

Samantha K. Trumbo

Assistant Professor, Astronomy & Astrophysics
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EDUCATION **Ph.D. Planetary Science**, California Institute of Technology **Spring 2021**
Dissertation: *Views of an Ocean World: The Signatures of Internal and External Processes on the Surface of Europa*
M.S. Oceanography, Scripps Institution of Oceanography, UCSD **Fall 2015**
Thesis: *Marine Export Productivity and the Demise of the Central American Seaway*
B.A. Astronomy, Biology (double major), Cornell University **Spring 2013**
Magna Cum Laude, Distinction in All Subjects

RESEARCH INTERESTS Surface and atmospheric processes and composition of planetary satellites and dwarf planets; Spacecraft exploration of ocean worlds and the outer Solar System; Coupled remote-sensing observations and laboratory experiments; Planetary habitability

RESEARCH POSITIONS **Assistant Professor**, Astronomy & Astrophysics, UC San Diego **July 2024–present**
51 Pegasi b Postdoctoral Fellow, Cornell University **July 2021–June 2024**
Postdoctoral Scholar, Caltech **Dec. 2020–June 2021**
NASA Earth and Space Science Graduate Fellow, Caltech **2017–2020**
Graduate Student Researcher, Caltech **2015–2017**
Graduate Student Researcher, Scripps Institution of Oceanography, UCSD **2013–2015**
Undergraduate Researcher, Cornell University **2011–2013**
NASA Airborne Science Intern, Student Airborne Research Program (SARP) **Summer 2012**

SELECTED PUBLICATIONS (full list to follow)

Trumbo, S.K. and Brown, M.E. (2023) The distribution of CO₂ on Europa indicates an internal source of carbon. *Science*, 381, 1308, [doi:10.1126/science.adg4155](https://doi.org/10.1126/science.adg4155).

Trumbo, S.K., Brown, M.E., Bockelée-Morvan, D., de Pater, I., Fouchet, T., Wong, M.H., Fletcher, L.N., de Kleer, K., Lellouch, E., Mura, A., Poch, O., Quirico, E., Rodriguez-Ovalle, P., Showalter, M.R., Tiscareno, M.S., and Tosi, F. (2023) Hydrogen peroxide at the poles of Ganymede. *Science Advances*, 9, 29, [doi:10.1126/sciadv.adg3724](https://doi.org/10.1126/sciadv.adg3724).

Trumbo, S.K., Davis, M.R., Cassese, B., and Brown, M.E. (2022) Spectroscopic mapping of Io's surface with HST/STIS: SO₂ frost, sulfur allotropes, and large-scale compositional patterns. *PSJ*, 3, 272, [doi:10.3847/PSJ/aca46d](https://doi.org/10.3847/PSJ/aca46d).

Trumbo, S.K., Becker, T.M., Brown, M.E., Denman, W.T.P., Molyneux, P., Hendrix, A., Retherford, K.D., Roth, L., and Alday, J. (2022) A new UV spectral feature on Europa: Confirmation of NaCl in leading-hemisphere chaos terrain. *PSJ*, 3, 27, [doi:10.3847/PSJ/ac4580](https://doi.org/10.3847/PSJ/ac4580).

Trumbo, S.K., Brown, M.E., and Hand, K.P. (2019) H₂O₂ within chaos terrain on Europa's leading hemisphere. *AJ*, 158, 127, [doi:10.3847/1538-3881/ab380c](https://doi.org/10.3847/1538-3881/ab380c).

Trumbo, S.K., Brown, M.E., and Hand, K.P. (2019) Sodium chloride on the surface of Europa. *Science Advances*, 5, 6, [doi: 10.1126/sciadv.aaw7123](https://doi.org/10.1126/sciadv.aaw7123).

Trumbo, S.K., Brown, M.E., and Butler, B.J. (2017) ALMA thermal observations of a proposed plume source region on Europa. *AJ*, 154, 148, [doi:10.3847/1538-3881/aa8769](https://doi.org/10.3847/1538-3881/aa8769).

GRANT FUNDING

Space Telescope Science Institute (PI, JWST-GO), *Complete NIRSpec coverage of Europa's surface: CO₂, salt hydrates, and the potential for unexpected discovery*, \$194,054 (awarded 2023, 3-year period).

