

Rohan Sood

Curriculum Vitae

Research Website: asrl.ua.edu

Department of Aerospace Engineering and Mechanics
The University of Alabama
238 Hardaway Hall, Tuscaloosa, AL 35487

Astrodynamics and Space Research Laboratory
O: (205) 348-4020
rsood@eng.ua.edu

Professional Summary

Dr. Rohan Sood is an Assistant Professor in the Department of Aerospace Engineering at the University of Alabama. His research has emerged as a combination of two fields, applying engineering tools to study advanced concepts within multi-body dynamical systems and investigating scientific data to explore celestial bodies. His primary research investigates innovative spacecraft trajectory design leveraging natural dynamics to deliver cost-effective solutions for scientific exploration of space and celestial bodies.

In 2018, NASA Marshall Space Flight Center (MSFC) selected Dr. Sood's Technical Excellence proposal on Advanced Trajectory Design. In 2019, Dr. Sood was awarded the Astrodynamics in Support of Icy World Missions grant by NASA HQ. He is also the recipient of the Center innovation Funds from NASA-Jet Propulsion Laboratory for two consecutive years (2019-2021). His ongoing collaboration with MSFC involves exploring solutions for NASA's Near Earth Asteroid Scout mission slated to be launched in late 2021. More recently, he is actively involved with NASA's Solar Cruiser trajectory design in collaboration with MSFC's Mission Design and Navigation Team to find innovative solutions to meet mission specifications. The spacecraft is set to launch in 2025 with IMAP and his work is exploring trajectories that leverage multibody dynamics and additional sail parameters to ensure mission success. Dr. Sood has also collaborated with NASA Goddard Space Flight Center, NASA Ames Research Center, and small businesses on emerging technologies in space flight.

Since his appointment at UA, Dr. Sood has taught service courses, undergraduate professional courses, and graduate courses. As the demand for more space-oriented courses increased, he introduced new topics (Advanced Astrodynamics, Spacecraft Attitude Dynamics) and updated Orbital Mechanics to better prepare the graduates based on the current state-of-the-art in the field of space exploration. Dr. Sood also employs a variety of hardware and software to enhance visualization (*3-D* and *Virtual Reality*, and *Augmented Reality*) of spacecraft trajectories, mission architecture, and to improve student classroom experience.

Dr. Sood's scientific discoveries of lunar lava tubes and buried craters has received widespread coverage by the BBC and National Geographic that led to collaboration with the Japanese Space Agency, JAXA. He is an active member of the American Institute of Aeronautics and Astronautics (AIAA) Astrodynamics Technical Committee and the American Astronautical Society (AAS). In recognition of his professional standing and successful practice, he is a senior member of AIAA. Dr. Sood has chaired conference sessions at the AIAA/AAS conferences and will be the Conference Chair for the 33rd AAS/AIAA Space Flight Mechanics Meeting in January 2023. He has reviewed numerous national/international journals and has served on NASA and Dutch proposal review committees. He has successfully secured \$1,200,000+ (900,000+ as Dr. Sood's share) to support his lab's research activities and graduate students. The success of his lab is also evident from achievements of his students at international, national, state, and university level. He is currently mentoring 12 students (5 PhD, 3 MS, 4 UG) and has successfully mentored 5 students (1 PhD, 4 MS) to degree completion. Dr. Sood has published 48+ referred journal articles and conference papers, and 2 bulletins for the Decadal Survey.

Research Interests

Astrodynamics and space applications, spacecraft attitude dynamics & control, orbital mechanics, interplanetary trajectory design, motion in the vicinity of asteroids, icy worlds, and other celestial bodies, multi-body dynamics, small-body dynamics, artificial intelligence in astrodynamics, remote sensing – Earth and space based observations, human exploration and habitation, extraterrestrial lava tubes

Education

Purdue University, Aeronautics and Astronautics

Ph.D., 2016

Astrodynamics and Space Applications, Minor: Dynamics and Control

Advisors: **Dr. Kathleen C. Howell**, *Hsu Lo Distinguished Professor of Aeronautics & Astronautics*

Dr. Henry (Jay) Melosh, *Distinguished Professor of Earth, Atmospheric & Planetary Sciences*

Dissertation: *Significance of specific force models in two applications: solar sails to Sun-Earth L₄/L₅ and Grail data analysis suggesting lava tubes and buried craters on the Moon*

Purdue University, Aeronautics and Astronautics

M.S., 2012

Astrodynamics and Space Applications, Minor: Dynamics and Control

Advisor: **Dr. Kathleen C. Howell**, *Hsu Lo Distinguished Professor of Aeronautics & Astronautics*

Thesis: *Solar sail applications for mission design in sun-planet systems from the perspective of the circular restricted three-body problem*

University at Buffalo SUNY, Department of Mechanical and Aerospace Engineering

B.S., 2009

Double major: Aerospace Engineering and Mechanical Engineering, *Summa Cum Laude*

Professional Experience

Feb. 2017 – Present *Assistant Professor, Dept. of Aerospace Engineering & Mechanics, University of Alabama*

2012 – 2016 *Research Assistant, School of Aeronautics and Astronautics, Purdue University*

2009 – 2012 *Teaching Assistant, School of Aeronautics and Astronautics, Purdue University*

Current Research

Director: Astrodynamics and Space Research Laboratory (asrl.ua.edu)

- Astrodynamics, space exploration and applications
- Spacecraft trajectory design and attitude dynamics
- Remote sensing – Earth and space based observations
- Human exploration and habitation on extraterrestrial bodies – empty lava tubes on Moon and Mars
- Artificial intelligence – applications of neural network to spacecraft trajectory design
- 3D visualization, virtual reality (VR) and augmented reality (AR) for applications in astrodynamics

