CARL SAGAN CENTER

Activity Report May 2017

Dr. Nathalie A. Cabrol, Director

Peer-Reviewed Publications (only in press or published)

1. Blunt, S. et al., **including E. Nielsen & F. Marchis** 2017. Orbits for the Impatient: A Bayesian Rejection Sampling Method for Quickly Fitting the Orbits of Long-Period Exoplanets. *The Astronomical Journal, Volume 153, Issue 5, article id. 229, 22 pp. (2017).*, 153. Available at: http://arxiv.org/abs/1703.10653.
2. Chilcote, J. et al., **including E. Nielsen & F. Marchis** 2017. 1 to 2.4 micron Near-IR spectrum of the Giant Planet β Pictoris b obtained with the Gemini Planet Imager. *The Astronomical Journal, Volume 153, Issue 4, article id. 182, 15 pp. (2017).*, 153. Available at: http://arxiv.org/abs/1703.00011
3. Desch SJ, **Estrada PR**, Kalyaan A, and Cuzzi JN (2017). Formulas for Radial Transport in Protoplanetary Disks. Astrophys. J. 840, article id. 86, 8pp.
4. Follette, K.B. et al., **including E. Nielsen & F. Marchis** (2017). Complex Spiral Structure in the HD 100546 Transitional Disk as Revealed by GPI and MagAO. *eprint arXiv:1704.06260*. Available at: http://arxiv.org/abs/1704.06260.
5. Gede M, **Hargitai H** (2017) An Online Planetary Exploration Tool: "Country Movers". *Acta Astronautica.* https://doi.org/10.1016/j.actaastro.2017.04.028
6. Howard, Alan D., Jeffrey M. Moore, **Oliver L. White**, **Orkan M. Umurhan**, Paul M. Schenk, et al. including **Ross A. Beyer**. Pluto: Pits and mantles on uplands north and east of Sputnik Planitia, Icarus, Volume 293, 2017, Pages 218-230, https://doi.org/10.1016/j.icarus.2017.02.027.
7. Howett CJA, Parker AH, Olkin CB, Reuter DC, Ennico K, et al., including **Dalle Ore CM** (2017). Inflight radiometric calibration of New Horizons' Multispectral Visible Imaging Camera (MVIC). Icarus 287, 140-151.
8. Johnson-Groh, M. et al., **including E. Nielsen & F. Marchis** (2017). Integral Field Spectroscopy of the Low-Mass Companion HD984B with the Gemini Planet Imager. *The Astronomical Journal, Volume 153, Issue 4, article id. 190, 13 pp. (2017).*, 153. Available at: http://arxiv.org/abs/1703.02607
9. Lacap-Bugler, D. C., Lee, K. K., Archer, S., Gillman, L. N., Lau, M. C. Y., Leuzinger, S., et al. including **Warren-Rhodes K. A.** (2017). Global Diversity of Desert Hypolithic Cyanobacteria. *Frontiers in Microbiology, 8*(867). doi:10.3389/fmicb.2017.00867
10. Lu N, Zhao Y, Díaz-Santos T, Xu CK, Gao Y et al., including **Lord S** (2017). A Herschel Space Observatory Spectral Line Survey of Local Luminous Infrared Galaxies from 194 to 671 Microns. Astrophys. J. Supp. 230, article id. 1, 34pp.
11. Lupisella M & **MS Race** (2017). Low-Latency Teleoperations, Planetary Protection & Astrobiology, *International Journal of Astrobiology*, in press.
12. Protopapa S, Grundy WM, Reuter DC, Hamilton DP, **Dalle Ore CM** et al. (2017). Pluto's global surface composition through pixel-by-pixel Hapke modeling of New Horizons Ralph/LEISA data. Icarus 287, 218-228.

13. Rajan, A. et al., **including E. Nielsen & F. Marchis** (2017). Characterizing 51 Eri b from 1-5 μm: a partly-cloudy exoplanet. *eprint arXiv:1705.03887*. Available at: http://arxiv.org/abs/1705.03887.
14. Rameau, J. et al., **including E. Nielsen & F. Marchis** (2017). An Optical/near-infrared investigation of HD 100546 b with the Gemini Planet Imager and MagAO. *eprint arXiv:1704.06317*. Available at: http://arxiv.org/abs/1704.06317
15. Ruffio, J.-B. et al., **including E. Nielsen & F. Marchis** (2017). Improving and Assessing Planet Sensitivity of the GPI Exoplanet Survey with a Forward Model Matched Filter. *eprint arXiv:1705.05477*. Available at: http://arxiv.org/abs/1705.05477
16. Schmitt B, Philippe S, Grundy WM, Reuter DC, Côte R et al., including **Dalle Ore CM** (2017). Physical state and distribution of materials at the surface of Pluto from New Horizons LEISA imaging spectrometer. Icarus 287, 229-260.
17. Tajeddine R, Nicholson PD, **Tiscareno MS,** Hedman MM, and Burns JA (2017). Dynamical phenomena at the inner edge of the Keeler gap. *Icarus* **289,** 80–93.
18. Tayar J, Somers G, Pinsonneault MH, Stello D, Mints A, et al., including **Huber D** (2017). The Correlation between Mixing Length and Metallicity on the Giant Branch: Implications for Ages in the Gaia Era. Astrophys. J. 840, article id. 17, 12pp.
19. Triaud AHMJ, Neveu-VanMalle M, Lendl M, Anderson DR, Collier C et al., including **Tregloan-Reed J** (2017). Peculiar architectures for the WASP-53 and WASP-81 planet-hosting systems. MNRAS 467, 1714T.

