Sonar Remote Sensing of Marine Organisms

Monday, January 12, 2009 10:00 a.m. ARL Auditorium

Dr. Timothy K. Stanton
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts
http://www.whoi.edu

Since sound can travel such great distances in the ocean, it is an attractive tool for studying the spatial and temporal distributions of marine organisms such as fish and zooplankton over a large range of scales and at high resolution. One major challenge is in the interpretation of the echo data, which can contain many ambiguities with respect to the type, size, and numerical density of the organisms. In this presentation, a systematic development of interpretation methods and associated equipment is described based on the past 20 years of research in the WHOI bioacoustics group. The presentation begins with a description of the complexity of the scattering problem associated with the diverse range of organisms that scatter sound in the ocean.Laboratory measurements are summarized involving various classes of zooplankton and fish. Broadband and narrowband acoustic signals are used spanning the range 24 kHz to 1.2 MHz. Matched filter processing and spectral analysis are performed in order to identify dominant scattering mechanisms. Based on this analysis, first-order scattering models as well as more complex models are developed and compared with the data. The methods are then applied to ocean measurements using advanced instrumentation. Studies using two systems are described, one with four narrowband channels (38 kHz to 420 kHz) for studies of zooplankton, and the other with three broadband channels (1.5 kHz to 100 kHz, with some gaps) for studies of fish. Each system is towed by a ship. The spectral characteristics of the backscattering in the ocean studies, in combination with scattering models and net tows, are used to classify the organisms in terms of their type, size, and numerical density.

The Near Pressure Field of Coaxial Subsonic Jets

Friday, January 30, 2009 4:00 p.m. ETC 4.120

Professor Charles E. Tinney
Department of Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin
http://www.ae.utexas.edu

The principle focus of this presentation is towards developing a better intuition for the mechanisms by which unbounded turbulent jet flows generate sound. The research was performed as part of the European Program CoJeN with an emphasis towards improving the jet noise prediction tools used by modern aerospace industries. A subset of the experimental campaign will be presented, comprised of measurements of the near pressure field, acquired within the hydrodynamic periphery of a coaxial transonic jet. A variety of velocity and temperature ratios were investigated including configurations both with and without serrations on the secondary nozzle. The significance of the pressure field in this region is its capacity to carry two distinctly different types of signature—one that is representative of the passage of turbulent vortex cores (large-scale flow events, or pseudo sound), the other comprising the infant stages of a sound field that is destined to reach the far field. A variety of analytical techniques are used to develop a global intuition for the turbulence and source mechanisms of this coaxial jet. In particular, an ad

hoc separation of the two signatures is invoked based on an analysis in wavenumber-frequency space, thus permitting an independent investigation of the hydrodynamic and acoustic fields.

High-Frequency Ultrasound Transducers and Applications

Wednesday, February 4, 2009 4:00 p.m. BME 3.204

Dr. Jeffrey A. Ketterling
Riverside Research Institute
New York, New York
http://www.rri-usa.org/biomed.php

This seminar will focus on recent work involving high-frequency ultrasound (HFU) transducers (>20 MHz) that are widely used for fine-resolution ophthalmic and small-animal imaging. Most HFU imaging is now performed with single-element, focused transducers. These devices have excellent lateral resolution, but a fairly limited depth of field (DOF). Array devices are an obvious approach to improving image quality for HFU, but it has proven difficult to fabricate and fully instrument linear array devices. An annular array provides a simplified approach to improving DOF while still maintaining excellent lateral resolution. The design, fabrication, and testing of 40 MHz and 20 MHz annular arrays will be discussed. Examples of ophthalmic and small-animal images will be presented and compared to the current state of the art. The results reveal that annular arrays lead to a significant improvement in image quality versus currently utilized single-element devices. Finally, the seminar will summarize ongoing work related to HFU excitation of ultrasound contrast agents (UCAs). UCAs designed for use with HFU would permit the visualization of slow-moving microcirculation in ophthalmic and small-animal applications.
Polymer-shelled UCAs were examined for their single-bubble backscatter when excited with 40 MHz tone bursts of 1, 3, 5 to 10, 15, and 20 cycles. The backscatter signals were then examined to determine if a 20 MHz subharmonic component was present. The subharmonic was initiated between 8 to 10 cycles and then increased in magnitude as the number of cycles increased. An optimal range of pressures for the presence of subharmonic activity was also observed and this pressure range shifted based on the mean size of the agents.