Space Telescope Science Institute (Co-I, HST-GO), *HST-Juno Io Campaign: Connecting Volcanos to the Plasma Environment*, \$21,162 requested (time awarded, funding pending).

Space Telescope Science Institute (PI, HST-GO), *Targeted observations of Ceres' Occator crater with HST/STIS*, \$74,748 (awarded 2022, 3-year period).

Space Telescope Science Institute (PI, HST-GO), *Europa's UV absorptions: oceanic or exogenic origins?* \$154,020 (awarded 2022, 3-year period).

Heising-Simons Foundation (51 Pegasi b Fellowship), *The surfaces of icy worlds: Windows to the oceans below*, \$375,000 (awarded 2021, 3-year period).

Space Telescope Science Institute (Co-I, HST-GO), *Complete spectral maps of the Galilean satellites from 200-1000 nm: salts, radiolytic cycles, and O₂ production*, \$175,842 (awarded 2019).

Space Telescope Science Institute (Co-I, HST-AR), *Complete spectral maps of the Galilean satellites from 200-1000 nm: salts, radiolytic cycles, and O₂ production*, \$76,677 (awarded 2019).

NASA (Earth and Space Science Graduate Fellowship), *The Signatures of Exogenous and Endogenous Processes on the Surface of Europa*, \$135,000 (awarded 2017).

PI & SCIENCE-PI OBSERVING PROGRAMS (Facility and instrument listed) JWST: 1 program as PI, Cycle 2 GO (2023–2024), NIRSpec, 6 hours.
Hubble Space Telescope (HST): 3 programs as PI, Cycles 30 & 32 (2022–2025), STIS, 10 total orbits.
Gemini Observatory: 2 programs as PI (2019–2021), GMOS-S, 6.6 total hours.
W.M. Keck Observatory: 3 programs as Science PI (2018–2021), NIRSPEC, 9 total half nights.
The Atacama Large Millimeter Array (ALMA): 1 program as PI, Cycle 6 (2018–2019), 2.5 hours.
NASA Infrared Telescope Facility (IRTF): 2 programs as PI (2018–2019), SpeX, 28.5 total hours.

CO-I OBSERVING PROGRAMS JWST: 5 programs, Cycle 2 & 3 GO+GTO (2023–2024), NIRSpec+MIRI, 58 total hours.
Hubble Space Telescope (HST): 3 programs, Cycles 24, 27, 31 (2016–2023), 151 total orbits.
The Atacama Large Millimeter Array (ALMA): 1 program, Cycle 5 (2017–2018), 4 hours.

ADVISING & MENTORING NASA Europa ICONS Mentor, Juli Keiper, NASA undergraduate intern, Cornell **Summer 2024**
Research Supervisor & Thesis Committee Member, Peiyu Wu, Ph.D. student, Cornell **2021–present**
NASA AMP-UP Mentor, Astronomy Mentorship Program for Upcoming Postdocs **2023–2024**
Career Mentor, Pasadena City College Natural Sciences Mentoring Program **2021**
Research Mentor, Sherry Liang, undergraduate student, Caltech **Fall 2019**
Research Mentor, Yiluo Li, Visiting undergraduate student, Caltech **Summer 2018**

TEACHING EXPERIENCE Physics Tutor, Volunteer Physics Tutoring Pilot Program, Pasadena City College **2020–2021**
Math Tutor, Caltech Rise Program for the Pasadena Unified School District **2020–2021**
Teaching Assistant, Caltech **2017–2019**
Ge 108: Applications of Physics to the Earth Sciences (graduate-level course; guest lectured)
Ge 157c: Remote Sensing (senior undergraduate/graduate-level course with lab and field component)
Ge 131: Planetary Interiors (senior undergraduate/graduate-level course)
Teaching Assistant, Scripps Institution of Oceanography, UCSD **2014–2015**
SIO 1: The Planets (large undergraduate course; designed and led discussion sections)
SIO 104/255: Paleobiology and the History of Life (undergraduate course with lab component)
Undergraduate Teaching Assistant, Physics Learning Center, Cornell University **2011**
PHYS 1102: General Physics II (large undergrad. course with lab component; staffed lab/tutoring center)
STEM Tutor, K-12 & undergraduate, self-employed, Ithaca & San Diego **2010–2013**
Science Enrichment Intern, Rendezvous Science Center, San Diego **2008–2009**

