

**NATASHA BOSANAC**  
Curriculum Vitae

**CONTACT INFORMATION**

Colorado Center for Astrodynamics Research  
Smead Department of Aerospace Engineering Sciences  
University of Colorado Boulder  
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Email: natasha.bosanac@colorado.edu

**RESEARCH INTERESTS**

Astrodynamics; celestial mechanics; dynamical systems theory; small satellites.

**EDUCATION**

Ph.D. in Aeronautical & Astronautical Engineering, Purdue University, 2016  
“Leveraging Natural Dynamical Structures to Explore Multi-Body Systems”  
M.S.A.A in Aeronautical & Astronautical Engineering, Purdue University, 2012  
“Exploring the Influence of a Three-Body Interaction Added to the Gravitational Potential in the Circular Restricted Three-Body Problem: A Numerical Frequency Analysis”  
S.B. in Aerospace Engineering, Massachusetts Institute of Technology, 2010

**PROFESSIONAL EXPERIENCE**

2017- Present Assistant Professor, Colorado Center for Astrodynamics Research, Department of Aerospace Engineering Sciences, University of Colorado Boulder  
2016 Postdoctoral Research Assistant, School of Aeronautics & Astronautics, Purdue University (research performed at NASA Goddard Space Flight Center)  
2013-2016 Graduate Research Assistant, School of Aeronautics & Astronautics, Purdue University

**JOURNAL PUBLICATIONS** Key: **N. Bosanac**, N. Bosanac’s Students

8. Elliott, I; Sullivan, C; **Bosanac, N**; Stuart, J; Alibay, F, 'Designing Low-Thrust Trajectories for a SmallSat Mission to Sun-Earth L5,' October 2020, Vol. 43, No. 10, pp. 1854-1864, Journal of Guidance, Control and Dynamics, DOI: 10.2514/1.G004993

7. **Bosanac, N**, ‘A Data Mining Approach to Poincaré Maps in Multi-Body Trajectory Design,’ June 2020, Vol. 43, No. 6, pp. 1190-1200, Journal of Guidance, Control and Dynamics, DOI: 10.2514/1.G004857

6. **Bosanac, N**; Webster, C.M.; Howell, K.C.; Folta, D.C, ‘Trajectory Design for the Wide Field Infrared Survey Telescope Mission,’ September 2019, Vol. 42, No. 9, pp. 1899-1911, Journal of Guidance, Control and Dynamics, DOI: 10.2514/1.G004179

5. **Bosanac, N**; Cox, A; Howell, K.C.; Folta, D.C., 'Trajectory Design for a Cislunar CubeSat Leveraging Dynamical Systems Techniques: The Lunar IceCube Mission,' Available Online, Acta Astronautica, DOI: 10.1016/j.actaastro.2017.12.025

4. Guzzetti, D; **Bosanac, N**; Haapala, A; Howell, K.C.; Folta, D.C., 'Rapid Trajectory Design in the Earth-Moon Ephemeris System via an Interactive Catalog of Periodic and Quasi-Periodic Orbits,' **September-October 2016**, Volume 126, pp. 439-455, Acta Astronautica, DOI: 10.1016/j.actaastro.2016.06.029

3. **Bosanac, N**; Howell, K.C; Fischbach, E, 'A Natural Autonomous Force Added in the Restricted Problem and Explored via Stability Analysis and Discrete Variational Mechanics,' **February 2016**, Volume 361, No. 49, Astrophysics and Space Science. DOI: 10.1007/s10509-015-2638-3

2. **Bosanac, N**; Howell, K.C; Fischbach, E, 'Stability of Orbits Near Large Mass Ratio Binary Systems,' **May 2015**, Volume 122, pp. 27-52, Celestial Mechanics and Dynamical Astronomy. DOI: 10.1007/s10569-015-9607-6

1. Folta, D.C; **Bosanac, N**; Guzzetti, D; Howell, K.C, 'An Earth-Moon System Trajectory Design Reference Catalog,' **May-June 2015**, Volume 110, pp. 341-353, Acta Astronautica. DOI: 10.1016/j.actaastro.2014.07.037

## **PEER-REVIEWED CONFERENCE PROCEEDINGS**

2. Sullivan, C; **Bosanac, N**; Anderson, R; Mashiku, A; Stuart, J.R., 'Exploring Transfers between Earth-Moon Halo Orbits via Multi-Objective Reinforcement Learning,' IEEE Aerospace Conference, **March 2021**, Virtual.

1. **Bosanac, N**; Alibay, F; Stuart, J.R., 'A Low-Thrust-Enabled SmallSat Heliophysics Mission to Sun-Earth L5,' IEEE Aerospace Conference, **March 2018**, Big Sky, MT.