Why Make Complex Acoustic Signals that Attract Predators? The Dynamics of Túngara Frog Signal Complexity

Friday, February 13, 2009 4:00 p.m., ETC 4.120

Karin L. Akre and Professor Michael J. Ryan
Section of Integrative Biology
The University of Texas at Austin
http://www.biosci.utexas.edu/ib

Female túngara frogs (Physalaemus pustulosus) use male acoustic signals to make mate choice decisions. Males produce advertisement calls of variable complexity. They produce frequency-modulated vocalizations, called whines, and can add 1 to 7 short bursts of multi-harmonic sound, called chucks, to a whine. Females preferentially approach calls with any number of chucks over whines alone. However, they have not been shown to prefer more chucks to fewer chucks, thus the production of multiple chucks has been somewhat of a paradox, especially because predatory bats and parasitic flies use chucks to find their frog prey. Further, bats have been shown to preferentially hunt frogs that make more chucks. We examined natural production of multiple chucks in male-female interactions and tested whether female preference for male calling varies with proximity (which covaries with call amplitude), and whether acoustic properties of male vocalizations influence cognitive factors beyond preference (specifically, memory) that are used in mate choice decisions. We found that female preference depends upon proximity to males, that the time period over which females retain a preference varies with signal complexity, and that males increase signal complexity in response to female approach.

Parametric Array: A Novel Application of Nonlinear Acoustics

Friday, February 20, 2009 4:00 p.m. RLM 7.104

Professor David T. Blackstock
Department of Mechanical Engineering
and
Applied Research Laboratories
The University of Texas at Austin
http://www.me.utexas.edu

When two intense primary sounds of different frequencies propagate together, their nonlinear interaction produces various distortion components. Particularly interesting is the difference frequency component, which is at the heart of one of the best known applications of nonlinear acoustics: the parametric array. In the parametric array the two primaries are narrow, collinear beams at high frequencies, f1 and f2, which are close together so that the difference frequency, f1 – f2, is low. Because of their short wavelengths, only a small transmitter is needed to radiate the primary beams. The difference-frequency sound produced by nonlinear interaction of the two primaries is generated not back at the transmitter, but rather in the medium all along the beam axis. It is as though a long line of virtual sources radiating at the difference frequency were deposited in the medium, phased so as to form a long end-fire array. The difference frequency sound produced is therefore itself a very narrow beam, far more narrow than if the transmitter had produced it directly. The parametric array thus provides a way to generate a narrow beam of low-frequency sound despite the fact that the transmitter that set all this up is small compared to the difference wavelength. Another very attractive feature of the parametric array is that although the primary beams have many sidelobes, the difference-frequency beam has none. The history and some experiments and applications of the parametric array are discussed.

Micromachined Optical Diffraction-Based Sound and Vibration Sensors

Friday, February 27, 2009 4:00 p.m. in ETC 4.120

Professor Neal A. Hall
Department of Electrical and Computer Engineering
The University of Texas at Austin
www.ece.utexas.edu

This presentation will summarize recent developments with micromachined microphones employing diffraction-based optical displacement detection. The approach has the advantage of providing high-displacement detection resolution of the microphone diaphragm, independent of device size and capacitance, creating an unconstrained mechanical and acoustical design space for the mechanical structure itself. Micromachined microphone structures with 1.5 mm-diameter polysilicon diaphragms and monolithically-integrated diffraction grating electrodes are presented in this work. Their architectures deviate substantially from traditional condenser MEMS microphones. These structures have been designed for a 20 kHz broadband frequency response and low levels of Brownian (i.e., thermal mechanical) noise. The rigorous experimental characterization of these structures to be presented indicates a diaphragm displacement detection resolution of 20 fm/√Hz and a thermal-mechanical induced diaphragm displacement noise density of 60 fm/√Hz, corresponding to an A-weighted sound pressure level detection limit of 24 dB(A) for these structures. Modeling and characterization results lead to the projection of 15 dB(A) noise levels from subsequent prototyping efforts, thus approaching the threshold of hearing. For reference, such performance figures are characteristic of only the highest quality traditionally-manufactured microphones available today, which are roughly 100 times larger in size. The potential commercial impact of the technology will be highlighted with reference to design-win opportunities in the areas of hearing aids, acoustic instrumentation, and some medical device applications. Time permitting, possible future directions and applications in medical ultrasound imaging and scanning probe microscopy will be discussed.

