§6. Experimental Study on Turbulence Transition with an Axial Vector Field

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Self-organizations in turbulence are often observed in nature with axial vector fields such as rotation, magnetic field. The axial field affects on the turbulence and structure formation, however, the physics mechanism is not well understood. In this study, we will try to investigate the effects of axial vector field on turbulence transition due to experimental study using electrohydrodynamic convection (EHC) turbulence on rotating stage.

The EHC turbulence is a turbulence state excited in liquid crystal fluid between electrodes which is biased with much higher voltage than(the minimum voltage to drive convection of liquid crystal (so-called 'critical voltage'). The turbulence transport characteristics were investigated and the diffusive process dominated in the highly developed turbulence regime in the previous fiscal year (2012). In this year (2013), a construction of rotary stage have been completed, which is shown in Fig. 1, and the experimental study of turbulence characteristics with rotation have been performed.

Figures 2 and 3 show a preliminary result of frequency and wave number spectra of vertical velocity parallel to the applied electric field in EHC turbulence, respectively. The bias voltage applied the electrodes is 14.2 V and is about three times higher than the critical voltage. The frequency of the voltage is 50 Hz and is standard for EHC experiments. The distance between the two electrodes is 50 μm. When the stage rotates, the mechanical vibration appear in the CCD camera signal. The mechanical vibration is removed with the motion of the particles fixed on the electrode. Then the frequency spectrum is analyzed. The frequency spectra with applied rotations (60 rpm and 110 rpm) are almost identical each other and slightly different in low ($\sim$ 0.1Hz) and high ($\geq$ 3 Hz) frequency regions from that without rotation, although the spectra near the rotation frequency do not change. A tiny changes seem to be visible in the wave number spectra depending on the rotation frequency, although no clear difference appears in low and middle wave number regions.

In this experiment, the effect of the rotation (axial vector field) is not clear although the changes are observed in frequency and wave number spectra. In order to observe clear response of turbulence characteristics on rotation, the higher Rossby number (higher rotation frequency) region should be explored and nonlinear analysis of the turbulence spectra should be carried out in the future.

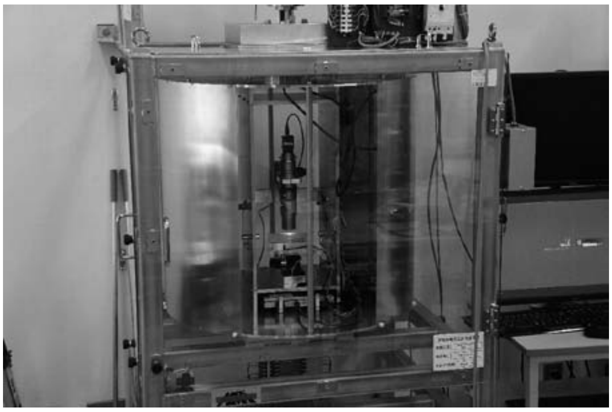

Fig. 1: A picture of rotary stage developed for EHC turbulence experiment.

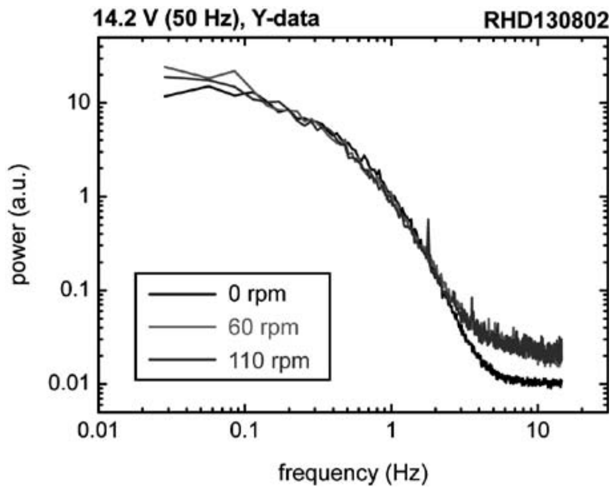

Fig. 2: Frequency spectra with the rotation frequency of 0 Hz, 1 Hz (60 rpm) and 1.83 Hz (110rpm).

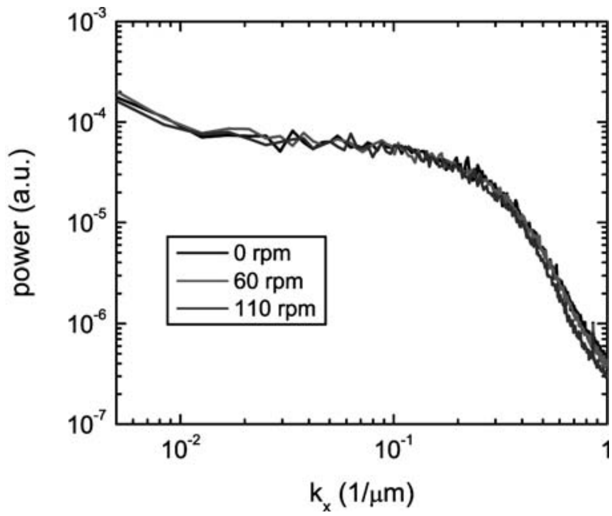

Fig. 3: Wave number spectra with the rotation frequency of 0 Hz, 1Hz and 1.83 Hz.