PROFESSIONAL DEVELOPMENT Alda Center for Science Communications Workshop, two-part workshop run by the Alan Alda Center for Science Communication. Summer 2023.
GET-SET Course Design Institute, series of workshops through the Cornell Center for Teaching Innovation on the development of learning outcomes and student-centered courses. March 2023.
Teaching and Learning in the Diverse Classroom, month-long course through the Cornell Center for Teaching Innovation on inclusive teaching strategies and best practices. June 2022.
Culturally Mindful Mentoring Workshop, three-part workshop led by Dr. Kelly Mack on effective mentorship of students from underrepresented groups. Winter 2022.

SPACECRAFT MISSION INVOLVEMNT NASA Europa Clipper Composition Working Group Co-Chair **Nov. 2023–present**
NASA Europa Clipper Science Team, Postdoctoral Affiliate (MISE) **2021–present**
NASA Europa Clipper Science Team, Graduate-student Affiliate (Europa-UVS) **2019–2021**

PROFESSIONAL AFFILIATIONS & SERVICE Review Panelist for NSF, STScI
Referee, *AGU Journals*, *AAS Journals*, *Icarus*
AAS Division of Planetary Sciences (DPS), DPS Meeting session co-chair (2020, 2021)
American Geophysical Union (AGU)

**PUBLIC
OUTREACH
& SCI. COMM.**

Cornell REU Program Guest Lecture, July 2024
California Academy of Sciences Benjamin Dean Astronomy Lecture, Sep. 2023
NPR Morning Edition Radio Appearance, Sep. 2023
BBC Newsroom Radio Appearance, Sep. 2023
Cornell REU Program Guest Lecture, June 2023
NASA Community College Network, Subject Matter Expert, 2022–present
Cornell Friends of Astronomy Lecture, March 2022
Cornell Astronomical Society Lecture, March 2022
W.M. Keck Observatory Donor Talk, Dec. 2020
Science Magazine Podcast Appearance, June 2019
L.A. Public Radio Appearance, June 2019
NASA SARP Guest Lecture, July 2017
Public Education Volunteer, The Birch Aquarium at Scripps Institution of Oceanography, 2008

**SELECTED
AWARDS**

William A. Lee Endowed Junior Faculty Fellowship, UC San Diego 2024
CCAPS Research Innovation Award, Cornell University 2023
Heising-Simons Foundation 51 Pegasi b Fellowship in Planetary Astronomy 2021
NASA Earth and Space Sciences Fellowship 2017
E.W. Scripps Fellowship, Scripps Institution of Oceanography 2013
Outstanding Student Paper Award (OSPA), AGU Fall Meeting 2012

**SELECTED
PRESS**

NASA+ Streaming, Other Worlds: Europa, Feb. 26, 2024
NASA Press Release, NASA's Webb Finds Carbon Source on Surface of Jupiter's Moon Europa, Sep. 2023
Scientific American, Jupiter's Moon Europa May Hide Tantalizing Carbon in Mysterious Ocean, Sep. 2023
(and many other outlets, including Forbes, NPR, Newsweek)
Gizmodo, Webb Space Telescope Unlocks Secrets of Jupiter's Moons, Aug. 2023
Cornell Press Release, James Webb Space Telescope sees Jupiter moons in a new light, Aug. 2023
The Atlantic, There's Hope for Life on Europa, a Distant Moon, Oct. 2022
Caltech/JPL Press Release, Table Salt Compound Spotted on Europa, June 2019
Scientific American, Water on Europa—with a Pinch of Salt, June 2019 (and many other outlets, including Gizmodo, EOS, CNN)
NRAO Press Release, ALMA Maps Europa's Temperature, Oct. 2018
EOS, How Hot is Europa? There's a Map for That, Sep. 2018
New Scientist, One of Europa's Plumes May Not Exist, Making Hunt for Life Hard, Aug. 2017