The Design and Construction of an Acoustic Research Facility

Friday, March 6, 2009 4:00 p.m. in ETC 4.120

Dr. Douglas F. Winker
ETS-Lindgren Acoustic Systems
Cedar Park, Texas
www.ets-lindgren.com

This presentation will focus on the design and construction of a new acoustic lab facility in Cedar Park, Texas. Acoustic Systems was purchased by ETS-Lindgren in 2002. In January 2008, the Acoustic Systems facility in South Austin was closed and moved to ETS-Lindgren's global headquarters in Cedar Park, Texas. Acoustic Systems now operates under the name ETS-Lindgren. A major portion of the move was the relocation of Acoustic Systems Acoustic Research Laboratory. Instead of relocating the existing test chambers, new higher-performance chambers were constructed.

The new lab consists of a hemi-anechoic chamber and a reverberation chamber suite. The hemi-anechoic chamber was designed to obtain a noise floor of 0 dBA at frequencies above 100 Hz. Another design goal was a 2 m radius free field above 80 Hz that was compliant with ISO 3745. It features a 200 m3 volume inside the wedges. To achieve the design goals, several aspects were considered including ambient levels, vibration isolation, HVAC noise, and free field performance. The design solutions for each of these areas will be presented.

The reverb chamber suite consists of two reverberation chambers designed to perform transmission loss tests and sound absorption testing. The source chamber has an internal volume of 214 m3 and the receive room has an internal volume of 418 m3. Design considerations will be discussed including vibration isolation, wall panel design, and diffuser placement. Additionally, the design and construction of the transmission loss coupling will be addressed.

Modeling of Sonic Tools with hp-Adaptive Finite Elements

Friday, March 13, 2009 4:00 p.m. in ETC 4.150

Professor Leszek F. Demkowicz
Department of Aerospace Engineering and Engineering Mechanics
Assistant Director, Institute for Computational and Engineering Sciences
The University of Texas at Austin
www.ices.utexas.edu

In finite element modeling, hp-adaptive methods allow for locally varying element size, h, and polynomial order, p, combining the strengths of both low-order and spectral methods of solving problems. Ongoing work on modeling sonic borehole tools with hp-adaptive elements will be presented. The problem is modeled as a coupled acoustics/elasticity (borehole/formation, tool) problem set up in an axisymmetric geometry in the frequency domain. An additional Fourier series expansion in θ decouples the problem into a series of individual single-mode (in θ) boundary-value problems in the 2-D r-z domain (relevant for modeling both monopole and dipole sources). The Perfectly Matched Layer complex stretching techniques are then used to truncate the problem to a bounded, rectangular domain. A standard variational formulation in terms of elastic displacement and acoustic pressure forms a foundation for hp discrimination. The fully automatic hp-adaptive strategy is then used to generate a sequence of optimally-refined meshes that result in a highly accurate and reliable finite element solution. The problem is run for many frequencies with the inverse Fourier transform used to produce the final results in the time domain. Numerical results for both monopole and dipole sources will be presented. The presentation will conclude with an outline of more complicated models including poroelasticity (formation) and possible couplings with Maxwell equations (conducting fluid).

The Development and Execution of Mate Choice in Túngara Frogs

Friday, April 10, 2009 4:00 p.m. in ETC 4.120

Alexander T. Baugh
The Institute for Neuroscience
The University of Texas at Austin
www.neuroscience.utexas.edu

