Kathryn Volk

kvolk@psi.edu katvolk.com

Education

Ph.D. Planetary Sciences, The University of Arizona, 2013
B.S. Physics, Russian Area Studies, Wittenberg University, 2006 *Summa Cum Laude*.

Positions Held

Senior Scientist, Planetary Science Institute **2022–present**

Staff Scientist, University of Arizona 2018–2024

Postdoctoral Research Associate, University of Arizona 2015–2018
Supervisor: Renu Malhotra

Postdoctoral Research Fellow, University of British Columbia 2013–2015
Supervisor: Brett Gladman

Graduate Research Associate, University of Arizona 2006–2013
Advisor: Renu Malhotra
Dissertation: Dynamical Studies of the Kuiper Belt and the Centaurs

Professional Leadership

- Co-Editor of "Centaurs" an IOP review book (published 2025)
- SOC Chair for the Division for Planetary Sciences (DPS) Meeting (2024)
- Member of the LSST Survey Cadence Optimization Committee (2023-present)
- Active member of the LSST Solar System Science Collaboration (2018-present)
- American Astronomical Society (AAS) Task Force on Green Astronomy member (2022-2023)
- Past Chair of the AAS Division on Dynamical Astronomy (DDA) (2021-2022)
- Chair of the DDA (2020-2021)
- DDA Meeting Scientific/Virtual Organizing Committee Member (2021)
- Chair of the DDA Meeting Scientific/Virtual Organizing Committee (2020)
- AAS Strategic Assembly Member (2020-2021)
- Vice-Chair of the DDA (2019-2020)
- DDA committee member (2017-2019)
- DPS Meeting SOC member (2017)

Selected Honors & Awards

2022 Vera Rubin Early Career Prize, AAS Division on Dynamical Astronomy
2021 Art of Planetary Science 2nd place award for data art
2013 College of Science Outstanding Scholarship Award, University of Arizona
2013 Gerard P. Kuiper Memorial Award, University of Arizona
2011, 2009 Galileo Circle Scholar, University of Arizona
2010 Department of Planetary Sciences Service Award, University of Arizona
2007 College of Science Graduate Teaching Assistant Award, University of Arizona
2006 Department of Planetary Sciences Graduate Teaching Award, University of Arizona

2006 Departmental Honors in Physics, Wittenberg University
2006 Award for Excellence in the Russian Studies Program, Wittenberg University

Grants and Fellowships

PI, Tools for Advanced Dynamical Characterization of Solar System Small Bodies, NASA Planetary Data Archiving, Restoration, and Tools (2022-2025)

Co-I, The Classical and Large-a Distant Solar System Survey: the Importance of Outer Resonances in Constraining Solar System History, NASA Solar System Observations (2023-2026; PI R. Pike)

Co-I, Investigating Centaur surface colors: connecting surface transformation to thermal and dynamical history, NASA Solar System Observations (2023-2026; PI E. Lilly)

PI, Constraining Neptune's migration using the surface properties of resonant trans-Neptunian objects, NASA Emerging Worlds (2021-2024)

PI, Dynamics of sticky resonances and detached Kuiper belt objects, NASA Solar System Workings (2019-2023)

PI, Dynamical Characterization of Solar System Small Bodies, Preparing for Astrophysics with LSST Kickstarter grant (2021-2022)

Co-I, Distribution of planet masses, planet-planet separations and dynamical lifetimes of planetary systems, NASA Exoplanet Research Program (2018-2021, PI: R. Malhotra)

Co-I, Kuiper Belt Dynamics with a Distant Unseen Planet, NSF (2018-2021, PI: R. Malhotra)

Co-I/Science PI, Current dynamics of Neptune's distant mean motion resonances, NASA Solar System Workings (2015-2019, PI: R. Murray-Clay)

Canadian Institute for Theoretical Astrophysics National Fellow (2013-2015)

Spacecraft Mission Proposal Involvement

Co-I, Chimera: Orbital Exploration of 29P/Schwassmann-Wachmann as a Gateway to the Centaurs and the Secrets of Small Body Formation (proposed in response to the 2019 NASA Discovery Mission Announcement of Opportunity, PI Walt Harris, University of Arizona – not selected)