## **CONFERENCE PAPERS** Key: **N. Bosanac**, N. Bosanac's Students

32. Bonaser, S; Elliott, I; Sullivan, C; **Bosanac N**; Ahmed, N; McMahon, J; 'Designing Impulsive Station-Keeping Maneuvers Near a Sun-Earth L2 Halo Orbit via Reinforcement Learning' AAS/AIAA Space Flight Mechanics Meeting, **February 2021**.

31. Elliott I; **Bosanac N**, 'Spacecraft Formation Control Near a Periodic Orbit Using Geometric Relative Coordinates' AAS/AIAA Space Flight Mechanics Meeting, **February 2021**.

30. Bonaser, S.; **Bosanac, N**, 'Using Unsupervised Learning to Improve Analysis and Visualization of Higher-Dimensional Poincaré Maps in Multi-Body Trajectory Design,' 2020 AAS/AIAA Astrodynamics Specialist Virtual Conference, **August 2020**.

29. Smith, T.; **Bosanac, N**, 'Motion Primitives Summarizing Periodic Orbits and Natural Transport Mechanisms in the Earth-Moon System,' 2020 AAS/AIAA Astrodynamics Specialist Virtual Conference, **August 2020**.
28. Bonaser, S.; **Bosanac, N**, 'Transitions Between Quasi-Periodic Orbits Near Resonances in the Circular Restricted Three-Body Problem,' 2020 AAS/AIAA Astrodynamics Specialist Virtual Conference, **August 2020**.
27. Sullivan, C.; **Bosanac, N**, 'Using Multi-Objective Deep Reinforcement Learning to Uncover a Pareto Front in Multi-Body Trajectory Design,' 2020 AAS/AIAA Astrodynamics Specialist Virtual Conference, **August 2020**.
26. Elliott, I.; **Bosanac, N**, 'Geometric Relative Orbital Element Set for Motion Near a Periodic Orbit with Oscillatory Modes,' 2020 AAS/AIAA Astrodynamics Specialist Virtual Conference, **August 2020**.
25. Short, C; Haapala, A.; **Bosanac, N**, 'Technical Implementation of the Circular Restricted Three-Body Model in STK Astrogator,' 2020 AAS/AIAA Astrodynamics Specialist Virtual Conference, **August 2020**.
24. Bonaser, S.; **Bosanac, N**, 'Applications of Clustering to Higher-Dimensional Poincaré Maps in Multi-Body Systems,' 30th AIAA/AAS Space Flight Mechanics Meeting, **January 2020**, Orlando, FL.
23. Elliott, I.; **Bosanac, N**; Ahmed, N; McMahon, J.W., 'Apprenticeship Learning for Maneuver Design in Multi-Body Systems,' 30th AIAA/AAS Space Flight Mechanics Meeting, **January 2020**, Orlando, FL.
22. Sullivan, C.; **Bosanac, N**, 'Using Reinforcement Learning to Design Low-Thrust Approaches into Periodic Orbits in a Multi-Body System,' 30th AIAA/AAS Space Flight Mechanics Meeting, **January 2020**, Orlando, FL.
21. Smith, T.R.; **Bosanac, N**, 'Constructing a Set of Motion Primitives in the Circular Restricted Three-Body Problem via Clustering,' AAS/AIAA Astrodynamics Specialist Conference, **August 2019**, Portland, ME.
20. Smith, T.R.; **Bosanac, N**; Berger, T.E., Duncan, N; Wu, G, 'Trajectory Design for a Solar Polar Observing Constellation,' AAS/AIAA Astrodynamics Specialist Conference, **August 2019**, Portland, ME.
19. Stuart, J.R.; Anderson, R.L.; Sullivan, C.; **Bosanac, N**, 'Accessing Highly Out-of-Ecliptic Science Orbits via Low-Energy, Low-Thrust Transport Mechanisms,' AAS/AIAA Astrodynamics Specialist Conference, **August 2019**, Portland, ME.
18. **Bosanac, N**, 'A Data Mining Approach to Using Poincaré Maps in Multi-Body Trajectory Design Strategies,' AAS/AIAA Spaceflight Mechanics Meeting, **January 2019**, Ka'anapali, HI.

