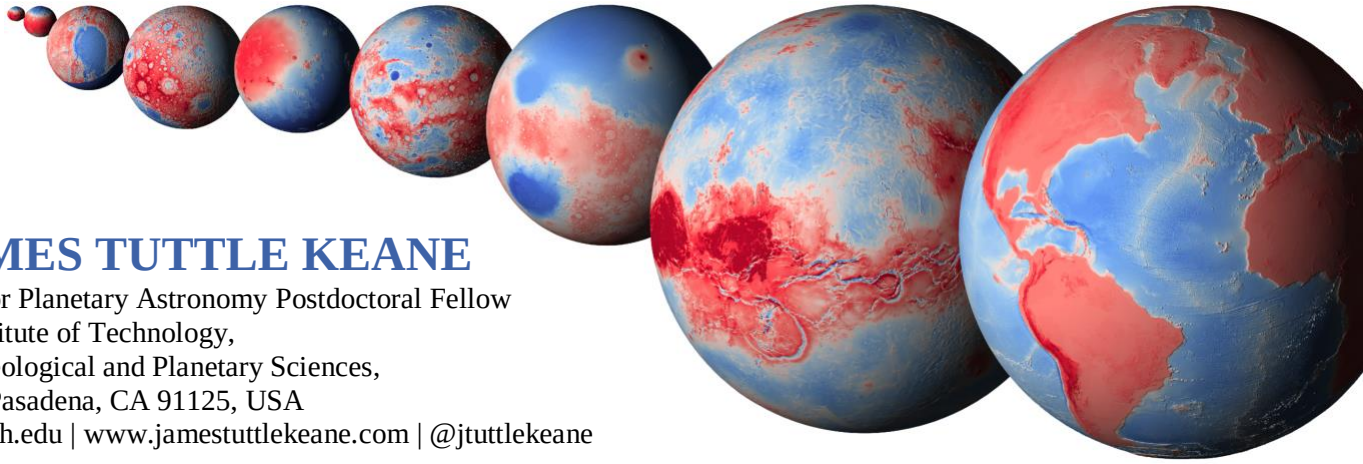

DR. JAMES TUTTLE KEANE

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RESEARCH INTERESTS

I study the interaction between orbital dynamics, rotational dynamics, and geologic processes on terrestrial and icy worlds—from the Moon to Pluto and beyond. I employ a combination of analytical and numerical methods, and use a variety of spacecraft-derived datasets, including planetary gravity, topography, and imagery.

▲*Global topography of worlds I have studied, left-to-right: Vesta, Ceres, Pluto, Moon, Io, Mercury, Mars, Venus, Earth. Visualization by James Tuttle Keane.*

I. EMPLOYMENT

2017–present Joint Center for Planetary Astronomy Postdoctoral Fellow: Division of Geological and Planetary Sciences, California Institute of Technology.
- *Host:* Professor Michael E. Brown.

2013–2017 Graduate Research Associate: Department of Planetary Science, University of Arizona.

2011–2013 Graduate Research/Teaching Assistant: Department of Planetary Science, University of Arizona.

2008–2010 Undergraduate Teaching Assistant: Department of Astronomy, University of Maryland, College Park.

II. EDUCATION

2017 Ph.D., Planetary Science: Department of Planetary Science, University of Arizona.
- *Thesis:* Tidal/rotational dynamics of solar system objects, from the Moon to Pluto.
- *Advisor:* Associate Professor Isamu Matsuyama.

2011 M.S., Planetary Science: Department of Planetary Science, University of Arizona.

2011 B.S., Astronomy (with high honors): Department of Astronomy, University of Maryland, College Park.
- *Thesis:* Modes of planetesimal-driven planet migration.
- *Advisor:* Professor Douglas P. Hamilton.

2011 B.S. Geology (with honors): Department of Geology, University of Maryland, College Park.
- *Thesis:* Lithospheric extension on icy satellites.
- *Advisor:* Associate Professor Laurent G. J. Montési.

III. RESEARCH GRANTS AND FELLOWSHIPS AWARDED

(Total amount awarded as PI or Science-PI: $475,482.)

2017–2020 NASA Solar System Workings (SSW): "Interior Structure, Stresses, and Tectonics of Planets." PI: Isamu Matsuyama, U. Arizona.
- *Role:* Co-Investigator.

2016–2019 NASA Solar System Workings (SSW): "True Polar Wander of Terrestrial Planets and its Implications for the Long-Term Stability of Polar Volatiles."
- *Role:* Science-Principal Investigator.
- *Total award:* $382,982.

2016 University of Arizona Theoretical Astrophysics Program Small Matching Grant.
- *Total award:* $1,000.

2015 University of Arizona Theoretical Astrophysics Program Small Matching Grant.

– *Total award:* $1,500.

2013–2016 NASA Earth and Space Science Fellowship (NESSF): "Stability of Asteroid Regolith during Planetary Close Approaches."
– *Role:* Graduate Student Fellow.
– *Total award:* $90,000.

IV. PLANETARY EXPLORATION

(Activities that are directly related to NASA planetary exploration missions, mission development, or strategy.)

2018–present Io Volcano Observer (IVO): IVO (PI: Alfred McEwen, U. Arizona) is a NASA Discovery-class mission concept for exploring Jupiter's volcanic moon, Io, and answering fundamental questions about tidal heating and extreme volcanism.
– *Role:* Co-Investigator.

2018 Keck Institute for Space Studies (KISS): "Tidal Heating: Lessons from Io and the Jovian System": An invitation-only, week-long "think-tank" program aimed at developing new, innovative, and revolutionary mission concepts for understanding tidal heating. Team leads: Katherine de Kleer (Caltech), Alfred McEwen (U. Arizona), Ryan Park (JPL).
– *Roles:* Co-author of proposal and program participant.

2018 Keck Institute for Space Studies (KISS): "Large Constellations and Formations for Exploring Interstellar Objects and Long-Period Comets": An invitation-only, week-long "think-tank" program aimed at developing new, innovative, and revolutionary mission concepts for exploring Oort cloud comets and interstellar visitors (e.g., 1I/'Oumuamua). Team leads: Julie Castillo-Rogez (JPL), Soon-Jo Chung (Caltech), Karen Meech (U. Hawai'i).
– *Role:* Program participant.

2018 Keck Institute for Space Studies (KISS): "Lunar Challenges: Concept Generation": An invitation-only, one-day "think-tank" program aimed at developing new, innovative, and revolutionary mission concepts for lunar science and exploration. Study lead: Brent Sherwood (JPL).
– *Role:* Program participant.

2017–present New Horizons: New Horizons (PI: Alan Stern, SwRI) is a NASA New Frontiers-class mission to explore the Kuiper Belt—including Pluto and the first flyby of a cold classical Kuiper belt object, (486958) MU_{69}.
– *Roles:* science team contributor to the Geology and Geophysics Investigation (GGI) and Composition (COMP) teams, and the mission illustrator.

2016 Lunar Reconnaissance Orbiter (LRO): LRO is a NASA mission currently orbiting and studying the Moon.
– *Role:* Contributor to the Extended Science Mission (ESM3) proposal

2014–2017 Gravity Recovery and Interior Laboratory (GRAIL): GRAIL (PI: Maria Zuber, MIT) was a NASA Discovery-class mission that measured the gravity field of the Moon.
– *Role:* Graduate student member of the science team.

2014 NASA/JPL Planetary Science Summer School: Five-month long mission concept study developing a New Frontiers-class mission concept for exploring Jupiter's volcanic moon, Io.
– *Roles:* Science lead for the Interiors and Geophysics working group, principal investigator of the laser altimetry instrument, co-investigator of the gravity science experiment, and attitude control subsystem chair.