Review Articles/Book Chapters

- **Volk**, Womack, & Steckloff (2025) Introduction, chapter in IOP Ebook "Centaurs", edited by K. Volk, M. Womack, & J. Steckloff 10.1088/2514-3433/ada267ch1
- Womack, **Volk**, & Steckloff (2025). Highlights and the Next Ten Years for Centaur Research, chapter in IOP Ebook "Centaurs", edited by K. Volk, M. Womack, & J. Steckloff 10.1088/2514-3433/ada267ch17
- Johansen et al. (2025). Formation of Planetesimals in the Outer Solar System, chapter in IOP Ebook "Centaurs", edited by K. Volk, M. Womack, & J. Steckloff 10.1088/2514-3433/ada267ch2

- **Volk** & Malhotra (2025). Machine Learning Assisted Dynamical Classification of Trans-Neptunian Objects, chapter for Elsevier book "Machine Learning for Small Solar System Bodies, edited by V. Carruba, E. Smirnov, and D. Oszkiewicz, B978-0-44-324770-5.00012-X, arXiv.2405.05185
- Kaib & **Volk** (2024). Dynamical Population of Comet Reservoirs, chapter for Comets III, edited by K. Meech et al., jj.21819446.10, arXiv.2206.00010
- Fraser, Dones, **Volk**, Womack & Nesvorný, (2024). The Transition From The Kuiper Belt To The Jupiter-Family Comets, chapter for Comets III, edited by K. Meech et al., jj.21819446.11, arXiv.2210.16354
- Gladman & **Volk** (2021). Transneptunian Space, Annual Reviews of Astronomy & Astrophysics, 10.1146/annurev-astro-120920-010005

Journal Articles

- Buchanan et al., Col-OSSOS: Investigating the Origins of Different Surfaces in the Primordial Kuiper Belt, submitted to PSJ
- Murtagh et al. (2025), Predictions of the LSST Solar System Yield: Discovery Rates and Characterizations of Centaurs, AJ in press
- Pike, Murray-Clay, **Volk**, et al. (2025), L*i*DO: Discovery of a 10:1 Resonator with a Novel Libration State, PSJ in press
- Hermosillo Ruiz, Murray-Clay, **Volk**, & Pike (2025), Forcing Planets to Evolve: The Relationship Between Uranus and Neptune at Late Stages of Dynamical Evolution, ApJ, 10.3847/1538-4357/add6a1
- Cambioni et al. (2025), Can metal-rich worlds form by giant impacts?, A&A, 10.1051/0004-6361/202450128
- Graham & **Volk** (2024), Uranus's influence on Neptune's exterior mean motion resonances, PSJ, 10.3847/PSJ/ad4707
- Kareta, Noonan, **Volk**, Strauss, & Trilling (2024), Jupiter Co-Orbital Comet P/2023 V6 (PANSTARRS): Orbital History and Modern Activity State, ApJ Letters, 10.3847/2041-8213/ad3dea
- **Volk** & Malhotra (2024), Differences between Stable and Unstable Architectures of Compact Planetary Systems, AJ, 10.3847/1538-3881/ad3de5
- **Volk** & Van Laerhoven (2024), Dynamical Classifications of Multi-opposition TNOs as of 2023 December, RNAAS, 10.3847/2515-5172/ad22d4
- Lilly et al. (2024), Semi-major Axis Jumps as the Activity Trigger in Centaurs and High-Perihelion Jupiter Family Comets, ApJ Letters, 10.3847/2041-8213/ad1606
- Noonan, **Volk**, Nesvorný, & Bottke (2024), Dynamical feasibility of (3) Juno as a parent body of the H chondrites, Icarus, 10.1016/j.icarus.2023.115838, arXiv.2310.18252
- Pike, Fraser, **Volk** et al. (2023), Col-OSSOS: The Distribution of Surface Types in Neptune's Resonances, PSJ, 10.3847/PSJ/ace2c2
- Marsset et al. (2023), Col-OSSOS: Evidence for a Compositional Gradient Inherited from the Protoplanetary Disk?, PSJ 10.3847/PSJ/ace7d0
- Balaji et al. (2023), Can the orbital distribution of Neptune's 3:2 mean motion resonance result from stability sculpting?, MNRAS, 10.1093/mnras/stad2026
- Beaudoin et al. (2023), OSSOS XXIX: The Population and Perihelion Distribution of the Detached Kuiper Belt, PSJ, 10.3847/PSJ/ace88d

