Revised

THE UNIVERSITY OF HONG KONG

DEPARTMENT OF MECHANICAL ENGINEERING

SEMINAR

Online

Title: Dolphin acoustics and bioinspired applications

Speaker: Prof. Yu Zhang
College of Ocean and Earth Sciences
Xiamen University
China

Date: 6 October, 2022 (Thursday)

Time: 9:30 a.m. (Hong Kong Time)

Zoom meeting: 1) Link to join the meeting:

https://hku.zoom.us/j/7833237971?pwd=UmltcHRtSTdvZExGS0Z3QkhwQTYrZz09

2) Meeting ID: 783 323 7971

3) Password: 172639

Abstract:
Dolphin acoustics belongs to the interdisciplinary field of ocean acoustics, biology, bionics and informatics. It is of great significance to bionics, underwater sonar technology, signal processing, underwater detection and communication. After long-term natural selection, dolphins have evolved compact, sensitive and efficient biosonar with superior performance over technical sonar. In this study, the acoustic principle and bioinspired technology of dolphins were investigated. Firstly, the high-precision three-dimensional acoustic structures of typical toothed whales were reconstructed by using computed tomography and ultrasonic measurement techniques. The gradient characteristics of sound speed, density and acoustic impedance of biological tissues were revealed. In addition, multiphase theory was established to study the formation and manipulation mechanism of dolphin's directional acoustic beams. The results show that scattering of air sacs, acoustic-solid coupling of skull, and gradient property of melon significantly strengthens directional acoustic radiation and enables localized acoustic waves. Furthermore,

bioinspired metamaterial devices are designed by using artificial composite materials. Due to the limitation of acoustic wave diffraction, it is difficult for traditional sub-wavelength transducers to achieve directional acoustic emission. However, the bioinspired acoustic emission system based on dolphin's acoustic principle is studied, and the physical model of dolphin acoustics is established. The directional beam control of sub-wavelength sound source and the detection ability of target are improved, which provides innovative ideas for the development of small low-frequency and high-directional acoustic devices. This study provides important information for revealing the principle of biosonar, and has important scientific significance and potential application value for the development of novel ocean detection and sensing technology.

Biography:

Professor Yu Zhang is the vice dean of the College of Ocean and Earth Sciences at Xiamen University and has been entitled "Changjiang Chair Professor" by the Ministry of Education of China since 2019. Professor Zhang teaches and conducts research in the area of applied marine physics and engineering. Prof. Zhang earned his B.S. and Ph.D degrees in Acoustics from Nanjing University, China. He was a post-doctoral fellow in biomedical acoustics at Northwestern University and University of Wisconsin-Madison from 2000 to 2003. He then was an assistant scientist from 2003 to 2007, and an associate scientist from 2007 to 2009 at University of Wisconsin-Madison. He was invited as a senior visiting scientist at Massachusetts Institute of Technology from 2017 to 2019.

Professor Zhang's research focuses on marine bioacoustics, bionics, underwater matematerials, and biomedical engineering. He proposed multiphase theory of dolphin sonar and bioinspired designs of underwater acoustic sensors as well as fish-style robots. He developed novel functional material and devices for phase and energy controls in biomedical imaging. His group also pursues the ocean sustainability applications of smart sensing technique in detecting disaster-causing marine organism, fish finding in ocean farms, and noise monitoring in offshore wind farm. He had more than 130 peer-reviewed publications in journals including Science Advances, National Science Review, Journal of the Acoustical Society of America etc. He was the principal investigator in projects granted from National Natural Science Foundation of China, the National Key Research and Development Program of China, etc. He was a member of the Council of Marine Physics Branch of Oceanographic Societ and Deep-sea Technology Branch of Oceanographic Society of China.

ALL INTERESTED ARE WELCOME

For further information, please contact Prof. Nicholas Fang at 3917 2639.

Research areas: Advanced Materials and Biomedical Engineering