

Rahil Makadia

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EDUCATION

Ph.D. in Aerospace Engineering at University of Illinois at Urbana-Champaign 2021 - present
B.S. in Aerospace Engineering at University of Illinois at Urbana-Champaign 2017 - 2020

RESEARCH EXPERIENCE

Astrodynamics, Planetary Defense and Exoplanet Research Group Advisor: Dr. Siegfried Eggli

Double Asteroid Redirection Test (DART) Mission May 2020 - present

- Created an efficient solar system propagator with sub-kilometer position accuracy over 100 years compared to solutions from NASA's Jet Propulsion Laboratory (JPL).
- Analyzed high-fidelity kinetic impactor simulation results from JPL for impacts in the (65803) Didymos binary asteroid system.
- Simulated the effect of DART spacecraft's impact on Dimorphos and the change in the system's heliocentric orbit.
- Implemented a novel method to impart momentum changes in the Didymos system after the DART impact.
- Conducted post-deflection impact risk assessments for Didymos using parallelized Monte Carlo simulations in Python.
- Generated updated B-plane maps to conclude that the Didymos system will not collide with the Earth after the DART impact.
- Simulated expected post-DART radio and optical observations of the Didymos system for covariance analysis.
- Wrote MATLAB and Python parameter estimation packages to assess measurability of the heliocentric momentum enhancement from the DART impact.

Aerospace Mission Analysis Laboratory

Advisor: Dr. Zachary Putnam

Venus Aerogravity Assist Performance Assessment

Aug 2022 - Jan 2023

- Analyzed the performance of blunt-body vehicles in Venus aerogravity assist missions.
- Compared several performance characteristics for blunt-body vehicles with previously studied waverider vehicle concepts.
- Implemented a MATLAB analysis pipeline to perform parameter sweeps for varying trajectories and vehicle configurations.

WORK EXPERIENCE

NASA Goddard Space Flight Center

Advisors: Kenneth Getzandanner, Andrew Liounis

OSIRIS-REx/OSIRIS-APEX CelNav Intern

Jun 2022 - Aug 2022

- Developed simulations to assess performance of celestial navigation using onboard optical instruments during the OSIRIS-APEX cruise phase.
- Simulated more than 8,000 solar system bodies to obtain optimal observable clusters for the spacecraft.
- Performed covariance analysis using NASA's MONTE software to study the spacecraft's state uncertainty on its way to asteroid (99942) Apophis.

TEACHING EXPERIENCE

University of Illinois at Urbana-Champaign

Instructor: Dr. Siegfried Eggli

Teaching Assistant for AE 352: Aerospace Dynamical Systems

Aug 2021 - Dec 2021

- Focused on developing and teaching the aerospace curriculum's core dynamics course with aerospace applications.
- Syllabus emphasized on covering Newtonian, Lagrangian, and Hamiltonian mechanics to represent particle motion.
- Assisted 16 student teams with Project Clear Constellation, which called for novel methods to remove orbital debris.

University of Illinois at Urbana-Champaign

Instructor: Dr. Huy Tran

Undergraduate Course Assistant for AE 199: Aerospace Computing

Jan 2020 - May 2020

- Assisted with grading for a new course focused on using Python to solve problems such as analyzing air traffic data and designing martian landers.
- Worked with instructor to augment course for a fully online learning environment without affecting students due to the COVID-19 pandemic.

