Rahil Makadia

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Education

Ph.D. in Aerospace Engineering, University of Illinois at Urbana-Champaign — Jan 2021 - present
B.S. in Aerospace Engineering, University of Illinois at Urbana-Champaign — Aug 2017 - Dec 2020

Research Experience

Astrodynamics and Planetary Exploration Research Group — Advisor: Dr. Siegfried Eggl

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

- Analyzed high-fidelity kinetic impactor simulation results from NASA's Jet Propulsion Laboratory (JPL) for impacts in the (65803) Didymos binary asteroid system.
- Implemented a novel method to impart momentum changes in the Didymos system after the DART impact.
- Produced a post-deflection impact risk assessment for Didymos using parallelized Monte Carlo simulations.
- Generated updated B-plane maps to conclude that the Didymos system will not collide with the Earth after the DART impact.
- 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.
- Implemented a MATLAB analysis pipeline to perform parameter sweeps for varying trajectories and vehicle configurations, and assessed performance of blunt-body vehicles and waveriders.

Work Experience

NASA Jet Propulsion Laboratory — Advisors: Steven Chesley, Davide Farnocchia

NSTGRO Visiting Technologist — May 2023 - Aug 2023

- Created an efficient solar system propagator with sub-1 km position accuracy over 250 years compared to JPL's internal small body software.
- Wrote an orbit determination submodule alongside the propagator that has sub-1σ agreement with JPL small-body orbit solutions.
- Developed a publicly available Python package, GRSS, to allow the scientific community to accurately propagate and determine the orbits of solar system bodies.

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 Eggl

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.

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

Awards and Affiliations

NASA Space Technology Graduate Research Opportunities Fellow Aug 2022 - present

NSTGRO award from NASA Space Technology Mission Directorate (STMD)

Double Asteroid Redirection Test (DART) Investigation Team Member Dec 2020 - present

NASA/Johns Hopkins University Applied Physics Laboratory (APL)

John C. Mather Nobel Scholar Jul 2022 - Jun 2023

National Space Grant Foundation

Fellowship for Outstanding Academic and Research Achievement Apr 2023

Aerospace Engineering Department at the University of Illinois at Urbana-Champaign

President's Award Aug 2017 - Dec 2020

University of Illinois at Urbana-Champaign

Hans von Muldau Team Award October 2019

70th International Astronautical Congress (IAC), Washington D.C.

Dean's List Spring 2019, Spring 2020

University of Illinois at Urbana-Champaign

Journal Articles

[1]**R. Makadia** et al., "Measurability of the heliocentric momentum enhancement from kinetic impactors: Applications to the Double Asteroid Redirection Test (DART) mission", The Planetary Science Journal **in prep.** (2023).

[2]D. C. Richardson et al., "The Dynamical State of the Didymos System Before and After the DART Impact", The Planetary Science Journal **in prep.** (2023).

[3]J.-Y. Li et al., "Ejecta from the DART-produced active asteroid Dimorphos", Nature **616**, 452–456 (2023).

[4]T. S. Statler et al., "After DART: Using the First Full-scale Test of a Kinetic Impactor to Inform a Future Planetary Defense Mission", The Planetary Science Journal **3**, 244 (2022).

[5]**R. Makadia** et al., "Heliocentric Effects of the DART Mission on the (65803) Didymos Binary Asteroid System", The Planetary Science Journal **3**, 184 (2022).

[6]D. C. Richardson et al., "Predictions for the Dynamical States of the Didymos System before and after the Planned DART Impact", The Planetary Science Journal **3**, 157 (2022).

Conference and Meeting Proceedings

[1]**R. Makadia** et al., "The DART mission: Measurability of the heliocentric changes to the (65803) Didymos system", in 14th Asteroids, Comets, Meteors Conference (June 2023).

[2]**R. Makadia** et al., "Measurability of the heliocentric momentum enhancement of the Didymos system from the DART impact", in 8th IAA Planetary Defense Conference (Apr. 2023).

[3]D. Engel, **R. Makadia**, and Z. Putnam, "Assessment of aerogravity assist at Venus using blunt-body vehicles", in 33rd AAS/AIAA Space Flight Mechanics Meeting (Jan. 2023).

[4]**R. Makadia** et al., "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).

[5]**R. Makadia**, S. Eggl, and E. 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).

[6]**R. Makadia**, S. Eggl, and E. Fahnestock, "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).

[7]**R. Makadia** et al., "Changing the heliocentric orbit of the Didymos system with DART", in 7th IAA Planetary Defense Conference (Apr. 2021).