Acoustics Seminar Abstracts 1988
University of Texas at Austin

Ultrasonic Imaging and Velocimetry in Multiphase Flow

Wednesday, January 27, 1988 1:00 p.m.

Steve Morriss
Department of Petroleum Engineering
The University of Texas at Austin

The objective of this project is to determine the feasibility of using ultrasonic techniques to measure fluid velocities and to create images of the phase distribution in multiphase flow. The measurement system is based on a commercial medical instrument modified as needed. Measurements are made in a 42 ft. long, 7.25 in. ID pipe of the multiphase flow loop in the Petroleum Engineering Department. This facility can simulate a wide range of possible downhole (oil well) flow conditions due to its rate capabilities and its continuously variable inclination.

Atmospheric Acoustic Noise as a Function of Altitude

Friday, February 5, 1988 1:00 p.m.

Dr. Tom Griffy
Department of Physics
Applied Research Laboratories
and
The University of Texas at Austin

Measurements of ambient acoustic noise in the atmosphere have been limited to a few meters from the ground. In August of 1987, a hot air balloon was used as a platform to measure noise up to 3400 meters in octave bands and with A and “flat” weighting. Measurements were made in the early morning over a rural area. Results of those measurements will be presented.

Frequency Resolution and Speech Reception in Persons with Sensorineural Hearing Loss

Wednesday, February 10, 1988 1:00 p.m.

Dr. Linda Thibodeau
Department of Speech Communication
The University of Texas at Austin

One explanation for the speech recognition difficulties of hearing-impaired persons with sensorineural hearing loss is a reduction in their ability to differentiate spectral information. A proposal for how this inability relates to speech recognition will be explained. Data from three experiments which evaluated the relationships among frequency resolution, discrimination of synthetic speech syllables, and identification of natural speech syllables for seven hearing-impaired subjects will be reviewed.

The Space Thermoacoustic Refrigerator

Monday, February 15, 1988 1:00 p.m.

Dr. Steven Garrett
Department of Physics
Naval Postgraduate School
Monterey, California

The Space Thermoacoustic Refrigerator (STAR) is currently under development at the Naval Postgraduate School. This novel cryocooler uses resonant sound waves in a He/Xe gas mixture to pump heat at high efficiency without the use of sliding seals which tend to fail in conventional (eg. Sterling Cycle) refrigerators and with much lower vibration levels. The system is presently designed to “fly” on the Space Shuttle as a Get Away Special (GAS Can) in 1989. Because of space applications to cooling of infrared detectors and “High T_c” superconductors, STAR is the top priority DoD small payload. This talk will cover the basic thermodynamics of thermoacoustic processes, describe the major STAR subsystems (electrodynamic drive, GAS canister, electronics, automated control, etc.), and will include the demonstration of a simple thermoacoustic engine.

Computer Music at The University of Texas at Austin

Wednesday, February 24, 1988 1:00 p.m.

Keith Lent
Department of Electrical Engineering
and
Department of Music
The University of Texas at Austin

During the past twenty five years a number of technological advances have made it possible for a musician to digitally synthesize compositions. This is usually done within the framework of a general purpose sound synthesis language (e.g., MUSIC4, MUSIC5, CMUSIC, MIX, etc.). This method of creating music is particularly fascinating because of its unlimited potential to create any sound that can be played through a loudspeaker. In this presentation the basic techniques, algorithms and equipment used in creating computer music will be demonstrated.

Scattering of Sound by Sound from Two Gaussian Sources

Wednesday, March 2, 1988 1:00 p.m.

Corinne Darvennes
Department of Mechanical Engineering
The University of Texas at Austin

The generation of difference frequency sound by two beams that interact at a nonzero angle is referred to as scattering of sound by sound. Whether the difference frequency sound can be radiated outside the noncollinear interaction region formed by the intersecting primary beams has fueled controversy over the

past three decades. Extensive theoretical work has been done at the University of Texas to solve this problem. In our analysis, we consider the interaction of two Gaussian beams that intersect at small angles. Computed propagation curves and beam patterns show the existence of difference frequency sound outside of the interaction region and demonstrate its dependence on geometry and frequency ratio. Results are also presented for the scattered sum frequency sound.

Ray Theory Modeling in Shallow Water

Monday, March 7, 1988 12:00 p.m.

Evan Westwood
Department of Electrical Engineering
and
Applied Research Laboratories
The University of Texas at Austin

A new method based on ray theory for modeling acoustic propagation in shallow water environments will be presented. While classical ray theory is a high-frequency approximation which is not valid in shallow water, this new method can be used when the water depth is on the order of wavelengths. A complete analysis of the field reflected from a plane interface will be given, and a review of the necessary mathematical tools will be provided. The ray model will then be applied to both flat and sloping oceanic waveguides. The validity of the method will be demonstrated by comparisons with other models for a low-frequency case of upslope propagation.

