9:15

2aPA4. Time-domain observations of fast and slow ultrasonic group velocities in microsphere suspensions. Joel Mobley and Robert Evans Heithaus (Dept. of Phys. and Astron., Univ. of Mississippi, University, MS 38677)

In dispersive media, propagating wave packets can exhibit abnormal group velocities that differ substantially from the phase velocity of the dominant mode comprising the pulse. Recently, both arbitrarily large and negative acoustic group velocities were shown to exist in an aqueous suspension of polymer microspheres, using a broadband measurement technique. In this talk, we report on the direct time-domain observation of abnormal group velocities in microsphere suspensions. These dispersion-related propagation effects include slow group velocities, where the envelope speed is reduced by as much as 25%, relative to the phase velocity, and fast group velocities, which can be arbitrarily large or negative. The role of signal bandwidth in creating pulses in which such group velocities are manifested is discussed. The practical limits of slowing the group velocity in microsphere suspensions is also explored.

9:30

2aPA5. Nonlinear phenomena in acoustics: Traveling waves, bifurcations, and singular surfaces. Pedro M. Jordan (Naval Res. Lab., Code 7181, Stennis Space Ctr., MS 39529, pjordan@nrlssc.navy.mil)

Traveling wave solutions (TWS) are explored in the context of nonlinear acoustics. Exact solutions are given, including one involving the recently introduced Lambert *W*-function, along with asymptotic and stability results. Poroacoustic propagation under Darcy's and Forchheimer's laws is examined, as well as acoustic phenomena in thermoviscous fluids. Additionally, a connection between discontinuity formation in the TWS and the associated singular surface, which is known as an acceleration wave, is pointed out. Last, if time permits, applications to nonlinear kinematic wave phenomena (e.g., second-sound and traffic flow) are briefly noted. [Work supported by ONR/NRL funding (PE 061153N).]

9:45

2aPA6. Computer simulations of a maximum length sequence modulated photoacoustic spectrometer. Arash Soleimani-Karimabad and Ralph T. Muehleisen (Civil, Architectural, and Environ. Engr., Illinois Inst. of Tech., 3201 S. Dearborn St., Rm. 228, Chicago, IL 60616, muehleisen@iit.edu)

There is a great need for inexpensive, rugged, portable, and versatile chemical detectors for use in both security and environmental measurement, but current technologies that meet that criterion are usually limited in sensitivity and/or are dedicated to detecting a limited number of chemicals. Photoacoustic spectrometers are among the most sensitive instruments for trace analysis in gases, liquids, and on surfaces, and many are able to detect a wide range of different substances. Unfortunately, photoacoustic systems are usually expensive, are usually not portable, and usually cannot be used for both surface and airborne measurements. A new photoacoustic measurement system has been proposed that utilizes maximum length sequence (MLS) modulation of small, rugged, inexpensive laser diodes. The use of MLS modulation eliminates the need for lock-in amplifiers, optical modulators, or resonant measurement cells allowing for portable use on both gas and surfaces. In this paper, results of computer simulations to examine the sensitivity limits and noise immunity of the proposed design are presented.

10:00–10:15 Break

10:15

2aPA7. Validation of laser Doppler anemometer measurements of power dissipation in an arbitrary termination. Ki Won Jung and Anthony A. Atchley (Grad. Program in Acoust., Penn State Univ., University Park, PA 16802, kuj102@psu.edu)

The two-microphone technique is commonly used to measure power dissipation in arbitrary acoustic terminations. This method is well established and provides reliable results when care is taken to avoid problematic microphone configurations (e.g., a pressure node at a microphone location or the microphone spacing being too small in comparison to the wavelength). A laser Doppler anemometer (LDA) technique of measuring power dissipation is discussed in this paper. The LDA method has several disadvantages over microphone methods, including cost of the equipment, the need to use periodic test signals, the need for tracer particles, and the need for a transparent duct. However, rather than being limited to fixed microphone locations and working under the plane wave assumption, the LDA method allows measurement of multiple components of the velocity field at numerous locations with arbitrary spacing in three dimensions. In this paper, the LDA method is validated by measuring the power dissipated in a variable RC load [Fusco and Ward, J. Acoust. Soc. Am. **91**, 2229–2235 (1992)]. The results are also compared to those obtained with the two-microphone technique. [Work supported by the Penn State Graduate Program in Acoustics.]

10:30

2aPA8. The wave behavior in the simple 1 dimensional lattice. Kanghyun Chu and Yang-Hann Kim (Ctr. for Noise and Vib. Control, KAIST, 373-1 Guseong, Yuseong, Daejeon, Republic of Korea, yanghannkim@kaist.ac.kr)

The behavior of an acoustic wave in a periodic lattice was mathematically shown for both infinite and finite cases. For simplicity, the lattice is assumed to be composed of two kinds of medium in ABABABAB order for the infinite case, and BBBABABABABBB order for the finite case. For the infinite lattice, by using the Blochs theorem, the dispersion relation of the wave in the periodic lattice was driven. This gives an acoustic band gap (the frequency region that the wave cannot propagate) and negative group velocity. In addition, for the finite lattice, by using symmetry and the superposition principle, reflection coefficient (between the outer medium and the lattice surface) and transmission coefficient (through the finite lattice) were driven. It was then shown that the result of the finite case agrees to the result from the infinite lattice case, if the number of periods goes to infinity. Finally, possible applications by using what we have learned would be discussed.

10:45

2aPA9. Anisotropic dynamical mass density by two-dimensional arrays of solid cylinders in air. Daniel Torrent and José Sánchez-Dehesa (Polytechnic Univ. of Valencia, Valencia, Spain)

The long wavelength limit (homogenization) of two-dimensional (2-D) periodic arrangements of elastic cylinders in a fluid or a gas (i.e., sonic crystals) is analyzed through the linear part of their band structure. It is found that sonic crystals behave (in the homogenization limit) as effective metamaterials with anisotropic dynamical mass density and fluidlike speed of sound. The special case of rigid cylinders embedded in several 2-D lattices is studied here. It is shown that these systems are suitable to build 2-D anisotropic fluidlike metamaterials. Finally, the reflection and transmission through an anisotropic-elastic medium will be discussed. [Work supported by MEC of Spain and GVA of Valencia.]

11:00

2aPA10. A gradient index sonic lens based on acoustic metamaterials. José Sánchez-Dehesa and Daniel Torrent (Polytechnic Univ. of Valencia,Valencia, Spain)

We report a method to design and characterize broadband gradient index lenses. The lenses are based on two-dimensional sonic crystals, which are periodic arrangements of elastic cylinders embedded in air. It will be shown that gradient index sonic lenses built with rigid cylinders are more powerful than conventionally curved lenses. We also demonstrate that the designing possibilities increased by considering the mixture of two types of cylinders in the sonic crystal. So, a gradient index lens with zero reflectance at the surface is proposed by employing a mixture of aerogel and rigid cylinders. Finally, a multiple scattering theory has been employed to compare the performance of conventionally curved lenses and gradient index lenses. [Work supported by MEC of Spain and GVA of Valencia.]