MECHANICAL ENGINEERING COLLOQUIUM

UNIVERSITY OF CALIFORNIA UCRIVERSIDE

The Department of Mechanical Engineering

PRESENTS

Monica Wilhelmus

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Pasadena, CA

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WCH Room 205/206
11:10-12:00PM

Biogenic Ocean Mixing

Abstract:
The concept of large-scale ocean mixing by swimming organisms has remained controversial due to the lack of evidence for energy introduction at scales at which mixing can be efficient. Field measurements of individual swimming jellyfish have demonstrated the so-called Darwinian drift mechanism that enables large-scale fluid transport, but it has remained an open question how this transport process is manifested in the smaller species of vertically-migrating plankton that occur in sufficiently large numbers to impact upper ocean dynamics. Direct observation of this biomixing process has been hindered due to the inability to predict its occurrence in situ or to reproduce it in a laboratory setting. In this seminar, I will describe the development of a multi-laser guidance system that leverages the phototactic abilities of plankton to achieve controllable vertical migrations concurrently with laser velocimetry of the surrounding flow. I will present measurements in unstratified fluid, which show that the hydrodynamic interactions between neighboring swimmers establish an alternate energy transfer route from the small scales of individually migrating plankton to significantly larger scales. We will see that the measured energy spectrum is consistent with the notion that migrating plankton can affect the large-scale structure of the water column despite their small individual size. Finally, I will present flow visualizations of laser-induced vertical migrations of A. salina that reveal the appearance of eddy-like structures with characteristic length scales much larger than the organisms as a result of the onset of a Kelvin-Helmholtz instability. These results motivate further experiments in the presence of stratification to assess the contribution of migrating plankton to upper ocean dynamics.

About the Speaker:
Monica is a Ph.D. candidate in Mechanical Engineering at the California Institute of Technology. She graduated from Universidad Nacional Autonoma de Mexico (UNAM) with a B.S. degree in Mechanical Engineering in 2010 and came to Caltech as a Mechanical Engineering Option Fellow and received an M.S. degree in Mechanical Engineering in 2012. She is currently working with Prof. John Dabiri at the Biological Propulsion Laboratory and expects to receive her Ph.D. degree in March 2015. Monica's research interests lie at the intersection between fluid mechanics, oceanography and biology. I have conducted research in the areas of biological fluid dynamics, turbulence and two-phase flows.