

## Kevin Peter Hand, Ph.D.

March 2013

Deputy Chief Scientist for Solar System Exploration  
NASA Jet Propulsion Laboratory, California Institute of Technology  
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Kevin P. Hand is a planetary scientist/astrobiologist at JPL working on numerical modeling, laboratory experiments, and instrument development to advance our understanding of the physics and chemistry of icy moons in the outer solar system.

### Education

Ph.D., Geological & Environmental Sciences, Stanford University, Stanford, CA. (2007)  
Dissertation: 'On the physics and chemistry of the ice shell and sub-surface ocean of Europa'.  
Advisor: C.F. Chyba

M.S., Mechanical Engineering, focus on robotics (2002), Stanford University, Stanford, CA.

B.A. Physics, with minor in Astronomy (1998), Dartmouth College, Hanover, New Hampshire.  
Thesis: A Search for the Optical Counterpart to the Mysterious High-Latitude Transient X-ray Source, 4U0042+32.

### Research Interests

- Icy moons and sub-surface oceans of the outer solar system
- Electromagnetic field interactions at icy worlds
- Radiolytic chemistry in planetary and astrophysical environments
- Spectroscopic biosignatures
- Understanding connection between terrestrial cryosphere processes and the climate change record.

### Currently Funded Proposals

- ASTID 2010, *Miniature Hyperspectral Laser Spectrometer Probe for Astrobiology*, PI: Nan Yu. Co-I: K.P. Hand.
- Exobiology 2010, *Laboratory Investigation of the Workman-Reynolds Effect*, PI: K.P. Hand
- JPL Internal Advanced Concepts: *Europa Surface Science Package for EJSM*, PI: K.P. Hand
- NAI-CAN5, *Astrobiology of Icy Worlds*. PI: I. Kanik, Science PI: K.P. Hand
- PIDDP, *CIRIS A combined infrared interferometric spectrometer for compositional and thermal studies of moons, comets, and asteroids*. PI: R.W. Carlson. Co-I: K.P. Hand

### Professional Experience

- Deputy Chief Scientist for Solar System Exploration (4x), JPL, Oct. 2011-Present.
- Scientist, Planetary Ices Group (3227), Jet Propulsion Laboratory, California Institute of Technology (Oct. 2007-Sept. 2011).
- Europa Flagship Mission Science Definition Team (2007, 2008, 2011 studies).
- Visiting Research Fellow, Dept. of Astrophysical Sciences, Princeton University (2006-2007).
- Geobiology Summer School, University of Southern California/Agouron Institute. Catalina Island, CA. (June-July 2003).
- Research Assistant to C.F. Chyba, SETI Institute, (2000).
- Michelson Interferometry Summer School, NASA Jet Propulsion Laboratory/California Institute of Technology, Pasadena, CA. (July-August 1999).
- Research Assistant, Center for Mars Exploration, NASA Ames Res. Ctr. (1998-1999).

- Intern, Theoretical Astrophysics Division (TA-6), Los Alamos National Laboratory. Worked with S. Colgate on the late-time light curve of Type Ia Supernovae and on modeling plume convection in stellar atmospheres. (Spring 1995. Winter 1996)
- Research Assistant, Michigan-Dartmouth-MIT Observatory, Kitt Peak, AZ. Operated the 1.3 m reflector for 8 nights (Fall 1996).

## Awards

National Geographic Society Emerging Explorer Award, 2011  
 Lew Allen Award for Excellence, 2012  
 Kavli Frontier of Science Fellow, 2007, 2011

## Teaching Experience

Lecturer for the 2012 University of Mexico, 'Astrobiology of Icy Worlds' graduate and undergraduate student short-course. This course was held at the Universidad Nacional Autonoma de Mexico (UNAM) in Mexico City and was simultaneously broadcast to 7 other universities in Mexico and Spain. I gave 18 hours of lectures. Organizers: Dr. Antígona Segura Peralta, Irma Lozada Chavez, and L. C. Delgado.

