



# Steven D. Vance

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## Research Focus

My research focuses on using geophysical and geochemical methods to understand ocean worlds: how oceans couple to the thermal evolution and composition, and what this might mean for life. My experimental research program involves collecting thermodynamic equations of state for fluids and ices. I have applied these aqueous equations of state to evaluate oceanic heat transport and double diffusive convection in Europa, and the geophysical constraints imposed by ocean composition on the radial structures Europa, Ganymede, Callisto, Enceladus, and Titan. I am also interested in the global geochemical fluxes in ocean worlds, by analogy to biogeochemical fluxes in the Earth system.

## Education

2001–2007 **Ph.D.**, *University of Washington*, Seattle, Geophysics and Astrobiology.

1996–2000 **B.S.**, *University of California*, Santa Cruz, Physics (*with honors*).

## Ph.D. Thesis

title *Thesis title: High Pressure and Low Temperature Equations of State for Aqueous Sulfate Solutions: Applications to the Search for Life in Extraterrestrial Oceans, with Particular Reference to Europa.*

advisor Prof. J. Michael Brown

## Bachelor Thesis

title *The Role of Methanol Frost in Particle Sticking and the Formation of Planets in the Early Solar Nebula*

advisor Prof. Frank G. Bridges

## Current Appointments

**Research Scientist, Europa Project Staff Scientist, MASPEX Investigation Scientist:** Jet Propulsion Laboratory, Caltech

**Global Science Coordinator:** ELSI Origins Network, Tokyo Institute of Technology

**Visiting Scholar:** University of Washington, Seattle; Tokyo Institute of Technology

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## PI'd Grants; by submittal year

- 2017–2020 **Vital Signs: Seismic Investigation of Icy Ocean Worlds**, *NASA ROSES Habitable Worlds*, \$772K.
- 2015–2018 **Science Drivers for Icy Moon Seismology**, *JPL Strategic Research and Technology Development*, \$355.1K.
- 2011–2013 **CubeSat Hydrometric Atmospheric Radiometric Mission (CHARM)**, *NASA Hands-On Project Experience (HOPE)*, \$2.8M.

## Co-I and Collaborator Grants; by submittal year

- 2017–present **Planetary Solution Chemistry**, *NASA ROSES Solar System Workings*, PI: J. Michael Brown, \$636K.
- 2016–2017 **Magnetic Induction Responses from Icy Satellites with Conductive Oceans**, *JPL Spontaneous Concepts*, PI: Bruce Bills, \$30K.
- 2016–present **Water and Hydrate Isotopes via a Rapid Laser Sensor**, *NASA ROSES MATISSE*, PI: Talso Chui, \$4M.
- 2016–present **A Planetary Broadband Seismometer for the Lunar Geophysical Network and the Ocean Worlds**, *NASA ROSES PICASSO*, PI: Max Coleman, \$429K.
- 2014–present **ICY WORLDS: Astrobiology at the Rock-Water Interface and Beyond?**, *NASA Astrobiology Institute, CAN 7*, PI: Isik Kanik, \$8.08M.
- 2013 **Mapping the Ice Layer of Europa Using Radio Detection of Ultra-High Energy Cosmic Rays (UHECRs)**, *JPL Spontaneous Concepts*, PI: Andrew Romero Wolf, \$30K.
- 2012–2015 **Solution Thermochemistry Relevant to Outer Planets and Satellites**, *NASA ROSES Outer Planets Research*, PI: J. Michael Brown, \$156K.
- 2009–2014 **Astrobiology of Icy Worlds: Habitability, Survivability and Detectability**, *NASA Astrobiology Institute, CAN5*, PI: Isik Kanik, \$8.18M.

## Refereed Publications

- **Vance, S. D.**, 2018. The Habitability of Icy Ocean Worlds in the Solar System. In: Deeg H., Belmonte J. (eds) *Handbook of Exoplanets*. Springer, Cham, 1-23. [https://doi.org/10.1007/978-3-319-30648-3\\_63-1](https://doi.org/10.1007/978-3-319-30648-3_63-1)
- **Vance, S. D.**, S. Kedar, M. P. Panning, S. C. Stähler, B. G. Bills, R. D. Lorenz, H.-H. Huang, W. T. Pike, J. C. Castillo, P. Lognonne, V. C. Tsai, A. R. Rhoden, 2018. Vital Signs: Seismology of Icy Ocean Worlds. *Astrobiology*, 18(1) 37-53. <https://doi.org/10.1089/ast.2016.1612>.
- **Vance, S. D.**, M. P. Panning, S. Stähler, F. Cammarano, B. G. Bills, S. Kedar, C. Sotin, W. T. Pike, R. Lorenz, V. Tsai, H.-H. Huang, J. M. Jackson, B. Banerdt, 2018. Geophysical investigations of habitability in ice-covered ocean worlds, *JGR-Planets*, **123**. <https://doi.org/10.1002/2017JE005341>, archiv:1705.03999
- Stähler, S., M. P. Panning, **S. D. Vance**, R. Lorenz, M. van Driel, T. Nissen-Meyer, S. Kedar, 2018. Seismic wave propagation in icy ocean worlds, *JGR-Planets*, **123**. <https://doi.org/10.1002/2017JE005338> arxiv:1705.03500
- Panning, M. P., S. C. Stähler, H.-H. Huang, **S. D. Vance**, S. Kedar, V. Tsai, W. T. Pike, R. D. Lorenz, 2018. The seismic noise environment of Europa, *JGR-Planets*, **123**.