- Petit et al. (2023), The hot main Kuiper belt size distribution from OSSOS, ApJ Letters, 10.3847/2041-8213/acc525
- Fraser et al. (2023), Col-OSSOS: The Two Types of Kuiper Belt Surfaces, PSJ, 10.3847/PSJ/acc844
- Schwamb, Jones, Yoachim, **Volk** et al. (2023), Tuning the Legacy Survey of Space and Time (LSST) Observing Strategy for Solar System Science, ApJS, 10.3847/1538-4365/acc173
- **Volk** & Malhotra (2022), Orbital dynamics landscape near the most distant known trans-Neptunian objects, ApJ, 10.3847/1538-4357/ac866b
- Lisse et al. (2022), 29P/Schwassmann-Wachmann: A Rosetta Stone for Amorphous Water Ice and CO to CO2 Conversion in Centaurs and Comets?, PSJ, 10.3847/PSJ/ac9468
- Abedin et al. (2022), OSSOS XXVI. On the Lack of Catastrophic Collisions in the Present Kuiper Belt, AJ, 10.3847/1538-3881/ac9cdb
- Crompvoets, Lawler, **Volk**, et al. (2022), OSSOS XXV: Large Populations and Likely Ongoing Scattering-Sticking in the Distant Transneptunian Resonances, PSJ, 10.3847/PSJ/ac67e0
- Huang, Gladman, & **Volk** (2022), Free inclinations for transneptunian objects in the main Kuiper Belt, ApJS, 10.3847/1538-4365/ac559a
- Buchanan et al. (2022), Col-OSSOS: Probing Ice Line/Colour Transitions within the Kuiper Belts Progenitor Populations, PSJ, 10.3847/PSJ/ac42c9
- Kavelaars et al. (2021), OSSOS finds an Exponential Cutoff in the Size Distribution of the Cold Classical Kuiper belt, ApJ Letters, 10.3847/2041-8213/ac2c72
- Alexandersen et al. (2021), OSSOS XXII: 2013 VZ70 and the Temporary Coorbitals of the Giant Planets, PSJ, 10.3847/PSJ/ac1c6b
- Fink, Harris, Doose, **Volk**, Woodney, Farnham, & Womack (2021), Dust outburst dynamics and hazard assessment for close spacecraft-comet encounters, PSJ, 10.3847/PSJ/ac09f0
- Fraser et al. (2021), Col-OSSOS: The Distinct Colour Distribution of Single and Binary Cold Classical KBOs, PSJ, 10.3847/PSJ/abf04a
- Hardegree-Ullman et al. (2021), K2-138 g: Spitzer Spots a Sixth Planet for the Citizen Science System, AJ, 10.3847/1538-3881/abeab0
- Abedin et al. (2021), Collision Probabilities in the Edgeworth-Kuiper belt, AJ, 10.3847/1538-3881/abe418
- Kareta et al. (2021), Contemporaneous Multi-Wavelength and Precovery Observations of Active Centaur P/2019 LD2 (ATLAS), PSJ, 10.3847/PSJ/abe23d
- Lin, Chen, **Volk**, et al. (2021), OSSOS: The Eccentricity and Inclination Distributions of the Stable Neptunian Trojans, Icarus, 10.1016/j.icarus.2021.114391, arXiv.2006.10674
- Steckloff, Sarid, **Volk**, et al. (2020), P/2019 LD2 (ATLAS): An Active Centaur in Imminent Transition to the Jupiter Family, ApJ Letters, 10.3847/2041-8213/abc888
- **Volk** & Malhotra (2020), Dynamical instabilities in systems of multiple short-period planets are likely driven by secular chaos: a case study of Kepler-102, AJ, 10.3847/1538-3881/aba0b0
- Smullen & **Volk** (2020), Machine Learning Classification of Kuiper Belt Populations, MNRAS, 10.1093/mnras/staa1935
- Kareta, **Volk**, et al. (2020), An Extremely Temporary Co-orbital: The Dynamical State of Active Centaur 2019 LD2, RNAAS, 10.3847/2515-5172/ab963c
- Nesvorný et al. (2020), OSSOS XX: The Meaning of Kuiper Belt Colors, AJ, 10.3847/1538-3881/ab98fb
- Ashton et al. (2020), OSSOS: XI. An upper limit on the number of distant planetary objects in the Solar System, Icarus, 10.1016/j.icarus.2020.113793

