IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Mixing in stratified fluids due to micro-swimmers**	
Project Number	**IMURA0402**	
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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?
(*Feel free to nominate more than one. For more information, see www.iitbmonash.org)*

1. Advanced computational engineering, simulation and manufacture

The research problem

Fluid mixing in stratified fluids is of great interest for ocean mixing. The mixing in the ocean can be primarily attributed to shear, turbulence, and internal waves. However, over the years it has been quantified that swimming of micro-organisms in the ocean is also responsible for mixing, and that they are the main drivers of localized hotspots (*see Dabiri, 2010 [Geophys. Rev. Lett] & Doostmohammadi, 2012 [PNAS]*). The vertical migration of micro-organisms at pycnoclines (region of biggest density gradient) has shown to play a major role in the ocean mixing efficiency. The nature and amount of mixing due to these micro-swimmers is still an open question, which is important from a modelling viewpoint. The buoyancy fluxes and the kinetic energy dissipation have not been modelled precisely in the experiments, and such studies would be useful for parameterization of mixing length models.

In a stably stratified fluid, the turbulence is inhibited due to the stabilization of the fluid layers and the fact that the small scales are dissipated by fluid viscosity in a low Reynolds number flow (such as micro-swimming). However, the vertical migration of string of micro-swimmers produces a different effect, and the mixing is enhanced. This study has not been performed experimentally, and is of interest for both geophysical and engineering applications.

Project aims

The aim of the project will be to experimentally and numerically study the fluid mixing due to micro-swimming in stratified fluids. The experimental set up will be stationed at IIT-Bombay. We will use a commercial code to model this problem computationally. The mixing efficiency, mass and momentum transfer due to the motion of these organisms will be studied quantitatively. The primary objective is as follows:

1. To study the mixing dynamics in a stratified fluid in the presence of micro-swimmers.
2. To quantify buoyancy fluxes, kinetic energy production and other mixing parameters.
3. To study the vorticity dynamics and wake interaction between adjacent micro-swimmers.

Expected outcomes

The project will address the issues surrounding the sources of mixing in the ocean. It will also address some of the discrepancies related to micro-organisms and fluid mixing.

How will the project address the Goals of the above Themes?

The target of this project is to design and engineer an experimental set up for study of mixing in stratified fluids. Quantities such as kinetic energy, buoyancy fluxes etc will be measured and the results will be compared with numerical data.

Capabilities and Degrees Required

1. The student should have a strong knowledge of fluid dynamics and turbulence.
2. He/she should have a good mathematical background. Good grades in Fluid mechanics, applied mathematics and related courses would be a plus.
3. He/she should possess good experimental skills. Knowledge of using commercial codes such as Ansys Fluent/Star CCM+ is highly desirable, since this project will involve some coding.
4. High level of motivation is required.
5. Good communication and writing skills is a must.
6. Knowledge of Labview is a plus.
7. Knowledge of geophysical flows is a plus.

Degree requirement: Graduate degree (M.S/MTECH or equivalent in Mechanical engineering or Physics)