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<https://doi.org/10.1002/2017JE005332>. arxiv:1705.03424

- Zhu, P., G. E. Manucharyan, A. F. Thompson, J. C. Goodman, **S. D. Vance**, 2017. The influence of meridional ice transport on Europa's ocean stratification and heat content. *Geophys. Res. Lett.*, **44**, doi:10.1002/2017GL072996.
- Aglyamov, Y., D. M. Schroeder, **S. D. Vance**, 2017,. Bright prospects for radar detection of Europa's ocean. *Icarus*, **281**, 334-337. <http://dx.doi.org/10.1016/j.icarus.2016.08.014>
- Romero-Wolf, A., D. M. Schroeder, P. Ries, B. G. Bills, C. Naudet, B. R. Scott, R. Treuhaft, **S. Vance**, 2016. Prospects of Passive Radio Detection of a Subsurface Ocean on Europa with a Lander. *Planetary and Space Sciences*, **15**, 118-121, 10.1016/j.pss.2016.06.010.
- **Vance, S. D.** K.P. Hand, R. T. Pappalardo, 2016. Geophysical controls of chemical disequilibria in Europa and other wet, rocky worlds, *Geophys. Res. Lett.*, 10.1002/2016GL068547.
- **Vance, S. D.** T. Loerting, J. Stern, M. Kropf, B. Journaux, C. Jamieson, M. L. Cable. and O. Bollengier, 2016. Solids and fluids at low temperatures, in *Low Temperature Materials and Mechanisms*, CRC Press.
- Castillo, J. C., Y. Bar-Cohen, **S. D. Vance**, M. Choukroun, H. J. Lee, X Bao, M. Badescu, S. Sherritt, M. G. Trainer, and S. Getty, 2016. Sample handling and instruments for the in-situ exploration of ice-rich planets, in *Low Temperature Materials and Mechanisms*, CRC Press.
- Romero-Wolf, A., **S. Vance**, F. Maiwald, E. Heggy, P. Ries, K. Liewer, 2015. A Passive Probe for Subsurface Oceans and Liquid Water in Jupiter's Icy Moons, *Icarus*, **248**, 463-477.
- **Vance, S.**, M. Bouffard, M. Choukroun, and C. Sotin. Ganymede's Internal Structure Including Thermodynamics of Magnesium Sulfate Oceans in Contact with Ice. 2014 *Planetary and Space Science*, **96**, 62-70.
- Russell, M. J., L. M. Barge, R. Bhartia, D. Bocanegra, P. J. Bracher, E. Branscomb, R. Kidd, S. McGlynn, D. H. Meier, W. Nitschke, T. Shibuya, **S. Vance**, L. White, and I. Kanik. 2014. The drive to life on wet and icy worlds. *Astrobiology*, **14**(4), 308-343.
- Pappalardo, R. T., **S. Vance**, F. Bagenal, B. G. Bills D. L. Blaney, D. D. Blankenship, W. B. Brinckerhoff, J. E. P. Connerney, K. P. Hand, T. M. Hoehler, J. S. Liesner, W. S. Kurth, M. A. McGrath, M. T. Mellon, J. M. Moore, G. W. Patterson, L. M. Prockter, D. A. Senske, B. E. Schmidt, E. L. Shock, D. E. Smith, K. M. Soderlund. Science potential from a Europa lander. *Astrobiology*, **13**(8), 740-773, 2013.
- Etiope, G., **S. Vance**, L.E. Christensen, J.M. Marques, R. da Costa, I, 2013. Abiotic methane in serpentinized ultramafic rocks in Portugal. *Marine and Petroleum Geology*, **45**, 12-16.
- **Vance, S.** and J.M. Brown, 2013. Equations of State for Aqueous MgSO<sub>4</sub> to 800 MPa at Temperatures from -20 to 100 °C and Concentrations to 2.5 mol kg<sup>-1</sup> from Sound Velocities with Applications to Icy Ocean Worlds. *Geochim. Cosmochim. Acta* **110**, 176-189.
- Allwood A., D. Beaty, D. Bass, C. Conley, G. Kminek, M. Race, **S. Vance**, and F. Westall, 2013. Conference Summary: Life Detection in Extraterrestrial Samples. *Astrobiology* **13**, 203-216.
- **Vance, S.**, L. E. Christensen, C. R. Webster and K. Sung, 2011. Volatile Organic Sulfur Compounds as Biomarkers Complementary to Methane: Infrared Absorption Spectroscopy of CH<sub>3</sub>SH Enables in Situ Measurements on Earth and Mars. *Planetary and Space Science* **59**, 299-303.
- **Vance, S.**, 2011. Icy Satellite Processes in the Solar System: A Plurality of Worlds. Vision and Voyages for Planetary Science in the Decade 2013-2022, Appendix B.
- Sohl, F., M. Choukroun, J. Kargel, J. Kimura, R. Pappalardo, **S. Vance** and M. Zolotov, 2010. Subsurface Water Oceans in Icy Satellites: Chemical Composition and Exchange Processes. *Space Science Reviews, Europlanet Volume on Icy Satellites* 1-26, DOI 10.1007/s11214-010-9646-y.

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- **Vance, S.** and J.M. Brown, 2009. Sound Velocities and Thermodynamic Properties of Water to 700 MPa and -20 to 100 °C. *JASA* **127**(1), 174-180.
- **Vance, S.** and J. Goodman, 2009. Oceanography of an Ice-covered Moon. *EUROPA*, University of Arizona Press.
- Som, S. M., Z. R. Adam and **S. Vance**, 2009. Use the Water: In-Situ Resource Technology for Icy-Surface Landers. *Acta Astronautica* **64**, 1006-1010.
- **Vance, S.**, and J.M. Brown 2008. The Icy Satellite Interior Simulator, an Apparatus for Optical Measurements in Aqueous Systems in the range -20 to 100 °C and 700 MPa. *Rev. Sci. Inst.* **79**(1), 105105.
- **Vance, S.**, J. Harnmeijer, J. Kimura, H. Hussmann, B. de Martin and J. M. Brown, 2007. Hydrothermal Systems in Small Ocean Planets. *Astrobiology* **7**(6), 987-1005.
- **Vance, S.** 2005. Exploration & Characterization of Europa. *in* The Astrobiology Primer: An Outline of General Knowledge—Version 1, 2006. *Eds.* L.J. Mix, J.C. Armstrong, A.M. Mandell, A.C. Mosier, J. Raymond, S.N. Raymond, F.J. Stewart, K. von Braun, and O. Zhaxybayeva *Astrobiology* **6**, 735-813.
- **Vance, S.** and J. M. Brown, 2005. Layering and Double-Diffusion Style Convection in Europa's Ocean. *Icarus* **177**, 506-514.