Upcoming/Past Mission Involvement

- **Solar Cruiser** in collaboration with NASA Marshall Space Flight Center (MSFC), launch 2025
 - Innovation trajectory design solution to ensure mission success
 - Explore future missions enabled by Solar Cruiser's sail technology to explore the Sun's poles
 - Engage students in challenging activities to characterize sail performance
- **BAMA-1** NASA selected University of Alabama's first satellite to be launched in December 2021
- **Near-Earth Asteroid Scout** in collaboration with NASA MSFC, to be launched in November 2021
 - Contingency trajectory design and analysis
 - Target assessment (as a secondary payload on Artemis I)
 - Solar sail application to multiple asteroid flyby
- **Mars Sample Return** in collaboration with NASA Jet Propulsion Laboratory (JPL)
 - Mars to Earth sample return trajectory design
 - Application of reinforcement learning to missed thrust events
- **GRAIL Science Team** in collaboration with MIT and NASA JPL
 - Gravity data analysis
 - Lava tube exploration as potential sites for human habitats
 - Buried lunar craters

Rohan Sood

*Curriculum Vitae
(continued)*

Awarded and Pending Grants and Research Support

Awarded

	Agency, Title	Role	Duration	Total	Sood Share
1.	NASA-HQ , Astrodynamics in Support of Icy Worlds Missions	PI	11/15/2019 – 11/14/2022	\$300,000	\$300,000
2.	NASA-JPL , Designing Trajectories Resilient to Missed Thrust Events	PI	01/01/2021 – 12/31/2021	\$72,000	\$72,000
3.	NASA-JPL , Application of Reinforcement Learning: Trajectories Resilient to Missed Thrust Events	PI	01/06/2020 – 12/31/2020	\$72,000	\$72,000
4.	NASA-MSFC , The University of Alabama Support of the Solar Cruiser Mission* (incoming)	Collaborator UA-PI	07/16/2021 – 07/15/2024	\$150,000	\$150,000
5.	NASA-MSFC , Technical Excellence (Revery Enhancement)	PI	07/01/2019 – 08/31/2020	\$25,000	\$25,000
6.	NSF GRFP , Solar Sail Trajectory Design Enabling Sustainable Heliophysics Science Missions – James Pezent	PI	08/16/2019 – 08/15/2022	\$138,000	\$138,000
7.	NSF GRFP , Applying Expected Thrust Fraction to Solar Sailing Trajectory Design and Mission Analysis – Carrie Sandel (incoming)	PI	08/16/2021 – 08/15/2024	\$138,000	\$138,000
8.	ASGC/UAH , UA/ASGC Workforce Development (UA/ASGC WFD) Program	Co-PI	04/23/2020 – 03/22/2024	\$103,000	\$4,120
9.	NASA , Development of Metasurface Reflectors to Enable Future Solar Sail Missions	Co-PI	01/06/2020 – 12/31/2021	\$38,921	\$11,676
10.	NASA , Electrically Tunable Liquid Crystal Integrated Metasurface based Attitude Control Devices to Enable Future Solar Sail Mission (incoming)	Co-PI	10/01/2021 – 09/30/2022	\$65,185	\$19,556
11.	NASA SBIR , Sail Trimming Actuator for Targeted Reentry (STARTR) – Rocco	Collaborator UA-PI	09/16/2019 – 02/18/2020	\$150,000	\$25,000
Total				\$1,252,106	\$955,355

*Dr. Sood assisted the Solar Cruiser team (led by PI Les Johnson of NASA MSFC, Huntsville AL.) with the proposal. The Solar Cruiser investigation is budgeted for \$65 million.

Under Review/Pending Submission

- **(PI) CAREER: Autonomous Scientific Study of Near-Earth Asteroids and Deep Space Exploration**, *NSF CAREER Proposal*, 07/01/2022 – 06/30/2027. (to be submitted on 07/26/2021)
- **(PI) HARVEST: High-energy AeRospace Vehicle Sustainable Transport**, *NASA Innovative Advanced Concept (NIAC), Phase 1, Step A*, 06/16/2022 – 03/15/2023. (submitted)

Publications and Presentations:

Underline indicates students advised by me.