**INVITED
SEMINARS &
COLLOQUIA**

UC San Diego, Astronomy and Astrophysics Colloquium, Feb. 16, 2024
Cornell University, Earth and Atmospheric Sciences Seminar, Sep. 29, 2023
Europa Clipper Team, Composition Working Group Science Talk, July 11, 2023
Boston University, Space Physics Seminar, April 20, 2023
UC Santa Cruz, EPS/IGPP Seminar, May 13, 2022
Cornell University, Planetary Lunch Seminar, Oct. 19, 2020
UC Berkeley and UCLA, Joint CIPS and EPSS Seminar, Sep. 30, 2020
CU Boulder, Laboratory for Atmospheric and Space Physics Seminar, Sep. 3, 2020
JPL, Europa Clipper Lecture Series, Jan. 10, 2020
Europa Clipper Team, Habitability Working Group Science Talk, June 13, 2019
JPL, Icy Worlds Seminar, April 18, 2019
University of Copenhagen, Centre for Star and Planet Formation Seminar, Sep. 24, 2018
Europa Clipper Team, E-THEMIS Science Team Meeting, Nov. 8, 2017

PUBLICATIONS

(full list)

22. Becker, T.M. (inc. **Trumbo, S.K.**) et al. and the Europa Clipper Composition Working Group (2024) Exploring the composition of Europa with the upcoming Europa Clipper mission. *Space Science Reviews*, 220, 49, doi:10.1007/s11214-024-01069-y.
21. Bockelée-Morvan, D., Lellouch, E., Poch, O., Quirico, E., Cazaux, S. de Pater, I., Fouchet, T., Fry, P.M., Rodriguez-Ovalle, P., Tosi, F., Wong, M.H., Boshuizen, I., de Kleer, K., Fletcher, L.N., Mura, A., Roth, L., Saur, J., Schmitt, B., **Trumbo, S.K.**, Brown, M.E., O'Donoghue, J.O., and Showalter, M.R. (2023) Composition and thermal properties of Ganymede's surface from JWST/NIRSpec and MIRI observations. *Astronomy & Astrophysics*, 681, A27, doi:10.1051/0004-6361/202347326.

