

Naoki HIRAIWA

JSPS Postdoctoral Researcher at ISAS, JAXA

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EDUCATION

Kyushu University, Fukuoka, Japan

Advisor: Prof. Mai Bando and Prof. Shinji Hokamoto

Ph.D. in Engineering, 2025 GPA 4.00/4.00

- Thesis: "Low-Energy Trajectory Design Leveraging Sequences of Lobe Dynamics"

M.Eng. in Aeronautics and Astronautics, 2022 GPA 4.00/4.00

- Thesis: "Analysis of Ballistic Transfer Based on Lobe Dynamics"

B.Eng. in Aeronautics and Astronautics, 2020 GPA 3.78/4.00

- Thesis: "Analysis of Orbital Dynamics in the Binary Asteroid System Based on Center Manifold Theory" (in Japanese)

PROFESSIONAL POSITIONS

JSPS Postdoctoral Researcher, ISAS, JAXA Apr. 2025 - Current

ISAS: Institute of Space and Astronautical Science, JAXA: Japan Aerospace Exploration Agency

CCAR Visiting Student Researcher, University of Colorado Boulder Sep. 2023 - Aug. 2024

CCAR: Colorado Center for Astrodynamics Research

JSPS DC2 Research Fellow, Kyushu University Apr. 2023 - Mar. 2025

Kyushu University SPRING Research Fellow, Kyushu University Apr. 2022 - Mar. 2023

PUBLICATIONS

Peer-reviewed Journal Publications

First author

1. N. Hiraiwa, M. Bando, I. Nisoli, and Y. Sato: "Designing robust trajectories by lobe dynamics in low-dimensional Hamiltonian systems," *Physical Review Research*, Vol. 6, L022046, 2024.
2. N. Hiraiwa, M. Bando, and S. Hokamoto: "Halo-to-Halo Low-Thrust Transfer via Successive Convex Optimization with Intermediate Orbit Design," *Journal of Evolving Space Activities*, Vol. 1, Article No. 48, 2023.
3. N. Hiraiwa, M. Bando, and S. Hokamoto: "Trajectory Design in Irregular Gravitational Fields Based on Center Manifold Theory," *Journal of Guidance, Control, and Dynamics*, Vol. 46, No. 8, pp. 1637–1648, 2023.

Co-author

1. S. Yamaguchi, N. Hiraiwa, M. Bando, S. Hokamoto, D. B. Henry, and D. J. Scheeres: "Trajectory Design for Awaiting Comets on Invariant Manifolds with Optimal Control," *Astrodynamics*. (Accepted)
2. K. Ikeda, N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Low-Energy Transfer Trajectories from Jupiter to Europa with Ballistic Transfer," *Journal of Evolving Space Activities*, Vol. 1, Article No. 35, 2023.

Conference Proceedings

First author

1. N. Hiraiwa, M. Bando, and S. Hokamoto: "Extending Earth–Moon Transfer Based on Lobe Dynamics into the Restricted Four-Body Problem," 25-320, *35th AAS/AIAA Space Flight Mechanics Meeting*, Jan. 2025.
2. N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Earth–Moon Low-Energy Transfers Based on Lobe Dynamics" (in Japanese), 4J07, *68th Space Sciences and Technology Conference*, Nov. 2024.