2013–2015 Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx): OSIRIS-REx (PI: Dante Lauretta, U. Arizona) is a NASA New Frontiers-class asteroid sample return mission.
– *Role:* Community and public engagement volunteer, developing the *321Science* YouTube series.

V. HONORS AND AWARDS

(Total amount awarded: $11,600.)

2018 Editor's Citation for Excellence in Refereeing: *Geophysical Research Letters*.

2018 Travel Stipend Award: New Views of the Moon 2—Asia, USRA/Lunar and Planetary Institute.
– *Award:* $2,500.

2017 Pellas-Ryder Award: Best student paper (Keane et al. 2016, *Nature*), Geological Society of America, Division of Planetary Geology.
– *Award:* $500.

2017 Galileo Circle Scholar: College of Science, University of Arizona.
– *Award:* $1,000.

2016 Galileo Circle Scholar: College of Science, University of Arizona.
– *Award:* $1,000.

2016 Eugene M. Shoemaker Impact Cratering Award: Geological Society of America, Division of Planetary Geology.
– *Award:* $2,500.

2015 SSERVI ESF Student Poster Award: Solar System Exploration Research Virtual Institute, Exploration Science Forum.
– *Award:* $1,000.

2015 Gerard P. Kuiper Memorial Award: Department of Planetary Science, University of Arizona.
– *Award:* $1,000.

2014 AGU Outstanding Student Paper Award (OSPA): American Geophysical Union Fall Meeting.
– *Award:* $1,000.

2016 Galileo Circle Scholar: College of Science, University of Arizona.
– *Award:* $1,000.

2014 Best Graduate Student Talk Award: Department of Planetary Science, University of Arizona.

2014 Service and Outreach Award: Department of Planetary Science, University of Arizona.
– *Award:* $100.

2013 Graduate Student Talk—Honorable Mention: Department of Planetary Science, University of Arizona.

VI. PEER-REVIEWED PUBLICATIONS

(3 first author publications, plus 1 in review† and 2 in preparation‡;
13 co-author publications, plus 2 in review†.)

2019‡ **Keane, J.T.**, Johnson, B.C., Matsuyama, I., Siegler, M.A. The wibbly-wobbly Moon: rotational dynamics of the Moon in the aftermath of large impacts. *Journal of Geophysical Research: Planets*, in preparation.

2019‡ **Keane, J.T.**, de Kleer, K.R., Rathbun, J.A., Ahern, A.A., Radebaugh, J. Comprehensive spherical harmonic analysis of the spatial distribution of Io's volcanoes, mountains, heat flow, and other geologic phenomena. *Geophysical Research Letters*, in preparation.

2019† Bouley, S., **Keane, J.T.**, Baratoux, D., Langlais, B., Matsuyama, I., Costard, F., Hewins, R., Monnereau, M., Sautter, V., Séjourné, A, Vanderhaegue, O., Zanda, B. (2019). Mars without Impact Basins and Volcanoes. *Nature Geoscience*, in review.

2019† **Keane, J.T.**, Ermakov, A.I. No Evidence for True Polar Wander of Ceres from Dawn Gravity and Topography Data. *Nature Geoscience*, in review.

2019† Spencer, J.R., and 78 co-authors including **Keane, J.T.** (2019). The Geology and Geophysics of Kuiper Belt Object (486958) 2014 MU69. *Science*, in review.

2019† Spencer, J.R., and 45 co-authors including **Keane, J.T.** (2019). Color, Composition, and Thermal Environment of Transneptunian Object (486958) 2014 MU69. *Science*, in review.

2019 Stern, S.A., and 205 co-authors including **Keane, J.T.** (2019). Initial Results from the New Horizons Exploration of 2014 MU69, a small Kuiper Belt Object. *Science*, 649, eaaw9771.

2019 Cruikshank, D.P., Umurhan, O.M., Beyer, R.A., Schmitt, B., **Keane, J.T.**, Runyon, K.D., Atri, D., White, O.L., Matsuyama, I., Moore, J.M., McKinnon, W.B., Sandford, S.A., Singer, K.N., Grundy, W.M., Dalle Ore, C.B., Cook, J.C., Bertrand, T., Stern, S.A., Olkin, C.B., Weaver, H.A., Young, L.A., Spencer, J.R., Lisse, C.M., Binzel, R.P., Earle, A.M., Robbins, S.J., Gladstone, G.R., Cartwright, R.J., Ennico, K. (2019). Recent Cryovolcanism in Virgil Fossae on Pluto. *Icarus*, 330, 155-168.

2019 Cruikshank, D.P., Materese, C.K., Pendleton, Y.J., Boston, P.J., Grundy, W.M., Schmitt, C.M., Lisse, K.D., Runyon, K.D., **Keane, J.T.**, Beyer, R.A., Summers, M.E., Scipioni, F., Stern, S.A., Dalle Ore, C.M., Olkin, C.B., Young, L.A., Ennico, K., Weaver, H.A., Bray, V.J. (2019). Prebiotic Chemistry of Pluto. *Astrobiology*, 19.

2019 Beyer, R.A., Spencer, J.R., McKinnon, W.B., J.R., Nimmo, F., Beddingfield, C., Grundy, W.M., Ennico, K., **Keane, J.T.**, Moore, J.M., Olkin, C.B., Robbins, S., Runyon, K., Schenk, P., Singer, K.N, Stern, S.A.,

Weaver., H.A., Young, L.A., and the New Horizons Team (2019). The Nature and Origin of Charon's Smooth Plains. *Icarus*, 323, 16-32.

2019 White, O.L., Moore, J.M., Howard, A.D., McKinnon. W.B., **Keane, J.T.**, Singer, K.N., Bertrand, T., Robbins, S.J., Schenk, P.M., Schmitt, B., Buratti, B.J., Stern, S.A., Ennico, K., Olkin, C.B., Weaver, H.A., Young, L.A., and the New Horizons Team (2019). Washboard Terrain on Pluto Evinces Ancient Glaciation. *Nature Astronomy*, 3, 62-68.

2017 Andrews-Hanna, J.C., Head, J.W., Johnson, B.C., **Keane, J.T.**, Kiefer, W.S., McGovern, P.J., Neumann, G.A., Wieczorek, M.A., Zuber, M.T. (2017). Ring faults and ring dikes around the Orientale basin on the Moon. *Icarus*, 310, 1-20.

2016 **Keane, J.T.**, Matsuyama, I., Kamata, S., & Steckloff, J.K. (2016). Reorientation and faulting of Pluto due to volatile loading within Sputnik Planitia. *Nature*, 540, 90-93.

2016 Simon, M., Pascucci, I., Edwards, S., Feng, W., Gorti, U., Hollenbach, D., Rigliaco, E., & **Keane, J.T.** (2016). Tracing Slow Winds from T Tauri Stars via Low Velocity Forbidden Line Emission. *The Astrophysical Journal*, 831, 169-199.

2016 Zuber, M.T., Smith, D.E., Neumann, G.A., Goossens, S., Andrews-Hanna, J.C., Head, J.W., Kiefer, W.S., Asmar, S.W., Konopliv, A.S., Lemoine, F.G., Matsuyama, I., Melosh, H.J., McGovern, P.J., Nimmo, F., Phillips, R.J., Solomon, S.C., Taylor, G.J., Watkins, M.M., Wieczorek, M.A., Williams, J.G., Jansen, J.C., Johnson, B.C., **Keane, J.T.**, Mazarico, E., Miljković K., Park, R.S., Soderblom, J.M., Yuan, D.-N. (2016). Gravity Field of the Orientale Basin from the Gravity Recovery and Interior Laboratory Mission. *Science*, 354, 438-441.

