Date: October 22th

Time: 2:00 PM

Location: Olin 305

Speaker: Dr. Mark Grosenbaugh
Woods Hole Oceanographic Institution

Title: "Vortex Ring Formation in the Presence of Background Flow with Implications for Squid Propulsion"

Abstract

The results from experimental studies on squid propulsion and numerical studies of axisymmetric pulsed-jet flow are presented in order to show the importance of background flow when considering jet propulsion of aquatic animals. DPIV is used to measure the hydrodynamic properties of actual jets produced by swimming squid. These results show that squid produce long jets with little or no identifiable leading vortex ring. This result is contrary to previous theoretical models for squid propulsion and suggestions about thrust optimization based on what is known about leading vortex ring generation in calm water. Numerical simulations using a round-headed axisymmetric body with an internal piston and an opening at the posterior end were used to better understand the fluid dynamics of vortex ring generation in the presence of background flow. We used the simulations to confirm the existence of a leading vortex ring and a universal formation number for zero to low background flow. However, we found that for moderate background flow, the magnitude of the formation number was reduced considerably. Furthermore, no leading vortex ring formed under the influence of high-level background flow. The underlying mechanism for this was identified to be vortex stripping or erosion, the intensity of which was controlled by the level of shear produce by the background flow. The numerical results further suggested that the wavy flow pattern observed in a squid jet was due to a trailing jet instability growing at the interface between the jet flow and the background flow. It was also shown that the long, continuous jet used by a steady-swimming squid had optimal thrust for a given amount of input energy.