Peer Reviewed Journals

- [18] Elkins, J., Sood, R., and Rumpf, C., “Bridging Reinforcement Learning and Online Learning for Spacecraft Attitude Control,” *Journal of Aerospace Information Systems*, 2021 (under review).
- [17] Rubinsztein, A., Sood, R., and Laipert, F., “Missed Thrust Resilient Trajectory Design Applied to the Earth Return Orbiter,” *Acta Astronautica*, 2021 (under review).
- [16] Rubinsztein, A., Sandel, C. G., Sood, R., and Laipert, F., “Designing Trajectories Resilient to Missed Thrust Events Using Expected Thrust Fraction,” *Aerospace Science and Technology*, vol. 115, Aug. 2021. DOI: 10.1016/j.ast.2021.106780
- [15] Pezent, J., Sood, R., Heaton, A., Miller, K., and Johnson, L., “Preliminary Trajectory Design for NASA’s Solar Cruiser: A Technology Demonstration Mission,” *Acta Astronautica*, vol. 183, pp. 134-140, June 2021. DOI: 10.1016/j.actaastro.2021.03.006
- [14] Ledbetter, W.G., Sood, R., Keane, J.T., and Stuart, J., “SmallSat swarm gravimetry: Revealing the interior structure of asteroids and comets,” *Astrodynamics*, Feb. 2021. DOI: 10.1007/s42064-020-0098-1
- [13] Song, P., Gogineni, S.P., Galkin, I.A., Volakis, J.L., Soderblom, J.M., Hayes, A.G., Reinisch, B.W., Giles, R.H., Sood, R., Zhang, H., Braaten, D., Melosh, H.J., Bruzzone, L., Venkatakrishnan, S.B., Yan, S.J., and O’Neill, C., “Feasibility Study of a High-Resolution Shallow Surface Penetration Radar for Space Application,” *Radio Science*, vol. 56, issue 2, Feb. 2021. DOI: 10.1029/2020RS007118
- [12] Pezent, J.B., Sood, R., and Heaton, A., “Configuration Space and Stability Analysis of Solar Sail Near-Vertical Earth-Trailing Orbits,” *Advances in Space Research, Special Issue: Solar Sailing Advances*, vol. 67, issue 9, pp. 2981-2994, Oct. 2020. DOI: 10.1016/j.asr.2020.10.011
- [11] Pezent, J.B., Sood, R., and Heaton, A., “Innovative Solar Sail Earth-Trailing Trajectories Enabling Sustainable Heliophysics Missions,” *The Journal of the Astronautical Sciences*, vol. 67(4) pp.1249-1270, June 2020. DOI: 10.1007/s40295-020-00214-3
- [10] Rubinsztein, A., Sood, R., and Laipert, F., “Neural Network Optimal Control in Astrodynamics: Application to the Missed Thrust Problem,” *Acta Astronautica*, vol. 176, pp. 192-203, Nov. 2020. DOI: 10.1016/j.actaastro.2020.05.027
- [9] Pezent, J.B., Sood, R., and Heaton, A., “Contingency Target Assessment, Trajectory Design, and Analysis for NASA’s NEA Scout Solar Sail Mission,” *Advances in Space Research, Special Issue: Solar Sailing Advances*, vol. 67, issue 9, pp. 2890-2898, Feb. 2020. DOI: 10.1016/j.asr.2020.02.004
- [8] Pezent, J.B., Sood, R., and Heaton, A., “High-Fidelity Contingency Trajectory Design and Analysis for NASA’s Near-Earth Asteroid (NEA) Scout Solar Sail Mission,” *Acta Astronautica*, vol. 159, pp. 385-396, June 2019. DOI: 10.1016/j.actaastro.2019.03.050
- [7] Sood, R., and Howell, K., “Solar Sail Transfers and Trajectory Design to Sun-Earth L_4 , L_5 : Solar Observations and Potential Earth Trojan Exploration,” *The Journal of the Astronautical Sciences*, vol. 66, pp. 247-281, Feb. 2019. DOI: 10.1007/s40295-018-00141-4
- [6] Guzzetti, D., Sood, R., Chappaz, L., and Baoyin, H., “Stationkeeping Analysis for Solar Sailing the L_4 Region of Binary Asteroid Systems,” *Journal of Guidance, Control, and Dynamics*, pp. 1–13, Jan. 2019. DOI: 10.2514/1.g003994
- [5] Ullery, D.C., Soleymani, S., Heaton, A., Orphee, J., Johnson, L., Sood, R., Kung, P., and Kim, S.M., “Strong Solar Radiation Forces from Anomalous Reflecting Metasurfaces for Solar Sail Attitude Control,” *Nature, Scientific Reports*, vol. 8, no. 1, July 2018. DOI: 10.1038/s41598-018-28133-2
- [4] Kaku T., Haruyama J., Miyake W., Kumamoto A., Ishiyama K., Nishibori T., Yamamoto K., Crites S. T., Michikami T., Yokota Y., Sood, R., Melosh, H. J., Chappaz L., and Howell K. C., “Detection of Intact Lava Tubes at Marius Hills on the Moon by SELENE (Kaguya) Lunar Radar Sounder,” *Geophysical Research Letters*, vol. 44, no. 20, pp. 10,155–10,161, Oct. 2017. DOI: 10.1002/2017gl074998
- [3] Sood, R., Chappaz, L., Melosh, H.J., Howell, K.C., Milbury, C., Blair, D.M., and Zuber, M.T., “*Detection and characterization of buried lunar craters with GRAIL data*,” *Icarus*, vol. 289, pp. 157–172, June 2017. DOI: 10.1016/j.icarus.2017.02.013

-
- [2] Chappaz, L., **Sood, R.**, Melosh, H.J., Howell, K.C., Blair, D.M., Milbury, C., and Zuber, M.T., “Evidence of large empty lava tubes on the Moon using GRAIL gravity,” *Geophysical Research Letters*, vol. 44, no. 1, pp. 105–112, Jan. 2017. DOI: 10.1002/2016gl071588
- [1] Blair, D.M., Chappaz, L., **Sood, R.**, Milbury, C., Bobet, A., Melosh, H.J., Howell, K.C., and Freed, A.M., “The structural stability of lunar lava tubes,” *Icarus*, vol. 282, pp. 47–55, Jan. 2017. DOI: 10.1007/978-3-319-05546-6_52-1

