Athul P. Girija

Ph.D. Candidate · Astrodynamics and Space Applications

School of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907, USA

☐ (+1) 765-476-3703 | ✉ apradee@purdue.edu | 🏠 athulpg007.github.io | 🔗 athulpg007

Summary

Ph.D. candidate in Astrodynamics and Space Applications with expertise in orbital mechanics, space systems engineering and multidisciplinary optimization. Experience in performing end-to-end mission concept studies and architectures for planetary missions. Experience with software development (Python, C++), cloud computing (AWS), technical writing, documentation, and presentations to the scientific community. Developer of the open-source Aerocapture Mission Analysis Tool (AMAT). Actively looking for full-time opportunities. **Citizenship:** India.

Education

School of Aeronautics and Astronautics, Purdue University
West Lafayette, IN, USA

Ph.D. Candidate, Advanced Astrodynamics Concepts (AAC) Lab
Aug. 2016 - present

- Dissertation: "A Systems Framework for Rapid Conceptual Design of Aerocapture Mission Concepts".
- Advisors: Dr. Sarag J. Saikia and Prof. James M. Longuski
- Major: Astrodynamics and Space Applications; Minor: Aerospace Systems
- GPA: **3.9/4.0**; Expected completion: July 2021

School of Aerospace Engineering, Indian Institute of Technology (IIT), Madras
Chennai, India

Dual Degree (B.Tech.+M.Tech.) in Aerospace Engineering
Aug. 2011 - Jul. 2016

- Major: Aerospace Propulsion; Minor: Industrial Engineering
- GPA: **9.16/10.0**; Silver Medallist, Class of Aerospace Engineering, 2016
- Graduated with Honors, awarded the Mayan Prize for best academic record and senior design project.

Internships / Summer Programs

Year-Round Intern, Pioneer Astronautics
Lakewood, CO

Aerospace Engineering Intern, Magnetic Sail Project
Sep. 2020 - May. 2020

- Leading the modeling and simulation efforts for the Magnetic Sails for Spacecraft Deorbit NASA SBIR project.
- Performed magnetohydrodynamic (MHD) and particle-in-cell (PIC) simulations for a magnetic sail in LEO.
- Assist the PI in preparing review presentations, project report and proposal writing efforts.

Planetary Science Summer Seminar (PSSS), NASA Jet Propulsion Laboratory
Pasadena, CA

Mission Formulation Section, Team X, JPL
May. 2018 - Jul. 2020

- Participant of the 30th NASA PSSS which formulated a New Frontiers mission concept to Uranus.
- Led the mission design and Uranus system tour design to achieve the science within the mission constraints
- Co-led the magnetosphere science team, led the magnetometer instrument team.

Summer Intern, Indian Space Research Organization (ISRO)
Trivandrum, Kerala, India

Aeroheating Division, Vikram Sarabhai Space Center, ISRO
May. 2013 - Jul. 2013

- Studied modeling and simulation techniques for entry vehicle thermal protection systems (TPS) materials.
- Developed a MATLAB code to compute the TPS material thermal response during Earth re-entry.
- Supported an on-going investigation of a temperature anomaly during the PSLV-C20 mission.

Research Projects

JPL-Purdue Outer Planet Aerocapture Studies
FUNDED BY NASA JET PROPULSION LABORATORY (JPL)

West Lafayette, IN, USA
Jan. 2018 - Sept. 2019

- Led the joint JPL-Purdue effort which performed the most state-of-the-art end-to-end aerocapture mission study to date for missions to Uranus and Neptune.
- Coordinated project planning, execution, and delivery with Mission Design and Navigation Section at JPL.
- Presented results to senior JPL program managers and scientists. Link to Final Report and Presentation

Systems Framework for Rapid Conceptual Design of Aerocapture Missions
IN COLLABORATION WITH NASA JET PROPULSION LABORATORY

West Lafayette, IN, USA
Jan. 2017 - Present

- Formulated an integrated systems analysis framework for rapid aerocapture mission concept studies
- Created "aerocapture feasibility charts" unifying interplanetary trajectory and vehicle design, now commonly used as a graphical method for aerocapture mission design and analysis.
- Implemented the framework in the open-source Aerocapture Mission Analysis Tool (AMAT).