Calculation of the Intensity and Absorption of a Finite-Amplitude Sound Wave

Wednesday, March 9, 1988 1:00 p.m.

Dr. David T. Blackstock
Department of Mechanical Engineering
Applied Research Laboratories
and
The University of Texas at Austin

An operational definition of absorption $\alpha = -\nabla \cdot I/2I$, where I is the sound intensity, was popular in the 1950's as a means of quantifying the increased attenuation of finite-amplitude ultrasonic beams. Note here that α is the total absorption of the wave, not just the absorption of the fundamental component. Although the relation fell into disuse in the 1960's and 1970's, Carstensen et al. (Acustica 51, 166-123 (1982)] recently revived it as a natural and useful tool to characterize attenuation in biological media. For a wave sinusoidal at the source, Carstensen et al. calculated α and I from the Fourier series expansion for the pressure of a finite-amplitude wave. Presented in this talk is an alternative calculation based on the time-domain version of the weak shock solution. Exact, closed-form expressions for α and I are given for all distances from the source. The extension to pulses is indicated.

Modeling the Acoustic Field Near the Focus of a Reflector

Wednesday, March 23, 1988 1:00 p.m.

C. L. Morfey
Institute of Sound and Vibration Research
University of Southampton, England

Progress will be reported on the problem of modeling the sound field produced by an extracorporeal shock wave lithotripter. This is a device now in routine clinical use for noninvasive fragmentation of kidney stones. It operates by focusing a pulsed acoustic wave onto the target. Repeated pulses eventually fragment the stone into pieces small enough to pass out through the urinary tract.

The device being modeled consists of an underwater spark source and an ellipsoidal reflector. The source is at one focus; the patient is positioned so that the target stone is at the other focus. Problems to be solved include:

(a) Linear-theory calculation of the focused waveform produced in water

(b) Departures from the above result caused by absorption and dispersion by body tissue

(c) Nonlinear effects: waveform steepening and attenuation.

Results for problem (a) are presented, and compared with laboratory waveform measurements. There is qualitative agreement, but nonlinearity evidently needs to be included in order to get the correct peak pressure.

Sound Generation in the Pipe Organ

Wednesday, March 30, 1988 1:00 p.m.

A professionally edited video program shows the general construction of a pipe organ and the fabrication and voicing of the pipes. The relationship between the pipe shape and the acoustic spectrum is also illustrated. Professor Wilson Nolle of the Physics Department will add a few comments on this aspect.

Acoustic Interferometer for Downhole Measurements of Fluid Properties while Drilling

Wednesday, April 6, 1988 1:00 p.m.

Ola Michael Vestavik
Department of Petroleum Engineering
The University of Texas at Austin

When drilling for petroleum resources, formation fluids may enter the well and lead to serious problems including disastrous blowouts. In order to reduce this danger, improved techniques for detection of gas in the well must be developed. One technique which may serve this purpose is presented here. An acoustic interferometer is used to measure fluid properties by creating standing waves in the fluid. Fluid resonance spectra are recorded with various transducer arrangements for assorted fluids including air and water. Measurements of sound velocity and attenuation in some pure fluids are presented. Measurements on water containing air bubbles show that the method is very sensitive for detecting gas in fluids.

Wave-Scatter Methods and S-Matrix Applications in Acoustics

Wednesday, April 13, 1988 1:00 p.m.

Henry M. Paynter
Professor Emeritus and Senior Lecturer
Massachusetts Institute of Technology
and
Adjunct Professor, The University of Texas at Austin

Wave-scattering formalism deals with the operators which relate incoming particles or waves to outgoing particles or waves subjected to scattering obstacles or events. Introduced 50 years ago to deal with high energy particle interactions by Wheeler, Heisenberg and others, the approach soon became used for microwave ductwork and low frequency circuitry. For acoustics this method permits descriptions in terms of directly measured amplitudes and powers of waves, rather than by introducing artificial electric circuit analogies. The corresponding squared-amplitudes are a measure of the wave powers and not the commonly used voltages, currents, pressures, or volume velocities. The scattering operator becomes the scattering matrix (or S matrix) for linear physical systems; the squared magnitudes of its matrix elements (the scattering coefficients) correspond to respective fractions of energy.

Dynamics of an Acoustical Multimode Oscillator

Wednesday, April 20, 1988 1:00 p.m.