Conference Publications and Presentations

- [35] Rubinsztein, A., **Sood, R.**, and Laipert, F., “Chaining Moon-to-Moon Trajectories Using Network Analysis,” *32nd AIAA/AAS Space Flight Mechanics Meeting (2022 AIAA SciTech Forum)*, San Diego, CA, Jan. 2022 (submitted).
- [34] Pezent, J.B., Sikes, J.D., Ledbetter, W.G., **Sood, R.**, Howell, K.C., and Stuart, J., “ASSET: Astrodynamics Software and Science Enabling Toolkit,” *32nd AIAA/AAS Space Flight Mechanics Meeting (2022 AIAA SciTech Forum)*, San Diego, CA, Jan. 2022 (submitted).
- [33] Rubinsztein, A., Sandel, C.G., Pezent, J.B., **Sood, R.**, Laipert, F., Heaton, A., and Johnson, L., “Design of Solar Sailing Trajectories Resilient to Safe Mode Events,” *2021 AAS/AIAA Astrodynamics Specialist Conference*, 21-621, Big Sky, MT, Aug. 2021 (accepted).
- [32] Gogineni, S.P., Yan, S., Song, P., Volakis, J.L., Deshpande M., Galkin, I.A., Soderblom, J.M., Hayes, A.G., Reinisch, B.W., Giles, R.H., **Sood, R.**, Zhang, H., Braaten, D., Bruzzone, L., Venkatakrishnan, S.B., Yan, S.J., Taylor, D., “UWB MIMO Radars for Sounding and Imaging of Ice on the Earth and Other Celestial Bodies,” *IEEE International Geoscience and Remote Sensing Symposium*, 4467, Brussels, July 2021.
- [31] Rubinsztein, A., **Sood, R.**, and Laipert, F., “Measuring Resilience of Autonomous Controllers to Spacecraft Missed Thrust Events,” *ESA GNC*, June 2021.
- [30] Rubinsztein, A., **Sood, R.**, and Laipert, F., “Expected Thrust Fraction: Resilient Trajectory Design Applied to the Earth Return Orbiter,” *AAS Space Flight Mechanics*, 21-232, Feb. 2021.
- [29] Elkins, J.G., **Sood, R.**, and Rumpf, C., “Autonomous Spacecraft Attitude Control Using Deep Reinforcement Learning,” *IAC 2020 CyberSpace Edition*, IAC–20–C1.9.8, Oct. 2020.
- [28] Pezent, J., **Sood, R.**, Heaton, A., Miller, K., Johnson, L., “Preliminary Trajectory Design for NASA’s Solar Cruiser: A Technology Demonstration Mission,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-653, Lake Tahoe, CA, Aug. 2020.
- [27] Elkins, J., **Sood, R.**, and Rumpf, C., “Adaptive Continuous Control of Spacecraft Attitude Using Deep Reinforcement Learning,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-475, Lake Tahoe, CA, Aug. 2020.
- [26] Rubinsztein, A., Sandel, C.G., **Sood, R.**, and Laipert, F., “Designing Trajectories Resilient to Missed Thrust Events Using Expected Thrust Fraction,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-452, Lake Tahoe, CA, Aug. 2020.
- [25] Schoenwetter, L., **Sood, R.**, and Barbee, B., “Optimal Intercept of Evasive Spacecraft,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-540, Lake Tahoe, CA, Aug. 2020.
- [24] Rubinsztein, A., Bryan, K., **Sood, R.**, and Laipert, F., “Using Reinforcement Learning to Design Missed Thrust Resilient Trajectories,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-453, Lake Tahoe, CA, Aug. 2020.
- [23] Sikes, J., **Sood, R.**, Medina, K., and Turse, D., “Keeping Low Earth Orbit Clean: Deorbit and Stability Analysis for an Articulating Boom Drag Sail,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-629, Lake Tahoe, CA, Aug. 2020.
- [22] Heaton, A. and **Sood, R.**, “Space Launch System Departure Trajectory Analysis for Cislunar and Deep-Space Exploration,” *2020 AAS/AIAA Astrodynamics Specialist Conference*, 20-604, Lake Tahoe, CA, Aug. 2020.
- [21] Rubinsztein, A., **Sood, R.**, and Laipert, F., “Neural Network Based Optimal Control: Resilience to Missed Thrust Events for Long Duration Transfers,” *2019 AAS/AIAA Astrodynamics Specialist Conference*, 19-773, Portland, ME, Aug. 2019.

-
- [20] Pezent, J.B., Sood, R., and Heaton, A., “Contingency Target Assessment, Trajectory Design and Analysis for NASA’s NEA Scout Solar Sail Mission,” *5th International Symposium on Solar Sailing*, 19050, Aachen, Germany, July 2019.
- [19] Pezent, J.B., Sood, R., and Heaton, A., “Solar Sail Enabled Near-Vertical Earth-Trailing Orbits,” *5th International Symposium on Solar Sailing*, 19049, Aachen, Germany, July 2019.
- [18] Kaku, T., Haruyama, J., Miyake, W., Kumamoto, A., Ishiyama, K., Nishibori, T., Iwata, T., Crites, S. T., Michikami, T., Yokota, Y., Ohno, T., **Sood, R.**, Melosh, H. J., Chappaz, L., and Howell, K. C., “Global Distribution of Possible Lava Tubes from Near-Surface to a Hundred Meter Depth on the Moon,” *Lunar and Planetary Science Conference*, vol. 50, no. 2205, Houston, TX, Mar. 2019.
- [17] Pezent, J., Heaton, A., and **Sood, R.**, “Innovative Solar Sail Earth-Trailing Trajectories Enabling Sustainable Heliophysics Missions,” *29th AAS/AIAA Space Flight Mechanics*, 18-541, Ka'anapali, Maui, HI, Jan. 2019.
- [16] Ledbetter, W.G., Sood, R., and Stuart, J., “Expected Accuracy of Density Recovery using Satellite Swarm Gravity Measurements,” *29th AAS/AIAA Space Flight Mechanics*, 18-529, Ka'anapali, Maui, HI, Jan. 2019.
- [15] Ledbetter, W.G., Sood, R., and Keane, J.T., “SmallSat Swarm Gravimetry: Revealing the Interior Structure of Asteroids and Comets,” *AAS/AIAA Astrodynamics Specialist Conference*, 18-225, Snowbird, UT, Aug. 2018.
- [14] Gogineni, P., Simpson, C. R., Yan, J., O'Neill, C. R., **Sood, R.**, Gurbuz, S. Z., Gurbuz, A. C., “A CubeSat Train for Radar Sounding and Imaging of Antarctic Ice Sheet,” *IGARSS 2018 - IEEE International Geoscience and Remote Sensing Symposium Conference*, Valencia, Spain, July 2018.
- [13] **Sood, R.**, Pezent, J., and Heaton, A., “NEA Scout-X: A Cost-Effective Mission Performing Flybys of Multiple Near-Earth Asteroids and Rendezvous,” *Lunar and Planetary Science Conference*, vol. 49, no. 2217, Houston, TX, Mar. 2018.
- [12] Ledbetter, W.G., Sood, R., and Keane, J.T., “The Interior Structure of Asteroids and Comets Revealed by ChipSat Swarm Gravimetry,” *Lunar and Planetary Science Conference*, vol. 49, no. 2136, Houston, TX, Mar. 2018.
- [11] Kaku T., Haruyama J., Miyake W., Kumamoto A., Ishiyama K., Nishibori T., Yamamoto K., Iwata, T., Crites, S. T., Michikami T., Yokota Y., **Sood, R.**, Melosh, H. J., Chappaz, L., Howell K. C., “Existence of a Lunar Lava Tube West of Rima Mairan Suggested by SELENE LRS,” *Lunar and Planetary Science Conference*, vol. 49, no. 1830, Houston, TX, Mar. 2018.
- [10] Pezent, J.B., Sood, R., and Heaton, A., “Near Earth Asteroid (NEA) Scout Solar Sail Contingency Trajectory Design and Analysis,” *2018 Space Flight Mechanics Meeting*, Orlando, FL, Jan. 2018. DOI: 10.2514/6.2018-0199
- [9] Haruyama J., Kaku T., Shinoda R., Miyake W., Kumamoto A., Ishiyama K., Nishibori T., Yamamoto K., Kurosawa K., Suzuki A.I., Crites S.T., Michikami T., Yokota Y., **Sood, R.**, Melosh, H. J., Chappaz L., Howell K. C., “Detection of Lunar Lava Tubes by Lunar Radar Sounder Onboard SELENE (Kaguya),” *Lunar and Planetary Science Conference*, vol. 48, no. 1711, Mar. 2017.
- [8] **Sood, R.**, Chappaz, L., Melosh, H.J., Howell, K.C. and Milbury, C., “Detection of Buried Empty Lunar Lava Tubes Using GRAIL Gravity Data,” *Lunar and Planetary Science Conference*, vol. 47, no. 1509, Houston, TX, Mar. 2016.
- [7] **Sood, R.**, and Howell, K., “L₄, L₅ Solar Sail Transfers and Trajectory Design: Solar Observations and Potential Earth Trojan Exploration,” *26th AAS/AIAA Space Flight Mechanics Meeting*, vol. 158, no. 16-467, Napa, CA, Feb. 2016.
- [6] **Sood, R.**, Melosh, H. J. and Howell, K., “Lunar advanced radar orbiter for subsurface sounding (LAROSS): lava tube exploration mission,” *26th AAS/AIAA Space Flight Mechanics Meeting*, vol. 158, no. 16-464, Napa, CA, Feb. 2016.
- [5] **Sood, R.**, Chappaz, L., Melosh, H.J., Howell, K.C., Blair, D.M. and Milbury, C., “Detection of Buried Empty Lunar Lava Tubes Using GRAIL Gravity Data,” *2nd Planetary Caves Conference*, no. 9016, Flagstaff, AZ, Oct. 2015.