Interest in the question of when and how species recognition and mate preferences emerge in animals with strong species-typical predispositions has faded since the time of the classical ethologists. In its place, the role of plasticity has surfaced as a central emphasis in the study of animal behavior. Here, I step back and examine the origin and execution of sexual behavior in a tropical frog for which auditory predispositions are key. These experiments challenge assumptions about behavioral development, auditory perception, and stereotyped behavior. First, I illustrate when and how a sex- and species-typical behavior—conspecific phonotaxis—emerges during development. Next, I describe a set of dynamic mate choice studies that highlight how decision-making in a relatively simple system is more flexible, and less stereotyped, than was previously thought. Lastly, I describe a mate choice study that revealed categorical perception of acoustic signals in frogs, the first lower vertebrate now known to exhibit a perceptual mode previously considered a hallmark of higher organisms. Collectively, I make the following arguments: (1) constraints on sensory systems play a larger role in shaping behavior than is generally appreciated, irrespective of the involvement of learning; (2) unstudied sources of variation may contribute significantly to the raw material for sexual selection; and (3) phonotaxis in anurans amphibians is not the simple, stereotyped behavior that has been suggested of it in the past.

Vowel Discrimination and its Auditory Model

Friday, April 17, 2009 4:00 p.m. in ETC 4.120

Professor Chang Liu
Department of Communication Sciences and Disorders
The University of Texas at Austin
http://csd.utexas.edu

Many studies have shown that spectral prominences of vowel sounds, called formants, are important for vowel categorization, especially the first two formant frequencies (F1 and F2). Listeners rely on the F1 and F2 frequency to identify and discriminate vowel signals. The study of vowel formant discrimination investigates sensitivity of the human auditory system to changes of vowel formant frequency. A series of studies have found that discrimination of vowel formant frequency is affected by many factors, such as formant frequency, fundamental frequency, linguistic context, noise background, speech level, and listener training. Acoustically, a change in vowel formant frequency alters the spectral shape of vowel sounds, resulting in a corresponding change in internal representation of vowels like excitation patterns and loudness patterns. Such changes in excitation patterns and loudness patterns may be constant, independent of vowel formant frequency, speech level, and noise background, implying that there exists a relative constant auditory mechanism for listeners to discriminate changes in vowel formant frequency.

Architectural Acoustic Design Processes for Fine Arts Education Facilities

Friday, April 24, 2009 4:00 p.m. in ETC 4.150

Andy Miller
BAi, LLC
Austin, Texas
www.baiaustin.com

Two case studies help illustrate the focus of this seminar: The University of South Florida School of Music's new music building and the renovation of a 1962 high school auditorium in Temple, Texas.

The new School of Music in Tampa, Florida is a 118,000-square-foot facility in the final phase of construction document production. It consists of individual practice rooms, music rehearsal rooms, faculty performance studios, a 500-seat concert hall, and a 100-seat recital hall. The design team and the University of South Florida collaborated using the counsel of BAi. Design constraints and opportunities are highlighted as well as team compromises.

The Temple High School Auditorium is receiving a facelift after falling into disrepair 47 years after opening its doors. The room suffered a reverberation time that was too short for musical performance despite finishes on walls, ceiling, and floor that would imply longer reverberation. Regenerative electronic room acoustics enhancement, teamed with traditional room acoustics solutions, were employed to meet the acoustical criteria of this speech, music performance, and theater performance facility.

Comparing Emissions from the Cochlea with Behavioral Performance

Friday, May 1, 2009 4:00 p.m. in ETC 4.120

Professor Dennis McFadden and Kyle P. Walsh
Department of Psychology and Center for Perceptual Systems
The University of Texas at Austin
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In all sensory systems, the incoming stimulus information is subjected to numerous stages of processing as it moves from the periphery to the cortex, where perception, consciousness, and responding presumably arise. An implicit, long-term goal of sensory neuroscience is to determine what modifications to the sensory stream are made at each successive waystation of processing. In humans, the species for which the most is known about the behavioral aspects of perception, there are obvious difficulties associated with gaining access to the successive physiological stages of processing. As a consequence, auditory science has had to rely on physiological measurements made on other species when developing explanations for human auditory experience. Here we use a nonlinear form of stimulus-frequency otoacoustic emissions (SFOAEs) to measure the early stages of processing in humans subjected to auditory stimuli commonly used in psychophysical tasks, such as auditory masking. SFOAEs are sounds produced in the cochlea that propagate back through the middle ear into the external ear canal where they sum with the acoustic input stimulus. Averaging and subtraction procedures are used to reveal the SFOAE. The results suggest that these OAE measures have considerable potential to provide details about human cochlear processing in general, and also may help explain individual differences in human cochlear processing that might be related to individual differences in human psychophysical performance.