A. Wilson Nolle
Department of Physics
The University of Texas at Austin

A closed-loop system in which several simple oscillators are driven by a single saturable element is considered. This element is in turn excited by the summed oscillator velocities. Oscillation is started by increasing the loop gain in a time ΔT from zero to a final value large enough to sustain oscillation in the nonlinear (switching) range. In computer simulations, the choice of fixed parameters determines whether the system evolves to aperiodic behavior, or to periodic motion jointly controlled by two or more oscillators. A range of ΔT may be found for which one oscillator dominates the initial behavior and another the steady state. As suggested by N. H. Fletcher, this model explains the main dynamical features of acoustical oscillations in jet-driven systems (flutes, organ pipes, etc.). Acoustical samples resembling the simulations are shown, and supplemented with demonstrations.

A New Apparatus for Measuring Dynamic Compressibility

Wednesday, April 27, 1988 1:00 p.m.

David E. Edmonds
Department of Mechanical Engineering
The University of Texas at Austin

Knowledge of the dynamic compressibility (β_D) of organic solids used in sonar transducers is important if the transducers are built to operate at a wide range of depths, pressures, and frequencies. Measuring β_D (p, T, f) has previously been hindered by the fact that the test chamber, which is affected by its own pressure history, must be pressurized 3 times per data point. To resolve this problem, we are developing a new test chamber in which the sample can effectively be removed and inserted while the apparatus remains at a constant pressure. Some preliminary results will be discussed and compared to those obtained with different apparatuses. The apparatus will someday be standard test equipment for use at the Applied Research Laboratories.

Refining the Art of Violin Making

Wednesday, May 4, 1988 1:00 p.m.

Dr. Charles R. Ervin
Violin Maker and Restorer
Austin, TX

Dr. Ervin, a fine stringed instrument maker who lives in Austin, has developed a method of plate thinning which can improve even a very good sounding violin. He will give a short presentation and slideshow on how a violin is made and what the plate thinning method entails, then move on to a discussion of some recent attempts to quantify the differences in a particular violin before and after plate thinning was applied. A demonstration of the finished product will be included.

Nonlinear Acoustics and Perestroika in the Soviet Union

Wednesday, September 14, 1988 1:00 p.m.

Professor Mark F. Hamilton
Department of Mechanical Engineering
The University of Texas at Austin

A report will be given on the author's trip last month to acoustics institutes in Moscow, Leningrad, and Tallinn. The seminar will consist of a slide show, a discussion of research performed at the various institutes, and anecdotes about life in the Soviet Union.

The Bedient Organ at St. Mark's

Wednesday, September 21, 1988 1:00 p.m.

Another professionally taped video on pipe organs. This time we follow the design and construction of a single organ from start to finish. It is a French-style 'tracker' organ built by the Bedient Organ Co, Lincoln Nebraska, and installed in St. Mark's Episcopal Church, Grand Rapids, Michigan. Prof. Wilson Nolle will be on hand to answer questions.

The Shortcomings of Pure Circuit Models of Transducers

Wednesday, September 28, 1988 1:00 p.m.

Professor Ilene Busch-Vishniac
Department of Mechanical Engineering
The University of Texas at Austin

Circuit models of transducers have been used for decades, and have proven to be useful tools for prediction of transducer behavior. In this approach the transduction mechanism is typically modeled using ideal two-port transformers or gyrators which neither dissipate nor store energy. Energy loss and storage is taken into account using one-port elements connected to the transducing gyrator or transformer. An alternative approach to transducer modeling recognizes that the transduction mechanism itself generally is associated with energy storage or dissipation. In this formulation the transduction mechanism is typically modeled using a two-port energic element (such as a two-port capacitance). A comparison of the two formulations for piezoelectric transducers shows that there are two fundamental shortcomings introduced in the circuit model approach which are not present in the energic multiport element approach: the transformer modulus must be made a function of the strain of the piezoelectric material, and it is not possible to discuss the piezoelectric material response without imposing a load on the transducer.

Design of an Ultrasonic Robotic Endpoint Detector

Wednesday, October 5, 1988 1:00 p.m.

Jack Leifer
Department of Mechanical Engineering
The University of Texas at Austin

An acoustical system is being developed for use as a highly accurate positioning device in robotics applications. The system includes a high frequency, omnidirectional ultrasonic source, and a number of PVDF based pick-up microphones. This seminar will present several alternative methods of implementing the acoustical source. In addition, the theory and operation of the PVDF based microphones will be discussed and demonstrated.

Nonlinear Behavior of Sound and its Application to Soliton Formation

Monday, October 10, 1988 1:00 p.m.

