“Multiscale Analysis, Modeling and Simulation”
Top Global University Project, Waseda University
REPORT ON STUDY ABROAD

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1. **Study abroad destination: Virginia Polytechnic Institute and State University, USA**
2. **Dates of stay: July 26, 2015 – August 21, 2015 (27days)**
3. **Purpose:** To develop the trajectory of spacecrafts from the Earth to the Moon in the 4-Body Problem from the idea of the Coupled Planar Restricted Circular 3-Body Problem
4. **Host Professor: Dr. Shane Ross (Virginia Tech)**
5. **Education and research activity in the destination**

Research Results: The purpose of this visit is to develop the trajectory of spacecrafts from the Earth to the Moon in the 4-Body Problem(4BP) from the idea of the Coupled Planar Restricted Circular 3-Body Problem(Coupled PRC3BP). First, I introduced our research about the design method in the 4BP to Dr. Ross. He developed the idea of the Coupled PRC3BP and is familiar with the Lagrangian Coherent Structures(LCS). He suggested me some ideas for our research, for example, how to make the low energy trajectory with short flight time. In particular, we were concentrated on studying the Finite Time Lyapunov Exponents(FTLE) and LCS in the PRC3BP. By the numerical analysis, we found that the LCS, defined by the ridges in the FTLE fields in the PRC3BP, revealed the hyperbolic LCS associated with the Lyapunov orbit, as well as the shear LCS related with the Moon. To extract the hyperbolic LCS, we started to investigate the LCS in the Linearized PRC3BP. However, the LCS was not appeared in the linear system. This result has shown by Haller. Instead, we tried to understand another idea which is called the repulsion rate, suggested by Haller to reveal the LCS in the Linearized PRC3BP. By the calculation of the repulsion rate, we found that the repulsion rate approach might not work in the Linearized PRC3BP. There are still things that we should do to understand the repulsion rate in the PRC3BP.

6. **Other comments:** This is my first time to work with a professor in a foreign country. I appreciate Dr. Ross’s hospitality during my stay. Since his schedule was tight, we had to discuss in short time and decide what to do

before the next meeting. For the communication in English, I sometimes got in trouble to explain myself. During the visit, my English has been improved.