TITLE: Bubble acoustics in the oceanic water column

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ABSTRACT
Gas bubbles are the most potent naturally-occurring entities that can influence the acoustic environment in any liquid, be it seawater, human tissue or liquid metals. In the ocean, bubbles occur in sediment and the water column, as a result of biological or geophysical activity, etc., but most spectacularly they are generated by breaking ocean waves. They not only generate ambient noise, but the also affect the propagation of acoustic signals dramatically (such that, compared to bubble-free seawater, the sound speed can change by as much as 50%, and the attenuation increased by more than 100 dB/m). These effects need to be understood if sonar and acoustic communications in bubbly seawater are to be optimized (a particular concern given the current dominance on coastal waters in military activity). In addition, the effect of bubbles on acoustic propagation can be exploited to monitor the oceans. Important environmental parameters which relate to such measurements include and coastal erosion, and the fluxes of mass, momentum and energy between atmosphere and ocean (over 1000 million tons of atmospheric carbons alone is transferred between atmosphere and oceans).
Upon entrainment under breaking waves, waterfalls, or rainfall over water, each bubble undergoes small amplitude decaying pulsations with a natural frequency that varies approximately inversely with the bubble radius, giving rise to the 'plink' of a dripping tap or the roar of a cataract. When they occur in their millions per cubic meter in the top few meters of the ocean, bubbles can dominate the underwater sound field. Similarly, when driven by an incident sound field, bubbles exhibit a strong pulsation resonance, and generate nonlinear effects.
This lecture will describe from first principles the acoustic effects of oceanic bubble and their origins. It will describe the various ways by which bubble populations can be measured, and how bubble acoustics can be used to monitor the undersea environment (including recent examples from the *Cassini-Huygens* mission to Titan). We explore how bubbly ocean water, currently considered a highly attenuating (and therefore nuisance) medium, might be exploited, giving examples of the ways whales and dolphins might function in bubbly ocean waters, which they actively utilize in hunting.

BIOGRAPHY

Professor Timothy Leighton
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Timothy Leighton is Professor of Ultrasonics and Underwater Acoustics and Director of ISVR Postgraduate Research at the Institute of Sound and Vibration Research (ISVR), University of Southampton, UK. He is also founder of the Centre for Ultrasonics and Underwater Acoustics (http://www.isvr.soton.ac.uk/fdag/uaua.HTM).

He has been awarded both the A. B. Wood (1994) Medal and the Tyndall (2001) Medal of the Institute of Acoustics. Twice he has been the first recipient of a new international award: the inaugural Early Career Medal and Award of the International Commission for Acoustics in 2004; and in 2001 he was the inaugural recipient of the international Medwin Prize for Acoustical Oceanography, awarded by the Acoustical Society of America. In 2000 he was awarded a Leverhulme Senior Research Fellowship by the Royal Society. He has been awarded Fellowship of the Acoustical Society of America (1998), Fellowship of the Institute of Acoustics (1999), and Fellowship of the Institute of Physics (2000).

He graduated in 1985 from the University of Cambridge with a Double First Class Degree in Physics and Theoretical Physics, and the highest mark of the year for an experimental project. He obtained a PhD at the Cavendish Laboratory, Cambridge, in 1988.

At the age of 28, he joined ISVR as Lecturer in Underwater Acoustics, and in the same year he completed the monograph "The Acoustic Bubble" (Academic Press); and at 35 he was awarded a Personal Chair. The author of over 200 publications he has served on committees and working groups for the Acoustical Society of America; the World Federation for Ultrasound in Medicine and Biology; the UK National Measurement System Policy Unit; the UK Institute of Acoustics (for which he is also a Trustee and Council Member); the UK Defense Scientific Advisory Council; and the UK National Radiological Protection Board. His conference organization includes the Institute of Acoustics Conference on 'Acoustical Oceanography' (2001), the Fourth International Conference on Natural Physical Processes Associated With Sea Surface Sound (1997). In ocean acoustics, he has worked on a wide range of topics, from sediments to fauna. However he is best known for his work on ocean bubbles.