Rohan Sood

Curriculum Vitae
(continued)

- [4] Blair, D.M., Chappaz, L., **Sood, R.**, Milbury, C., Bobet, A., Melosh, H.J., Howell, K.C. and Freed, A.M. “Modeling the Structural Stability of Lunar Lava Tubes,” *2nd Planetary Caves Conference*, no. 9014, Flagstaff, AZ, Oct. 2015.
- [3] **Sood, R.**, Chappaz, L., Milbury, C., Blair, D.M., Melosh, H.J. and Howell, K.C., “A Large, Previously Unknown Lunar Nearside Crater Revealed by GRAIL Gradiometry,” *Lunar and Planetary Science Conference*, vol. 46, no. 1883, Houston, TX, Mar. 2015.
- [2] Blair, D.M., Chappaz, L., **Sood, R.**, Milbury, C., Bobet, A., Melosh, H.J., Howell, K.C. and Freed, A.M., “Determining the structural stability of lunar lava tubes,” *Lunar and Planetary Science Conference*, vol. 46, no. 2174, Houston, TX, Mar. 2015.
- [1] Chappaz, L., **Sood, R.**, Melosh, H. and Howell, K., “Buried empty lava tube detection with GRAIL data,” *AAS/AIAA Astrodynamics Specialist Conference*, vol. 45, no. San Diego, CA, Aug. 2014.

Decadal Survey Bulletins

- [1] Keane, J., Ahern, A. A., Bagenal, F., Barr-Mlinar, A. C., Basu, K., Becerra, P., ... Sood, R., ..., and Williams, D. A. The Science Case for Io Exploration. *Bulletin of the American Astronautical Society*, 53(4), 178, Mar. 2021. DOI: 10.3847/25c2cfef.f844ca0e
- [2] Keane, J., Ahern, A. A., Bagenal, F., Barr-Mlinar, A. C., Basu, K., Becerra, P., ... Sood, R., ..., and Williams, D. A. Recommendations for Addressing Priority Science in the Next Decade. *Bulletin of the American Astronautical Society*, 53(4), 179, Mar. 2021. DOI: 10.3847/25c2cfef.3de45b59

Current and Former Research Students

6 PhD, 7 MS, 4 UG: *Names in bold indicates students graduated in 2020/2021.*

	Name	Degree/grad date	Awards and job/internship placement
1.	Ari Rubinsztein	PhD candidate, May 2022	Summer 2019 and 2020: NASA Jet Propulsion Lab 2021-22: Alabama Space Grant Consortium Fellow
2.	Brennan Blumenthal	PhD student	NASA Johnson Space Center
3.	James Pezent	PhD student	NSF GRFP and David A. Francko Fellow 2019-2024 Summer 2019: NASA Marshall Space Flight Center
4.	Jared Sikes	PhD student	National Alumni Association Fellow Summer 2020: The Aerospace Corporation
5.	Carrie Sandel	PhD student	NSF GRFP and UA Capstone Graduate Council Fellow 2021-2026; Summer 2021: Aerospace Corporation
6.	Aaron Houin	MS	NASA Marshall Space Flight Center
7.	Nate McCoun	MS	a.i. solutions
8.	Abram Aguilar	MS	a.i. solutions, NASA Goddard Space Flight Center
9.	Kyra Bryan	Junior	NASA Pathway Intern, Marshall Space Flight Center
10.	Alexandria Boehm	Junior	NASA Pathway Intern, Marshall Space Flight Center
11.	Will Lage	Junior	Defense Intelligence Agency Summer 2021
12.	Noah Jacobs	Sophomore	Wisk Autonomous Air Vehicles Summer 2021
13.	William Ledbetter	PhD, July 2021	2019-2021: Alabama Space Grant Consortium Fellow Summer 2020-21: Sandia National Laboratories
14.	Luke Schoenwetter	MS, July 2021	2019, 2020, 2021 intern, and hired by a.i. solutions
15.	Andrew Sweeten	MS, May 2021	United States Air Force to United States Space Force
16.	Jake Elkins	MS, May 2021	2019 intern at Lockheed Martin; Summer 2020: United States Navy; NDSEG Fellow
17.	Russell Solomon	MS, May 2020	United States Navy