2016 Johnson, B.C., Blair, D.M, Collins, G.S., Melosh, H.J., Freed, A.M., Taylor, G.J., Head, J.W., Wieczorek, M.A., Andrews-Hanna, J.C., Nimmo, F., **Keane, J.T.**, Miljković, K., Soderblom, J.M., & Zuber, M.T. (2016). Formation of the Orientale Lunar Multi-Ring Basin. *Science*, 354, 441-444.

2016 Matsuyama, I., Nimmo, F., **Keane, J.T.**, Chan, N.H., Taylor, G.J., Wieczorek, M.A., Kiefer, W.S., Williams, J.G. (2016). GRAIL, LLR, and LOLA constraints on the interior structure of the Moon. *Geophysical Research Letters*, 43, 8365-8375.

2016 Thompson, M.S., Zega, T.J., Becerra, P., **Keane, J.T.**, Byrne, S. (2016). The oxidation state of Fe nanoparticles in the lunar soil. *Meteoritics and Planetary Science*, 51, 1082-1095.

2016 Siegler, M.A. Miller, R.S., **Keane, J.T.**, Matsuyama, I., Paige, D.A., Poston, J., Lawrence, D.J. (2016). Lunar true polar wander inferred from polar hydrogen. *Nature*, 531, 480-484.

2014 **Keane, J.T.**, Matsuyama, I (2014). Evidence for lunar true polar wander and a past low-eccentricity synchronous lunar orbit. *Geophysical Research Letters*, 41, 6610-6619.

2014 **Keane, J.T.**, Pascucci, I., Espaillat, C., Woitke, P., Andrews, S., Kamp, I., Thi, W.-F., Meeus, G., Dent, W.R.F (2014). Herschel Evidence for Disk Flattening or Gas Depletion in Transitional Disks. *The Astrophysical Journal*, 787, 153-177.

VII. SCIENTIFIC ILLUSTRATIONS

(23 published scientific illustrations.)

2019 **Keane, J.T.** (2019). The geologic history of Bennu. *Nature Geoscience*, 12, 226.

2019 **Keane, J.T.** (2019). Stress in the neck of bilobate comets. *Nature Geoscience*, 12, 153.

2018 Thompson, A.F., Stewart, A.L., Spence, P., Heywood, K.J., The Antarctic Slope Current in a Changing Climate. *Reviews of Geophysics*, 56, 741-770.
- See Figure 1.

2018 Larochelle, S. Human-induced Earthquakes: A Blessing and a Curse. *Caltech Letters*, 13 November 2018.
- See Figure 4.

2018 **Keane, J.T.** (2018). Sketch-up: Haboobs on Titan. *Nature Geoscience*, 11, 705.

2018 **Keane, J.T.** (2018). Sketch-up: Volatile Siberian trap eruptions. *Nature Geoscience*, 11, 626.

2018 **Keane, J.T.** (2018). Sketch-up: A changeable day in the life of Venus. *Nature Geoscience*, 11, 465.

2018 **Keane, J.T.** (2018). Sketch-up: The rise and fall of the Great Barrier Reef. *Nature Geoscience*, 11, 338.

2019 Beyer, R.A., Spencer, J.R., McKinnon, W.B., J.R., Nimmo, F., Beddingfield, C., Grundy, W.M., Ennico, K., **Keane, J.T.**, Moore, J.M., Olkin, C.B., Robbins, S., Runyon, K., Schenk, P., Singer, K.N, Stern, S.A., Weaver., H.A., Young, L.A., and the New Horizons Team (2019). The Nature and Origin of Charon's Smooth Plains. *Icarus*, 323, 16-32.

"Sketch-Ups" are illustrated summaries of Nature Geoscience articles that are published as their own "News and Views" articles.

– See Figure 18.

2018 InSight: A look inside Mars. *BBC News*, 5 May 2018.

2018 Batygin, K. (2018). On the terminal rotation rates of giant planets. *The Astronomical Journal* 155, 178-185.

– See Figure 2.

2018 **Keane, J.T.** (2018). Sketch-up: Gravitational pulse of an earthquake. *Nature Geoscience*, 11, 305.

2019 Cruikshank, D.P., Materese, C.K., Pendleton, Y.J., Boston, P.J., Grundy, W.M., Schmitt, C.M., Lisse, K.D., Runyon, K.D., **Keane, J.T.**, Beyer, R.A., Summers, M.E., Scipioni, F., Stern, S.A., Dalle Ore, C.M., Olkin, C.B., Young, L.A., Ennico, K., Weaver, H.A., Bray, V.J. (2019). Prebiotic Chemistry of Pluto. *Astrobiology*, 19.

– See Figure 6.

2018 **Keane, J.T.** (2018). Sketch-up: Wandering exoplanets. *Nature Geoscience*, 11, 152.

2018 **Keane, J.T.** (2018). Sketch-up: Catastrophic glacier collapse. *Nature Geoscience*, 11, 87.

2018 Batygin, K. (2018). Schrödinger evolution of self-gravitating disks. *Monthly Notices of the Royal Astronomical Society*, 475, 5070-5084.

– Figure created for press release graphics (example).

2017 **Keane, J.T.** (2017). Sketch-up: Intra-Plate volcanism. *Nature Geoscience*, 11, 8.

2017 **Keane, J.T.** (2017). Sketch-up: Carbon at continental rifts. *Nature Geoscience*, 10, 886.

2017 **Keane, J.T.** (2017). Sketch-up: Southern Ocean mixing. *Nature Geoscience*, 10, 805.

2017 **Keane, J.T.** (2017). Sketch-up: Impact-induced subduction. *Nature Geoscience*, 10, 716.

2017 **Keane, J.T.** (2017). Artwork for editorial, "Moving beyond Cassini," *Nature Astronomy*, 1, 557.

2017 **Keane, J.T.** (2017). Cover artwork for the Cassini grand finale issue, *Nature Astronomy*, 1, Issue 9.

2017 **Keane, J.T.** (2017). Sketch-up: Snowstorms on Mars. *Nature Geoscience*, 10, 625.

VIII. INVITED PRESENTATIONS, SEMINARS, COLLOQUIA

(11 invited presentations.)

2019 Jet Propulsion Laboratory, Planetary Science Seminar: "Geophysics at the Edge of the Solar System: New Horizons at 2014 MU69."

2019 Interior of the Earth, Gordon Research Seminar: "Sketch your science."

2019 Western Washington University, Department of Earth, Atmospheric, and Planetary Sciences Colloquium: "The Wibbly Wobbly Moon: Rotational Dynamics of the Moon and its Implications for Polar Volatiles, Magnetic Fields, and More."

2019 Western Washington University, Departments of Geology and Physics & Astronomy, Research Seminar: "The Wibbly Wobbly Moon: Rotational Dynamics of the Moon and its Implications for Polar Volatiles, Magnetic Fields, and More."

2019 Western Washington University: "The Wibbly Wobbly Moon: Rotational Dynamics of the Moon and its Implications for Polar Volatiles, Magnetic Fields, and More."

2018 Technologies for Exo-Planetary Science, University of British Columbia: "Planetary Dynamics."

2018 University of Texas Institute for Geophysics (UTIG) Seminar: "Rotational Dynamics of the Moon over Time."

2018 California Institute of Technology, Dix Planetary Science Seminar: "The Wibbly-Wobbly Moon: Rotational Dynamics of the Moon over Time."

2018 University of California Santa Cruz, Institute of Geophysics and Planetary Physics Seminar: "The Wibbly-Wobbly Moon: Rotational Dynamics of the Moon over Time."

2017 California Institute of Technology, Yuk Yung Lunch Seminar: "Pluto followed its heart: reorientation and faulting of Pluto due to volatile loading in Sputnik Planitia."

2015 Lowell Observatory Colloquium: "Tidal/Rotational Dynamics of the Moon and Near-Earth Asteroids."

IX. BOOK CHAPTERS

(1 submitted† and 2 in preparation‡.)