17. Elliott, I.L.; Sullivan, C.J.; **Bosanac, N**; Alibay, F; Stuart, J, 'Designing Low-Thrust Enabled Trajectories for A Heliophysics SmallSat Mission to Sun-Earth L5,' 29th AAS/AIAA Spaceflight Mechanics Meeting, **January 2019**, Ka'anapali, HI.
16. Sullivan, C.J.; Elliott, I.L.; **Bosanac, N**; Alibay, F; Stuart, J, 'Exploring the Low-Thrust Trajectory Design Space for SmallSat Missions to the Sun-Earth Triangular Equilibrium Points,' 29th AAS/AIAA Spaceflight Mechanics Meeting, **January 2019**, Ka'anapali, HI.
15. **Bosanac, N**, 'Bounded Motions Near Resonant Orbits in the Earth-Moon and Sun-Earth Systems,' Accepted to: AAS/AIAA Astrodynamics Specialist Conference, **August 2018**, Snowbird, UT.
14. **Bosanac, N**; Webster, C.M; Howell, K.C; Folta, D.C, 'Trajectory Design and Station-Keeping Analysis for the Wide Field Infrared Survey Telescope Mission,' AAS/AIAA Astrodynamics Specialist Conference, **August 2017**, Stevenson, WA.
13. **Bosanac, N**; Cox, A; Howell, K.C.; Folta, D, 'Trajectory Design for a Cislunar CubeSat Leveraging Dynamical Systems Techniques: The Lunar IceCube Mission,' 27th AAS/AIAA Space Flight Mechanics Meeting, **February 2017**, San Antonio, TX.
12. Folta, D; **Bosanac, N**; Cox, A; Howell, K.C., 'The Lunar IceCube Mission Challenge: Attaining Science Orbit Parameters From a Constrained Approach Trajectory,' 27th AAS/AIAA Space Flight Mechanics Meeting, **February 2017**, San Antonio, TX.
11. Folta, D; Webster, C.M; **Bosanac, N**; Cox, A; Guzzetti, D; Howell, K.C, 'Trajectory Design Tools for Libration and Cislunar Environments,' 6th International Conference on Astrodynamics Tools and Techniques, **March 2016**, Darmstadtium, Germany.
10. Cox, A; **Bosanac, N**; Guzzetti, D; Howell, K.C; Folta, D; Webster, C.M, 'An Interactive Trajectory Design Environment Leveraging Dynamical Structures in Multi-Body Regimes,' 6th International Conference on Astrodynamics Tools and Techniques, **March 2016**, Darmstadtium, Germany.
9. Folta, D; **Bosanac, N**; Cox, A; Howell, K.C, 'The Lunar IceCube Mission Design: Construction of Feasible Transfer Trajectories with a Constrained Departure,' AAS/AIAA Space Flight Mechanics Meeting, **February 2016**, Napa Valley, CA.
8. Guzzetti, D; **Bosanac, N**; Haapala, A; Howell, K.C; Folta, D.C, 'Rapid Trajectory Design in the Earth-Moon Ephemeris System via an Interactive Catalog of Periodic and Quasi-Periodic Orbits,' 66th International Astronautical Congress, **October 2015**, Jerusalem, Israel.
7. **Bosanac, N**; Howell, K.C; Fischbach, E, 'Leveraging Discrete Variational Mechanics to Explore the Effect of an Autonomous Three-Body Interaction Added to the Restricted Problem,' AstroNet-II International Final Conference, **June 2015**, Tossa De Mar, Spain.

6. **Bosanac, N;** Howell, K.C; Fischbach, E, 'A Natural Autonomous Force Added in the Restricted Problem and Explored Via Stability Analysis and Discrete Variational Mechanics,' AAS/AIAA Space Flight Mechanics Meeting, **January 2015**, Williamsburg, VA.
5. Guzzetti, D; **Bosanac, N;** Howell, K.C, 'A Framework for Efficient Trajectory Comparisons in the Earth-Moon Design Space,' AIAA/AAS Astrodynamics Specialist Conference, **August 2014**, San Diego, CA.
4. **Bosanac, N;** Howell, K.C; Fischbach, E, 'Stability of Orbits Near Large Mass Ratio Binary Systems,' 2nd IAA Conference on Dynamics and Control of Space Systems, **March 2014**, Rome, Italy.
3. Folta, D.C; **Bosanac, N;** Guzzetti, D; Howell, K.C, 'An Earth-Moon System Trajectory Design Reference Catalog,' 2nd IAA Conference on Dynamics and Control of Space Systems, **March 2014**, Rome, Italy.
2. Capparelli, E; Delgado-López, L; **Bosanac, N;** Burg, A; Conley, J; Ho, K; Kugler, J; Langston, S.M; Lo Gatto, V; Mansurov, O.G; Nizenkov, P; Vrolijk, A; Zea, L; Battat, J.A, 'Evaluating International Collaboration for Human Exploration Beyond LEO,' IAA Space Exploration Conference, **January 2014**, Washington D.C.
1. **Bosanac, N;** Howell, K; Fischbach, E, 'Exploring the Impact of a Three-Body Interaction Added to the Gravitational Potential Function in the Restricted Three-Body Problem,' AAS/AIAA Space Flight Mechanics Meeting, **February 2013**, San Diego, CA.