Honors and Awards

- **Estus H. and Vashti L. Magoon Award** for excellence in teaching by School of Aeronautics and Astronautics, Purdue University **Aug 2010 – May 2011**
- **Senior Scholar Award** for excellence in engineering by School of Engineering & Applied Sciences, SUNY Buffalo **Jan 2009 – May 2009**
- **Gustav and Greta Zimmer Research Scholar Award** for continuing work in the field of dynamics and control, SUNY Buffalo **Aug 2008 – Dec 2008**
- **Gustav and Greta Zimmer Special Project Scholarship Award** for research on flight dynamics & control of UAVs, SUNY Buffalo **Jan 2007 – Jan 2009**
- **Gustav and Greta Zimmer Summer Scholar Award** for research in vibration measurements, SUNY Buffalo **May 2006 – Jul 2006**
- **Chuang Family Scholarship** based on academic merit by School of Engineering & Applied Sciences, SUNY Buffalo **Jan 2006 – May 2006**

Invited Speaker

- [7] **Sood, R.**, “Spacecraft Trajectory Design Leveraging Natural Dynamics for Space Exploration: Intertwining Engineering and Science,” *Princeton University*, Princeton, NJ, Mar. 2021.
- [6] **Sood, R.**, “Cost-Effective Spacecraft Trajectory Design Leveraging Natural Multi-Body Dynamics,” *University of California*, Davis, CA, Dec. 2019.
- [5] **Sood, R.**, “Collaboration Initiative for Upcoming NASA Missions and Spacecraft Trajectory Design,” *NASA Marshall Space Flight Center*, Huntsville, AL, Mar. 2019.
- [4] **Sood, R.**, “Road Towards Space Exploration,” *Samuel Ginn College of Engineering, Department of Aerospace*, Auburn University, Auburn, AL, Apr. 2018.
- [3] **Sood, R.**, “Astrodynamics and Space Research Laboratory: Exploring the Unknown,” *Industrial Advisory Board, Aerospace Engineering and Mechanics, The University of Alabama*, Tuscaloosa, AL, Apr. 2018.
- [2] **Sood, R.**, “UA and NASA JPL: Visualization Collaboration and Software Acquisition,” *The Jet Propulsion Laboratory*, Pasadena, CA, Oct. 2017.
- [1] **Sood, R.**, “Industry/Academia Collaboration: Virtual Reality for Spacecraft Trajectory Design,” *AstroLabs.Space*, Pasadena, CA, July 2017.

Teaching Experience

- **Assistant Professor:** Dynamics, Advanced Astrodynamics, Celestial Mechanics, Spacecraft Attitude D&C, University of Alabama **Feb 2017 – Present**
- **Substitute Instructor:** Spacecraft Attitude Dynamics, Dynamics and Vibrations, and Orbital Mechanics for Professor Kathleen C. Howell, Purdue University **Jan 2010 – May 2015**
- **Instructor:** Spacecraft Modeling and Simulation utilizing Trick and Avizo® Visualization software, Purdue University **Aug 2012 – May 2013**
- **Minority Engineering Program:** Teach, engage, and educate underrepresented students critical engineering skills, Purdue University **Summer 2011**
- **Teaching Assistant:**
 - Honors: Creativity and Innovation in Engineering, Purdue University **Aug 2011 – Dec 2011**
 - Dynamics and Vibrations, Orbital Mechanics, Purdue University **Aug 2009 – May 2011**
 - Statics, Université de Technologie de Troyes, France **Summer 2009**

Recent Courses Taught at UA

C: Cross-listed graduate and undergraduate course; G: Graduate course; U: undergraduate course

- **AEM 264 Dynamics (U):** undergraduate service course for the College of Engineering
- **AEM 425/525 Spacecraft Dynamics and Control (C):** new course developed at UA
- **AEM 469/569 Orbital Mechanics (C):** new material based on industry and academia standards
- **AEM 669 Advanced Astrodynamics (G):** new course developed at UA
- **AEM 491 Artificial Intelligence in Astrodynamics (U):** special course developed at UA
- **AEM 591 Advances in Astrodynamics (G):** special course developed at UA
- **AEM 491/591 Astrodynamics & Space Application (C):** special course developed at UA