## Patents and New Technology Reports

**Vance, S.**, L. E. Christensen, A. Aubrey, 2013. Carbon Responsive Isotope Laser Spectrometer (CRILS). NTR-49291.

## Flight Project Experience

- 2015–Present **Europa Clipper: Facilitator for the Habitability Working Group**, *Planetary Science Project Office*, Jet Propulsion Laboratory, Pasadena.  
Technical interface between the Europa Habitability Working Group and Project Science team.
- 2015–Present **Europa Clipper: MASPEX Investigation Scientist**, *Planetary Science Project Office*, Jet Propulsion Laboratory, Pasadena.  
Technical interface between the MASPEX instrument team at the Southwest Research Institute and the Europa Project Science team.
- 2013–Present **Europa Clipper: Staff Scientist**, *Planetary Science Project Office*, Jet Propulsion Laboratory, Pasadena.  
Participating in Europa Clipper mission concept formulation activities.
- 2015–Present **JPL Team A Participant**, Jet Propulsion Laboratory, Pasadena.  
Studies of a Ceres lander and long-lived Europa orbiter
- 2013, 2014 **Planetary Science Summer School Review Board Member**, Jet Propulsion Laboratory, Pasadena.  
Critiqued studies of Io and ice giants mission concepts
- October 2011–July 2012 **Project Manager and PI CubeSat Hydrometric Atmospheric Radiometric Mission (CHARM)**, *JPL Phaeton Program*, Jet Propulsion Laboratory, Pasadena.  
Developed the early stages of a small Earth-orbiting satellite project to measure radiance temperatures from low-Earth orbit for atmospheric science and rapid TRL advancement. Required hiring, schedule and budget management, and negotiating and documenting requirements according to NASA and JPL project practices.

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- October 2009 to 2013 **Europa Habitability Mission Study, Science Study Team Member, Science Definition Team member (2012-2013)**, *JPL Planetary Science Project Office*, Jet Propulsion Laboratory, Pasadena.  
Participated in studies of Flagship class missions to Europa, particularly in aspects related to habitability and composition.
- Summern 2008 **JPL Planetary Science Summer School**, *JPL Planetary Science Project Office*, Jet Propulsion Laboratory, Pasadena.  
Participated in development of a mission concept to impact trojan asteroids: SHOTPUT

## Prior Research Experience

- 2009–2010 **Caltech Postdoctoral Fellow**, *supervisor: Dr. Isik Kanik*, Jet Propulsion Laboratory, Pasadena, Developed applications of diffusion mobility spectroscopy. Participated in astrobiology related work as part of the Europa Jupiter System Mission science definition team. Developed the science rationale for instrument on the Jupiter Europa Orbiter for EJSM.
- 2007–2009 **NASA Postdoctoral Fellow**, *supervisor: Dr. Christopher R. Webster*, Jet Propulsion Laboratory, Pasadena, Developed scientific applications for the Mars Science Laboratory Tunable Laser Spectrometer using comparable laboratory and field instruments developed at JPL. Investigated applications of new insights in physical chemistry to the structure and evolution of habitable planets.
- 2001–2007 **Research Assistant**, *supervisor: Prof. J. Michael Brown*, University of Washington, Seattle, Constructed and operated high-pressure instrumentation; collected and analyzed sound velocity data for aqueous solutions obtained by the method of impulsive stimulated scattering (ISS). Applied results to understanding physical processes in deep extraterrestrial oceans and hydrothermal systems.
- 2003–2004 **Research Associate**, *supervisor: Prof. Jody Deming*, Canadian Arctic Shelf Exchange Study, Prepared and inventoried shipboard laboratory on CCGS Amundsen while frozen into Franklin Bay, Northwest Territories, Canada; collected and preserved ice core samples for characterizing winter intra-ice bacterial populations.
- 2003 **Research Associate**, *supervisor: Prof. Tilman Spohn*, Institut für Planetologie, Münster, Reviewed hydrothermal systems literature and investigated means for modeling permeability of extraterrestrial seafloors.
- 2001 **Research Associate**, *supervisor: Dr. Remington Stone*, UCO/Lick Observatory, Operated Nickel reflector telescope for acquisition of optical SETI data.
- 1998-2001 **Research Assistant**, *supervisor: Prof. Frank Bridges*, University of California, Santa Cruz, Performed experiments investigating impact sticking of water- and methanol-frosted ices. Applied results understanding accretion of large-particles (> *cm*-size) in the early solar nebula.