Investigations of Acoustic and Seismic Coupling at the Air-Earth Boundary

Friday, May 29, 2009 10:00 a.m. in the ARL Auditorium

Dr. Wheeler Howard
Miltec Research and Technology
Oxford, Mississippi
www.ducommun.com/miltec/mrt

Soils overlying naturally occurring hardpans, such as caliche or fragipan, normally experience decreased crop yield and increased erosion rates. Mapping these layers on a field scale would permit the judicious distribution of hydraulic and agricultural resources. Currently, the hardpans are mapped via core samples, auger holes, cone penetrometer measurements, and trench studies. This presentation focuses on the coupling between acoustic and seismic energy at the surface to determine the depth to these hardpans. Measurements of the acoustic to seismic coupling signature at two field sites will be presented. This data will be compared to ground truth measurements consisting of seismic refraction, cone penetrometer, trench, and core sample surveys. A multi-layered Thompson-Haskell viscoelastic forward model is presented to model the acoustic/seismic signature of the soil. Results for the inversion of synthetic and field data will be presented.

Model for the Response of Human Lung Tissue to Low-Frequency Underwater Sound

Friday, September 4, 2009 4:00 p.m. in ETC 4.120

Dr. Mark S. Wochner
Applied Research Laboratories
The University of Texas at Austin
www.arlut.utexas.edu

The time-dependent nature of mammalian lung damage due to acoustic excitation at the lung's resonance frequency has been demonstrated by Dalecki and coworkers at The University of Rochester. A finite-element-based model of human lung response to low-frequency underwater sound has been developed to calculate induced shear stresses and strains. The material properties of the lung parenchyma used in the finite element model are derived from a micromechanical model of lung tissue that approximates alveoli as truncated octahedra with elastic fiber bundles applied to the faces and edges of these octahedra. The model accounts for surface tension in the lungs, pulmonary surfactant, and the compressibility of air within the lungs. An extension of the model which allows for progressive damage over multiple acoustic cycles will also be discussed. Unlike for many man-made materials, there are very few experimental data from which fatigue parameters can be calculated for lung parenchyma. Methods of modeling the time-dependent damage known to occur in mammalian lungs exposed to low-frequency underwater sound will be presented, and attempts will be made to correlate reported thresholds for lung

damage to computational results obtained from our model. Discussions of the limitations of such an approach and future applications will be addressed.

Experimental Investigations of Bubble Dynamics in Constrained Geometries

Friday, September 18, 2009 4:00 p.m. in ETC 4.120

Dr. Todd A. Hay
Applied Research Laboratories
The University of Texas at Austin
www.arlut.utexas.edu

The behavior of ultrasound contrast agent (UCA) microbubbles in confining environments is relevant for several biomedical applications including imaging and targeted drug delivery. This talk will focus on experiments and associated modeling efforts in the area of UCA dynamics performed by the speaker during his year as a postdoctoral fellow at the University of Twente in the Netherlands. Measurements from experiments investigating the radial dynamics of UCA microbubbles near a single elastic plate, between parallel plates and within rectangular microchannels will be presented. The radial motion of several UCA bubbles was recorded over a range of insonation frequencies and at various offset distances from the plates or channel walls using a combination of optical tweezers and high speed imaging. Measurements of bubble behavior near a single plate will be compared with simulations from a model which takes into account both the elasticity and viscosity of the plate material.

Shock-wave lithotripsy is another application where bubble dynamics play a major role. In fact, cavitation cluster activity is thought to be a major contributor to kidney stone disintegration. Better understanding of the forces acting between bubbles and stone fragments may therefore increase the efficacy of the treatment. Laboratory measurements will be compared with simulations from an existing model describing bubble-particle interaction.

Cochlear Implants

Friday, September 25, 2009 4:00 p.m. in ETC 4.120

Amy Gensler, M.A., Cert. AVT
Austin Ear Clinic
Austin, Texas
www.austinear.com

Cochlear implants are life-changing prosthetic devices that can dramatically improve hearing and speech perception for people with severe-to-profound sensorineural hearing loss. Cochlear implant technology is much improved today compared to technology first commercially released in the late 1980s. This seminar will focus on all aspects of cochlear implants—the internal electrode array and external speech processor, creation of speech processing programs, and programming parameters. Anatomy of the auditory system, how a person qualifies for an implant, and post-operative programming and outcome will also be discussed.