Purdue Single Wheel Test Rig for Ocean World Rovers
FUNDED BY NASA SCIENCE MISSION DIRECTORATE, NASA H.Q.

West Lafayette, IN, USA
Aug. 2017 - Present

- Led the mechanical design (SolidWorks) and fabrication (machining, CNC, integration) of a state-of-the art planetary rover wheel-soil interaction test facility for Ocean Worlds.
- Led the testbed and simulant design effort to accommodate large tires (> 1 m dia.) and a range of surface conditions (such as snow, ice, cobblestones, boulders and sharp rock formations). Link to Factsheet, Video.
- Managed a team of five graduate students and coordinated project execution with industrial partners at Thin Red Line Aerospace and Smithers Inc.

SmallSats for Future Planetary Missions to Mars and Venus
PURDUE UNIVERSITY

West Lafayette, IN, USA
Jan. 2017 - Dec. 2018

- Led an internal research group effort to assess the feasibility of drag modulation aerocapture for small satellite orbit insertion at Mars and Venus.
- Studied potential mission architectures such as Synthetic Aperture Radar (SAR) constellations, communications relay, and magnetosphere observation clusters consisting of SmallSats at Mars and Venus.
- Presented results to the scientific community at VEXAG meetings in 2017 and 2018. Link Link

Human Journey to Mars - Pioneering Mars Base Architecture
PURDUE UNIVERSITY

West Lafayette, IN, USA
Jan. 2017 - Apr. 2017

- Systems engineer in an interdisciplinary mission concept study for 50 person manned Mars mission
- Responsible engineer for the "Mars Surface Tunnel" concept to mitigate issues related to dust.

Atmospheric Sample Return from the Habitable Zone of Venus
PURDUE UNIVERSITY

West Lafayette, IN, USA
Jan. 2017 - Jun. 2017

- Analyzed the feasibility of collecting and returning a sample from the Venusian atmosphere.
- Performed trade studies of various entry vehicle systems and ascent vehicle staging schemes.
- Presented poster at the Planetary Science Vision (PSV) 2050 Workshop. Link to poster and media coverage.

Journal Publications

1. **A. P. Girija**, S. J. Saikia, J. M. Longuski, S. Bhaskaran, M. Smith, and J. A. Cutts, "Feasibility and Performance Analysis of Neptune Aerocapture Using Heritage Blunt-Body Aeroshells", *AIAA Journal of Spacecraft and Rockets*. Vol. 57, Number 6. November 2020. DOI: 10.2514//1.A34719

2. **A. P. Girija**, Y. Lu, and S. J. Saikia, "Feasibility and Mass-Benefit Analysis of Aerocapture for Missions to Venus", *AIAA Journal of Spacecraft and Rockets*. Vol. 57, Number 1. January 2020. DOI: 10.2514/1.A34529

3. S. Jarmak, E. Leonard, A. Akins, E. Dahl, D. R. Cremons, S. Cofield, A. Curtis, C. Dong, E. T. Dunham , B. Journaux, D. Murakami, W. Ng, M. Piquette, **A. P. Girija**, K. Rink, L. Schurmeier, N. Stein, N. Tallarida, M. Telus, L. Lowes, C. Budney, K. L. Mitchell, "QUEST: A New Frontiers Uranus Orbiter Mission Concept Study", *Acta Astronautica*. Juanuary 2020. DOI: 10.1016/j.actaastro.2020.01.030

4. **A. P. Girija**, Y. Lu, A. Mudek, A. Arora, S. J. Saikia, J. M. Longuski, and J. A. Cutts, "Quantitative Assessment of the Aerocapture Mission Set". *In preparation.* Expected submission, March 2021.

5. **A. P. Girija**, Y. Lu, A. Arora, R. Agrawal, J. Prabha, M. de Jong, B. Aiken, M. Rajapakshe, M. Kent, S. J. Saikia, and J. M. Longuski, "Purdue Single Wheel Test Rig Facility for Ocean World Rovers". *In preparation.* Expected submission, March 2021.