## Community Service and Outreach Activities

- Participant, NASA Roadmap for Ocean Worlds, 2016
- Secretary, AOGS Planetary Sciences Section, 2014-present
- Contributor, Astrobiology Strategy development ([astrobiologyfuture.org](http://astrobiologyfuture.org)), 2013-2015
- NASA Panel Reviewer, 2009, 2014-2017

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- NASA Panel Review Chair, 2016
- Organizer, OP Colloquium Series (outerplanets.jpl.nasa.gov), 2008-2011
- Participant, AAS Planetary Science Congressional Visits, April 2012
- Participant, AGU Congressional Geosciences Visits, September 2008

## Conference Honors and Duties; C=Convener, SC=Session Chair

- **Cryovolcanism in the Solar System, LPI June 2018**, Science Organizing Committee member
- **American Geophysics Union Fall Meeting**
  - 2015: P026. Science from Current and Future Planetary Missions **C, SC**
  - 2014: P52A: Icy World Eruptions and Their Analogs **C, SC**
  - 2010: P17 Icy Ocean Worlds **C**
  - 2009: P18 Potential Biomarkers on Mars: Detection, Characterization and Earth Analogue Systems **C**
  - 2006: P31D, Once in a Blue Moon: The Surprising Diversity of Outer Planet Satellites I **SC**  
P23E, Satellites, Rings, and Ices Posters **SC**
- **Asia Oceania Geosciences Society Meeting**
  - 2018: Lead for proposed session on Icy Ocean Worlds **C**
  - 2015: US Secretary for Planetary Science; PS07 Icy Satellites and Rings **C**
  - 2014: PS03 Outer Solar System Satellites With an Atmosphere **C**, PS02 Icy Satellites and Rings, PS09-10 Astrobiology: Habitable Worlds in the Solar System and Beyond, and the Quest for Life's Origins **C**
  - 2013: PS04 Quest for Habitable Worlds, PS13 Active Satellites in the Solar System **C**
  - 2012: PS09 Active Satellites in the Outer Solar System, PS10 Exploring Habitability in the Solar System and Beyond **C**
  - 2011: PS06 Outer Planets and Icy Worlds, PS14 Astrobiology - Life in the Universe **C**
  - 2010: PS03 Astrobiology and Ices **C**, PS11 Satellites and Rings in the Outer Solar System **C**
  - 2009: PS09-15 Planetary Ices and Astrobiology **C**
  - 2008: PS08 Satellites and Rings in the Outer Solar System **C, SC**
- **Astrobiology Science Conference**
  - 2015: Panelist
  - 2012: Serpentinization in Astrobiology: From Molecular to Cosmic Scales **C**
  - 2008: Session 13. The Deep Cold Biosphere? Interior Processes of Icy Satellites and Dwarf Planets **C, SC**, Session 2. Advances in Astrobiological Instrumentation Development **C**
- **Conference on the Habitability of Icy Worlds 2014**: Member of Local Organizing Committee; Ocean Physics and Chemistry **SC**
- **Japanese Geoscience Union Meeting**  
2015: P-PS01 Outer Solar System Exploration **C, SC**, P-P04 International Collaboration **C, SC**
- **Lunar and Planetary Sciences Conference**
  - 2015: Pluto, Kuiper Belt Objects, and New Horizons: Casting Light on Dark Worlds **SC**
  - 2013: License to Chill (or, the solar system's icy moons), **SC** Dwornik Awards Judge
  - 2009: Special Session: Icy Satellites of Jupiter and Saturn: Cosmic Gymnasts **SC**
  - 2008: Titan **SC**
  - 2007: Astrobiology **SC**

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## Media Involvement

- Guest, The Pestle podcast, 2017/12/19
- Speaker, Oregon Eclipse Festival, 2017/08/19
- Panelist, Long Beach Aquarium World Oceans day, 2015/06/08
- Lead Artist, Interstellar Emissary, inspired by the Voyager Disc and Record, 2015-present:
  - Further Future, 2015
  - Burning Man, 2015, 2017
  - Dr. Mae Jemison - 25 Strong, 2017
  - Yuri's Night Los Angeles, 2017, 2018
- Guest, Bill Carroll Show, KFI AM 640, 2015/03/31
- Consultant, The Science and Entertainment Exchange, 2011-present
- Panelist, Exploration of Europa, Comic-Con 2013
- Scientific Advisor, "Europa Report", a feature film, 2011-2013
- Musical Director, "Piled Higher and Deeper," a feature film, 2011

## Weblog Contributions

- "Destination: Europa!" Planetary Society, 2013/12/16
- "My History with the Proposed Europa Clipper Mission," ELSI Blog, 2015/03/12
- "My Month in Japan," ELSI Blog, 2014/09/18
- "Scientific Inspiration in Tokyo," ELSI BLog, 2014/01/21

## Mentoring

- Postdoctoral - 4 total
  - Saikiran Tharimena, 2018-present (Caltech Postdoc)
  - Mohit Melwani Daswani, 2018-present (Caltech Postdoc)
  - Baptiste Journaux, 2016-present (NASA Postdoctoral Scholar, UW Seattle)
  - Olivier Bollengier, 2014-present (UW Seattle)
- Graduate - 12 total
  - Marshall Styczyinski, 2018 (NASA Space Grant, UW Seattle)
  - Bruno Jacob, 2016 (JVS RP, UC Santa Barbara; returning)
  - Nguyen Nguyen, 2015 (SIRI, CSU Long Beach)
  - Rodolfo Batista Negri, 2015 (JVS RP, George Washington U.)
  - Elena Amador, 2014 (JVS RP, UW, Seattle)
  - Jonathan Bapst, 2014 (JVS RP, UW, Seattle)
  - Nina Bothamy, 2014 (JVS RP, ENS Lyon)
  - Amira Elsenousy, 2014 (JVS RP, U Arkansas)
  - Bruno Pereira, 2013 (JVS RP, Brazil, U. Federal de Uberlândia)
  - Mathieu Bouffard, 2012 (JVS RP, ENS Lyon)
  - Aomawa Shields, 2011 (JVS RP, UW Seattle)
  - Shelly Shaul, 2009 (CSU STAR, Cal Poly Pomona)
- Undergraduate - 19 total
  - Eduardo Salazar, 2017-present (JPL YIP, Cal Poly Pomona)
  - Elise Cutts, 2016 (JPL SURF, Caltech)
  - Riley James, 2016 (JPL SURF, Occidental College)
  - Peiyun Zhu, 2016 (Caltech SURF, U. Michigan)