Student Opinion of Instruction

Course (all courses are 3 credits)	Term	Enrollment and (level*)	Dr. Sood's Rating*	COE Mean*	AEM Mean*
AEM 425/525 Spacecraft Dynamics & Control	Spring 21	17 (C)	4.50	4.07	3.93
AEM 525-920 Spacecraft Dynamics & Control	Spring 21	8 (G)	4.67	4.07	3.93
AEM 264 Dynamics (service course)	Spring 21	93 (U)	3.91	4.07	3.93
AEM 469/569 Orbital Mechanics	Spring 20	18 (C)	3.88	4.17	3.95
AEM 569-920 Orbital Mechanics	Spring 20	6 (G)	4.33	4.17	3.95
AEM 264 Dynamics (service course)	Spring 20	73 (U)	3.81	4.17	3.95
AEM 591 004 Advances in Astrodynamics	Spring 20	5 (G)	5.00	4.17	3.95
AEM 591 924 Advances in Astrodynamics	Spring 20	2 (G)	--		
AEM 491 005 AI in Astrodynamics	Spring 20	1 (U)	--		
AEM 264 Dynamics (service course)	Fall 19	72 (U)	3.93	4.07	3.81
AEM 591 002 Astrodynamics and Space App.	Fall 19	6 (G)	4.83	4.07	3.81
AEM 591 920 Astrodynamics and Space App.	Fall 19	3 (G)	--		
AEM 264 Dynamics (service course)	Spring 19	96 (U)	3.62	4.02	3.95
AEM 491 005 Astrodynamics: Mission Design	Spring 19	4 (U)	--		
AEM 591(669) 002 Advanced Astrodynamics	Fall 18	4 (G)	--		
AEM 591(669) 920 Advanced Astrodynamics	Fall 18	3 (G)	--		
AEM 469/569 Orbital Mechanics	Spring 18	15 (C)	4.50	4.06	3.94
AEM 569-999 Orbital Mechanics	Spring 18	10 (G)	3.80	4.06	3.94
AEM 492 002 Astrodynamics and Space App.	Spring 18	1 (U)	--		
AEM 591-001Spacecraft Attitude Dynamics	Fall 17	7 (G)	4.00	4.10	4.08
AEM 591-999 Spacecraft Attitude Dynamics	Fall 17	4 (G)	--		
AEM 264 Dynamics (service course)	Spring 17	16 (U)	4.85	4.13	4.16

*Dr. Sood's Rating, College of Engineering Mean, and AEM Department Mean scores are on a scale of 0-5.

-- No survey due to small class size

Student Comments on Courses Taught:

Spring 2021:

- **AEM 425/525:** Dr. Sood combined theory and practice very well. I learned a lot in the course due to its structure. In class, we covered the analytical theory, with the homework expanding that work by requiring coding and application to realistic problems.
- **AEM 525-920:** Dr. Sood was the most thorough professor I've ever had at UA. He takes the time to explain the basics very well and then challenges his students to work on harder/real world problems. The course was very challenging but is great preparation for the industry.
- **AEM 264:** Extremely well prepared, had put together lectures, was attentive to student questions, understands how to take students through problems so they learn. Very effective teacher; even if I was confused at first, I always ended up understanding the concepts as long as I attended the full lecture.

Spring 2020:

- AEM 469/569: Dr. Sood was polite, knowledgeable, had examples, had great notes, had an excellent flow of the notes and no gaps in information. The class was well-paced but not too slow. Dr. Sood could answer every question. A great job was done.
- AEM 569-920: Professor Sood is a well prepared and structured course instructor. I feel that he handled the Covid situation as well as he possibly could have, and that resulted in no gaps of information in the course, despite the modification of the final and cancellation of the last midterm. Homework could not be more perfect in terms of length, difficulty and relevance to what's been covered in class.
- AEM 264: Dr. Sood was phenomenal! He had an enthusiasm and joy for teaching that really showed itself, and it made his class a pleasure to be in. He really effectively conveys material, and he kept us learning without overwhelming us with busy-work. The only issue is that he sometimes flicks through slides a bit too fast in class, but he always would go back if we asked. His transition to online teaching was absolutely seamless, and he was by far the best professor I had during this change. Thank you Dr. Sood!

Fall 2019:

- AEM 591: Dr. Sood does a great job managing his research group and offers good, timely feedback while letting the students learn/solve problems for themselves.
- AEM 264: Professor Sood was great. He was always very energetic and kept the class engaged. He worked through problems with us and really tied them in to real world examples to help us understand the application of the topics we were learning.
- AEM 264: Professor Sood is extremely professional and respectful. He or the TA is always willing to help students if they cannot attend the office hours and he explains concepts very well with lots of examples.

Spring 2019:

- AEM 264: Very effective communicator and fantastic at simplifying complicated topics. Enjoyed having Dr. Sood as a professor.
- AEM 264: Professor Sood is the most passionate professor I've had at UA. I have never had anyone who is this concerned about whether or not the class understands the material.
- AEM 264: Dr. Sood covers all material extremely well and gives very clear expectations for the exams. He explains all problems in detail, allowing students to learn all concepts in detail.

Spring 2018:

- AEM 469/569: Very helpful and clearly puts a lot of time into developing homework and tests to maximize student learning outcomes. Loved this course and professor.
- AEM 468/569: This course was a wonderful learning opportunity and needs to be taught more frequently due to its highly applicable material. The lessons, material, and STK learned in the course will directly apply to my career, and I wish more courses taught as much real world material as this course.

Spring 2017:

- AEM 264: One of the best teachers I have ever had, explains hard concepts very well.
- AEM 264: Dr. Sood is probably the best professor this university has hired for the engineering department. He makes the class relevant and gets you excited to really grasp and understand the concepts that he teaches. Not only that but as an Aerospace student it's exciting to see more Aerospace come into the department. The university needs more professors like Dr. Sood in order to really produce great engineers.
- AEM 264: Dr. Sood was an amazing communicator. He was able to explain things very well and if someone didn't understand he would take the time to make sure they got it before moving on. I look forward to working with him down the road.