AWARDS AND AFFILIATIONS

NASA Space Technology Graduate Research Fellow

Aug 2022 - present

National Aeronautics and Space Administration (NASA)

John C. Mather Nobel Scholar

Jul 2022 - present

National Space Grant Foundation

Double Asteroid Redirection Test (DART) Investigation Team

Dec 2020 - present

Johns Hopkins University Applied Physics Laboratory (JHU/APL)

Dean's List

Spring 2019, Spring 2020

University of Illinois at Urbana-Champaign

President's Award

Aug 2017 - Dec 2020

University of Illinois at Urbana-Champaign

SKILLS

Programming Languages Python, C++, MATLAB

Software Tools \LaTeX , Git

Prepackaged Tools MONTE, GMAT, FreeFlyer, Siemens NX

Operating Systems Windows, Linux, MacOS

Languages English, Gujarati, Hindi, French

JOURNAL ARTICLES

Li, Jian-Yang, Masatoshi Hirabayashi, Tony L. Farnham, Jessica M. Sunshine, Matthew M. Knight, Gonzalo Tancredi, Fernando Moreno, Brian Murphy, Cyrielle Opitom, Steve Chesley, Daniel J. Scheeres, Cristina A. Thomas, Eugene G. Fahnestock, Andrew F. Cheng, Linda Dressel, Carolyn M. Ernst, Fabio Ferrari,

Alan Fitzsimmons, Simone Ieva, Stavro L. Ivanovski, Teddy Kareta, Ludmilla Kolokolova, Tim Lister, Sabina D. Raducan, Andrew S. Rivkin, Alessandro Rossi, Stefania Soldini, Angela M. Stickle, Alison Vick, Jean-Baptiste Vincent, Harold A. Weaver, Stefano Bagnulo, Michele T. Bannister, Saverio Cambioni, Adriano Campo Bagatin, Nancy L. Chabot, Gabriele Cremonese, R. Terik Daly, Elisabetta Dotto, David A. Glenar, Mikael Granvik, Pedro H. Hasselmann, Isabel Herreros, Seth Jacobson, Martin Jutzi, Tomas Kohout, Fiorangela La Forgia, Monica Lazzarin, Zhong-Yi Lin, Ramin Lolachi, Alice Lucchetti, **Rahil Makadia**, Elena Mazzotta Epifani, Patrick Michel, Alessandra Migliorini, Nicholas A. Moskovitz, Jens Ormö, Maurizio Pajola, Paul Sánchez, Stephen R. Schwartz, Colin Snodgrass, Jordan Steckloff, Timothy J. Stubbs, and Josep M. Trigo-Rodríguez. “Ejecta from the DART-produced active asteroid Dimorphos”. In: *Nature* (Mar. 1, 2023). DOI: [10.1038/s41586-023-05811-4](https://doi.org/10.1038/s41586-023-05811-4). URL: <https://doi.org/10.1038/s41586-023-05811-4>.

Statler, Thomas S., Sabina D. Raducan, Olivier S. Barnouin, Mallory E. DeCoster, Steven R. Chesley, Brent Barbee, Harrison F. Agrusa, Saverio Cambioni, Andrew F. Cheng, Elisabetta Dotto, Siegfried Eggl, Eugene G. Fahnestock, Fabio Ferrari, Dawn Graninger, Alain Herique, Isabel Herreros, Masatoshi Hirabayashi, Stavro Ivanovski, Martin Jutzi, Özgür Karatekin, Alice Lucchetti, Robert Luther, **Rahil Makadia**, Francesco Marzari, Patrick Michel, Naomi Murdoch, Ryota Nakano, Jens Ormö, Maurizio Pajola, Andrew S. Rivkin, Alessandro Rossi, Paul Sánchez, Stephen R. Schwartz, Stefania Soldini, Damya Souami, Angela Stickle, Paolo Tortora, Josep M. Trigo-Rodríguez, Flaviane Venditti, Jean-Baptiste Vincent, and Kai Wünnemann. “After DART: Using the First Full-scale Test of a Kinetic Impactor to Inform a Future Planetary Defense Mission”. In: *The Planetary Science Journal* 3.10 (Oct. 2022), p. 244. DOI: [10.3847/PSJ/ac94c1](https://dx.doi.org/10.3847/PSJ/ac94c1). URL: <https://dx.doi.org/10.3847/PSJ/ac94c1>.

