Research Report (April, 2021- March, 2022)

Enrollment from April 2019 | Department of Applied Mechanics and Aerospace Engineering | Masahito WATANABE

I. List of Papers

1. M. Watanabe and H. Yoshimura, "Experimental Observation of Lagrangian Coherent Structures in Perturbed Rayleigh-Benard Convection", Journal of Fluids Engineering, Vol. 144, 040902-1, 2022. (Transferred from ASME 2021 Fluids Engineering Division Summer Meeting, Flow Visualization Competition. Peer Reviewed.)
2. M. Watanabe and H. Yoshimura, "Experimental Observations of Lagrangian Coherent Structures and Fluid Transports in Perturbed Rayleigh-Benard Convection", Proc. Third IFAC Conference on Modelling, Identification and Control of Nonlinear Systems, 473-478, Online, September, 2021. (Peer Reviewed)
3. M. Watanabe and H. Yoshimura, "Experimental Investigation of Lagrangian Coherent Structures and Lobe Dynamics in Perturbed Rayleigh-Benard Convection", Proc. ASME 2021 Fluids Engineering Division Summer Meeting, No. 64945, Online, August, 2021. (Peer Reviewed)

II. List of Talks

4. M. Watanabe and H. Yoshimura, "Experimental Observations of Perturbed Rayleigh-Benard Convection and Analysis of Chaotic Fluid Transport", JSME Dynamics and Design Conference 2021, No. 117, Tokyo University (Online), September, 2021.
5. M. Watanabe and H. Yoshimura, "Experimental Analysis on Lagrangian Coherent Structures and Fluid Transport in Perturbed Rayleigh-Benard Convection", JSIAM 2021 Annual Meeting, Shibaura Institute of Technology (Online), September, 2021.

III. Research Results in AY2021

Rayleigh-Benard convection is natural convection that appears in a fluid layer with heated bottom and cooled top surfaces. The velocity field of the Rayleigh-Benard convection is perturbed by controlling the temperature difference. In such flow, some fluid particles may be transported chaotically. In order to clarify the global structures of the chaotic transports we have experimentally measured the two-dimensional velocity fields of the perturbed Rayleigh-Benard convection and have detected the invariant structures called the Lagrangian coherent structures (LCSs) from the obtained velocity data. Especially in AY2021, we have proposed a two-dimensional Hamiltonian model with perturbations that represents the experimental results.

IV. Research Plan for AY2022

When the Rayleigh number Ra is increased by raising the temperature difference, the amplitude of the perturbation become larger. It is clarified by the perturbed Hamiltonian model proposed by Solomon and Gollub (1988) that the stable orbits bifurcate to chaotic ones one by one when the amplitude of the perturbation is increased. Therefore, in AY2022, we plan to investigate how the chaotic structures of the Rayleigh-Benard convection varies with Ra. Especially, we plan to detect the LCSs at many conditions of Ra and also to clarify the bifurcation diagram of periodic orbits by using the perturbed Hamiltonian model proposed in AY2021.