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- Jesse Mendoza, 2016 (UCR MIRO, UC Riverside)
- Kimberly Lykens, 2015 (CSU STAR, Stebbins High School)
- Leila Chang, 2015 (JPL YIP, Yale)
- Garrett Levine, 2015 (JPL SURF, Caltech)
- Yury Aglyamov, 2015 (JPL SURF, Caltech)
- Cauê Borlina, 2015 (JPL YIP, U-Michigan)
- Jessica Williams, 2014-2016 (JPL SIRI-YIP, Cal Poly Pomona)
- Natalie Cobian, 2015 (SIRI, East LA College)
- Marika Leitner, 2014 (JPL YIP, CSU Humboldt)
- Eliav Maas, 2013-2014 (JPL SIRI-YIP, Santa Monica Community College)
- Rana Abdel Sattar, 2013 (JPL SIRI, Glendale Community College)
- Adam Hoffmann, 2013 (JPL SIRI, Mt. San Antonio Community College)
- Hohvannes Gregorchuk, 2014-2015 (JPL SIRI-YIP, Glendale Community College)
- Roshan Nanu, 2010 (JPL SURF, Caltech)
- Noemie Pochat, 2009 (Undergraduate Summer Fellow, Wheaton College)

## Teaching Experience

- 2005-2007 **Founder and Facilitator**, *UWAB Planetology Discussion Group*, University of Washington, Seattle, Organized weekly reviews among fellow astrobiology graduate students of selected journal articles pertaining to the formation and evolution of solar and extra-solar system objects.
- Winter 2004 **Teaching Assistant**, *Physics Department*, University of Washington, Seattle, 114 and 121: Waves and Mechanics. Taught three sections, approximately 20 students per section.
- 2002-2003 **Visiting Scientist**, *Project AstroBio*, Seattle, Presented two guest lectures for a Seattle fifth grade class of approximately 30 students.
- 2002-2005 **Tutor**, *University Tutoring Service*, Seattle, Three undergraduate or high-school students per year. Topics included algebra, trigonometry, calculus, physical chemistry and introductory physics.
- Spring- **Teaching Assistant**, *Physics Department*, University of California, Santa Cruz, Summer, 5B Labs: Wave motion in matter, including sound waves. Taught two sections, 2001 approximately 20 students per section.
- 1998-2001 **Mathematics and Physics Tutor**, *Self-employed*, University of California, Santa Cruz, Taught two undergraduate or high-school students per year on average. Topics included econometrics, calculus and introductory physics.

## Awards and Honors

- o JPL Voyager Award, "For significant contributions to the Europa Mission," 2016
- o JPL Voyager Award, "For refurbishments of the Planetary Ices Laboratory," 2015
- o JPL Group Achievement Award, "For significantly advancing our understanding of the habitability, survivability, and detectability of life on icy worlds through transdisciplinary astrobiological investigations," 2015
- o NASA Postdoctoral Fellowship, 2007-2009
- o Misch Fellowship, 2007

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- Stephens Graduate Support Grant, 2006
- National Science Foundation IGERT/NASA Astrobiology Institute Grant, 2002-2005
- Research support, University of Washington Alumni Grant, Winter / Spring, 2003-2004
- Elks National Foundation Scholarship, 1996-2000 / Kern County Elks Scholarship, 1996
- Howard and Mamie Nichols Scholarship, 1996-2000
- Texaco Foundation Scholarship, 1996-2000
- David Wayne Christensen Memorial Scholarship, 1997
- Kleines Deutschland Scholarship, 1996

## Recent Oral Presentations

**Vance, S.D.**, C. Glein, A. Bouquet, F. Cammarano, W. B. McKinnon, 2017. Europa's Compositional Evolution and Ocean Salinity. *Eos Trans. AGU, Fall Meet. Suppl.* Abstract P31E-03.

**Vance, S. D.**, S. Kedar, W. B. Banerdt, M. P. Panning, W. T. Pike, S. C. Stähler, 2017. Geophysical Tests for Habitability in Europa and Other Ocean Worlds. AbSciCon, Abstract 3283.

**Vance, S.D.**, 2016. DIY Thermodynamics: Developing flexible equations of state for fluids and using them to understand planetary interiors. *Georgia Tech Earth and Atmospheric Sciences Geophysics Seminar.* Atlanta. **INVITED**

**Vance, S.D.**, 2016. Atmosphere disequilibrium in different planetary contexts. *Georgia Tech Earth and Atmospheric Sciences Seminar.* Atlanta. **INVITED**

**Vance, S.D.**, 2016. Atmosphere disequilibrium in different planetary contexts. *Earth-Life Science Institute Annual Symposium.* Tokyo. **INVITED**

**Vance, S.D.**, K. P. Hand, R. T. Pappalardo, 2015. Geophysical Controls on the Habitability of Icy Worlds: Focus on Europa. *Japanese Geosciences Union.* Makuhari Messe, Chiba City.

**Vance, S.**, 2015. Europa and other icy worlds: Astrobiology at the water rock interface and beyond. Natural History Museum of Los Angeles, staff seminar, **INVITED**.

**Vance, S.**, 2015. Thermodynamic and Geophysical Constraints on the Habitability of Icy World and Exoplanet Oceans, Canadian Astrobiology Training Program Seminar. **INVITED**.