Service

- **University, College, and Department Service**
 - Graduate student recruitment
 - Trip to India to assist the UA Graduate School recruit talented engineering students
 - Assist department of Aerospace Engineering and Mechanics recruit MS and PhD students
 - Aerospace Engineering and Mechanics seminar organizer 2017-2018
 - Promote STEM education: actively recruit and mentor academically talented students from underrepresented and marginalized groups
 - Establish research collaborations between the Astrodynamics and Space Research Laboratory and:
 - NASA Marshall Space Flight Center
 - NASA Jet Propulsion Laboratory
 - NASA Goddard Space Flight Center
 - NASA Ames Research Center
 - Continuum Space Systems
 - Rocco
 - Volunteer assistant diving coach for the University of Alabama Swimming and Diving Team
- **Service to the Profession**
 - Invited international reviewer for the Dutch Research Council: Innovative Research Incentive Scheme of Science Domain
 - Invited reviewer for selected journals:
 - The Journal of the Astronautical Sciences
 - Journal of Spacecraft and Rockets
 - Acta Astronautica
 - Aerospace Science and Technology
 - Advances in Space Research
 - Celestial Mechanics and Dynamical Astronomy
 - Journal of Optimization Theory and Applications
 - Conference session chair/co-chair and paper reviewer:
 - 2021 AAS/AIAA Astrodynamics Specialist Conference, Virtual, August 8-12, 2021, Session(s): TBD
 - 31st AAS/AIAA Space Flight Mechanics Meeting, Virtual, February 1-3, 2021, Sessions: Interplanetary Trajectories; Trajectory Design III
 - AAS/AIAA Astrodynamics Specialist Conference, Virtual, August 9-13, 2020, Session: Trajectory Design and Optimization IV
 - 30th AIAA/AAS Space Flight Mechanics Meeting/AIAA SciTech, Orlando, FL, January 6-10, 2020, Sessions: Asteroid and Non-Earth Orbiting Missions II; Low-Thrust Trajectory Design and Optimization II
 - AAS/AIAA Astrodynamics Specialist Conference, Portland, ME, August 11-15, 2019, Session: Trajectory Design & Optimization VI
 - 29th AAS/AIAA Space Flight Mechanics Meeting, Ka'anapali, Maui, HI, January 13-17, 2019, Session: Astrodynamics
 - AAS/AIAA Astrodynamics Specialist Conference, Snowbird, UT, August 19-23, 2018, Sessions: Astrodynamics-III; Space Situational Awareness-II
 - 28th AIAA/AAS Space Flight Mechanics Meeting/ AIAA SciTech, Kissimmee, FL, January 8-12, 2018, Session: Space Trajectory Design and Optimization II

Certification and Membership

- **Certification**
 - Private pilot: single engine land airplane
- **Membership**
 - Senior Member: American Institute of Aeronautics and Astronautics (AIAA)
 - Astrodynamics Technical Committee: American Institute of Aeronautics and Astronautics (AIAA)
 - Member: American Astronautical Society (AAS)

Selected Media Appearances

- [16] “The solar wind bubble that protects Earth has been mapped for the first time.” July 7, 2021. *MIT Technology Review*. <https://www.technologyreview.com/2021/07/07/1027914/ibex-mapped-boundary-earth-heliosphere/>
- [15] “A Message from the President.” Feb. 18, 2021. *Office of the President, The University of Alabama*. <https://president.ua.edu/news/a-message-from-the-president-february-18-2021/>
- [14] “NASA Mission to Include Contributions from UA Engineering.” Feb. 1, 2021. *News Center, The University of Alabama*. <https://news.ua.edu/2021/02/nasa-mission-to-include-contributions-from-ua-engineering/>
- [13] “University of Alabama satellite team offering virtual space lessons.” Apr. 19, 2020. *Alabama News Center*. <https://www.alabamaneewscenter.com/2020/04/19/university-of-alabama-satellite-team-offering-virtual-space-lessons/>
- [12] “Randall Outstanding Undergrad Research Awards Recognize Innovation.” Aug. 8, 2019. *News Center, The University of Alabama*. <https://news.ua.edu/2019/08/randall-outstanding-undergrad-research-awards-recognize-innovation/>
- [11] “UA Recognizes Undergrad Randall Research Award Winners.” Apr. 25, 2018. *News Center, The University of Alabama*. <https://news.ua.edu/2018/04/ua-recognizes-undergrad-randall-research-award-winners/>
- [10] “Purdue professor says lunar lava tubes are key for human habitation.” Jan. 18, 2018. *The Purdue Exponent*. https://www.purdueexponent.org/city/article_d2a23ee9-b9f2-59fb-860d-a93635951abc.html
- [9] “Detection of intact lunar lava tubes in the data from SELENE (Kaguya) radar sounding.” Oct. 18, 2017. *JAXA: Japan Aerospace Exploration Agency*. <http://www.isas.jaxa.jp/en/topics/001159.html>
- [8] “UA Researcher on Team Exploring Potential Lunar Habitats for Humans.” Oct. 18, 2017. *News Center, The University of Alabama*. <https://news.ua.edu/2017/10/ua-researcher-on-team-exploring-potential-lunar-habitats-for-humans/>
- [7] “Lunar shelter: Moon caves could protect astronauts.” May 9, 2016. *Fox News: Science*. <https://www.foxnews.com/science/lunar-shelter-moon-caves-could-protect-astronauts>
- [6] “This strange hole in the moon might become an entrance to a future space colony.” Apr. 6, 2016. *Business Insider*. <https://www.businessinsider.com/lunar-lava-tubes-space-habitats-2016-4>
- [5] “Future Moon Bases Might Be Built in Underground Lava Tubes.” Mar. 29, 2016. *Smithsonian*. <https://www.smithsonianmag.com/smart-news/future-moon-bases-might-be-built-underground-lava-tubes-180958590/>
- [4] “Scientists May Have Spotted Buried Lava Tubes on the Moon.” Mar. 25, 2016. *National Geographic*. <https://www.nationalgeographic.com/science/article/scientists-may-have-spotted-buried-lava-tubes-on-the-moon>
- [3] “Earhart, Hiding in Plain Sight.” Mar. 18, 2015. *National Geographic*. <https://blog.education.nationalgeographic.org/2015/03/18/earhart-hiding-in-plain-sight/>
- [2] “New lunar crater named after aviation pioneer Earhart.” Mar. 17, 2015. *BBC News*. <https://www.bbc.com/news/science-environment-31917302>
- [1] “Purdue team puts Earhart on the moon with discovery of new crater.” Mar. 16, 2005. *Purdue University News*. <https://www.purdue.edu/newsroom/releases/2015/Q1/purdue-team-puts-earhart-on-the-moon-with-discovery-of-new-crater.html>
-

Hobbies and Extracurricular Activities

- Pianist and music composition
- Oil painting
- Swimming and competitive diving