20. **Trumbo, S.K.** and Brown, M.E. (2023) The distribution of CO₂ on Europa indicates an internal source of carbon. *Science*, 381, 1308, doi:10.1126/science.adg4155.
19. Davis, M.R., Brown, M.E., **Trumbo, S.K.** (2023) The spatial distribution of the unidentified 2.07 μm absorption feature on Europa and implications for its origin. *PSJ*, 4, 148, doi: 10.3847/PSJ/aced96.
18. **Trumbo, S.K.**, Brown, M.E., Bockelée-Morvan, D., de Pater, I., Fouchet, T., Wong, M.H., Fletcher, L.N., de Kleer, K., Lellouch, E., Mura, A., Poch, O., Quirico, E., Rodriguez-Ovalle, P., Showalter, M.R., Tiscareno, M.S., and Tosi, F. (2023) Hydrogen peroxide at the poles of Ganymede. *Science Advances*, 9, 29, doi:10.1126/sciadv.adg3724.
17. de Pater, I., Lellouch, E., Strobel, D., de Kleer, K., Fouchet, T., Wong, M.H., Holler, B., Stansberry, J., Fry, P.M., Brown, M.E., Bockelée-Morvan, D., **Trumbo, S.K.**, Fletcher, L.N., Hedman, M.M., Molter, E.M., Showalter, M., Tiscareno, M.S., Cazaux, S., Hueso, R., Luszcz-Cook, S., Melin, H., Moeckel, C., Mura, A., Orton, G., Roth, L., Saur, J., and Tosi, F. (2023) An energetic eruption with associated SO 1.707 micron emissions at Io's Kanehekili Fluctus and a brightening event at Loki Patera observed by JWST. *JGR: Planets*, 128, e2023JE007872, doi:10.1029/2023JE007872.
16. **Trumbo, S.K.**, Davis, M.R., Cassese, B., and Brown, M.E. (2022) Spectroscopic mapping of Io's surface with HST/STIS: SO₂ frost, sulfur allotropes, and large-scale compositional patterns. *PSJ*, 3, 272, doi:10.3847/PSJ/aca46d.
15. Becker, T.M., **Trumbo, S.K.**, Molyneux, P., Retherford, K.D., Hendrix, A., Roth, L., Raut, U., Alday, J., and McGrath, M.A. (2022) Mid-ultraviolet Hubble observations of Europa and the global distribution of SO₂. *PSJ*, 3, 129, doi:10.3847/PSJ/ac69eb.
14. **Trumbo, S.K.**, Becker, T.M., Brown, M.E., Denman, W.T.P., Molyneux, P., Hendrix, A., Retherford, K.D., Roth, L., and Alday, J. (2022) A new UV spectral feature on Europa: Confirmation of NaCl in leading-hemisphere chaos terrain. *PSJ*, 3, 27, doi:10.3847/PSJ/ac4580.
13. Denman, W.T.P., **Trumbo, S.K.**, and Brown, M.E. (2022) The influence of temperature and photobleaching on irradiated sodium chloride at Europa-like conditions. *PSJ*, 3, 26, doi:10.3847/PSJ/ac4581.
12. Brown, M.E., Denman, W.T.P., and **Trumbo, S.K.** (2022) The mid-UV spectrum of irradiated NaCl at Europa-like conditions. *PSJ*, 3, 28, doi:10.3847/PSJ/ac457f.
11. **Trumbo, S.K.**, Brown, M.E., Adams, D. (2021) The geographic distribution of dense-phase O₂ on Ganymede. *PSJ*, 2, 139, doi:/10.3847/PSJ/ac0cee.
10. de Kleer, K., Butler, B.J., de Pater, I., Gurwell, M.A., Moullet, A., **Trumbo, S.K.**, and Spencer, J. (2021) Thermal properties of Ganymede's surface from millimeter and infrared emission. *PSJ*, 2, 5, doi:10.3847/PSJ/abcbf4.
9. **Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2020) Endogenic and exogenic contributions to visible-wavelength spectra of Europa's trailing hemisphere. *AJ*, 160, 282, doi:10.3847/1538-3881/abc34c.
8. Ingersoll, A.P., Ewald, S.P., and **Trumbo, S.K.** (2020) Time variability of the Enceladus plumes: Orbital periods, decadal periods, and aperiodic change. *Icarus*, 344, 113345, doi: 10.1016/j.icarus.2019.06.006.
7. **Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2019) H₂O₂ within chaos terrain on Europa's leading hemisphere. *AJ*, 158, 127, doi:10.3847/1538-3881/ab380c.
6. **Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2019) Sodium chloride on the surface of Europa. *Science Advances*, 5, 6, doi: 10.1126/sciadv.aaw7123.
5. **Trumbo, S.K.**, Brown, M.E., and Butler, B.J. (2018) ALMA thermal observations of Europa. *AJ*, 156, 161, doi:10.3847/1538-3881/aada87.
4. **Trumbo, S.K.**, Brown, M.E., and Butler, B.J. (2017) ALMA thermal observations of a proposed plume source region on Europa. *AJ*, 154, 148, doi:10.3847/1538-3881/aa8769.
3. **Trumbo, S.K.**, Brown, M.E., Fischer, P.D., and Hand, K.P. (2017) A new spectral feature on the trailing hemisphere of Europa at 3.78 μm. *AJ*, 153, 250, doi:10.3847/1538-3881/aa6d80.
2. Corrales, L.R., Yi, T.D., **Trumbo, S.K.**, Shalloway, D., Lunine, J.I., and Usher, D.A. (2017) Acetonitrile cluster solvation in a cryogenic ethane-methane-propane liquid: Implications for Titan lake chemistry. *The Journal of Chemical Physics*, 146, 104308, doi:10.1063/1.4978395.
1. Fischer, P.D., Brown, M.E., **Trumbo, S.K.**, and Hand, K.P. (2016) Spatially resolved spectroscopy of Europa's large-scale compositional units at 3-4 μm with Keck NIRSPEC. *AJ*, 153, 13, doi:10.3847/1538-3881/153/1/13.