3. N. Hiraiwa, D. B. Henry, D. J. Scheeres, and M. Bando: "Design of Minimum-Time Low-Thrust Transfer between Quasi-Periodic Orbits," C1.4.8, *75th International Astronautical Congress*, Oct. 2024.
4. N. Hiraiwa, D. B. Henry, M. Bando, and D. J. Scheeres: "Analysis of Dynamical Structures in a Three-Dimensional Volume-Preserving Map," 24-239, *AAS/AIAA Astrodynamics Specialist Conference*, Aug. 2024.
5. N. Hiraiwa, M. Bando, and S. Hokamoto: "Analysis of Transfer Trajectories in Cislunar Space Using Sequences of Lobe Dynamics," C1.9.2, *74th International Astronautical Congress*, Oct. 2023.
6. N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Optimal Low-Thrust Transfer Trajectory for Halo Orbits via Convex Optimization" (in Japanese), 3L05, *66th Space Sciences and Technology Conference*, Nov. 2022.
7. N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Optimal Low-Thrust Orbit-to-Orbit Transfers via Convex Approach," C1.3.6, *73rd International Astronautical Congress*, Sep. 2022.
8. N. Hiraiwa, M. Bando, and S. Hokamoto: "Halo-to-Halo Low-Thrust Transfer via Successive Convex Optimization with Intermediate Orbit Design," *33rd International Symposium on Space Technology and Science*, 2022-d-58, Mar. 2022.
9. N. Hiraiwa, M. Bando, and S. Hokamoto: "Analysis of Ballistic Escape Based on Lobe dynamics," C1.7.10, *72nd International Astronautical Congress*, Oct. 2021.
10. N. Hiraiwa, M. Bando, and S. Hokamoto: "Trajectory Design in the Didymos System Based on the Center Manifold Theory" (in Japanese), 4M10, *64th Space Sciences and Technology Conference*, Oct. 2020.
11. N. Hiraiwa, M. Bando, and S. Hokamoto: "Trajectory Design in the Vicinity of 65803 Didymos Based on the Center Manifold Theory," 20-593, *AAS/AIAA Astrodynamics Specialist Conference*, Aug. 2020. (Published in *Advances in Astronautical Sciences*, 175:4849-4866, 2021)

Co-author

1. Y. Hayashi, N. Hiraiwa, M. Bando, and S. Hokamoto: "Station-Keeping for Earth–Moon Periodic Orbit with Solar Sail based on the Orbit-Attitude Coupled Model," 25-371, *35th AAS/AIAA Space Flight Mechanics Meeting*, Jan. 2025.
2. S. Yamaguchi, N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Parking Trajectories to Comets Leveraging Invariant Manifolds with Low Thrust" (in Japanese), 2F02, *67th Space Sciences and Technology Conference*, Oct. 2023.
3. A. Chikusa, N. Hiraiwa, M. Bando, and S. Hokamoto: "Guidance and Control System for Mars Aerocapture Considering Uncertainties" (in Japanese), 1D16, *67th Space Sciences and Technology Conference*, Oct. 2023.
4. S. Hirayama, N. Hiraiwa, M. Bando, and S. Hokamoto: "Optimal Trajectory Design by Adam under Stochastic Disturbing Acceleration," C1.7.2, *74th International Astronautical Congress*, Oct. 2023.
5. N. Pushparaj, N. Hiraiwa, and M. Bando: "Optimal Transfer Trajectories between Relative Quasi-Satellite Orbits," C1.6.10, *74th International Astronautical Congress*, Oct. 2023.
6. S. Yamaguchi, N. Hiraiwa, M. Bando, and S. Hokamoto: "Mission Strategy to Await Comets by Leveraging Manifolds and Low Thrust," C1.6.6, *74th International Astronautical Congress*, Oct. 2023.
7. A. Chikusa, N. Hiraiwa, M. Bando, and S. Hokamoto: "Guidance and Control Algorithm for Mars Aerospace Considering Uncertainties," C1.3.10, *74th International Astronautical Congress*, Oct. 2023.
8. S. Hirayama, N. Hiraiwa, M. Bando, and S. Hokamoto: "Optimal Transfer by Stochastic Gradient Descent Algorithm Adam," *34th International Symposium on Space Technology and Science*, 2023-d-43, Jun 2023.
9. S. Yamaguchi, N. Hiraiwa, M. Bando, and S. Hokamoto: "Feasibility Study of the Comet Observation Mission Using Sun-Earth-Moon Four-Body Problem" (in Japanese), JSASS-2022-S009, *Annual Meeting of Japan Society for Aeronautical and Space Science Western Branch*, Nov. 2022.
10. K. Ikeda, N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Satellite Tour Trajectories Using Poincaré Maps in Multibody Dynamics of Jovian System" (in Japanese), P051, *66th Space Sciences and Technology Conference*, Nov. 2022.
11. S. Hirayama, N. Hiraiwa, M. Bando, and S. Hokamoto: "Trajectory Optimization by Stochastic Gradient Descent Algorithm Adam" (in Japanese), P053, *66th Space Sciences and Technology Conference*, Nov. 2022.
12. S. Yamaguchi, N. Hiraiwa, M. Bando, and S. Hokamoto: "Design of Transfer Trajectories to Comets for Nano-