2020‡ Parker, A.H., Protopapa, S., Bannister, M.T., Lawler, S. **Keane, J.T.** (2020). The Kuiper Belt in the Pluto Context, in *Pluto After New Horizons*.

2019‡ **Keane, J.T.**, Rhoden, A.R. (2019). Tectonics Caused by Changes in Figure, in *Planetary Tectonism*

across the Solar System (Editors: Collins, G.C., Klimczak, C.). Anticipated publication by Elsevier in 2019.

2019† Andrews-Hanna, J.C., Weber, R.C., Garrick-Bethell, I., Evans, A.J., Kiefer, W.S., Grimm, R.E., **Keane, J.T.**, Laneuville, M., Ishihara, Y., Kamata, S., Matsuyama, I. (2019). The Structure and Evolution of the Lunar Interior, in *New Views of the Moon 2* (Editors: Gaddis, L.R., Jolliff, B.L., Lawrence, S.J., Mackwell, S.J., Neal, C.R., Shearer, C.K.). Anticipated publication by the Mineralogical Society of America in 2019.

X. CONFERENCE PRESENTATIONS

(30 first author conference proceedings and 35 co-author conference proceedings.)

2019 **Keane, J.T.**, Bierson, C.J., Lisse, C.M., Showalter, M.W., Stansberry, J.A., Umurhan, O.M., Moore, J.M., McKinnon, W.B., Verbiscer, A.J., Parker, J.W., Olkin, C.B., Weaver, H.A., Spencer, J.R., Stern, S.A., and the New Horizons Geology, Geophysics, and Imaging Team (2019). Gravity, Rotation, and Hill Slopes of 2014 MU69. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 **Keane, J.T.**, Verbiscer, A.J., Parker, J.W., Olkin, C.B., Weaver, H.A., Spencer, J.R., Stern, S.A., and the New Horizons Science Team (2019). The Illustrated Guide to the New Horizons Flyby of 2014 MU69. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Bills, B.G., Keane, J.T. (2019). Mars Obliquity Variations are Both Non-Chaotic and Possibly Fully Damped. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Bouley, S., **Keane, J.T.**, Baratoux, D., Langlais, B., Matsuyama, I., Costard, F., Hewins, R., Monnereau, M., Sautter, V., Séjourné, A, Vanderhaegue, O., Zanda, B. (2019). Crustal Structure of Early Mars Without Impact Basins and Volcanoes. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Bierson, C.J., Umurhan, O.M., Robbins, S.J., Lisse, C.M., Nimmo, F., Beyer, R.A., Schenk, P., **Keane, J.T.**, Moore, J.M., McKinnon, W.B., Verbiscer, A.J., Parker, J., Olkin, C.B., Weaver, H.A., Spencer, J.R., Stern S.A., and the New Horizons Geology, Geophysicsa, and Imaging Team (2019). Limb Topography of 2014 MU69: First Results from the New Horizons Flyby. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Binzel, R.P., Earle, A.M., Grundy, W.M., Moore, J.M., Stern, S.A., Spencer, J.R., Young, L.A., Olkin, C.B., Parker, J.W., Verbiscer, A.J., Weaver, H.A., Cheng, A., Reuter, D.C., Buie, M.W., Cruikshank, D.P., Stansberry, J.A., Schmitt, B., McKinnon, W.B., Schenk, P.M., Lisse, C.M., Zangari, A.M., Keane, J.T., Umurhan, O.M., Britt, D., Bagenal, F., and the New Horizons Composition and Geology, Geophysics, and Imaging Teams (2019). Highly Localized Seasonal Cold-Trapping in the Neck of 2014 MU69 "Ultima Thule." 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Dhingra, R.D., White, O.L., Umurhan, O.M., Banks, M.E., Moore, J.M., **Keane, J.T.**, Singer, K.N., McKinnon, W.B., Schenk, P.M., Bray, V.J., Robbins, S.J., Spencer, J.R., Stern, S.A., Lisse, C.M., Beyer, R.A., Beddingfield, C.B., Lauer, T.R., Weaver, H.A., Kavelaars, J.J., Young, L.A., Olkin, C.B., Parker, J.W., Verbiscer, A.J., Barnes, J.W., the New Horizons Geology, Geophysics, and Imaging Science Team, the New Horizons Ralph Team, and the New Horizons LORRI Team (2019). Kuiper Belt Object 2014 MU69: Correlation between Albedo and Landforms. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Kinczyk, M.J., Robbins, S.J., **Keane, J.T.**, Grundy, W.M., Throop, H.B., Bierson, C.J., Beddingfield, C.B., Beyer, R.A., White, O.L., Moore, J.M., Schenk, P., Lauer, T.R., McKinnon, W.B., Verbiscer, A.J., Parker, J.W., Olkin, C.B., Weaver, H.A., Spencer, J.R., Stern, S.A., and the New Horizons Geology, Geophysics, and Imaging Team (2019). Generating a 3D Shape Model of 2014 MU69 for Scientific Visualization and Public Outreach. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 McKinnon, W.B., Stern, S.A., Weaver, H.A., Spencer, J.R., Buie, M.W., Beyer, R.A., Bierson, C.J., Binzel, R.P., Britt, D., Cruikshank, D.P., Hamilton, D.P., Howett, C.J.A., **Keane, J.T.**, Lauer, T.R., Kavelaars, J.J., Parker, A.H., Parker, J.W., Porter, S.B., Robbins, S.J., Schenk, P.M., Showalter, M.R., Singer, K.N., Umurhan, O.M., White, O.L., Moore, J.M., Grundy, W.M., Gladstone, G.R., Olkin, C.B., Verbiscer, A.J., and the New Horizons Science Team (2019). A Pristine "Contact Binary" in the Kuiper Belt: Implications from the New Horizons Encounter with 2014 MU69 ("Ultima Thule"). 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Moore, J.M., McKinnon, W.B., Spencer, J.R., Stern, S.A., Binzel, R.P., Britt, D., Buie, M.W., Buratti, B.J., Cheng, A.F., Grundy, W.M., Kavelaars, J.J., Linscott, I.R., Porter, S.B., Reitsema, H.J., Schenk, P.M., Showalter, M.R., Singer, K.N., Young, L.A., Zangari, A.M., Weaver, H.A., Olkin, C.B., Parker, J.W., Verbiscer, A.J., Beddingfield, C., Beyer, R.A., Bierson, C.J., Bray, V.J., Chaikin, A., Chavez, C.L., Dhingra, R.D., El-Maarry, M.R., **Keane, J.T.**, Hamilton, D.P., Hofgartner, J.D., Kinczyk, M., Lauer, T.R., Lisse, C.M., Nimmo, F., Robbins, S.J., Runyon, K.D., Stryk, T., Throop, H., Umurhan, O.M., White, O.L., and the New Horizons Science Team (2019). The Geology of 2014 MU69 ("Ultima Thule"): Initial Results from the New Horizons Encounter. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Park, R.S., de Kleer, K.R., McEwen, A.S., Bierson, C.J., Davies, A.G., Della Giustina, D., Ermakov, A.I., Fuller, J., Hamilton, C.W., Harris, C.D.K., Hay, H., Jacobsen, R.A., **Keane, J.T.**, Kestay, L., Khurana, K., Kirby, K., Lainey, V., Matsuyama, I., McCarthy, I., Nimmo, F., Panning., M., Pommier, A., Rathbun, J.A., Steinbrügge, G., Stevenson, D.J., Tsai, V.C., Turtle, E.P. (2019). Tidal Heating: Lessons from Io and the Jovian System (Report from the KISS Workshop). 49th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Robbins, S.J., **Keane, J.T.**, Kinczyk, M.J., Runyon, K.D., Beddingfield, C.B., Beyer, R.A., Grundy, W.M., Moore, J.M., McKinnon, W.B., Schenk, P., Lauer, T.R., Binzel, R.P., Verbiscer, A.J., Parker, J., Olkin, C.B., Weaver, H.A., Spencer, J.R., Stern, S.A., and the New Horizons Geology, Geophysics, and Imaging Science Team (2019). Using Computer-Generated Imagery (CGI) for Science and Outreach on Missions: New Horizons's Encounter with the Pluto-Charon System and (486958) 2014 MU69. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Umurhan, O.M., Kavelaars, J.J., Cuzzi, J.N., McKinnon, W.B., Lyra, W., Hartlep, T., Hofgartner, H., Showalter, MR., Estrada, P.R., Moore, J.M., Bierson, C.J., Dhingra, R.D., **Keane, J.T.**, White, O.L., Grundy, W.M., Lisse, C.M., Verbiscer, A.J., Parker, J.W., Olkin, C.B., Weaver, H.A., Spencer, J.R., Stern, S.A., and the New Horizons Geology, Geophysics, and Imaging Team (2019). Ultima Thule: Possible Gravitational Collapse Scenarios for its Origin. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2019 Zangari, A.M., Beddingfield, C.B., Benecchi, S.D., Beyer, R.A., Bierson, C.J., Buie, M.W., Dhingra, R.D., El-Maarry, M.R., Kavelaars, J.J., **Keane, J.T.**, Kinczyk, M.J., Lauer, T.R., McKinnon, W.B., Moore, J.M., Olkin, C.B., Parker, A.H., Parker, J.W., Porter, S.B., Robbins, S.J., Runyon, K.D., Showalter, M.R., Spencer, J.R., Stern, S.A., Umurhan, O.M., Verbiscer, A.J., Weaver, H.A., and the New Horizons Geology, Geophysic, and Imaging Science Theme Team (2019). The Mysterious Missing Light Curve of (486958) 2014 MU69, a Bi-Lobate Contact Binary Visited by New Horizons. 50th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2018 **Keane, J.T.**, de Kleer, K., Rathbun, J., Ahearn A.A., Radebaugh, J. (2018). Comprehensive spherical harmonic analysis of Io's volcanoes, mountains, heat flow, and other geologic phenomena. American Geophysical Union Fall Meeting, Washington, DC, USA.

