Experimental Study of Turbulent Transport and the Effect of Rotation in an Eelectro-Convection

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Abstract

Turbulent transport is a very general subject in a wide area of physics research. The phenomena that we are interested in are very complex ones associated with structure formations in turbulence. It is well known that the Kolmogorov scaling appears in three-dimensional isotropic turbulence. However, it is less interested because nothing happens. In many cases of our interest, some structures appear in turbulence due to “symmetry breaking” such as temperature gradient, density gradient, intensity gradient of turbulence, rotation, velocity shear, magnetic field, etc. In order to understand turbulent transport characteristics in complex systems, a simple experimental research of turbulent transport using ElectroHydro-Convection (EC) is in progress.
The EC is a convection motion driven by the electric field in a liquid crystal, where the gravity and the temperature gradient in a Rayleigh Bernard convection (RBC) system can be replaced by the electric field alone. When the electric field is increased, the EHC becomes turbulent, which is the same feature as RBC with stronger buoyant force. The advantage of the EC turbulence is controllability of the turbulence (Rayleigh number, Prandtl number), diagnostics of spatial structure of flow and evaluation of transport via particle tracing method. Experiments of EC turbulence to investigate the effect of rotation on the turbulence transport were carried out using a rotary stage. These experiments show that (1) nonlinear coupling of turbulent flow increases with rotation while the spatial power spectra of the flow velocity does not change and (2) the turbulent diffusivity decreases significantly with rotation (Rossby number < 1). These observations indicates the importance of the nonlinear coupling of the turbulent flow on the turbulent transport characteristics. The detailed of the EC turbulence and the experimental results will be presented in the workshop.

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