Akira Nakamura
Oska University
Oska, Japan

As is well known, the nonlinear distortion of finite amplitude sound results from the fact that propagation speed depends on particle velocity and the nonlinearity parameter of the medium. In the case of a thin fiber of fused silica, the waveform of a finite amplitude sound is affected by velocity dispersion as well as nonlinear distortion. A soliton is formed when the waveform changes due to nonlinear distortion are balanced by those due to velocity dispersion. In this paper the soliton formation process is described by simulation using computer modeling.

Results obtained are as follows:

1) Solitary waves of hyperbolic form obeying the K-dV equation are found by computer simulation, not by solving the K-dV equation directly.

2) A waveform that is initially hyperbolic is changed in peak value and pulse width by the propagation until the condition of soliton formation is satisfied.

3) An initially sinusoidal wave is also changed by the propagation until the pulse form and its spectrum agree with those of the hyperbolic soliton.

Medical Applications of Ultrasonic Vibrations from 1 to 10 MHz

Wednesday, October 19, 1988 1:00 p.m.

Oscar M. Weaver, Jr. M.D.
Medical Imaging Department
Perry County Memorial Hospital
Tell City, Indiana

A short introduction to the clinical applications of diagnostic ultrasound will be provided, followed by a number of actual case presentations using the images physicians place at their disposal in clinical practice. Sales brochures including current price quotations will be available to provide some sort of familiarization with the types of equipment currently on the market.

Design of a Multiple Aperture Linear Array Microphone Using First-Order Gradient Elements

Friday, October 21, 1988 1:00 p.m.

Jeff McAteer
AT&T Consumer Products Lab
and
Department of Mechanical Engineering
The University of Texas at Austin

A broadside linear array microphone having near constant beamwidth and improved directivity over 300 to 3300 Hz frequency range is presented. The system consists of three collinear, 3-element arrays, but because of redundancy only seven elements are required. Using three 6th-order Butterworth bandpass filters, each array operates within a specific frequency range and the effective length of the system is decreased with increasing frequency. The effects of Pressure and First-Order Gradient (FOG) microphone elements are investigated. The FOG microphone elements have Cardioid and Figure-8 shaped directivity patterns that are frequency independent. The system is analytically designed, built, and tested in an anechoic chamber. Experimental results show beamwidth fluctuations of less than 10 degrees between 500 and 2500 Hz. Some deviation is present at the low and high frequency extremes because mixing between arrays does not occur. The FOG microphone elements significantly increase the directivity of the system at all frequencies. These results are in good agreement with the analytical model.

Ultrasonics in India

Wednesday, October 26, 1988 1:00 p.m.

Dr. V.N. Bindal
National Physics Laboratory
New Delhi, India

Dr. Bindal is Deputy Director and head of the Materials Division of National Physics Laboratory in New Delhi, India. His current works involve underwater acoustics, Ultrasonic Nondestructive Testing, medical ultrasonics, Ultrasonic Standards, and Ceramic Transducer Materials.

A Parametric Array for Use As an Ultrasonic Proximity Sensor in Air

Wednesday, November 2, 1988 1:00 p.m.

Yang-Sub Lee
Department of Mechanical Engineering
The University of Texas at Austin

Ultrasonic proximity sensors are used in robotics and other industrial processes to locate objects in air without direct physical contact. We investigate the possibility of using an ultrasonic proximity sensor employing a parametric array as an alternative to a conventional ultrasonic sensor whose operation is based on traditional small signal acoustics.

Dry Runs for the Presentations at the 116th Meeting of the Acoustical Society of America

Wednesday, November 9, 1988 12:30-2:00 p.m.

“Nonlinearity in Sound Beams with Application to the Scattering of Sound by Sound”
by Jacqueline Naze Tjøtta and Sigve Tjøtta

“Self Calibrating Apparatus for the Measurement of Dynamic Compressibility”
by Dave Edmonds

“A Parametric Array for Use as an Ultrasonic Proximity Sensor”
by Yang-Sub Lee

“Complex Ray Methods for Flat Sloping Waveguides”
by Evan Westwood

Evaluation of Auditory Enhancement Effect in Normal and Hearing-Impaired Listeners

Wednesday, December 7, 1988 1:00 p.m.

Dr. Linda M. Thibodeau
Department of Speech Communication
The University of Texas at Austin

The enhancement effect is the increased audibility of a target component in a harmonic series by prior exposure to the series with the target component deleted. One explanation for this effect involves the adaptation of the auditory suppression mechanism. This suppression process is often absent in hearing-impaired listeners. The results of experiments designed to evaluate the enhancement effect and auditory suppression in normal and hearing-impaired listeners will be reviewed.