Lecturer for 2011 University of Hawaii NASA Astrobiology Winter School, PI: Karen Meech. <http://www.ifa.hawaii.edu/UHNAI/2011winterschool/>

Lecturer for 2008 NASA Astrobiology Institute 'Josep Comas I Sola' International Summer School on 'The Astrobiology of Icy Worlds'. <http://nai.arc.nasa.gov/uimp/IcyWorlds/>

Lecturer for Split University two-week "International Winter School on Astrobiology and Extrasolar Planets". Split, Croatia. Feb-March 2007 and 2008. (<http://fizika.pmfst.hr/astro/english/astrobiologija.html>)

Stanford: "GES 51: Undergraduate seminar on the Origin and Evolution of the Universe" (Spring 2004) Teaching assistant for Professor Mike McWilliams. Responsibilities included giving many lectures, advising on research topics, and grading term papers. Also coordinated a class field trip to several locales in Southern California, including a visit to JPL. Class size: ~15.

Stanford: "GES 2: Earth System History" (Winter 2003/2004) Teaching assistant for Professor Mike McWilliams. Responsibilities included giving several lectures, grading, and running lab sessions and field trips. Class size: ~60 students.

Stanford: "Geological & Environmental Sciences (GES) 1: Dynamic Earth: Fundamentals of Earth Science" (Spring 2003) Teaching assistant for Professor Page Chamberlain. Responsibilities included giving several lectures, grading, and running lab sessions and field trips. Class size: ~60 students.

Stanford: "GES 2: Earth System History" (Winter 2002/2003) Teaching assistant for Professor Page Chamberlain. Responsibilities included giving lectures, grading, and running lab sessions and field trips. Class size: ~60 students.

Stanford: "GES 7: An Introduction to Wilderness Skills" (2002-2003) Instructor for course taught through the GES department. Course covers everything from camping basics to avalanche danger and technical climbing skills. Originally designed to prepare students for field work. Responsibilities included classroom lectures and weekend trips to the Sierra. Class size: ~10 students.

Santa Clara University: "Introduction to the Solar System" (Spring 1999) Guest lectured for two weeks, covering the terrestrial planets. Class size: ~40 students.

Dartmouth: "Astrophysics 15, Introduction to Astrophysics" (1997) Teaching assistant for Professor John Thorstensen. Responsibilities included grading problem sets and running observation sessions at the on-campus observatory (9.1 inch refractor). Class size: ~15 students.

Dartmouth: "Astronomy 3, Introduction to Astronomy", (TA'd on several occasions between 1995-1997). Teaching assistant for Professors R. Fesen, J. Thorstensen, and G. Wegner.

Responsibilities included grading homework and exams, and running observation sessions at the on-campus observatory (9.1 inch refractor). Class size: ~80 students.

## Publications

**Hand, K.P.** and Brown, M.E. (2013) Keck II Observations of Hemispherical Differences in H<sub>2</sub>O<sub>2</sub> on Europa. *The Astrophysical Journal Letters*, 766:2, L21, doi:10.1088/2041-8205/766/2/L21.

Brown, M.E. and **Hand, K.P.** (2013) Salts and Radiation Products on the Surface of Europa. *The Astronomical Journal*, 145:4, 110, doi:10.1088/0004-6256/145/4/110.

Lazcano, A. and **Hand, K.P.** (2012) Astrobiology: Frontier or fiction. *Nature, Forum*. 488, 7410, 160-161.

Boxe, C.S., **Hand, K.P.**, Nealon, K.H., Yung, Y.L., and Saiz-Lopez, A (2012) An active nitrogen cycle on Mars sufficient to support a subsurface biosphere. *International Journal of Astrobiology*, 11, 2, 109-115, doi: 10.1017/S1473550411000401.

Boxe, C.S., **Hand, K.P.**, Nealon, K.H., Yung, Y.L., Yen, A.S., and Saiz-Lopez, A (2012) Adsorbed water and thin liquid films on Mars, *International Journal of Astrobiology*, 11, 3, 169-175, doi:10.1017/S1473550412000080.

Priscu, J. C. and **Hand, K.P.** (2012) Microbial Habitability of Icy Worlds. *Microbe*, 7:4, 167-172.