Makadia, Rahil, Sabina D. Raducan, Eugene G. Fahnestock, and Siegfried Eggl. “Heliocentric Effects of the DART Mission on the (65803) Didymos Binary Asteroid System”. In: *The Planetary Science Journal* 3.8 (Aug. 2022), p. 184. DOI: [10.3847/PSJ/ac7de7](https://dx.doi.org/10.3847/PSJ/ac7de7). URL: <https://dx.doi.org/10.3847/PSJ/ac7de7>.

Richardson, Derek C., Harrison F. Agrusa, Brent Barbee, William F. Bottke, Andrew F. Cheng, Siegfried Eggl, Fabio Ferrari, Masatoshi Hirabayashi, Özgür Karatekin, Jay McMahon, Stephen R. Schwartz, Ronald-Louis Ballouz, Adriano Campo Bagatin, Elisabetta Dotto, Eugene G. Fahnestock, Oscar Fuentes-Muñoz, Ioannis Gkolias, Douglas P. Hamilton, Seth A. Jacobson, Martin Jutzi, Josh Lyzhoft, **Rahil Makadia**, Alex J. Meyer, Patrick Michel, Ryota Nakano, Guillaume Noiset, Sabina D. Raducan, Nicolas Rambaux, Alessandro Rossi, Paul Sánchez, Daniel J. Scheeres, Stefania Soldini, Angela M. Stickle, Paolo Tanga, Kleomenis Tsiganis, and Yun Zhang. “Predictions for the Dynamical States of the Didymos System before and after the Planned DART Impact”. In: *The Planetary Science Journal* 3.7 (July 2022), p. 157. DOI: [10.3847/PSJ/ac76c9](https://dx.doi.org/10.3847/PSJ/ac76c9). URL: <https://dx.doi.org/10.3847/PSJ/ac76c9>.

CONFERENCE AND MEETING PROCEEDINGS

Engel, Daniel, **Rahil Makadia**, and Zachary Putnam. “Assessment of Aerogravity Assist at Venus Using Blunt-Body Vehicles”. In: *33rd AAS/AIAA Space Flight Mechanics Meeting*. Jan. 2023.

Makadia, Rahil, Sabina Raducan, Eugene Fahnestock, and Siegfried Eggl. “Post-impact Prediction of Changes to the Heliocentric Orbit of the (65803) Didymos System due to the DART Mission”. In: *2022 AGU Fall Meeting*. Dec. 2022.

Makadia, Rahil and Siegfried Eggl. “Heliocentric beta (β_{\odot}) estimation”. In: *November 2022 DART Investigation Team Meeting*. Nov. 2022.

- Makadia, Rahil**, Siegfried Eggl, and Eugene Fahnestock. “The Double Asteroid Redirection Test (DART): Expected changes to the heliocentric orbit of (65803) Didymos”. In: *44th AAS Guidance, Navigation, and Control Conference*. Feb. 2022.
- “Changes to the Heliocentric Orbit of (65803) Didymos System due to DART: Simulation and Momentum Enhancement Estimation”. In: *53rd AAS Division for Planetary Sciences Meeting*. Oct. 2021. URL: <https://ui.adsabs.harvard.edu/abs/2021DPS....5311308M>.
 - “Changing the heliocentric orbit of the Didymos system with DART: Implications for β determination”. In: *June 2021 DART Investigation Team Meeting*. June 2021.
- Makadia, Rahil**, Siegfried Eggl, Eugene Fahnestock, Damya Souami, and Davide Farnocchia. “Changing the heliocentric orbit of the Didymos system with DART: Implications for β determination”. In: *June 2021 DART Investigation Team Meeting*. June 2021.
- Makadia, Rahil**, Siegfried Eggl, Eugene Fahnestock, Steve Chesley, Davide Farnocchia, and Nian Tong. “Changing the heliocentric orbit of the Didymos system with DART”. In: *7th IAA Planetary Defense Conference*. Apr. 2021. URL: <https://ui.adsabs.harvard.edu/abs/2021plde.confE.197M>.