Weekly Seminar: Fall 2010

Date: Friday October 8th

Time: 11:00 AM

Location: Maryland Hall 110

Speaker: Guowei He (Institute of Mechanics, Chinese Academy of Science)

Title: *"A non-frozen flow model for space-time correlations in turbulent shear flows"*

Abstract

Small-scale eddies in turbulent flows are progressively decorrelated in time. The decorrelation process can be characterized by two-point, two-time correlations of fluctuating velocities, or simply, space-time correlations. The space-time correlations are fundamental to turbulence statistical theory and have a broad application, such as turbulence-generated noise. The most well-known model for space-time correlations is Taylor's frozen flow model. However, it has many limitations such as a weak shear rate and low turbulence intensity. In this talk, I will introduce our recent work on space-time correlations. I will first introduce a non-frozen flow model for the space-time correlations in turbulent shear flows (PRE 79 046319 2009). The decorrelation process of small eddies in turbulent flows can arise either by the sweeping of small eddies by energy-contained eddies or the distortions of small eddies themselves. The non-frozen flow model includes both sweeping and distortion by a second approximation to iso-correleation contours, while Taylor's model is the first approximation. It relates the space-time correlations to the space correlations via the convection and sweeping characteristic velocities. Taylor' frozen flow model and Kraichnan and Tennekes' random sweeping model are its two extreme cases. The DNS of turbulent channel flows and the experiment on turbulent Rayleigh-Benard convection are used to verify this model: the correlation functions exhibit a fair good collapse, when plotted against the normalized space and time separations defined by the non-frozen flow model. Finally, I will briefly discuss its recent developments. The non-frozen flow model is used to convert the time-domain measurements to the spatial data in turbulent Rayleigh-Benard convection, where Taylor's frozen flow hypothesis is not satisfied. It is also used to develop a kinematic sub-grid scale model for missing scales in large-eddy simulation of turbulence-generated noise. This model is further used to calculate the scaling of noise spectra in subsonic jets.