**Vance, S.**, J. M. Brown, R. Barnes, M. Choukroun, and C. Sotin. Thermodynamic Equations of State for Aqueous Ammonia and Sodium Chloride Applied to Deep Icy World and Exoplanet Oceans. *Eos Trans. AGU, Fall Meet. Suppl.* Abstract P41E-07.

**Vance, S.**, 2015. Thermodynamic and Geophysical Constraints on the Habitability of Icy World and Exoplanet Oceans, Canadian Astrobiology Training Program Seminar. **INVITED**.

Pappalardo, R., B. Goldstein, T. Magner, L. Prockter, D. Senske, B. Paczkowski, B. Cooke, **S. Vance**, and G.W. Patterson, 2014. The Europa Clipper Mission Concept. *Asia Oceania Geosciences Society Meeting.* Sapporo, Japan.

**Vance, S.**, J. M. Brown, M. Choukroun, C. Sotin, 2014. Thermodynamic Constraints On Ocean Structure And Water-Rock Chemistry In Icy Worlds. *ISSOL Origins Meeting.* Nara, Japan.

**Vance, S.**, J. M. Brown, M. Choukroun, C. Sotin, 2014. Thermodynamic Constraints on Ocean Structure and Water-Rock Chemistry in the Large Icy Satellites. *Conference on the Habitability of Icy Worlds.* Pasadena, CA.

**Vance, S.** 2013. Thermodynamic Constraints on Ocean Structure and Water-Rock Chemistry in the Large Icy Satellites. *International Astrobiology Workshop,* Institute of Space and Astronautical Science. Japan.

**Vance, S.**, 2013. Mysteries of Europa. American Institute of Aeronautics and Astronautics, San Gabriel Valley Section Dinner Meeting. **INVITED**

**Vance, S.**, 2013. Constraints on the habitability of Europa and Ganymede through time from

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chemistry and ocean dynamics. Northwest Geological Society Symposium. Seattle, WA. **INVITED**

**Vance, S.** and L. Christensen, 2013. In situ characterization of naturally occurring methane and ethane at sites of active serpentinization by tunable diode laser spectroscopy. 245th ACS Meeting, Abstract 93. New Orleans, LA.

**Vance, S.**, M. Bouffard, M. Choukroun, C. Sotin, 2013. Aqueous and Solid-Phase Equations Of State For The H<sub>2</sub>O-MgSO<sub>4</sub> System: Prediction Of Ocean And Ice Thicknesses For Ganymede and Other Icy Worlds. LPSC XLIV, Abstract 1563. Woodlands, TX

**Vance, S.**, 2013. Oceanography of Icy Worlds. Colloquium presentation to Georgia Tech Department of Earth and Atmospheric Sciences. **INVITED**

**Vance, S.**, 2012. In Situ Investigations Detection of Methane and Ethane at Sites of Serpentinization, Implications for Life Detection and Geological Characterization. Special seminar: "The Cedars (EUA) vs. Cabeço de Vide (Portugal)" Technical Institute of Portugal, **INVITED**

**Vance, S.**, C. Sotin, M. Choukroun, and K. Mitchell, 2012. Titan's Subsurface Alkanology. Asia Oceania Geosciences Society Meeting, Singapore

**Vance, S.**, R.T. Pappalardo, L. Prockter, D. Senske, W. Patterson, and the Europa Science Definition Team, 2012. Mission Options For Exploring Europa's Habitability: Orbiter and Flyby Concepts. Asia Oceania Geosciences Society Meeting, Singapore, ST16-PS07-A018

**Vance, S.**, 2012. Insights into the Habitability of Icy Worlds from Snazzy Equations of State. Colloquium presentation to Georgia Tech Department of Earth and Atmospheric Sciences. **INVITED**

**Vance, S.**, R.T. Pappalardo, L. Prockter, D. Senske, W. Patterson, and the Europa Science Definition Team, 2012. Mission Options For Exploring Europa's Habitability. Astrobiology Science Conference, Atlanta, GA

**Vance, S.**, 2012 In Situ Investigations of Serpentine Settings for Habitability Characterization and Life Detection. Astrobiology Science Conference, Atlanta, GA

**Vance, S.**, C. Sotin, M. Choukroun, and K. Mitchell, 2012. Titan's Subsurface Alkanology. LPSC XLIII, Abstract 2939. Woodlands, TX

**Vance, S.**, 2011. Equations of State for Very Deep Icy World Ocean Fluids. Colloquium for University of California, Los Angeles, Department of Earth and Space Sciences. **INVITED**

**Vance, S.** and J. M. Brown, 2011. Laboratory Simulations of Ammonia-Rich Oceans in Icy Worlds. LPSC XLII, Abstract 1563. Woodlands, TX

**Vance, S.** 2011. High-Pressure Aqueous Geochemistry for Studies of Icy World Interior Oceans. Keynote Presentation for Second Annual Gala Event, University of Washington, Seattle, WA

**Vance, S.**, 2011. Habitability of Mars, Europa, and Other Icy Worlds. Public scientific presentation for the University of Arkansas, Fayetteville. **INVITED**

**Vance, S.** and R. T. Pappalardo, D. Senske, L. Prockter, and the JJSJT, 2010. Europa Jupiter System Mission Opportunities at Io. Io Workshop, Provo Utah. **INVITED**

**Vance, S.**, L. E. Christensen, O. J. Johnson, M. J. Russell and C. R. Webster, 2009. Laser Absorption Biosignatures on Mars and Earth. *Eos Trans. AGU, Fall Meet. Suppl.*, Abstract P41B-07

**Vance, S.**, N. Goff-Pochat, G.C. Collins, 2009. Thermal Weathering and Erosion on Planetary Surfaces Asia Oceania Geosciences Society Meeting, Singapore

**Vance, S.** 2009. Habitability of Icy Worlds: Electrochemical Capacitance of Serpentinizing Hydrothermal Systems. LPSC XL, Abstract 1994. Woodlands, TX