Amy Gensler is an audiologist who performs electrophysiological tests of the auditory system, as well as programs and adjusts all cochlear implant equipment after surgery. She is the only certified Auditory-Verbal Therapist in the greater Austin area (one of about 30 in the state). She has been director of the cochlear implant program at Austin Ear Clinic for the past 7 years, and manages over 250 cochlear implant patients (ages 1-85 years).

Wave Propagation in Water-Saturated Sand and Grain Contact Physics

Friday, October 2, 2009 4:00 p.m. in ETC 4.120

Dr. Nicholas P. Chotiros and Dr. Marcia J. Isakson
Applied Research Laboratories
The University of Texas at Austin
www.arlut.utexas.edu

Measurements in sandy ocean sediments over a broad range of frequencies show that the sound speed dispersion is significantly greater than that predicted by the standard Biot-Stoll model with constant coefficients, and the observed sound attenuation does not seem to follow a consistent power law. The sound speed dispersion may be explainable in terms of the Biot-Stoll model but with complex bulk and shear moduli introduced for the frame that are determined by the grain-grain contact physics. In the case of water-saturated sands, the contact stiffness is dominated by squirt flow and viscous drag of a thin fluid film that permeates the contact area. Using this approach, the observed compression and shear wave speeds, and attenuations, may be explained.

The Songs of Bats and Dissecting the Auditory System

Friday, October 9, 2009 4:00 p.m. in ETC 4.120

Professor George D. Pollak
Section of Neurobiology
School of Biological Sciences
The University of Texas at Austin
www.utexas.edu/neuroscience/Neurobiology/GeorgePollak/index.html

Bats are best known for their echolocation abilities but they also are among the most colonial of mammals, living in caves with populations that can number in the millions. To establish and maintain their communities in total darkness, they employ acoustic signals for social interactions. My students and I have been studying the vocal repertoire of a colony of Mexican free tailed bats maintained in Austin by my colleague, Barbara French. What I will show, and what is so surprising, is that their vocal communication is composed of a rich repertoire of complex signals. The most elaborate signals are used for courtship and territorial defense, and are actually “songs” that have defined structures and perhaps even a grammar and syntax. I will then discuss how acoustic signals are processed by the central auditory system, and show that inhibition allows the system to respond differentially to even subtle acoustic features. I will describe our recent studies in which we record from neurons within awake bats with patch electrodes that allow us to evaluate not only the inputs to neurons, but also exactly how excitation and

inhibition are integrated to produce discharges that are selective for features of the signals they use in their daily lives.

Introduction to Sonic Well Logging: Acoustic Measurements in a Fluid-Filled Earth Borehole

Friday, October 16, 2009 4:00 p.m. in ETC 4.120

Dr. David J. Scheibner
Schlumberger
Sugar Land, Texas
Fuchinobe, Japan
www.slb.com

The use of acoustic waves to measure earth formations spans a wide range of frequencies, from seismic to ultrasonic. This presentation will focus on the middle range, from 300 Hz to 30 kHz, in what is known as sonic well logging. I will discuss the types of waves that propagate in boreholes at these frequencies, the various rock properties we try to measure, and the instruments used to make the measurements. I will also describe some uses for acoustical modeling and simulation in instrument design and measurement interpretation.

Nonlinear Sound and Sound-Like Wave Interactions in Quantum Liquids

Friday, October 23, 2009 4:00 p.m. in ETC 4.150

Dr. Nellie I. Pushkina
Scientific Research Computing Center
Moscow State University
Moscow, Russia
www.srcc.msu.su/nivc/index_engl.htm

Quantum liquids present a very good opportunity for studying sound and sound-like wave processes. In these fluids there exist a number of various types of weakly damped excitations not present in classical fluids. Studying wave processes in superfluids is important not only for the spectroscopy of the superfluids themselves, but also to clarify the main features of various wave interactions.