Software

1. **A. P. Girija**, "Aerocapture Mission Analysis Tool (AMAT)". Project Website. AMAT provides rapid mission design capability for aerocapture and EDL mission concepts to all atmosphere-bearing Solar System destinations. AMAT is open-source and is made available under the CC-BY-SA-4.0 license.

Conference Publications

1. **A. P. Girija**, S. J. Saikia, J. A. Cutts, and J. M. Longuski, "A Unified Framework for Aerocapture Systems Analysis", AAS 19-811, AAS/AIAA Astrodynamics Specialist Conference, Portland, ME, August 2019. engrXiv

2. **A. P. Girija**, S. J. Saikia, J. M. Longuski, S. Bhaskaran, M. Smith, and J. A. Cutts, "Aerocapture Performance Analysis for a Neptune Mission using Blunt-Body Aeroshell", AAS 19-815, AAS/AIAA Astrodynamics Specialist Conference, Portland, ME, August 11–15, 2019. engrXiv

3. **A. P. Girija**, S. J. Saikia, and M. de Jong, "Candidate Mechanisms and Fabric Layup Materials for the Mars Surface Tunnel Concept", IEEE Aerospace Conf., Big Sky, MT, March, 2018. DOI:10.1109/AERO.2018.8396720

Oral Presentations

1. **A. P. Girija**, S. J. Saikia, J. M. Longuski, and J. A. Cutts, "AMAT: A Rapid Design Tool for Aerocapture Missions", 17th International Planetary Probe Workshop (IPPW), Invited student speaker for online webinar series based on submitted abstract. (Originally scheduled to be held in Monterey, CA.) Link

2. **A. P. Girija**, S. J. Saikia, J. M. Longuski, S. Bhaskaran, M. Smith, and J. A. Cutts, "Ice Giant Aerocapture Using Low-L/D Aeroshells: Uncertainty Quantification and Risk Assessment", 16th International Planetary Probe Workshop (IPPW), Oxford University, Oxford, United Kingdom, July 8–12, 2019. Link

3. **A. P. Girija**, Y. Lu, S. J. Saikia, J. M. Longuski, and J. A. Cutts, "Feasibility and Mass-Benefit Analysis of Aerocapture for SmallSat Missions to Venus", 16th NASA Venus Exploration Group (VEXAG) Meeting, Johns Hopkins University Applied Physics Lab (APL), Laurel, MD, November 5–8, 2018. Link

4. **A. P. Girija**, A. Arora, S. J. Saikia and J. A. Cutts, "Hybrid Aerocapture using Low L/D Aeroshells for Ice Giant Missions", 15th International Planetary Probe Workshop (IPPW), Boulder, CO, June 11–15, 2018. Link

5. Y. Lu, **A. P. Girija**, S. J. Saikia, and J. A. Cutts, "Venus Aerocapture Assessment", 15th NASA Venus Exploration Group Meeting, Johns Hopkins University APL, Laurel, MD, November 14–16, 2017. Link

6. **A. P. Girija**, E. Shibata, Y. Lu, S. J. Saikia and J. A. Cutts, "Considerations for Atmospheric Sample Return form the Habitable Zone of Venus", 14th International Planetary Probe Workshop (IPPW), The Hague, Netherlands June 12–17, 2017. Link

Poster Presentations

1. S. Jarmak, E. Leonard, A. Akins, E. Dahl, D. R. Cremons, S. Cofield, A. Curtis, C. Dong, E. T. Dunham , B. Journaux, D. Murakami, W. Ng, M. Piquette, **A. P. Girija**, K. Rink, L. Schurmeier, N. Stein, N. Tallarida, M. Telus, L. Lowes, C. Budney, K. L. Mitchell, "QUEST: A New Frontiers Uranus Orbiter Mission Concept Study", 50th Lunar and Planetary Science Conference (LPSC), The Woodlands, TX, March 18–22, 2019. Link