- Marsset et al. (2020), COL-OSSOS: Compositional homogeneity of three binaries found in the Outer Solar System Origins Survey, PSJ, 10.3847/PSJ/ab8cc0
- Kareta et al. (2020), Carbon Chain Depletion of 2I/Borisov, ApJ Letters, 10.3847/2041-8213/ab6a08
- Pike et al. (2020), OSSOS XVI: The missing small members of the Haumea family, Nature Astronomy, 10.1038/s41550-019-0867-z, arXiv.1908.10286
- Kareta et al. (2019), Physical Characterization of the December 2017 Outburst of the Centaur 174P/Echeclus, AJ, 10.3847/1538-3881/ab505f
- Chen, Gladman, **Volk**, et al. (2019), OSSOS XVIII: constraining migration models with the 2:1 resonance using the outer solar system origin survey, AJ, 10.3847/1538-3881/ab480b
- Sarid, **Volk**, Steckloff, Harris, Womack, & Woodney (2019), 29P/Schwassmann-Wachmann 1, A Centaur in the Gateway to the Jupiter-Family Comets, ApJ Letters, 10.3847/2041-8213/ab3fb3
- Alexandersen et al. (2019), OSSOS: XII. Variability studies of trans-Neptunian objects using the Hyper-Suprime Camera, ApJS, 10.3847/1538-4365/ab2fe4
- Nesvorný et al. (2019), OSSOS XIX: Testing Early Solar System Dynamical Models using OSSOS Centaur Detections, AJ, 10.3847/1538-3881/ab3651
- **Volk** & Malhotra (2019), Not a simple relationship between Neptune's migration speed and Kuiper belt inclination excitation, AJ, 10.3847/1538-3881/ab2639
- Van Laerhoven, Gladman, **Volk**, et al. (2019), OSSOS XIV : The Plane of the Kuiper Belt, AJ, 10.3847/1538-3881/ab24e1
- Schwamb et al. (2019), Col-OSSOS: the colours of the Outer Solar System Origin Survey, ApJS, 10.3847/1538-4365/ab2194
- Lawler et al. (2019), OSSOS: XIII. Fossilized resonant dropouts tentatively confirm Neptune's migration was grainy and slow, AJ, 10.3847/1538-3881/ab1c4c
- Marsset et al. (2019), Col-OSSOS: a distinct inclination distribution for each color seen in the dynamically excited trans-neptunian populations, AJ, 10.3847/1538-3881/aaf72e
- Cabral et al. (2019), OSSOS: XI. No active Centaurs in the Outer Solar System Origins Survey, A&A, 10.1051/0004-6361/201834021
- Schwamb et al. on behalf of the LSST Solar System Science Collaboration (2019), A Software Roadmap for Solar System Science with the Large Synoptic Survey Telescope, RNAAS, 10.3847/2515-5172/ab0e10
- Malhotra, Lan, **Volk**, & Wang (2018), Neptune's 5:2 Resonance in the Kuiper Belt, AJ, 10.3847/1538-3881/aac9c3
- Yu, Murray-Clay, & **Volk** (2018), Trans-Neptunian Objects Transiently Stuck in Neptune's Mean Motion Resonances: Numerical simulations of the current population, AJ, 10.3847/1538-3881/aac6cd
- **Volk** et al. (2018), OSSOS IX : two objects in Neptune's 9:1 resonance – implications for resonance sticking in the scattering population, AJ, 10.3847/1538-3881/aac268
- Lawler et al. (2018), OSSOS VIII – the transition between two size distribution slopes in the scattering disk, AJ, 10.3847/1538-3881/aab8ff
- Bannister, Gladman, Kavelaars, Petit, **Volk**, Chen, Alexandersen, Gwyn, & the OSSOS collaboration (2018), OSSOS: 800+ tans-Neptunian objects – the complete data release, ApJS, 10.3847/1538-4365/aab77a
- **Volk** & Malhotra (2017), The curiously warped mean plane of the Kuiper belt, AJ, 10.3847/1538-3881/aa79ff