Satellites Based on the Concept of Comet Interceptor” (in Japanese), P057, *66th Space Sciences and Technology Conference*, Nov. 2022.

13. A. Chikusa, [N. Hiraiwa](#), M. Bando, and S. Hokamoto: “Analysis of Mars Aerocapture Trajectories Considering Disturbances for Guidance System” (in Japanese), P061, *66th Space Sciences and Technology Conference*, Nov. 2022.
14. K. Ikeda, [N. Hiraiwa](#), M. Bando, and S. Hokamoto: “Design of Satellites Tours Using Periapsis Poincaré Map in Multibody Dynamics of Jovian System,” C1.8.8, *73rd International Astronautical Congress*, Sep. 2022.
15. K. Ikeda, [N. Hiraiwa](#), M. Bando, and S. Hokamoto: “Design of Low Energy Transfer Trajectories from Earth to Europa with Ballistic Capture,” *33rd International Symposium on Space Technology and Science*, 2022-d-23, Mar. 2022.
16. K. Ikeda, [N. Hiraiwa](#), M. Bando, and S. Hokamoto: “Design of Low Energy Transfer Trajectories to Europa Using Periapsis Poincaré Map” (in Japanese), P36, *65th Space Sciences and Technology Conference*, Nov. 2021.

Seminars and Talks

1. N. Hiraiwa: “Dynamical Structures of Lobe Dynamics for Spacecraft Trajectory Design,” at *Dynamics Days Sapporo 2024*, Dec. 2024.
2. N. Hiraiwa: “Design of Chaotic Transfers Based on Lobe Dynamics,” at *33rd Workshop on JAXA Astrodynamics and Flight Mechanics*, Jul. 2023.
3. N. Hiraiwa: “Analysis of Chaotic Trajectories Based on Lobe Dynamics,” at *32nd Workshop on JAXA Astrodynamics and Flight Mechanics*, Jul. 2022.

HONORS and AWARDS

Individual

Chiyoda Foundation Scholarship Apr. 2018 - Mar. 2020
Dean’s Award for Freshman (Top 2% GPA), Kyushu University Jul. 2017

Fellowships

Kyushu University SPRING program, from Japan Science and Technology Agency [\[URL\]](#)
• Total support up to ~\$16,000/year Apr. 2022 - Mar. 2023
JSPS Research Fellowships for Young Scientists (DC2), from Japan Society for the Promotion of Science [\[URL\]](#)
• Total support up to ~\$16,000/year Apr. 2023 - Mar. 2025

Research Grants

Grants-in-Aid by SPRING program (FY2022), from Japan Science and Technology Agency. Total budget is up to ~\$3,400/year.
Grants-in-Aid for Scientific Research <KAKENHI> (FY2023, 2024), from Japan Society for the Promotion of Science. Total budget is up to ~\$12,000/2 year.

PRESS RELEASES

- Kyushu University and Hokkaido University: “Successfully developed a novel methodology of spacecraft trajectory design based on chaotic orbits in the Earth–Moon system” (in Japanese, [\[URL\]](#)), based on the paper [Phys. Rev. Res. 6, L022046 \(2024\)](#), May 30th, 2024.

SKILLS

Language: Japanese (native), English (fluent)

Professional membership: AIAA, Japan Society for Aeronautical and Space Sciences (JSASS)

Programming: MATLAB (proficient), C/C++ (intermediate), L^AT_EX (proficient)