Conferences: Abstracts and Proceedings

1. Carson H, **Fenton LK**, **Michaels TI** (2017) Using atmospheric modeling to pinpoint ripple migration timing in Meridiani Planum during the last 400 ky, *Fifth Int'l Planetary Dunes Workshop*, 16-19 May, St. George, Utah, Abst. #3053. https://www.hou.usra.edu/meetings/dunes2017/eposter/3053.pdf. (Note that H. Carson is a student.)
2. **Glines N.H., Hargitai H.I.,** and **Gulick V.C.** 2017. Paleolakes of Northeastern Hellas Basin. EPSC Abstracts, Vol. 11, EPSC2017-418-1, 2017, European Planetary Science Congress 2017.
3. Hoover RH, Putzig NE, **Fenton LK**, Courville S (2017) Thermophysical characterization of southern hemisphere dunes on Mars, *Fifth Int'l. Planetary Dunes Workshop,* 16-19 May, St. George, Utah, Abst. #3063. https://www.hou.usra.edu/meetings/dunes2017/eposter/3063.pdf.
4. **Race MS** (2017). Using Astrobiology and Space Mission Planning to Bring STEM Challenges to Audiences of All Ages, *47th Conf on Environmental Systems*, July, Charleston SC.
5. **Sarrazin**, **P.,** D. Blake, M. Gailhanou, **F. Marchis**, **C. Chalumeau**, S. Webb, P. Walter, E. Schyns, K. Thompson and T. Bristow, 2017, ICXOM conference, Trieste, Italy.

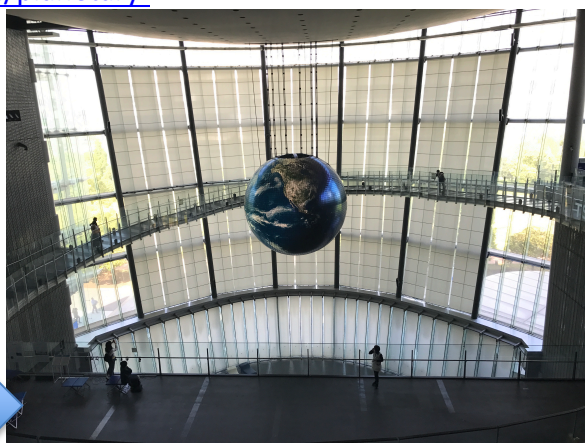
6. **Tiscareno MS**, Baker EJ, and The Cassini Imaging Team (6/15/17). Targeted flyby images of propellers in Saturn's A ring. AAS Division on Dynamical Astronomy Meeting 48, 401.02
7. Zamkotian, F., P. Lanzoni, R. Barette, M. Helmbrecht, **F. Marchis**, A. Teichman, Optical MEMS and Nanophotonics 2017 https://omn2017.exordo.com

Technical Reports & Data Releases

1. **Coughlin JL** (2017) 2017b, Planet Detection Metrics:Robovetter Completeness and Effectiveness for Data Release 25 (KSCI-19114-001).
2. **Showalter MR** and **Ballard L** released an update to OPUS, the search tool of the PDS Ring-Moon Systems Node, supporting detailed search capabilities for the Voyager images from Jupiter and Saturn.