2018 McCarthy, C., McEwen, A.S., de Kleer, K., Park, R.S., Bierson, C.J., Guistina, D.D., Khurana, K.K., Davies, A.G., Ermakov, A., Fuller, J., Hamilton, C.W., Harris, C.D.K., Hay, H., Helbert, J., Hibbard, K., Jacobson, R.A., **Keane, J.T.**, Lainey, V., Mackwell, S.J., Matsuyama, I., Nimmo, F., Panning, M.P., Rathbun, J., Showman, A.P., Steinbrügge, G., Tsai, V.C., Stevenson, D.J., Turtle, E.P. (2018). How do planetary bodies respond to periodic tidal forcing and how does that influence heat flow and orbital evolution? – Report from the KISS Workshop entitled "Tidal Heating-Lessons from Io and the Jovian System". American Geophysical Union Fall Meeting, Washington, DC, USA.

2018 McEwen A.S., and the IVO Science Team including **Keane. J.T** (2018). The Io Volcano Observer (IVO): Investigating the Solar System's most tidally heated and volcanically active world. American Geophysical Union Fall Meeting, Washington, DC, USA.

2018 Hamilton, C.W., McEwen, A.S., Turtle, E., Keszthelyi, L.P., **Keane, J.T.**, Davies, A.G., Nimmo, F., Khurana, K.K., Thomas, N., Park, R.S. (2018). The Io Volcano Observer (IVO): A NASA Discovery Mission Concept to Investigate Tidal Heating. Geological Society of America annual meeting, Indianapolis, Indiana, USA.

2018 **Keane, J.T.**, de Kleer, K., Rathbun, J. (2018). Comprehensive spherical harmonic analysis of Io's volcanoes, mountains, heat flow, and other geologic phenomena. 50th Division for Planetary Sciences Meeting, Knoxville, Tennessee, USA.

2018 Cruikshank, D., Umurhan, O.M., Moore, J.M., Grundy, W.M., McKinnon, W.B., Dalle Ore, C.M.,

Schmitt, B., Beyer, R.A., Runyon, K.D., Nimmo, F., Howard, A.D., Stern, S.A., **Keane, J.T.**, Cartwright, R., White, O.L., Spencer, J.R., Binzel, R.P., Olkin, C.B., Weaver, H.A., Young, L.A., Ennico, K., Lisse, C.M. (2018). Recent cryovolcanism on Pluto. 50th Division for Planetary Sciences Meeting, Knoxville, Tennessee, USA.

2018 Pendelton, Y., Cruikshank, D.P., Materese, C.K., Boston, P.J., Beyer, R.A., Bray, V.J., Dalle Ore, C.M., Ennico, K., Grundy, W.M., **Keane, J.T.**, Lisse, C.M., Olkin, C.B., Runyon, K.D., Schmitt, B., Scipioni, F., Stern, S.A., Summers, M.E., Weaver, H.A., Young, L.A. (2018). Prebiotic chemistry of Pluto. 50th Division for Planetary Sciences Meeting, Knoxville, Tennessee, USA.

2018 Stansberry, J.A., Young, L.A., Lunine, J.I., Trafton, L.M., Grundy, W.M., Spencer, J.B., McKinnon, W.B., Nimmo, F., Schenk, P.M., Moore, J.M., **Keane, J.T.**, Ennico, K., Olkin, C.B., Stern, S.A., Weaver, H.A. (2018). Long-term Evolution of Sputnik Planitia: Cryo-clastic Eruptions and their Implications. 50th Division for Planetary Sciences Meeting, Knoxville, Tennessee, USA.

2018 Beyer, R.A., Spencer, J.B., McKinnon, W.B., Nimmo, F., Beddingfield, C., Grundy, W.M., Ennico, K., **Keane, J.T.**, Moore, J.M., Olkin, C.B., Robbins, R., Runyon, K.D., Schenk, P.M., Singer, K.N., Stern, S.A., Weaver, S.A., Young, L.A. (2018). The Nature and Origin of Charon's Smooth Plains. 50th Division for Planetary Sciences Meeting, Knoxville, Tennessee, USA.

2018 **Keane, J.T.**, Matsuyama, I. (2018). True Polar Wander of Mercury. Mercury: Current and Future Science of the Innermost Planet, Columbia, MD, USA.

2018 **Keane, J.T.**, Johnson, B.C., Matsuyama, I. Siegler, M.A. (2018). The Wibbly-Wobbly Moon: Rotational Dynamics of the Moon after Large Impacts. New Views of the Moon 2: Asia, Aizuwakamatsu City, Fukushima, Japan.

2018 **Keane, J.T.**, Johnson, B.C., Matsuyama, I. Siegler, M.A. (2018). The Tumbling Moon: Rotational Dynamics in the Aftermath of Impact Basin Formation. 49th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2018 **Keane, J.T.** (2018). Pluto and Ceres—Illustrated. 49th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2018 Ledbetter, W.G., Sood, R., **Keane, J.T.** (2018). The Interior Structure of Asteroids and Comets Revealed by ChipSat Swarm Gravimetry. 49th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2017 **Keane, J.T.**, Johnson, B.C., Matsuyama, I. Siegler, M.A. (2017). The Wibbly-Wobbly Moon: Rotational Dynamics of the Moon after Large Impacts. 49th Division for Planetary Sciences Meeting, Provo, Utah, USA.