## THESES

- Bosanac, N,** 'Leveraging Natural Dynamical Structures to Explore Multi-Body Systems,' Ph.D. Dissertation, Purdue University, **August 2016**.
- Bosanac, N,** 'Exploring the Influence of a Three-Body Interaction Added to the Gravitational Potential in the Circular Restricted Three-Body Problem: A Numerical Frequency Analysis,' Masters Thesis, Purdue University, **December 2012**.

## SELECTED RECENT TALKS

- Bosanac, N,** 'Autonomous Maneuvering within Chaotic Multi-Body Systems' NASA Goddard Space Flight Center Mission Design and Navigation Branch, November 2020.
- Bosanac N.,** 'Trajectory and Maneuver Design in Cislunar Space,' Cislunar Working Group Meeting, Albuquerque NM, **February 2020**.
- Bosanac, N.;** McMahon, J.W., 'Astrodynamics Challenges for Autonomous Spacecraft in Complex Gravitational Environments,' NASA Ames Research Center, **May 2019**.

**Bosanac, N.**, ‘Enabling and Enhancing Space Exploration via Trajectory Design,’ presented to Ball Aerospace & Technologies, **November 2018**.

Berger, T; **Bosanac, N**; Duncan, N; Van Cleve, J, ‘SPOC: The Solar Polar Orbiting Constellation,’ Presented by Tom Berger at HAO Polar Perspectives in Boulder, CO. **Sept 2018**.

Elliott, I.L., Sullivan, C.J., Bosanac, N., ‘Enabling SmallSat Heliophysics Missions to Sun-Earth Lagrange Points,’ Presented by I. Elliott and C. Sullivan to Jet Propulsion Laboratory, **Aug 2018**.

Berger, T; **Bosanac, N**, ‘Space Weather Research and Operational Observations,’ Presented by Tom Berger at Deep Space Gateway Concept Science Workshop in Denver, CO. **Feb 2018**.

**Bosanac, N**, ‘Leveraging Dynamical Systems Techniques to Explore Multi-Body Systems,’ in: Numerical Algorithms for Space Flight Series, Jet Propulsion Laboratory, **May 15, 2017**.

**Bosanac, N**, ‘WFIRST Trajectory Design Lunch and Learn,’ at NASA Goddard Space Flight Center, **December 5, 2016**.

## **RECENT POSTER PRESENTATIONS**

**Bosanac, N.**, ‘Spacecraft Trajectory and Maneuver Design in Multi-Body Systems,’ presented at University of Colorado Boulder College of Engineering Interdisciplinary Research Theme Research Blitz, **March 2020**.

Berger, T, Duncan, N., **Bosanac, N.**, Smith, T.R., Elliott, I.L., Sullivan, C.J., Van Cleve, J., Shannon, M., Upton, L, “The Solar Polar Observing Constellation (SPOC) Mission” presented at Space Weather Workshop, **April 2019**.

Upton, L., Berger, T., Duncan, N., **Bosanac, N.**, “The Solar Polar Observing Constellation (SPOC)” presented at AAS Solar Physics Division Meeting, **June 2019**.

Berger, T., Duncan, N., Van Cleve, J., Shannon, M., **Bosanac, N.**, Elliott, I.L., Smith, T.R., Sullivan, C.J., Upton, L., Baker, D., Thayer, J., Cranmer, S., Pankratz, C., Hurlburt, N., "The Solar Polar Observing Constellation (SPOC) Mission: Combining Operational Full-Sun Magnetic Field Measurements with Polar Exploration," presented at American Geophysical Union Meeting in Washington, D.C., **December 2018**.

**Bosanac, N**, ‘Enabling and Enhancing Planetary Exploration via Trajectory Design’ Poster presented at: NASA Outer Planets Assessment Group Meeting, **February 2018**.