2. Y. Lu, **A. P. Girija**, M. Rajapakshe, J. M. Longuski, and S. J. Saikia, "A Single-Wheel Test Rig for Ocean Worlds", NASA Outer Planets Assessment Group (OPAG) Meeting, Pasadena, CA, Sept. 11–12, 2018. Link

3. R. Agrawal, B. Aiken, M. de Jong, **A. P. Girija**, J. M. Longuski and S. J. Saikia, "A Surface Mobility System with Large Deployable and Conformal Tires for Ocean Worlds Exploration, 15th International Planetary Probe Workshop (IPPW), Boulder, CO, June 11–15, 2018. Link

4. **A. P. Girija**, R. Agrawal, Y. Lu, B. Aiken, M. de Jong, and S. J. Saikia, "A Novel Surface Mobility System for Ocean Worlds", NASA Outer Planets Assessment Group (OPAG) Meeting, Hampton, VA, February 21–22, 2018. Link

5. Y. Lu, M. Rajapakshe, R. Agrawal, **A. P. Girija**, and S. J. Saikia, "A Single Wheel Test Rig for Ocean World Rover", NASA Outer Planets Assessment Group (OPAG) Meeting, Hampton, VA, Feb. 21–22, 2018. Link

6. E. Shibata, Y. Lu, **A. P. Girija**, J. A. Cutts, and S. J. Saikia, "A Venus Atmospheric Sample Return Mission Concept: Feasibility and Technology Requirements", Poster presented at Planetary Science Vision 2050 Workshop, NASA Headquarters, Washington D.C., February 27–28, 2017. Link

Scholastic Achievements

- **Mayan Prize** for best academic record in Aerospace Engineering, Class of 2016, IIT Madras.
- **Silver Medal** for academic excellence, Class of Aerospace Engineering (B.Tech + M.Tech), 2016, IIT Madras.
- **First Rank** in Infant Jesus High School, Indian School Certificate Examination (ICSE), 2009.
- **Top 1 percent** of students in the state of Kerala, India who took the Junior Astronomy Olympiad (2008).

Scholarships and Awards

- **IPPW Student Scholarship** to attend the International Planetary Probe Workshop (IPPW)
    — Awarded in 2017, 2018, and 2019
- **IPPW Student Poster Award** - 3rd place on co-authored poster, 15th IPPW, Boulder, CO.
- **NASA Planetary Science Summer Seminar Stipend** to attend the 30th annual NASA Planetary Science Summer Seminar (PSSS) at NASA Jet Propulsion Lab, Pasadena, California, August 6-10, 2018.
- **VEXAG Student Travel Grant** to attend the 16th NASA Venus Exploration Group (VEXAG) Meeting (2017, 2018)

Skills

- **Programming Languages:** Python and C++ (Advanced), MATLAB, Mathematica, Shell scripting
- **Operating Systems:** Linux, Windows
- **Cloud Computing:** Amazon Web Services Elastic Cloud Compute (EC2)

- **Packages:** tensorflow and keras (deep learning), pandas (dataframes), seaborn and matplotlib (visualization)
- **Code development**: Git, GitHub
- **Presentation Software:** Microsoft Office, Libre Office, LaTeX, Adobe InDesign, Adobe Illustrator
- **Astrodynamics Software and Packages:** STK, GMAT, AstroPy, jplephem, spicepy
- **CAD and Visualization Software:** Blender, Autodesk Inventor, SolidWorks, matplotlib

Research Experience

Research Assistant (RA) - Purdue-JPL Aerocapture Studies   *West Lafayette, IN, USA*
SUPERVISORS : PROF. SARAG SAIKIA AND PROF. JAMES LONGUSKI   *Jan. 2018 - Dec. 2018*

- Assessment of aerocapture for outer planet missions, guidance, navigation and control (GNC) algorithms

Research Assistant (RA) - NASA COLDTech Program   *West Lafayette, IN, USA*
SUPERVISORS : PROF. SARAG SAIKIA AND PROF. JAMES LONGUSKI   *Jun. 2018 - Aug. 2019*

- Design, fabrication, assembly, and validation of planetary rover wheel test rig for Ocean World surfaces
- Design of test methods and selection of simulants or planetary surfaces