- Pike et al. (2017), Col-OSSOS: z band photometry reveals three distinct TNO surface types, AJ, 10.3847/1538-3881/aa83b1
- Shankman et al. (2017), OSSOS VI. Striking biases in the detection of large semimajor axis trans-Neptunian objects, AJ, 10.3847/1538-3881/aa7aed
- Bannister, Shankman, **Volk**, et al. (2017), OSSOS: V. Diffusion in the orbit of a high-perihelion distant Solar System object. AJ, 10.3847/1538-3881/aa6db5
- Fraser et al. (2017), All planetesimals born near the Kuiper belt formed as binaries, Nature Astronomy, 10.1038/s41550-017-0088, arXiv.1705.00683
- Bannister et al. (2016), OSSOS: IV. Discovery of a dwarf planet candidate in the 9:2 resonance with Neptune, AJ, 10.3847/0004-6256/152/6/212
- **Volk** et al. (2016), OSSOS III - Resonant Trans-Neptunian Populations: Constraints from the first quarter of the Outer Solar System Origins Survey, AJ, 10.3847/0004-6256/152/1/23
- Malhotra, **Volk**, & Wang (2016), Corralling a distant planet with extreme resonant Kuiper belt objects, ApJ Letters, 10.3847/2041-8205/824/2/L22
- Bannister et al. (2016), The Outer Solar System Origins Survey I: design and first-quarter discoveries, AJ, 10.3847/0004-6256/152/3/70
- Shankman et al. (2015), OSSOS II: A sharp transition in the absolute magnitude distribution of the Kuiper belt's scattering population, AJ, 10.3847/0004-6256/151/2/31
- **Volk** & Gladman (2015), Consolidating and Crushing Exoplanets: Did it Happen Here?, ApJ Letters, 10.1088/2041-8205/806/2/L26
- Pike, Kavelaars, Petit, **Volk**, & Shankman (2015), The 5:1 Neptune Resonance as Probed by CFEPS: Dynamics and Population, AJ, 10.1088/0004-6256/149/6/202
- **Volk** & Malhotra (2013), Do Centaurs preserve their source inclinations?, Icarus, 10.1016/j.icarus.2013.02.016, arXiv.1211.2774
- **Volk** & Malhotra (2012), The effect of orbital evolution on the Haumea (2003 EL61) collisional family, Icarus, 10.1016/j.icarus.2012.06.047, arXiv.1206.7069,
- **Volk** & Malhotra (2011), Inclination mixing in the classical Kuiper belt, ApJ, 10.1088/0004-637X/736/1/11
- **Volk** & Malhotra (2008), The scattered disk as the source of the Jupiter family comets, ApJ, 10.1086/591839
- Cui, Yelle, & **Volk** (2008), Distribution and escape of molecular hydrogen in Titan's thermosphere and exosphere, JGR, 10.1029/2007JE003032

White Papers/ Reports

- Bianco & the SCOC (2024), LSST Survey Cadence Optimization Committee's Phase 3 Recommendations, Vera C. Rubin Observatory Project Science Technical Note PSTN-056
- Rector et al. (2024), Climate Change Task Force Report for the American Astronomical Society arXiv:2406.10451
- Harris, Fernandez, Sarid, Steckloff, **Volk**, Womack, & Woodney (2020), Active Primordial Bodies: Exploration of the primordial composition of ice-rich planetesimals and early-stage evolution in the outer solar system, White Paper submitted for the Planetary Science and Astrobiology Decadal Survey 2023-2032, 10.3847/25c2cfeb.983d5266
- Woodney, Rivkin, Harris, et al. (2020), Strength In Diversity: Small Bodies as the Most Important Objects in Planetary Sciences, White Paper submitted for the Planetary Science and Astrobiology Decadal Survey 2023-2032, 10.3847/25c2cfeb.fb837aba

- Schwamb, **Volk**, Lin, et al. (2018), A Northern Ecliptic Survey for Solar System Science, LSST Cadence Optimization White Paper arXiv.1812.01149
- **Volk** et al. (2018), The Effects of Filter Choice on Outer Solar System Science with LSST, LSST Cadence Optimization White Paper, arXiv.1812.00937

Selected Recent Seminars and Invited Talks

Using distant small body populations to reveal the solar system's dynamical history, invited Rubin prize lecture, DDA meeting, 2023, Lansing, MI.

Orbital resonances in the outer solar system: probing their surprising prevalence and using them to understand the solar systems history, Colloquium, Brigham Young University, November 2022.

Using distant small body populations to reveal the solar systems dynamical history, Seminar, Planetary Science Institute, March 2022.