2017 **Keane, J.T.**, Johnson, B.C., Matsuyama, I. Siegler, M.A. (2017). The Wibbly-Wobbly Moon: Rotational Dynamics of the Moon after Large Impacts. American Geophysical Union Fall Meeting, New Orleans, LA, USA.

2017 **Keane, J.T.**, Matsuyama, I. (2017). Reorientation Histories of the Moon, Mercury, Venus, and Mars. 12th European Planetary Science Congress, Riga, Latvia.

2017 **Keane, J.T.**, Matsuyama, I. (2017). Reorientation Histories of the Moon, Mercury, Venus, and Mars. 48th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2016 **Keane, J.T.**, Matsuyama, I. (2017). Reorientation Histories of the Terrestrial Planets. American Geophysical Union Fall Meeting, San Francisco, CA, USA.

2016 Matsuyama, I., **Keane, J.T.**, Kamata, S. (2016). Global-scale tectonic patterns on Pluto. American Geophysical Union Fall Meeting, San Francisco, CA, USA.

2016 **Keane, J.T.**, Matsuyama, I., Kamata, S., Steckloff, J. (2016). Pluto followed its heart: reorientation and faulting of Pluto due to volatile loading in Sputnik Planum. Joint 48th Division for Planetary Sciences & 11th European Planetary Science Congress Meeting, Pasadena, CA, USA.

2016 Matsuyama, I., **Keane, J.T.** (2016). Cassini State Transitions with a Fossil Figure. Joint 48th Division for Planetary Sciences & 11th European Planetary Science Congress Meeting, Pasadena, CA, USA.

2016 **Keane, J.T.**, Matsuyama, I., Kamata, S., Steckloff, J.K. (2016). Pluto Followed its Heart: Reorientation and Faulting of Pluto due to Volatile Loading in Sputnik Planum. Geologic Society of America Annual Meeting, Denver, CO, USA.

2016 **Keane, J.T.**, Matsuyama, I., Siegler, M.A. (2016). Impact-Driven True Polar Wander of the Moon and its Implications for the Long-Term Stability of Polar Volatiles. Geologic Society of America Annual Meeting, Denver, CO, USA.

2016 **Keane, J.T.**, Matsuyama, I., Siegler, M.A. (2016). New Insights into Lunar True Polar Wander. New Views of the Moon 2, Houston, TX, USA.

2016 Matsuyama, I., Nimmo, F., **Keane, J.T.**, Taylor, G.J., Chan, N.H., Williams, J.G., Wieczorek, M.A., Kiefer, W.S. (2016). GRAIL, LLR, and LOLA Constraints on the Interior Structure of the Moon. New Views of the Moon 2, Houston, TX, USA.

2016 **Keane, J.T.**, Matsuyama, I. (2016). Pluto followed its Heart: True Polar Wander of Pluto due to the Formation and Evolution of Sputnik Planum. 47th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2016 Siegler, M.A., **Keane, J.T.**, Laneuville, M., Chen, Y., Economos, R. (2016). Do Lunar Volatiles Record the Geophysical Evolution of the Moon? 47th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2015 **Keane, J.T.**, Siegler, M. A., Miller, R., Matsuyama, I., Paige, D. A., Poston, J., Lawrence, D. J. (2015). Hidden in the neutrons: physical evidence for lunar true polar wander. American Geophysical Union Fall Meeting, San Francisco, CA, USA.

2015 **Keane, J.T.**, Siu, H.C., Moskovitz, N.A., Binzel, R.P. (2015). Surprise! The oft-ignored Moon might actually be important for changing the spins of asteroids during Earth flybys. 47th Meeting for the Division for Planetary Sciences, National Harbor, MD, USA.

2015 Siu, H.C., **Keane, J.T.**, Siu, H.C., Moskovitz, N.A., Binzel, R.P. (2015). Effects of Earth Encounters on the Rotational Properties of Near-Earth Objects. 47th Meeting for the Division for Planetary Sciences, National Harbor, MD, USA.

2015 **Keane, J.T.**, Siegler, M. A., Miller, R., Matsuyama, I., Paige, D. A., Poston, J., Lawrence, D. J. (2015). Hidden in the neutrons: physical evidence for lunar true polar wander. SSERVI Exploration Science Forum, NASA Ames, Mountain View, CA, USA.

2015 **Keane, J.T.**, Matsuyama, I. (2015). Cleaning up degree-2: the contribution of impact basins and mascons to the gravity fields of the Moon, Mercury, and other terrestrial planets. 46th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2015 Siegler, M. A., Miller, R., **Keane, J.T.**, Matsuyama, I., Paige, D. A., Poston, J., Lawrence, D. J. (2015). Hidden in the neutrons: physical evidence for lunar true polar wander. 46th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2015 Thompson, M. S., Zega, T. J., **Keane, J.T.**, Becerra, P., Byrne, S. (2015). The oxidation state of Fe nanoparticles in the lunar soil: implications for space weathering processes. 46th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2015 Marcucci, E., Hays, L., Holstein-Rathlou, C., **Keane, J.T.**, Becerra, P., Basu, K., Davis, B., Fox, V.K., Herman, J.F.C., Hughes, A., Mendez Ramos, E., Nelessen, A., Neveu, M., Parrish, N.L., Scheinberg, A.L., Wrobel, J.S. (2015). Argus: a concept study for an Io observer mission from the 2014 NASA/JPL Planetary Science Summer School. 46th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2015 Zuber, M. T., Smith, D. E., Goosens, S. J., Andrews-Hanna, J., Head, J. W., Kiefer, W. S., Asmar, S. W., Konopliv, A. S., Lemoine, F. G., Matsuyama, I., McGovern, P. J., Melosh, H. J., Neumann, G. A., Nimmo, F., Phillips, R. J., Solomon, S. C., Taylor, G. J., Watkins, M. M., Wieczorek, M. A., Johnson, B. C., **Keane, J.T.**, Milkjović, K., Park, R. S., Soderblom, J. M., Blair, D. M., Mazarico, E., Yuan, D.-N. (2015). Gravity field of the Orientale Basin from the Gravity Recovery And Interior Laboratory (GRAIL). 46th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2015 **Keane, J.T.**, Matsuyama, I. (2015). Rejuvenating asteroids during planetary flybys: applications to (99942) Apophis and other near-Earth asteroids. 46th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2014 **Keane, J.T.**, Matsuyama, I. (2014). The Contribution of Impact Basins and Mascons to the Lunar Figure: Evidence for Lunar True Polar Wander and a Past Low-Eccentricity, Synchronous Lunar Orbit. American Geophysical Union Fall Meeting, San Francisco, CA, USA.

2014 Hays, L.E., Holstein-Rathlou, C., Becerra, P., Basu, K., Davis, B., Fox, V.K., Herman, J.F.C., Hughes, A.C.G., **Keane, J.T.**, Marcucci, E., Mendez Ramos, E., Nelessen, A., Neveu, M., Parrish, N.L., Scheinberg, A.L., Wrobel, J.S. (2014). Argus: an Io observer concept study from the 2014 NASA/JPL Planetary Science Summer. American Geophysical Union Fall Meeting, San Francisco, CA, USA.

2014 **Keane, J.T.**, Matsuyama, I. (2014). Rejuvinating NEOs: The Efficiency of Asteroid Resurfacing via Planetary Flybys. 46th Meeting for the Division for Planetary Sciences, Tucson, AZ, USA.

2014 Molaro, J., **Keane, J.T.**, Peacock, S., Schaefer, E., Tanquary, H. (2014). The Art of Planetary Science: An Exhibition – Bringing Together the Art and Science Communities to Engage the Public. 46th Meeting for

the Division for Planetary Sciences, Tucson, AZ, USA.