## **INVITED WORKSHOPS**

Workshop on Autonomy for Future NASA Science Missions in Pittsburgh, PA, **October 2018**.  
Focus on autonomy for In-Space Assembly missions

## HONORS & AWARDS

2020	University of Colorado Boulder College of Engineering Dean's Faculty Fellowship
2016	Purdue University Aeronautics and Astronautics Outstanding Graduate Student Research Award
2014 & 2015	Zonta International Amelia Earhart Fellowship
2010-2011	Computational Science and Engineering Lynn Fellowship
2009	David J. Shapiro Memorial Award
<i>Travel Awards</i>	
2018	NASA Outer Planets Assessment Group Meeting Early Career Travel Award
2017	JPL Center for Academic Partnerships Faculty Travel Funds (\$10K)
2015	AAS John V. Breakwell Student Travel Award

## TEACHING

Spaceflight Dynamics, ASEN 5050, University of Colorado Boulder (Fall 2017-2019, Spring 2020)

Advanced Astrodynamics, ASEN 6060, University of Colorado Boulder (Fall 2020)

Independent Study: Multi-Body Dynamics, University of Colorado Boulder (Fall 2017-2019)

Orbit Mechanics and Attitude Dynamics and Control, ASEN 3200, University of Colorado Boulder (Spring 2017-2020)

Orbit Mechanics, AAE 532, Purdue University (Fall 2015)

## ADVISING

### **Current Ph.D. Students:**

1. Ian L. Elliott: 08/2017-Present (GAANN Fellowship 2020)
2. Christopher J. Sullivan: 08/2017-Present (NASA Space Technology Research Fellowship 2019)
3. Stefano Bonasera: 08/2018-Present
4. Thomas R. Smith: 08/2018-Present (GAANN Fellowship 2019, NASA Space Technology Research Fellowship 2019)
5. Kristen Bruchko: 08/2019-Present (NASA Space Technology Graduate Research Opportunity)

### **Current M.S. Thesis Students:**

1. Renee Spear (NSF Graduate Research Fellowship Program)
2. Connor Johnstone

### **Graduated M.S. Thesis Students:**

1. Saikiran Chikine (Summer 2019)
2. Bryce Huber (Spring 2019)
3. Chelsea Thangavelu (Fall 2019)

**Former Undergraduate Researchers:** Connie M. Childs (Summer 2018, 2019), Marisa Exnicious (Summer 2019)

### **Ph.D. Committee Membership:**

Nicola Baresi (Advisor: Daniel J. Scheeres, Graduated: Spring 2017)

Stijn De Smet (Advisor: Daniel J. Scheeres, Graduated: Fall 2018)

Alex Davis (Advisor: Daniel J. Scheeres, Graduated: Spring 2020)

Lucas Bury (Advisor: Jay McMahon)

**M.S. Thesis Committee Membership:**

Christopher Rabotin (Advisor: Hanspeter Schaub, Graduated: Spring 2017)

Jacob Vendl (Advisor: Marcus Holzinger, Graduated: Spring 2020)

**SERVICE TO PROFESSION**

- 2020 Organizing committee co-chair for CU Boulder, MIT, Stanford Women in Aerospace Symposium (Event cancelled due to COVID-19)
- 2020 Reviewer for NASA
- 2020 Session Chair, AAS/AIAA Astrodynamics Specialist Conference
- 2020 Session Chair, AAS/AIAA Space Flight Mechanics Meeting at the AIAA Scitech Forum
- 2019 AAS Space Flight Mechanics Technical Committee – Technical Administration Subcommittee
- 2019 Session Chair, AAS/AIAA Astrodynamics Specialist Conference
- 2019 Panelist for ACTIVE: Faculty Development and Leadership Initiative at CU Boulder
- 2019 Reviewer for NSF, NASA
- 2019 Panelist for MIT, Stanford, CU Boulder Women in Aerospace Symposium
- 2018 Panelist, Session Chair for MIT, Stanford, CU Boulder Women in Aerospace Symposium
- 2018 Panelist for ACTIVE: Faculty Development and Leadership Initiative at CU Boulder
- 2018 Reviewer for NSF
- 2017 Session Chair, International Workshop on Satellite Constellations and Formation Flying
- 2017 Organizing committee for CU Boulder, MIT, Stanford Women in Aerospace Symposium, Session Chair and Panelist

**JOURNAL REVIEWS**

Advances in Space Research (2018); Aerospace Science and Technology (2019); Acta Astronautica (2017); Astrophysics and Space Science (2014, 2017-18, 2020); Celestial Mechanics and Dynamical Astronomy (2015-16, 2018); Journal of the Astronautical Sciences (2017-20); Journal of Guidance, Control & Dynamics (2017-18, 20) (Excellent Reviewer 2017,2020)

**EXTERNAL SERVICE**

2014-16,18-20 MIT Educational Counselor

**PROFESSIONAL AFFILIATIONS**

American Institute of Aeronautics and Astronautics, American Astronautical Society, Tau Beta Pi Engineering Honor Society