Orbital resonances in the outer solar system: how they help reveal the solar systems history, Virtual Colloquium, Institute for Astronomy, University of Edinburgh, March 2021.

Active Centaurs in context: understanding future members of the Jupiter family comets, Invited Plenary Talk, DPS Virtual Meeting, October 2020.

Solar System Shake-up: how planet migration rearranged our system, invited talk, Breakthrough Discuss Conference, April 2019, Berkeley, CA.

Selected Recent Conference Proceedings

2025: K. Volk at al. Detailed Dynamical Classification of TNOs with Machine Learning. DDA Meeting, Atlanta, GA.

2024: K. Volk et al. The Small Bodies Dynamics Tool (SBDynT) - a python tool for easy dynamical characterization of solar system small bodies. DPS Meeting, Boise, ID.

2024: K. Volk et al. Dynamical Classification of TNOs with Machine Learning. TNO 2024, Taipei, Taiwan.

2023: K. Volk et al. Using Resonant TNO populations to Constrain Neptune's Migration. DPS Meeting, San Antonio, TX.

2023: K. Volk et al. Small Body Dynamics Tool (SBDynT): Developing User-Friendly Open-Source Software for Dynamical Characterization of Small Solar System Bodies. Asteroids, Comets, Meteors Conference, Flagstaff, AZ.

2022: K. Volk et al. Close enough? How variations in the giant planets' final orbits in migration simulations affect predicted resonant transneptunian populations. DDA Meeting, New York, NY.

2021: K. Volk, R. Malhotra, & S. Graham. Mapping Neptune's resonances into the distant solar system. DPS Virtual Meeting.

Telescope Time Awarded

PI, Large Binocular Telescope (MODS), 0.5 nights in 2019B, 'Searching for Cold Classical Interlopers in the 3:2 Neptune Resonance

Co-I, Large Binocular Telescope (MODS, LBC), 7 nights in 2018A-2019B, Constraining Neptune's Migration: Surfaces of Resonant TNOs (PI: R. Murray-Clay)

PI, Large Binocular Telescope (LBC), 1.5 nights in 2018A, Constraining Neptune's Migration: Surfaces of Resonant TNOs

Teaching

Instructor, University of Arizona, Fall 2015 – PTYS/ASTR 170B2 The Universe and Humanity: Origins and Destiny (general education introductory astronomy course; $\sim$ 120 students)

Graduate Teaching Assistant Instructor/Co-Instructor, University of Arizona, Fall 2009, Spring 2010, Fall 2012 – LASC 297a: Letters, Arts, and Science Specialty Training Workshop (9-week course to improve scientific literacy and help students become peer mentors in their science classes; $\sim$ 20 students per class)

Graduate Teaching Assistant, University of Arizona, Fall 2006, Spring 2008, Spring 2009 – various general education astronomy/planetary science undergraduate courses

Professional Service

Referee for AAS journals, PSJ, A&A, MNRAS, Nature, Nature Astronomy, Science, Icarus, Cel. Mech. & DA, Astrophysics & Space Science, Astronomy & Computing
External grant reviewer for NASA Research Programs
Panelist for NASA Research Program grant reviews
Panelist for NSF Astronomy grant reviews
Reviewer for telescope proposal calls (Spitzer, Gemini, K2, CFHT)
2019-2020 Staff Representative, Dept. of Planetary Sciences, University of Arizona
2018-2019 LPL representative on the Steward Observatory Telescope Allocation Committee

Recent Outreach/Public Engagement Activities

2023-2025 Science City volunteer at the annual Tucson Festival of Books
2023, 2022 Evening lecture at the Grand Canyon South Rim Visitor Center
2022 published feature article The Comet Highway in Sky & Telescope Magazine
2019 Discussion Moderator for the Tucson Festival of Books
2019, 2017, 2015 speaker for Astronomy on Tap, Tucson
2018 speaker for Astronomy on Tap, Seattle
2018 Phoenix Comic Fest panelist
2016-2017 guest lecturer for the University of Arizona's Osher Lifelong Learning Institute
2017, 2016 Judged the Southern Arizona Research, Science & Engineering Foundation Science Fair
2015-2022 volunteer for numerous Lunar & Planetary Lab outreach events
2015-present invited speaker for a variety of amateur astronomy associations