Popular Publications/Web Stories/ Other Media / Interviews

1. **Bishop J** (May 31). Interviewed for TheVerge, upcoming article on redox stratification in ancient lake at Gale crater, Mars; https://www.theverge.com/2017/6/1/15720814/nasa-curiosity-rover-mars-petrified-mud-lake-gale-crater-habitable-microbial-life.
2. **Cabrol, NA** (May 4) Interview with Newsweek.
3. **Cabrol, NA** (May 4) Review and quote in Time Magazine for the book *Aliens* (edited by Jim Al Khalili to which she contributed a chapter)
4. **Cabrol, NA** (May 9) Interview on NPR (1A) about the book *Aliens* edited by Jim Al Khalili, to which she contributed a chapter.
5. **Cabrol, NA** (May17) Interview for a possible NOVA documentary on what microbial life on Earth can teach us about searching for life beyond Earth.
6. **Cabrol, NA** (May 30) Skype with producers for a potential series about life beyond Earth.
7. **Marchis, F.** (2017) Characterizing Exoplanets: Where Are We and What Will Come Next? Capeia:20170525.007 https://beta.capeia.com/planetary-science/2017/05/25/characterizing-exoplanets-where-are-we-and-what-will-come-next
8. **Marchis, F.** Hangout in Deep Astronomy including The Future of SETI w/ Ground-Based Telescopes May 17 2017 https://www.youtube.com/watch?v=Jy-HlhWLS4A&t=1337s
9. **Marchis, F. and Busch**, M. Facebook live with from the Planetary Defense



Conference, Tokyo, Japan on May 17 2017

10. **Race MS** (May 18). Interviewed for New Scientist magazine, upcoming article on Policy Issues and Ethics of Interplanetary Settlement on Mars.
11. **Tiscareno MS** (4/3) was interviewed by Science for the article "In mission's last hurrah, Cassini aims to solve riddle of Saturn's rings." The article appeared 4/13, using material from the interview but not quoting Tiscareno directly.
12. **Tiscareno MS** (4/7) was interviewed on the SETI Institute's Facebook Live segment.
13. **Tiscareno MS** (4/10) was interviewed on film by Discovery Canada, who are working on a documentary about Cassini. The documentary will likely appear in September.
14. **Tiscareno MS** (4/17) is quoted in the article "Cassini Swoops Past Saturn's Moon Atlas for a Final Glorious Photoshoot" on Now Space.
15. **Tiscareno MS** (4/19) was interviewed for the SETI Institute's Big Picture Science podcast. The segment "Spacecraft Elegy" was published 4/24.
16. **Tiscareno MS** (4/29) was interviewed by radio station KVMR (Nevada City CA) for an audio segment and an article.

Invitation to Speak (Professional and Public)

1. **Andersen, D. :** 9 May, 2017, Public talk, **Life on Ice, Antarctica and Mars**, at the Karijini Eco Retreat at Joffre Gorge within the Karijini National Park, Western Australia.
2. **Bishop J** (May 30). *Exploring Mars with a Rover*, Alto International School, Middle School students, Menlo Park.
3. **Busch MW** (5/14 - 5/20) ran the @astro_tweeps astronomy public outreach Twitter account, conveying material presented at the 2017 Planetary Defense Conference to the public.
4. **Gorti, U** (2017). Invited colloquium speaker, Geophysics and Planetary Science Dept, Caltech, May 9, 2017.
5. **Marchis F**. invited to speak at the Prospect High School Astronomy Club, "Adaptive Optics, Io, Asteroids and exoplanets", June 1st, Performing Arts Center (PAC), Saratoga, CA.
6. **Marchis F.** invited to speak at Dropbox Inc., "The Search for a Cousin of Earth: Science or Fiction?", Droptalk, June 14, San Francisco CA
7. **Race MS** (May 24). Environmental Law, Space Policy and Human Missions to Mars, Stanford University Law School, Environmental Law seminar.
8. **Showalter MR** (5/26) spoke about all aspects of astronomy to the entire sixth grade class of an elementary school in Maryland via Skype.

9. **Zalucha AM** (4/30 - 5/6) ran the @astro_tweeps astronomy public outreach Twitter account, discussing topics of planetary atmospheres, planetary protection, SETI science, daily life as a scientist, and other planetary science facts.
10. **Zalucha AM** (4/28) invitation to speak at Denver Comic Con (early July) about planetary protection (title: "Contamination Mars!").
11. **Zalucha AM** (5/12) wrote final letter of the school year to middle school pen-pal in the "Letters to a Pre-scientist" program.