**CONFERENCE
TALKS**

- (Invited) Trumbo, S.K.**, Brown, M.E., Bockelée-Morvan, D., de Pater, I., Fouchet, T., Wong, M.H., Fletcher, L.N., de Kleer, K., Lellouch, E., Mura, A., Poch, O., Quirico, E., Rodriguez-Ovalle, P., Showalter, M.R., Tiscareno, M.S., and Tosi, F. (2023) Hydrogen Peroxide at the Poles of Ganymede Revealed by JWST. AGU Fall Meeting, San Francisco.
- Trumbo, S.K.** and Brown, M.E. (2023) Evidence for an Internal Source of Carbon on Europa from JWST. AGU Fall Meeting, San Francisco.
- Trumbo, S.K.** and Brown, M.E. (2023) Evidence for an Internal Source of Carbon on Europa from JWST. Workshop on the Origins and Habitability of the Galilean Moons, Marseille, France.
- Trumbo, S.K.**, Davis, M.R., Cassese, B., and Brown, M.E. (2022) Volcanic Sulfur Products and Large-scale Compositional Patterns on Io from HST/STIS. 54th AAS DPS Meeting, London, Ontario, Canada, 112.02.
- (Invited) Trumbo, S.K.** (2022) Surface chemistry of the icy Galilean satellites: Observations, laboratory perspectives, and future directions. Japan Geoscience Union Meeting (Hybrid), Chiba, Japan, PPS01-04.
- (Invited) Trumbo, S.K.** (2022) The surface of Europa: A window to the ocean below? Ice-Ocean Interactions on Icy Moons in the Solar System. Princeton Center for Theoretical Science, Princeton, NJ.
- (Invited) Trumbo, S.K.**, Becker, T.M., Brown, M.E., Denman, W.T.P., Molyneux, P., Hendrix, A., Retherford, K.D., Roth, L., and Alday, J. (2022) A new UV absorption on Europa's surface: Confirmation of NaCl in leading-hemisphere chaos terrain. AGU Fall Meeting (Hybrid), New Orleans, LA, P24C-05.
- Trumbo, S.K.**, Brown, M.E., and Adams, D. (2021) The geographic distribution of dense-phase O₂ on Ganymede. 53rd AAS DPS Meeting (Virtual), 103.02.
- Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2020) Endogenic and exogenic contributions to visible-wavelength spectra of Europa's trailing hemisphere. 52nd AAS DPS Meeting (Virtual), 106.03.
- Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2020) H₂O₂ within chaos terrain on Europa. Keck Science Meeting (Virtual).
- Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2019) H₂O₂ within chaos terrain on Europa's leading hemisphere, 51st AAS DPS Meeting/EPSC Meeting, Geneva, Switzerland, EPSC-DPS2019-825.
- Trumbo, S.K.**, Brown, M.E., and Hand, K.P. (2018) A Search for signatures of irradiated chloride salts on the surface of Europa. 50th AAS DPS Meeting, Knoxville, TN, 407.02.
- Trumbo, S.K.**, Brown, M.E., de Kleer, K., and Hand, K.P. (2018) Observational constraints on the distribution and temperature dependence of H₂O₂ on the surface of Europa. Europa Deep Dive 2: Composition, Houston, TX, 3020.
- Trumbo, S.K.**, Brown, M.E., de Kleer, K., and Hand, K.P. (2018) Observational constraints on the distribution and temperature dependence of H₂O₂ on the surface of Europa. European Planetary Science Congress (EPSC), Berlin, Germany, EPSC2018-203.
- Trumbo, S.K.**, Brown, M.E., and Butler, B.J. (2017) ALMA thermal observations of Europa. 49th AAS DPS Meeting, Provo, UT, 203.05.
- Trumbo, S.K.**, Ewald, S.P., and Ingersoll, A.P. (2016) The time variability of individual geysers in the plume of Enceladus. AGU Fall Meeting, San Francisco, CA, P32A-04.
- Trumbo, S.K.**, Fischer, P.D., Hand, K.P., and Brown, M.E. (2016) A new spectral feature on the trailing hemisphere of Europa at 3.78 μ m. 48th AAS DPS Meeting, Pasadena, CA, 517.01.
- Trumbo, S.K.**, Palacios, S.L., Zimmerman, R.C., and Kudela, R.M. (2012) A mathematical model for estimation of kelp bed productivity: Age dependence and contributions of subsurface kelp. AGU Fall Meeting, San Francisco, CA, B34D-06.