Wilson, J.P., Grotzinger, J.P., Fischer, W.W., **Hand, K.P.**, Jensen, S., Knoll, A.H., Abelson, J., Metz, J.M., McLoughlin, N., Cohen, P.A., Tice, M.M. (2012) Deep-Water Incised Valley Deposits at the Ediacaran-Cambrian Boundary in Southern Namibia Contain Abundant Treptichnus Pedum. *Palaios*. Vol. 27, 252-273.

**Hand, K.P.** and Carlson, R.W. (2012) Laboratory spectroscopic analyses of electron irradiated alkanes and alkenes in solar system ices *J. Geophys. Res.*, 117, E03008, doi:10.1029/2011JE003888.

**Hand, K.P.** and Carlson, R.W. (2011) H<sub>2</sub>O<sub>2</sub> production by high-energy electrons on icy satellites as a function of surface temperature and electron flux. *Icarus*. doi:10.1016/j.icarus.2011.06.031

**Hand, K. P.**, K. K. Khurana, and C. F. Chyba (2011), Joule heating of the south polar terrain on Enceladus, *J. Geophys. Res.*, 116, E04010, doi:10.1029/2010JE003776.

Korablev, O., Gerasimov, M., Dalton, J.B., **Hand, K.**, Lebreton, J-P., and Webster, C. (2011) Methods and measurements to assess physical and geochemical conditions at the surface of Europa, *Adv. Space Res.* doi:10.1016/j.asr.2010.12.010..

**Hand, K.P.**, McKay, C.P., & Pilcher, C. (2010). Spectroscopic and spectrometric differentiation between abiotic and biogenic material on icy worlds. *Proceedings of the International Astronomical Union*, 6, pp 165-176 doi:10.1017/S1743921310007374.

Raulin, F., **Hand, K. P.**, McKay, C., Fortes, D., Viso, M. (2010). Exobiology, Habitability, and Planetary Protection. In *Satellites of the Outer Solar System: Exchange Processes Involving the Interiors*, Space Sciences Series of ISSI. Eds. O. Grasset, M. Blanc, A. Coustenis, W. Durham, H. Hussmann, R. Pappalardo, D. Turrini. 536p.

Cassidy, T., Coll, P., Raulin, F., Carlson, R.W., Johnson, R.E., Loeffler, M.J., **Hand, K. P.**, Baragiola, R.A. Radiolysis and Photolysis. (2010). In *Satellites of the Outer Solar System: Exchange Processes Involving the Interiors*, Space Sciences Series of ISSI. Eds. O. Grasset, M. Blanc, A. Coustenis, W. Durham, H. Hussmann, R. Pappalardo, D. Turrini. 536p.

Sparks, W.B., McGrath, M., **Hand, K.P.**, Ford, H.C., Geissler, P., Hough, J.H., Turner, E.L., Chyba, C.F., Carlson, R., Turnbull, M. (2010) Hubble Space Telescope observations of Europa in and out of eclipse. *Int. J. of Astrobiology* 9(4):265-271.

