

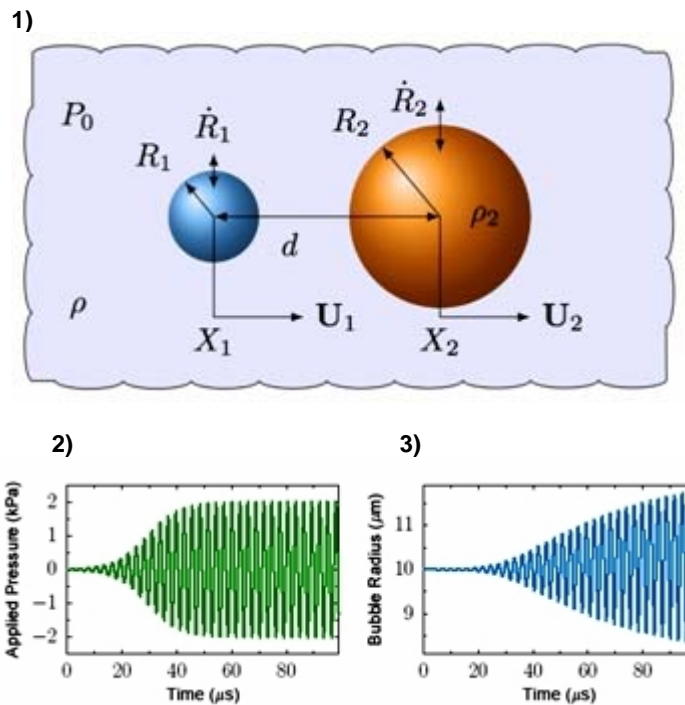
NONLINEAR AND BIOPHYSICAL ACOUSTICS

Nonlinear and biophysical acoustics research conducted within the Signal Physics Division (SPD) centers on:

- Biomedical applications of bubble dynamics
- Battlefield applications of micro-electro-mechanical system (MEMS) transducer arrays
- Harbor defense based on bioresponse to low-frequency underwater sound

BIOMEDICAL APPLICATIONS OF BUBBLE DYNAMICS.

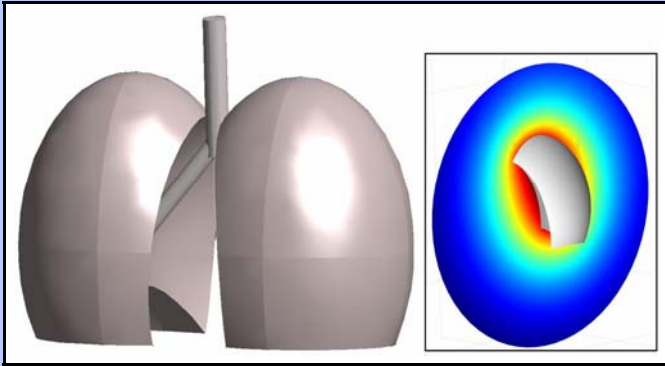
The interaction of acoustic waves with bubbles is important in several common medical applications, such as shock wave lithotripsy (a kidney stone treatment) and contrast agent imaging (in which bubbles are injected into the blood to enhance its echogenicity). Acoustically driven bubbles may also contribute to decompression sickness in human divers and marine mammals. SPD has acquired funding for several projects devoted to studying various aspects of bubble dynamics in sound fields, with sponsorship by NIH, NSF, ONR and ARL:UT IR&D.



1) The coordinates for a mathematical model of the pulsation and translation of an interacting bubble and particle; 2) Acoustic pressure waveform applied to a bubble; 3) Bubble oscillation resulting from the acoustic pressure shown in #2

**PARAMETRIC ACOUSTIC ARRAY FORMATION IN AIR USING MEMS TRANSDUCERS.** SPD received DARPA funding to enable Professor Mark Hamilton of the University's Mechanical Engineering department to collaborate with Stanford University Professor Pierre Khuri-Yakub on a project to investigate the potential for secure audio communication on the battlefield using parametric acoustic arrays. The two components of the project are:

- Fabrication, at Stanford, of Micro-Electro-Mechanical System (MEMS) transducer arrays, incorporating capacitive micromachined ultrasonic transducer (CMUT) technology. These arrays are used to transmit the ultrasonic primary beam.
- Testing of the devices at ARL:UT for medium range (20 meter) and long range (100 meter) transmission of the audio-frequency sound generated parametrically in the air.



**HUMAN BIORESPONSE TO LOW-FREQUENCY UNDERWATER SOUND.** Professor Mark Hamilton is participating with The Pennsylvania State University, NRL, BAE Systems, and Applied Physical Sciences Corp. in a collaborative project aimed at developing a nonlethal deterrent to invasion of harbors by divers. The deterrent is to be acoustical excitation of the fundamental resonance of the human lung underwater. SPD is charged with developing a biomechanical lung model to assist in determining nonlethal levels and frequencies of operation.

**Diagram depicting the conceptual basis of the lung model used in this research (left), and the calculated scattered field produced by one lung in water (right)**

For further information regarding our work in nonlinear and biophysical acoustics, please contact:

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