinese experiments in the late 1980's-90's showed that the interaction of low frequency (10-1000 Hz) sound with nonlinear coastal internal waves (*soliton trains*) could cause a 40 dB drop in sound intensity due to scattering. These observations resulted in an interest in coastal nonlinear internal waves that continues to this day. In this talk, I will review the history and results of the acoustics/nonlinear internal wave research. I will then address the questions one must ask after a prolonged effort: *Are we there yet? Is there anything useful left to do?*

The Dense Plasma That Forms Inside a Sonoluminescing Bubble

PHYSICS DEPARTMENT COLLOQUIUM AND ACOUSTICS SEMINAR

Wednesday, November 18, 2015 4:00 p.m. in RLM 4.102

Professor Seth Putterman
Department of Physics
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The passage of a sound wave through a fluid with a bubble leads to pulsations that are so nonlinear that acoustic energy is concentrated by 12 orders of magnitude to make flashes of ultraviolet light as short as 35 picoseconds. These flashes—sonoluminescence—can be seen with the unaided eye. Time-resolved spectra reveal the formation of an ideal Planck blackbody. The measurements are interpreted in terms of a first order phase transition to a plasma with a charge density that can exceed 1021/cc. To study this dense plasma we have duplicated the parameter space of sonoluminescence with laser breakdown and electric discharges in dense gases. The sparks can block broad-band high-power laser pulses and the laser breakdown can generate a plasma condensate that influences the transport properties.