In the talk, three different types of sound and sound-like nonlinear interactions are considered. The first one is the nonlinear excitation of sound by two fourth-sound waves in superleaks. This problem is close to that of sound propagation in classical media such as marine sediments. The second one is absorption-induced stimulated excitation of second sound. This process is conceptually close to absorption-induced wave interactions in nonlinear optics. The third topic concerns the possibility of entropy flow in superfluids, which corresponds to acoustic streaming in classical fluids.

Speech Perception: An Engineer's View

Friday, November 6, 2009 4:00 p.m. in Burdine 208

Professor Robert I. Damper
School of Electronics and Computer Science
University of Southampton
Southampton, UK
www.isis.ecs.soton.ac.uk/areas/?view=speech

Human speech is a complex biological and social phenomenon. Historically, in among the morass of complexity, it has not always been clear precisely what is the explanandum (the phenomenon or phenomena to be explained) and the explanans (the explanation of this phenomenon or phenomena) for the scientific study of speech perception. This presentation will aim to answer these questions, setting out what a scientific model of speech perception ought to do. Along the way, after first making some remarks about black boxes and the Helmholtz-Thevenin theorem and its implications for the study of perception, and about "boxologies" in general, I will review the array of phenomena that have traditionally been taken as the explananda. These include categorical perception, duplex perception (including phonemic restoration), the supposed lack of invariance in the acoustic signal, auditory/visual illusions such as the McGurk effect, and perception of "weird" speech analogs like sine-wave speech. Much of the action in debating these has centered on the nature of the so-called "objects" of speech perception. Are they auditory, or articulatory or both or something else? As the field is characterized as much by what we don't know as what we do, I will conclude with some questions: How "discrete" is speech really? Is the concept of "object of perception" coherent? What is the best current model of speech perception? How good a model is a state-of-the-art automatic speech recognizer?

Investigation of the Cancellation of Acoustic Waves Scattered from an Elastic Sphere

Friday, November 13, 2009 4:00 p.m. in ETC 4.120

Matthew D. Guild
Applied Research Laboratories
The University of Texas at Austin
www.arlut.utexas.edu

The topic of acoustical cloaking has gained significant attention in recent years due to the successful creation of electromagnetic cloaks using metamaterials. Two specific approaches have been suggested to successfully construct acoustical cloaks: (i) the transformation method and (ii) the scattering cancellation technique. Transformation methods require materials whose properties are strongly anisotropic and functionally graded in order to bend incident acoustic waves around the cloaked object. By contrast, the scattering cancellation technique utilizes elastic layers designed to eliminate the field scattered from an insonified object. Unlike the transformation method, this technique can be used to minimize the scattered signal within a chosen frequency band while simultaneously allowing energy to penetrate the object. The work presented here employs the scattering cancellation technique to investigate the effectiveness of a single isotropic elastic layer to cloak an elastic sphere. The presentation discusses the benchmarked analytical and finite element scattering models which were employed to explore the design space of the

cloaking layer. Parametric studies showing the influence of cloak stiffness and geometry on the frequency dependent scattering cross section are then presented. These case studies clearly illustrate the fundamental physical behavior leading to the observed reduction in scattering cross section at design frequencies. Finally, material selection of a scattering cancellation layer is discussed, including the use of auxetic materials and the creation of isotropic particulate composite materials.

Technical Aspects of Acoustical Engineering for the International Space Station

Friday, November 20, 2009 4:00 p.m. in ETC 4.150

Christopher S. Allen
NASA Johnson Space Center
Houston, Texas
hefd.jsc.nasa.gov/acoustics.htm

It is important to control sound levels on manned space flight vehicles and in habitats to protect the hearing of the crew, allow for voice communications, and to ensure a healthy and habitable environment in which to work and live. For the International Space Station (ISS) this is critical because of the long duration crew-stays of approximately six months. NASA and the JSC Acoustics Office set acoustical requirements that must be met for hardware to be certified for flight. Modules must meet the NC-50 requirement, and other component hardware are given lower-level allocations to meet. In order to meet these requirements many aspects of noise generation and control must be considered. This presentation has been developed to provide insight into the various technical activities performed at JSC to ensure that a suitable acoustic environment is provided for the ISS crew. Examples discussed include fan noise, acoustical flight material development, on-orbit acoustical monitoring, and the ISS Crew Quarters as a specific hardware development and acoustical design case.