Contributed Papers

10:40

4aPAc8. The acoustic excitation mechanism of bubbles released from a nozzle. Grant Deane (Scripps Inst. Oceanography, Univ. Califiornia, San Diego, La Jolla, CA 92093, USA, gdeane@ucsd.edu), Helen Czerski (Scripps Inst. Oceanography, Univ. Califiornia, San Diego, La Jolla, CA 92093, USA, hczerski@ucsd.edu)

At the moment of their formation, bubbles emit a short pulse of sound. Bubble noise is associated with sound from a variety of natural processes, including whitecaps, waterfalls, breaking surf and rain. A number of acoustic excitation mechanisms for bubble noise have been proposed, including the increase in internal pressure of the bubble associated with the Laplace pressure, hydrostatic pressure effects, shape mode to volume mode coupling, and a fluid jet associated with the collapse of the neck of air formed during bubble creation. Using bubbles released from a nozzle as a model system, we have determined that sound production is excited by a sudden decrease in bubble volume driven by the collapse of the neck of gas joining the bubble to its parent. A simple analytical model of neck collapse driven by surface tension energy is in agreement with high speed photographic measurements, and sufficient to explain the details of acoustic excitation. [Work supported by ONR and NSF]

11:00

4aPAc9. Characterizing microbubble interactions with ultrasound using flow cytometry. Thomas Matula (Center for Industrial and Medical Ultrasound, Applied Physics Lab., University of Washington, 1013 NE 40th St., Seattle, WA 98105, USA, matula@apl.washington.edu), Jarred Swalwell (Center for Industrial and Medical Ultrasound, Applied Physics Lab., University of Washington, 1013 NE 40th St., Seattle, WA 98105, USA, jarred@u.washington.edu)

Characterizing the fundamental interaction of ultrasound with microbubbles is challenging because of the small spatial and temporal scales. High speed optical imaging is perhaps the most well-known method, as it provides direct information about their response. Although the image is in a plane, the image quality can be sufficient to obtain important information about bubble response. However, high-speed cameras are expensive, data is very limited, and difficult to process. We previously showed how light scattering can be used to obtain similar information - volume oscillations, destruction, even shell properties. Light scattering can be an inexpensive method for probing microbubbles. The difficulties with light scattering (also with optical imaging) are alignment and signal/noise. In this talk we will describe a technique to use commercially-available light-scattering systems to investigate the interaction of pulsed ultrasound with microbubbles. In particular, we developed a technique to insonify microbubbles flowing through the focal region of a flow cytometer. Attached to the quadrature side of a flow cuvette is a small piezoelectric transducer, driven in pulsed mode at various voltages to induce a bubble response. The light scattered from the bubbles can be used for sizing, destruction thresholds, and to assess volume oscillations. Funded by NIH #5R01EB000350

Invited Paper

11:20

4aPAc10. Determination of cavitation bubble lifetimes using bubble-bubble coalescence data. Franz Grieser (Department of Chemical and Biomolecular Engineering, The University of Melbourne, Parkville, Victoria, 3010 Melbourne, Australia, franz@unimelb.edu.au), Devi Sunartio (Department of Chemical and Biomolecular Engineering, The University of Melbourne, Parkville, Victoria, 3010 Melbourne, Australia, franz@unimelb.edu.au), Muthupandian Ashokkumar (Department of Chemical and Biomolecular Engineering, The University of Melbourne, Parkville, Victoria, 3010 Melbourne, Australia, masho@unimelb.edu.au)

The effect that surface-active solutes, such as aliphatic alcohols and sodium dodecylsulfate, have on the extent of bubble coalescence in liquids under different sonication conditions has been investigated by measuring the volume change of the solution following a period of sonication. The data obtained led to the conclusion that SDS does not reach equilibrium adsorption level at the bubble/solution interface. On this basis, a method is proposed for estimating nonequilibrium surface excess values for solutes that do not fully equilibrate with the bubble/solution interface during sonication. For the case of SDS in the presence of excess NaCl, the method was further employed to estimate the maximum lifetime of bubbles in a multibubble field. Data obtained from this study suggests that an acoustic bubble in a multibubble field has a finite lifetime, and that this lifetime decreases with increasing applied frequency, ranging from up to 0.35 ± 0.05 ms for 213 kHz to 0.10 ± 0.05 ms for 1062 kHz. These estimated lifetimes equate to a bubble in a multibubble field undergoing an upper limit of 50-200 oscillations over its lifetime for applied acoustic frequencies between 200 kHz and 1 MHz.

Contributed Papers

11:40

4aPAc11. Interpretation of the pressure waves radiated by oscillating bubbles. Karel Vokurka (Technical University of Liberec, Physics Department, Studentska 6, 461 17 Liberec, Czech Republic, karel.vokurka@tul.cz), Silvano Buogo (CNR-Istituto di Acustica 'O,M.Corbino', Via del Fosso del Cavaliere, 100, 00133 Rome, Italy, silvano.buogo@idac.rm.cnr.it)

An oscillating bubble is an excellent acoustic radiator. In a pressure wave emitted by the oscillating bubble information about the bubble properties and behavior is present. Hence, when using a suitable method, this information could be extracted and used to improve our understanding of the physical processes accompanying the bubble oscillations. However, to be able to extract this information, a number of prerequisites must be met. First, the measuring apparatus should be able to record a faithful copy of the pressure wave. Second, a large, statistically representative set of pressure records must be available for the analysis. Third, a suitable method must be used to analyze the recorded waves. All these requirements will be discussed in detail at the conference. Presented results are based on experience gained during evaluation of a large set of pressure records obtained recently in experiments with spark generated bubbles. [Work has been partly supported (K.V.) by the Czech Ministry of Education as the research project MSM 46747878501.]

12:00

4aPAc12. Dynamics and radiation of single cavity in an abnormal compressible bubbly media. Valeriy K. Kedrinskiy (Lavrentyev Institute of Hydrodynamics, Siberian Division of the Russian Academy of Sciences, Lavrentyev prospect 15, 630090 Novosibirsk, Russian Federation, kedr@hydro.nsc.ru)

The equation of a pulsation of a single cavity in the equilibrium (on pressure) bubbly medium was suggested. The state of such medium is described by Lyakhov's equation which at the condition of pressure equilibrium in the both phases (gas/liquid) becomes essentially simpler. The numerical analysis of features of cavity dynamics and the acoustic losses was executed. The notion ″acoustic losses″ mean a radiation generated by cavity. The analysis of radiation parameters was restricted by the vicinity of cavity wall from a liquid side. The studies of cavity behavior, the structure and