**Vance, S.**, 2009. Serpentinization and the Habitability of Ocean-Bearing Worlds. Colloquium for Virginia Tech, Geosciences Department. **INVITED**

**Vance, S.**, 2009. Habitability of Icy Worlds. Colloquium for University of Southern California,

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Biology Department. **INVITED**

**Vance, S.**, 2009. Habitability of Icy Worlds. Colloquium for University of Minnesota, Mankato, Geology Department. **INVITED**

**Vance, S.**, 2009. Habitability of Icy Worlds. Planetary Sciences Seminar for Science Division, Jet Propulsion Laboratory, Caltech. **INVITED**

**Vance, S.**, 2009. Serpentinization and the Habitability of Ocean-Bearing Worlds. Colloquium for Case Western Reserve University, Department of Geological Sciences. **INVITED**

**Vance, S.**, 2008. Serpentinization and the Habitability of Ocean-Bearing Worlds. Colloquium for the University of California Irvine, Department of Earth System Sciences. **INVITED**

**Vance, S.**, R.T. Pappalardo and J. Baross 2008. Pressure-induced Limits to Hydrothermal Activity in Small Ocean Worlds. Asia Oceania Geosciences Society Meeting, Busan, South Korea.

**Vance, S.**, 2008. Deep Cold Biospheres? Icy Worlds as Cool Places for Life Under Pressure. JPL Director's Seminar. **INVITED**

**Vance, S.**, R.T. Pappalardo and J. Baross 2008. Long-Lived Serpentinization Activity in Habitable Icy Worlds. Astrobiology Science Conference, Santa Clara, CA. **INVITED**

J. Castillo-Rogez, **S. Vance**, T. McCord, D. Matson 2008. Hydrothermal Activity: Effects On Evolution of Icy Worlds Focus on Ceres. Astrobiology Science Conference

**Vance, S.**, J. M. Brown and C. Sotin 2008. Laboratory Simulations of Titan's Internal Ocean. LPSC XXXIX, Abstract 2136. Houston, TX.

**Vance, S.**, 2008. Improving our understanding of very deep oceans: MgSO<sub>4</sub> chemistry to 700 MPa from -20 to 100 °C. UCLA Earth and Space Sciences Seminar. **INVITED**

## Recent Poster Presentations

**Vance, S.**, C. R. Glein, A. Bouquet, W. B. McKinnon, F. Cammarano, 2017. Permeability and Hydration State of Europa's Rocky Interior, 49th DPS, Abstract 214.05.

**Vance, S.**, R. Barnes, J. M. Brown, C. Sotin and M. Choukroun, 2015. Interior Structure and Habitability of Super-Europas and Super-Ganymedes. LPSC XLVI, Abstract 2717. Woodlands, TX

**Vance, S.**, J. M. Brown, C. Choukroun, O. Bollengier, B. Journaux, C. Sotin, and R. Barnes, 2015. Thermodynamic Equations of State for Ammonia and Sodium Chloride Solutions Applied to Exoplanet Oceans and Interiors. *Physics of Exoplanets: From Earth-Sized to Mini Neptunes*. Santa Barbara.

**Vance, S.**, J. M. Brown, R. Barnes, C. Choukroun, and C. Sotin, 2015. Thermodynamic Equations of State for Ammonia and Sodium Chloride Solutions Applied to Deep Icy World and Exoplanet Oceans. *ELSI Symposium*. Tokyo, Japan.

**Vance, S.**, J. M. Brown, C. Choukroun, and C. Sotin, 2014. Thermodynamic Constraints on Water-Rock Chemistry in Icy Worlds. *Asia Oceania Geosciences Society Meeting*. Sapporo, Japan.

Pappalardo, R., B. Goldstein, T. Wagner, L. Prockter, D. Senske, B. Paczkowski, B. Cooke, **S. Vance**, and G.W. Patterson, 2014. The Europa Clipper Mission Concept. *ISSOL Origins Meeting*. Nara, Japan

**Vance, S.**, J. M. Brown, M. Choukroun, C. Sotin, 2013. Oceans and Internal Structures of the Large Icy Satellites, *Eos Trans. AGU, Fall Meet. Suppl.*, Abstract P41E-1974

**Vance, S.** and J. C. Goodman, 2013. The Structure and Evolution of Europa's Ocean and Ice Shell in the Presence of Aqueous MgSO<sub>4</sub> LPSC XLIV, Abstract 1563. Woodlands, TX

**Vance, S.**, and J. M. Brown, 2011. Exploring Deep Icy World Oceans through New Experimental Equations of State for Aqueous MgSO<sub>4</sub> and NH<sub>3</sub> *Eos Trans. AGU, Fall Meet. Suppl.*, Abstract P23D-1735

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**Vance, S.**, L. Christensen, O. Johnson, C. Webster, 2009. Mars Analog Tunable Laser Spectroscopy at a Site of Active Serpentinization. LPSC XV, Abstract 2005. Woodlands, TX

**Vance, S.**, L. Christensen, O. Johnson, P. Morrill and C. R. Webster, 2008. Mars Analog Tunable Laser Spectroscopy at a Site of Active Serpentinization *Eos Trans. AGU, Fall Meet. Suppl.*, Abstract P53C-1461

**Vance, S.**, R.T. Pappalardo and J. Baross, 2008. Tidal Evolution and Hydrothermal Activity in Habitable Icy Worlds. Gordon Research Conference on the Origin of Life, Ventura, CA

## Recent Coauthored Conference Presentations

\*Chui, T. C., K. J. Stone, H. J. Paik, D. S. Shelton, S. Kedar, C. E. Griggs, M. V. Moody, I. Hahn, N. C. Schmerr, W. B. Banerdt, C. R. Neal, **S. Vance**, P. R. Williamson, 2017 The development of a Planetary Broadband Seismometer (PBBS) for the Lunar Geophysical Network and the Ocean Worlds. *Eos Trans. AGU, Fall Meet. Suppl.* Abstract P43F-05.

