# Research Report（April, 2019 - March, 2020）

Enrollment from April 2019

Department of Applied Mechanics and Aerospace Engineering

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## I. List of Papers

Not applicable

## II. List of Talks

[1]○M. Watanabe and H. Yoshimura, ”Chaotic Mixing in Two-dimensional Rayleigh-Benard Convection with Periodic Perturbations”, Fourth International Conference on Recent Advances in Nonlinear Mechanics, p. 49-52, Lodz, Poland, May, 2019. (peer review)

[2] ○ M. Watanabe, H. Yoshimura, ”Chaotic Mixing and Structure of Bifurcations in Rayleigh-Benard Convection with Perturbations”, JSIAM 2019 Annual Meeting, p. 198-199, the University of Tokyo, September, 2019 (in Japanese).

[3] ○ M. Watanabe, H. Yoshimura, ”Chaotic Mixing and Bifurcation Phenomena in Rayleigh-Benard Convection with Perturbations”, JSME Dynamics and Design Conference 2019, No. 154, the University of Kyushu, August, 2019 (in Japanese).

[4] ○ M. Watanabe, H. Yoshimura, ”Chaotic Mixing and Bifurcation Phenomena in Rayleigh-Benard Convection with Perturbations”, JSME Kanto Branch The 26th General Meeting and Conference, Waseda University, March, 2020 (in Japanese).

## III. Research Results in AY2019

Solomon and Gollub (1988), and Camassa (1991) etc. proposed a model of Rayleigh-Benard convection with periodic perturbations using a two-dimensional Hamiltonian system to investigate the mechanism of chaotic fluid transport. However, the bifurcations of periodic orbits associated with the amplitude $\varepsilon$ of the perturbations have not been investigated enough. Analyzing the structure of the $\varepsilon$-parameter bifurcations is important to clarify the global structures of chaotic mixing and in the future to investigate the stability of Rayleigh-Benard convection. Hence, we have investigated the $\varepsilon$-parameter bifurcations of periodic orbits in perturbed Rayleigh-Benard convection by numerical calculation in AY2019.

## IV. Research Plan for AY2020

In AY2020, we plan to distinguish the $\varepsilon$-parameter bifurcations of periodic orbits according to the eigenvalues of the monodromic matrix of periodic orbits. Also, we plan to investigate the bifurcations when the period $T$ of the perturbations is varied in order to clarify the global structures of chaotic mixing furthermore. In addition, since chaotic mixing have not been investigated enough experimentally, we will measure the velocity field of Rayleigh-Benard convection with perturbations by Particle Image Velocimetry (PIV) method and analyze invariant structures such as Lagrangian coherent structures (LCSs) to investigate the mechanism of chaotic fluid transport.