2014 Becerra, P., Holstein-Rathlou, C., Hays, L., **Keane, J.T.**, Neveu, M., Basu, K., Davis, B., Mendez Ramos, E., Nelessen, A. Fox, V.K., Herman, J.F.C., Parrish, N.L., Hughes, A.C., Marcucci, E., Scheinberg, A., Wrobel, J.S. (2014). Argus: a concept study for an Io observer mission from the 2014 NASA/JPL Planetary Science Summer School. 46th Meeting for the Division for Planetary Sciences, Tucson, AZ, USA.

2014 Spitz, A., Dykhuis, M., Platts, S., **Keane, J.T.**, Tanquary, H.E., Zellem, R., Hawley, T., Lauretta, D.S., Beshore, E., Bottke, W.F., Hergenrother, C., Dwornik, J.P., Patchell, R., Spitz, S.E., Bentley, Z. (2014). Communicating Science on YouTube and Beyond: OSIRIS-REx Presents 321Science! 46th Meeting for the Division for Planetary Sciences, Tucson, AZ, USA.

2014 **Keane, J.T.**, Matsuyama, I. (2014). The Contribution of Mascons to the Lunar Figure. 45th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2014 **Keane, J.T.**, Matsuyama, I. (2014). Hill Slope Failure as a Mechanism to Resurface Asteroids During Planetary Flybys. 45th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2014 Molaro, J., **Keane, J.T.** (2014). The Art of Planetary Science: an Exhibition – Bringing Together the Art and Science Communities to Engage the Public. 45th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2014 Spitz, A. H., Dykhuis, M., Platts, S., **Keane, J.T.**, Roper, H., Bentley, Z., Pachell, R., Spitz, S.E., (2014). OSIRIS-REx Launches 321Science – Engaging the Public in Science and Engineering Through YouTube Videos. 45th Lunar and Planetary Science Conference, The Woodlands, TX, USA.

2013 **Keane, J.T.**, Matsuyama, I. (2013). The Contribution of Mascons to the Lunar Figure. American Geophysical Union Fall Meeting, San Francisco, CA, USA.

2013 **Keane, J.T.**, Matsuyama, I. (2013). Hill Slope Failure as a Mechanism to Resurface Asteroids During Planetary Flybys. 45th Meeting for the Division for Planetary Sciences, Denver, CO, USA.

2013 **Keane, J.T.**, Pascucci, I., Andrews, S. M., Dent, W.R.F., Espaillat, C. Meeus, G., Thi, W.-F., Woitke, P. (2013). From Classical Disks to Transition Disks: An Increasing Dust-to-Gas Ratio? 221st Meeting of the American Astronomical Society, Long Beach, CA, USA.

XI. SELECTED PRESS RELEASES AND NEWS ARTICLES

(Press releases and news articles either about my science, outreach, or broader engagement.)

2018 The wibbly wobbly Moon, Nola Taylor Redd, *Astronomy Magazine*, 26 February 2018.

2017 #DPS17: Wobbling the Moon and art by James Tuttle Keane, Emily Lakdawalla, *The Planetary Society Blog*, 24 October 2017.

2018 Chalk One Up for Science, *Caltech Magazine*, Fall 2018.

2018 Touring the Solar System with Science Art, Kimberly M.S. Cartier, *EOS*, 22 May 2018.

2018 Thumbs Up Viz: Handcrafted, Robert Simmon, *Medium*, 4 February 2018.

2016 Planetary science: Pluto's telltale heart, Amy C. Barr, *Nature*, News & Views, 1 December 2016.

2016 NASA's New Horizons Unveils Its Masterpiece: Pluto's Interior! Ethan Siegel, *Forbes*, 22 November 2016.

2016 Pluto's icy heart may hide an underground ocean, Sarah Kaplan, The *Washington Post*, 16 November 2016.

2016 Pluto has a cold, wandering heart, and maybe a hidden ocean too, Deborah Netburn, *Los Angeles Times*, 16 November 2016.

2016 Pluto's heart holds key to ocean beneath icy surface, Traci Watson, *USA Today*, 16 November 2016.

2016 A Hidden Ocean Beneath Pluto's Icy Heart, Rebecca Boyle, *The Atlantic*, 16 November 2016.

2016 Pluto's Frozen Heart may hide an Ocean Inside, Sarah Fecht, *Popular Science*, 16 November 2016.

2016 Pluto's icy surface may conceal a vast ocean, say researchers, Nicola Davis, *The Guardian*, 16 November 2016.

2016 A Heavy Heart May Have Rolled Pluto Over, Kenneth Chang, *The New York Times*, 16 November 2016.

2016 How Pluto Got Its Mysterious Heart, Maddie Stone, *Gizmodo.com*, 16 November 2016.

2016 How the Pull of an Icy 'Heart' Sent Pluto's Poles Wandering, Ben Panko, *Smithsonian.com*, 16 November 2016.

2016 Pluto's Icy Heart Broke Pluto, Emma Grey Ellis, *Wired.com*, 16 November 2016.

2016 Pluto's Wandering Heart Hints at a Subsurface Ocean, Mike Wall, *Space.com*, 16 November 2016.
2016 Pluto's Icy Heart May Hide an Ocean, Lee Billings, *Scientific American*, 16 November 2016.
2016 Pluto 'has slushy ocean', below surface, Paul Rincon, *BBC News*, 16 November 2016.
2016 Pluto's cold heart could be hiding an OCEAN: Dwarf planet's strange spin points to a subsurface sea, Harry Pettit, *DailyMail.com*, 16 November 2016.
2016 Cracked, frozen and tipped over: New clues from Pluto's past, *ScienceDaily.com*, 16 November 2016.
2016 Cracked, Frozen and Tipped Over: New clues from Pluto's past, *UA News*, 16 November 2016.
2016 Icy heart could be key to Pluto's strange geology, Alexandra Witze, *Nature News*, 21 October 2016.
2016 DPS/EPSC update on New Horizons at the Pluto system and beyond, Emily Lakdawalla, *Planetary Society Blog*, 26 October 2016.
2016 Pluto May Have a Wandering Heart, Nola Taylor Redd, *Smithsonian Magazine*, 30 March 2016.
2016 Pluto Follows Its Cold, Cold Heart, Daniel Stolte, *UA News*, 28 March 2016.
2016 Planetary science: Signs of a wandering Moon, Ian Garrick-Bethell, *Nature*, News & Views, 24 March 2016.
2016 Moon's tilt changed by volcanic activity over three billion years ago, Nicola Davis, *The Guardian*, 23 March 2016.
2016 Tales of a Tilting Moon Hidden in Its Polar Ice, Daniel Stolte, *UA News*, 23 March 2016.
2016 Volcanic activity may have shifted the moon's axis Rachel Feltman, *The Washington Post*, 23 March 2016.
2016 Did the moon once flop over on its side? Well here's what scientists say, Lee Roop, *Al.com*, 23 March 2016.
2016 The Moon spun on a different axis billions of years ago, study finds, Loren Grush, *The Verge*, 23 March 2016.
2016 Earth's moon wandered off axis billions of years ago, study finds, *Phys.org*, 23 March 2016.
2016 Moon used to spin 'on different axis, *BBC News*, 23 March 2016.
2016 Moon's lack of water down to ancient shift in its spin axis, Rebecca Boyle, *New Scientist*, 23 March 2016.
2016 Volcanoes may have caused the Moon's poles to wander, according to ancient ice deposits, Dani Cooper, *ABC News*, 23 March 2016.
2016 The moon's poles have no fixed address, Christopher Crockett, *ScienceNews*, 23 March 2016.
2015 Lopsided ice on the moon points to past shift in poles, Eric Hand, *Science News*, 19 March 2015.
2015 How Did the Moon Get Its Shape? Catherine Minnehan, *AGU Research Spotlight*, 23 June 2015.
2015 UA Students Bring Together Art, Science, Rebecca Peiffer, *University of Arizona News*, 5 November 2015.
2015 See astronomy-inspired art this weekend at the Lunar and Planetary Laboratory's Art of Planetary Science exhibit, Mikayla Mace, *The Daily Wildcat*, 15 October 2015.
2014 At the intersection of Art and Science, *University of Arizona News*, 22 October 2014.
2014 UA hosts art show exploring beauty in science, Dan Desrochers, *Arizona Daily Star*, 14 October 2014.
2014 YouTube for Science, Anna H. Spitz, *Mercury*, Vol. 44, No. 1, Winter 2015.