Teaching Experience

Teaching Assistant (TA) for AAE450 (Spacecraft Design) - Purdue University   *West Lafayette, IN, USA*
INSTRUCTOR : PROF. JAMES LONGUSKI, SCHOOL OF AERONAUTICS AND ASTRONAUTICS.   *Jan. 2020 - May 2020*

- Capstone aerospace engineering course where students learn spacecraft systems engineering, conceptual design, technical communication, and project management. Project Website

Teaching Assistant (TA) for AAE301 (Signal Analysis) - Purdue University   *West Lafayette, IN, USA*
INSTRUCTOR : PROF. ARTHUR FRAZHO, SCHOOL OF AERONAUTICS AND ASTRONAUTICS.   *Aug. 2019 - Dec. 2019*

- Undergraduate level course where students learn basic signal processing and filtering techniques.

Teaching Assistant (TA) for AAE340 (Dynamics) - Purdue University   *West Lafayette, IN, USA*
INSTRUCTOR : PROF. CAROLINE FRUEH, SCHOOL OF AERONAUTICS AND ASTRONAUTICS.   *Jan. 2018 - May. 2018*

- AAE340 is an undergraduate dynamics course where students learn the basic principles of rigid body dynamics, vibrations, and orbital mechanics and is a prerequisite for many advanced courses in dynamics and control.

Teaching Assistant (TA) for AS5210 (Senior Design) - IIT Madras   *Chennai, Tamil Nadu, India*
INSTRUCTOR : PROF. M. MATHUR, SCHOOL OF AEROSPACE ENGINEERING.   *Jan. 2016 - Jun. 2016*

- Capstone aircraft/spacecraft/space mission design course for students in aerospace engineering.

Course Projects

Impact of Anthropogenic Aerosols on Climate   *West Lafayette, IN, USA*
ATMOSPHERIC PHYSICS (EAPS 531): PROF. D. T. DAWSON   *Jun. 2019*

- Studied the "whitehouse efffect", which is the effect of anthropogenic aerosols on Earth's radiative transfer budget and climate change.

Goddard problem of optimal rocket ascent with dynamic pressure constraint   *West Lafayette, IN, USA*
TRAJECTORY OPTIMIZATION (AAE508): PROF J. M. LONGUSKI   *Dec. 2017*

- Solved the optimal control problem using OpenGoddard, an open-source pseudospectral library. Report

Trajectory design for the Voyager 2 spacecraft *West Lafayette, IN, USA*
ORBITAL MECHANICS (AAE532): PROF K. C. HOWELL *Dec. 2016*

- Developed a Python code to reproduce the 'Grand Tour' trajectory using patched conic method.

Analytical solutions for the dynamics of near symmetric rigid bodies *West Lafayette, IN, USA*
RIGID BODY DYNAMICS (AAE507): PROF J. M. LONGUSKI. *Dec. 2016*

- Analyzed the spin motion of Galileo spacecraft and the ship *Endurance* in the movie *Interstellar*. Report

Service

Aerospace Engineering Association (AEA), IIT Madras *Chennai, Tamil Nadu, India*
SECRETARY *Jun. 2015 - Jul. 2016*

- Led a seven member team which organized various technical and non-technical, sporting, and cultural events at the Department of Aerospace Engineering, IIT Madras. Website

Extras

- **Languages:**
    - English
    - Hindi
    - Malayalam (native proficiency)
    - Chinese (basic proficiency)
    - Russian (elementary proficiency)

References

1. **Dr. Sarag J. Saikia**
   Research Assistant Professor, School of Aeronautics and Astronautics, Purdue University
   E-mail: ssaikia@purdue.edu, Phone: 765-203-1236

2. **Dr. James M. Longuski**
   Professor, School of Aeronautics and Astronautics, Purdue University
   E-mail: longuski@purdue.edu, Phone: 765-494-5139

3. **Dr. James A. Cutts**
   Program Manager, Solar System Exploration Directorate, NASA Jet Propulsion Laboratory
   E-mail: james.a.cutts@jpl.nasa.gov, Phone: 818-354-4120