- Lorenz, R.D., Gleeson, D., Prieto-Ballesteros, Gomez, F., **Hand, K. P.**, Bulat, S. (2010) Analog Environments for a Europa Lander Mission. *Adv. in Space Research*, doi: 10.1016/j.asr.2010.05.006.
- Clark, K., Boldt, J., Greeley, R., **Hand, K.P.**, Jun, I., Lock, R., Pappalardo, R.T., Van Houten, T., Yan, T. (2010) Return to Europa: Overview of the Jupiter Europa Orbiter Mission. *Adv. in Space Research*, doi:10.1016/j.asr.2010.04.011.
- Hand, K.P.** (2010) The ocean of Europa and implications for habitability and the origin of life. *Astrobiology: from simple molecules to primitive life*. Eds. V.A. Basiuk and R. Navarro-Gonzalez.
- Hand, K.P.**, Chyba, C.F., J.C. Priscu, Carlson, R.W. & K.H. Nealson (2009) Astrobiology and the Potential for Life on Europa. In *Europa*. Eds. R. Pappalardo, W. McKinnon, & K. Khurana. Univ. of AZ Press.
- Khurana, K.K., Kivelson, M.G., **Hand, K.P.**, and Russell, C.T. (2009) Electromagnetic induction from Europa's ocean and the deep interior. In *Europa*. Eds. R. Pappalardo, W. McKinnon, & K. Khurana. Univ. of AZ Press.
- (Book review) **Hand, K.P.** (2009) Is there life on Europa? *Nature*, 457:384.
- Cohen, P.A., Bradley, A., Knoll, A.H., Grotzinger, J.P., Jensen, S., Abelson, J., **Hand, K.**, Love, G., Metz, McLoughlin, N., Meister, P., Shepherd, R., Tice, M., Wilson, J.P. (2008) Tubular Compression Fossils from the Ediacaran Nama Group, Namibia. *Journal of Paleontology*.
- Hand, K.P.**, Carlson, R. W., & Chyba, C. F. (2007) Energy, chemical disequilibrium, and geological constraints on Europa. *Astrobiology*. 7:6, 1-18.
- Hand, K. P.**, & Chyba, C.F. (2007) Empirical constraints on the salinity of the European ocean and implications for a thin ice shell. *Icarus*. 189:2, 424-438.
- Hand, K. P.**, Carlson, R. W., Cooper, J., & Chyba, C. F. (2006) Clathrate hydrates of oxidants in the ice shell of Europa. *Astrobiology*. 6:3, 463-482.
- Chyba, C. F. & **Hand, K. P.** Astrobiology: The Study of the Living Universe (2005) *Annual Reviews of Astronomy and Astrophysics*. 43:2.1-2.44.
- Hand, K.P.**, Carlson, R.W., Sun, H., Anderson, M., Wadsworth, W., Levy, R. (2005) Utilizing active mid-infrared microspectrometry for in-situ analysis of cryptoendolithic microbial communities of Battleship Promontory, Dry Valleys, Antarctica. *Proceedings of SPIE Vol. #5906*. Optical Engineering and Instrumentation Instruments, Methods, and Missions for Astrobiology IX, 31 July- 2 August, 2005.
- Anderson, M.S., Andringa, J.M., Carlson, R.W., Conrad, P., Hartford, W., Shafer, M., Soto, A., Tsapin, A.I., Dybwad, J.P., Wadsworth, W., **Hand, K.P.** (2005) Fourier transform infrared spectroscopy for Mars science. *Review of Scientific Instruments*. 76: 034101.
- McKay, C. P., **Hand, K. P.**, Doran, P. T., Andersen, D. T. & Priscu, J. C. (2003) Clathrate formation and the fate of noble and biologically useful gases in Lake Vostok, Antarctica. *Geophys. Res. Lett.* Vol. 30, No. 13, 1702.
- Zaitseva, L., and **Hand, K. P.** (2003) Nuclear Smuggling Chains: Suppliers, Intermediaries, and End-Users. *American Behavioral Scientist* 46:6, 822-844.
- Chyba, C.F. and **Hand, K.P.** (2001) Life without Photosynthesis. *Science* 292, 2026-2027.
- Hand, K.P.** and Chyba, C.F. (2001) Prospects for Life on Europa. In "Frontiers of Life" (L.Celnikier, Ed.) *Proceedings of the Frontiers of Life Conference*, Blois, France, 25th June - 1st July 2000.

Colgate, S.A., Fryer, C.L., and **Hand, K.P** (1997) Low Mass SN Ia and the Late Light Curve. In *"Thermonuclear Supernovae"* (P.Ruiz-Lapuente, R. Canal, J. Isern, Eds.) NATO Science Series C. Kluwer Academic Publishers, Boston, MA. p273-302.

*Plus dozens of posters and talks at various DPS, AGU, NAI, etc. meetings*

### **Publications**

Future Science Chapter (2011) 'On the Coming Age of Ocean Exploration.'  
This Explains Everything (2012)  
This Explains Everything (2013)  
Nature – Petri dishes and Popcorn Physics  
Nature – Is there life on Europa?  
CNN piece

### **References**

Available upon request.