XII. PROFESSIONAL ACTIVITIES AND SERVICE

2017–present Reviewer for publications: *Journal of Geophysical Research: Planets*; *Icarus*; *Geophysical Research Letters*; *Space Science Reviews*; *Planetary and Space Sciences*.

2017–present Grant proposal reviewer: NASA Solar System Workings (SSW) program, NASA Cassini Data Analysis Program (CDAP), NASA New Frontiers Data Analysis Program (NFDAP), NASA Astrobiology Program, NASA Earth Space Science Fellowship (NESSF) program; NASA Lunar Data Analysis Program (LDAP).

2016–2017 University of Arizona, Department of Planetary Science, Men's Auxiliary: A group intended to bring together allies for discussing issues of harassment, bias, diversity, equity, and inclusion.
– *Role:* founder.

2014–2017 University of Arizona, Department of Planetary Science Departmental Life Committee (DLC): Committee that assessed the quality of life, student-advisor relationships, biases and harassment within the department.
– *Role:* Inaugural grad student member.

2014–2016 University of Arizona, Department of Planetary Sciences Graduate Student Colloquia.
- *Role:* Student organizer.

2010–2011 University of Maryland, Campus Student Technology Fee Advisory Committee.
- *Role:* College representative.

2010 University of Maryland, Enhancing Computational Abilities with MATLAB: Department initiative to bolster the computational strength of the undergraduate astronomy majors.
- *Role:* Volunteer code developer.

2009 University of Maryland, College of Computer, Mathematical, and Physical Science Student Technology Advisory Committee.
- *Role:* Astronomy department representative.

XIII. PROFESSIONAL AFFILIATIONS

2019–present Keck Institute for Space Studies (KISS), Affiliate.
2014–present International Association of Astronomical Artists (IAAA), Journeyman.
2014–2017 University of Arizona Theoretical Astrophysics Program (TAP), Graduate Student Member.
2013–present American Geophysical Union (AGU), Member.
2010–present American Astronomical Society (AAS), Junior Member.
2010–present AAS Division of Dynamical Astronomy (DDA), Junior Member.
2010–present AAS Division for Planetary Sciences (DPS), Junior Member.

XIV. TEACHING EXPERIENCE

2012–2016 Guest Lecturer (University of Arizona):
- PTYS170B1: The Universe and Humanity: Origins & Destiny (Caitlin Griffith);
- PTYS170A1: Planet Earth: Evolution of a Habitable Planet (Isamu Matsuyama).

2012, 2016 Graduate Teaching Assistant (University of Arizona):
- PTYS170B1: The Universe and Humanity: Origins & Destiny (Caitlin Griffith);
- PTYS170A1: Planet Earth: Evolution of a Habitable Planet (Isamu Matsuyama).

2008–2010 Undergraduate Teaching Assistant (University of Maryland):
- ASTR100: Introduction to Astronomy (Stacy McGaugh);
- ASTR100: Introduction to Astronomy (Douglas P. Hamilton);
- ASTR100: Introduction to Astronomy (Melissa Hayes-Gehrke);
- ASTR101: General Astronomy (Christopher Hunt);
- ASTR220: Collisions in Space (Melissa Hayes-Gehrke).

XV. PUBLIC OUTREACH

2018 AGU Workshop: How to Sketch Your Science.
- *Role:* Developed and led an interactive workshop at the American Geophysical Union Fall Meeting about how to communicate science using figures, graphics, and art.

2018 Career Day at Dahlia Heights Elementary School.
- *Role:* guest speaker, talking about careers in astronomy and planetary science.

2017–present Strange New Worlds: A Science and Star Trek Podcast: Podcast hosted by Dr. Michael L. Wong (University of Washington).
- *Role:* Recurring guest.

2016 Tucson Amateur Astronomy Association.
- *Role:* Guest speaker, presenting a talk: "A Tale of a Tipping Moon, Recorded in Lunar Ice."

2016 Space Drafts / Art on Tap: Local science lecture series hosted at a Tucson brewery.
- *Roles:* Guest speaker, volunteer, and graphic artist.

2014–2015 Pima Air and Space Museum.
- *Roles:* Guest speaker and activity leader for middle school student groups.

2014–2016 Astronomy Camp: A University of Arizona operated camp for high school students interested in astronomy, operated by Dr. Don McCarthy (U. Arizona).
- *Role:* Camp counselor, responsible for camp safety, astronomy education, and developing

observational projects using facilities at the Kitt Peak National Observatory (including the 0.9-meter WIYN, Steward Observatory 90" Bok, and 16" and 20" telescopes).

2013–2017 The Art of Planetary Science (TAPS): A homegrown, multi-night planetary science themed art show at the University of Arizona Lunar and Planetary Laboratory, which included the involvement of >200 artists, and an event with >500 persons in attendance, and managing a budget of several thousand dollars.
- *Role:* Co-creator.

2013–2015 321Science: an education and public outreach effort by the OSIRIS-REx mission, that published "fast draw" YouTube videos about asteroids.
- *Role:* Artist.

2013–2016 Tucson Festival of Books.
- *Role:* Volunteer.

2013–2016 International Observe the Moon Night: A celebration of lunar science and exploration, hosted locally at the University of Arizona Flandrau Planetarium.
- *Role:* Volunteer.

2012–2013 Starlight Science Cinema: Monthly science-themed movie night operated by the University of Arizona.
- *Role:* Graphic artist.

2012–2016 Summer Science Saturday/Sunday. Annual summer outreach event hosted by the University of Arizona Lunar and Planetary Laboratory.
- *Roles:* Graphic artist, developer of educational activities for K-12 students focusing on the robotic exploration of the solar system, volunteer.

2012 Math, Science, and Technology Funfest: Tucson K-12 STEM outreach event.
- *Role:* Volunteer.

2012 Science and Astronomy Expo: Tucson K-12 STEM outreach event.
- *Role:* Volunteer.

2012 Science Downtown: A graduate student operated temporary museum (where we literally took over a failing museum in downtown Tucson), that hosted two large (>300 persons) planetary science themed events for the public and K-12 students.
- *Roles:* Art director and volunteer.

2009 Space Camp Turkey, İzmir, Turkey: Yes. Space Camp. In Turkey.
- *Roles:* Camp counselor for international youth (ages 9-18) responsible for camp safety and education about astronomy and space exploration, and updating the science curriculum.

2007–2011 AstroTerps: The University of Maryland astronomy club.
- *Roles:* Member, graphic artist, volunteer for public outreach events.

2007–2008 Explore the Universe: A high school science program operated by the Unviersity of Maryland Observatory.
- *Role:* Volunteer student mentor, assisting local high school students in developing science fair projects using the observatory telescopes and facilities.

2007 Association des Jeunes Engagés pour la Promotion de la Santé (AJEPS), Maroua, Cameroon: A community service program based in Cameroon that seeks to work with HIV-positive youth in order to improve their public image and wellbeing.
- *Role:* Volunteer, and helped design and paint a large mural dedicated to the group.

XVI. REFERENCES

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Additional references available upon request.

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