הטכניון מכון טכנולוגי לישראל
TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering
הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING SEMINAR

Monday, December 29th, 2025 at 14:30, Lady Davis Building, Auditorium 250 and online: https://technion.zoom.us/j/99250095536

Direct and Inverse Problems in Ocean Acoustics: Propagation, Physics-Based Processing and Applications

Ernst Uzhansky, Ph.D.

Affiliation:

Faculty of Physics, Naval Postgraduate School, Monterey, California, USA

Email: ernst.uzhanskii@nps.edu ; Website: https://www.researchgate.net/profile/Ernst_Uzhansky

Hosted by: Prof. Alon Wolf

The deep ocean (200 m or deeper) covers 66% of Earth's surface, encompasses the largest ecosystem on our planet, provides critical services and resources to humankind, and is the least explored and understood biome on Earth. Due to rapid absorption of electromagnetic waves by seawater, limiting their range to tens or hundreds of meters, acoustics remains the only practical tool for sensing, communication, and exploration in the ocean, efficiently propagating over vast distances (tens to thousands of kilometers).

However, the high inhomogeneity of the marine environment, characterized by strong spatial and temporal variability, results in extremely complex acoustic conditions. This complexity poses significant challenges for both direct problems (predicting sound propagation) and inverse problems (determining environmental properties from sound measurements) in ocean acoustics. This seminar explores these difficulties by addressing one direct and one inverse problem, each set within drastically different acoustic environment.

First, we investigate how internal Kelvin gravity waves affect sound propagation in shallow water. Using an experimental data from Lake Kinneret and advanced sound propagation modeling, we demonstrate that internal Kelvin waves can produce a 12 dB drop in sound intensity (a fourfold pressure decrease) over a 5-km acoustic track, and cause substantial coupling of acoustic normal modes, making conventional adiabatic approximation invalid.

The second part focuses on the Challenger Deep, Earth's deepest point, where we use a synthetic-aperture autonomous acoustic recording system to address an inverse problem. We demonstrate how wind-driven ambient noise can be used to infer ocean acidity (pH), a key metric for assessing ecosystem health. By examining the depth-dependent attenuation of sound and applying passive absorption spectroscopy, we present a novel, scalable method for estimating the volume-integrated pH of seawater. This approach offers the potential for large-scale acidity measurements without relying on traditional, localized point sampling.

Seminars Coordinator: Prof. Sefi Givli

Bio

Ernst began his academic journey studying Nuclear Physics and Technology in Russia before making Aliyah and pursuing his Master's and PhD studies in Underwater Acoustics in Haifa University under the supervision of Prof. Boris Katsnelson, graduating with honors. His work combined theoretical work, extensive simulations, and acoustic experiments in Lake Kinneret and Mediterranean Sea, focusing on sound propagation in shallow and deep water with strong spatial and temporal variability. During the final stage of his PhD, he received the Batsheva de Rothschild scientific grant and joined the Naval Postgraduate School (Monterey, California, USA) as a visiting researcher, studying single-element time-reversal mirrors.

He then conducted postdoctoral research in nonlinear acoustics on parametric arrays and Schlieren ultrasonic imaging at the Department of Mechanical Engineering, Technion, under supervision of Prof. Izhak Bucher. Following this, Ernst undertook another postdoctoral position at Dalhousie University in Canada, developing deep-ocean noise spectroscopy methods under the supervision of Prof. David Barclay.

Ernst now is a postdoctoral research associate at the Naval Postgraduate School under supervision of Prof. Oleg Godin, supported by the National Academy of Sciences. He works on Distributed Acoustic optic fiber Sensing, noise interefometry, time-reversal mirrors, and geoacoustic inversion.

Ernst is a member of the Acoustical Society of America and its Technical Committee on Acoustical Oceanography, has chaired sessions at ASA meetings, and serves as a reviewer for leading journals, including JASA, Applied Acoustics, and the Journal of Sound and Vibration.