\*Bollengier, O., J. M. Brown, **S. Vance**, 2017. Experimental Thermodynamics of [Na-Mg-Cl-SO<sub>4</sub>] Aqueous Solutions at GPa Pressure With Application to Icy Worlds. *Eos Trans. AGU, Fall Meet. Suppl.* MR31B-0440.

\*Panning, M. P., S. C. Stähler, B. G. Bills, J. Castillo, H.-H. Huang, A. L. Husker, S. Kedar, R. D. Lorenz, W. T. Pike, N. C. Schmerr, V. C. Tsai, **S. Vance**, 2017. Seismic signal and noise on Europa and how to use it. *Eos Trans. AGU, Fall Meet. Suppl.* DI21A-0386.

\*Bills, B. and **S. Vance**, 2017. Magnetic induction constraints on electrical conductivity within Europa. *Eos Trans. AGU, Fall Meet. Suppl.* GP34A-02.

\*Panning, M., S. Stähler, B. Bills, J. Castillo Castellanos, H.-H. Huang, A. Husker, S. Kedar, R. Lorenz, W. T. Pike, N. Schmerr, V. Tsai, **S. Vance**, 2017. Seismic signal and noise on Europa, 49th DPS, Abstract 220.05.

\*Barnes, R. **S. Vance**, P. Driscoll, B. Guyer, C. Sotin, J. Brown, 2017, Habitable Ice-Covered Exoplanets. AbSciCon, Abstract 3418.

\*Bollengier, O., B. Journaux, J. M. Brown, **S. D. Vance**, 2017. The Evolution of Oceans in Large Icy Satellites. AbSciCon, Abstract 3672.

\*Senske, D. A., R. T. Pappalardo, H. Korth, R. Klima, S. D. Vance, K. Craft, 2017. Science Of The Europa Mission, Exploring The Habitability Of A Unique Icy World. AbSciCon, Abstract 3132.

**Vance, S.**, J. H. Roberts\*, and A. Ganse, 2015. Inverse Theory for Planning Gravity Investigations of Icy Moons. Abstract 2751, LPSC XLVI, Woodlands, TX.

\*Elsensousy, A., **S. Vance**, B. G. Bills, and J. Goodman, 2015. Modeling Heat and Salt Transfer at Europa's Ice-Ocean Interface. Abstract 1676. LPSC XLVI, Woodlands, TX.

\*Brown, J. M., **S. Vance**, O. Bollengier, G. Shaw, E. Abramson, 2014. Thermodynamics of Water and Aqueous Solutions under Mantle Conditions. American Geophysical Union, *Eos Trans. AGU, Fall Meet. Suppl.* Abstract MR21A-4308

\*Pappalardo, R., B. Goldstein, L. Prockter, D. Senske, B. Paczkowski, **S. Vance**, W. Patterson, T. Wagner, and B. Cooke, 2014. The Europa Clipper Mission Concept: Exploring Europa to Investigate Its Habitability. *IAA Space Exploration Conference*.

Pappalardo, R.T, D. Senske, L. Prockter, B. Paczkowski, G. W. Patterson, **S. Vance**, B. Goldstein, T. Wagner, B. Cooke, and the Europa Study Team, 2013. The Europa Clipper Mission Concept to Explore Europa and Investigate its Habitability. *Institute of Space and Astronautical Science, Conference Proceeding*, poster presented by \*K. Sayanagi.

\*Marques, J., **S. Vance**, L. Christensen, G. Etiope, P. Carreira, S. Suzuki, 2013. Methane and Ethane in Hyperalkaline Mineral Waters in the Alter-Do-Chão Ultramafic Intrusive Massif (Cabeço

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de Vide - Portugal). *10th Annual Applied Isotope Geochemistry Conference*, Budapest, Hungary.

\*Wang, W., B. Ayhan, C. Kwan, H. Qi, **S. Vance**, 2013. A Novel and Effective Multivariate Method for Compositional Analysis using Laser Induced Breakdown Spectroscopy. *35th International Symposium on Remote Sensing of Environment*, Beijing, China.

\*Senske, D. A., L. Prockter, R. T. Pappalardo, W. G. Patterson, **S. Vance**, B. Cooke and the Europa Science Definition and Technical Teams, 2012. The Europa Clipper and Orbiter Mission Concepts: Innovative Approaches for Exploring Europa's Habitability. *AAS Division for Planetary Sciences Meeting*, Reno, NV

\*Prockter, L., R.T. Pappalardo, D. Senske, W. Patterson, **S. Vance** and the Europa Science Definition Team, 2012. Mission Options For Exploring Europa's Habitability: Lander Concept. *Asia Oceania Geosciences Symposium*, Singapore, ST16-PS07-A017

\*Gavin, P. and **S. Vance** 2012. Modeling Hydrothermal Vents on Europa. LPSC XLIII, Abstract 1683. Woodlands, TX

\*Castillo-Rogez, J., D. Matson, J. Kargel, **S. Vance**, T. McCord, T. Johnson 2008. Role of Hydrothermal Geochemistry in the Geophysical Evolution of Icy Bodies. LPSC XXXIX, Houston, TX.

**Vance, S.**, and \*H. Hussmann 2008. Tidal Evolution and Hydrothermal Activity in Icy Worlds. European Planetary Sciences Conference, Muenster, Germany.

## — Languages

German	Fluent but out of practice
French	Intermediate
Japanese	Beginner
Spanish	Beginner
Turkish	Beginner

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