Significant Events and Activities

1. **Andersen, D.:** April 22-27. NHK (Japanese Broadcasting Corporation), Japan's national public broadcasting organization premiered its UHD 8K video trailer of the upcoming production tentatively titled **Antarctica, The Frozen Time Capsule** in the 8K Super Hi-Vision (SHV) theater with 350-inch screen at the 2017 NAB (National Association of Broadcasters) Show. This documentary captures the Antarctic research led by Dale Andersen at Lake Untersee, above and below the thick, perennial lake ice.
2. **Busch MW** and **Marchis F** attended the 2017 Planetary Defense Conference in Tokyo, and respectively presented radar observations of near-Earth asteroids and work addressing the impact hazard by the 2016 Frontier Development Lab.
3. **Cabrol NA and Rummel J** (May 10) started to organize the review of the SETI White Papers received as a response to the November 2016 Call.
4. **Cabrol NA** (May 24) was the guess of the Consul General of Luxembourg at the 19th Churchill's Club Top 10 Tech Trends, Santa Clara.
5. **Cabrol NA** met with Saad Khan (May 24) to discuss the organization, funding, and structure of activities related to the new SETI vision.
6. **DeVore E., Cabrol NA, Harman P, Dimock A, MacDonald R,** (May 10) hosted a Arizona State University team led by Ariel Anbar to discuss potential education and outreach collaboration with the SETI Institute.
7. **Fenton LK** participated in the organizing committee and chaired a session "Dune Morphology and Response to Wind Regime" at the 5th International Planetary Dunes Workshop, held in St. George, UT, 16-19 May 2017.
8. **The teams and projects for the 2017 Frontier Development Lab** have been selected, and the much-expanded program will begin in the later part of June.
9. **Freund, F. ULF EM Radiation Field:** Some of the previously poorly understood influences from the planetary environment are coming ever more into focus. With respect to the ultralow frequency (ULF) electromagnetic (EM) radiation field that is generated by the Schumann Resonances (SR), I have made progress. It has long been noticed that the ULF EM field has a remarkably strong effect on the proper functioning of essential life functions. Through my recent appointment as a Research Professor at the Stanford University Medical

School I have participated in a DARPA proposal designed to study the consequences that arise in living organisms when the ULF EM field is near-totally attenuated. This proposal has since been submitted.

10. **Freund, F. ULF EM Radiation Field. Electron Capture and other Nuclear Reactions –** Friedemannn participated in a 3-day workshop held at Stanford SLAC to discuss observations related to the release of radio-active radon from the Earth's surface. As part of this workshop I presented preliminary results pertaining to the observation that the activation of positive hole charge carriers and their propagation through the rock column appears to lead to an increased emission of geo-neutrinos. These subatomic particles are released when nuclear reactions take place that generate excited nuclei, which emit thermal neutrons and neutrinos, sometimes also gammas and alpha particles. Electron capture events appear to be the trigger of these emission processes. Theoretically, electron capture events can occur when the massively delocalized wave functions associated with positive hole charge carriers collapse into the small volume of single oxygen anions in the 1– valence state, which are isoelectronic with the fluorine atom and, hence, extremely reactive and oxidizing. During the bond formation, very high electric fields can be generated over very short time periods, on the order of atoseconds, enough to overcome the nuclear forces and inject an electron into a target nucleus.
11. **The SETI Institute NAI Team** had its monthly telecom (May 8), which was focused on upcoming preparations of manuscripts and publication of the results from the 2016 field expedition in the Andes.
12. **Peeters E** (May 9-10). Served on CanTAC (Canadian Time Allocation Committee for Gemini and CFHT.
13. **Showalter MR** is on the science organizing committee for a pair of workshops focusing on planetary science opportunities with JWST.
14. **Tiscareno MS** and **Beyer, RA**(continuing). Member of the NASA PDS Roadmap Study Team, which is working to draft a document to chart the future course of the NASA Planetary Data System.
15. **Tiscareno MS** (continuing). Member of the AAS DPS Subcommittee on Professional Culture and Climate, which works towards making the community of planetary scientists an environment in which professional merit is the only criterion that determines each person's success.
16. **Tiscareno MS** and **Beyer, RA**(continuing). Member of the NASA PDS Roadmap Study Team, which is working to draft a document to chart the future course of the NASA Planetary Data System.
17. **Zalucha AM** shifting focus of modeling cloud streets on Mars from launching local area of dust (which quickly dissipates into the background circulation) to running the MRAMS mesoscale model at times when a synoptic cold front yields potentially favorable conditions for dust lifting and cloud street formation.

Honors and Awards

Caldwell, D. Accepted unsolicited proposal: *Science and Operations Support for the Kepler and K2 Missions*, to NASA. Duration: 2.5 years, Amount: $4M. The new cooperative agreement will fund 11 scientists and data scientists to support the operations, data analysis, and data archival for the Kepler and K2 missions. The team's support for Kepler will enable the release of the final Kepler exoplanet catalog and the publication detailing its contents, along with software tools to interpret and extend the exoplanet results. The Kepler work will last through September 2017. The K2 support includes operational work to prepare for upcoming observing campaigns, to support the spacecraft operations, and to assist in anomaly resolution. The team will also support the K2 pipeline data analysis, including updating the pipeline as needed to allow for innovative K2 observations, as well as archiving and documenting the K2 data. The K2 work will last as long as the mission operates, up to 2.5 years.

Highlights

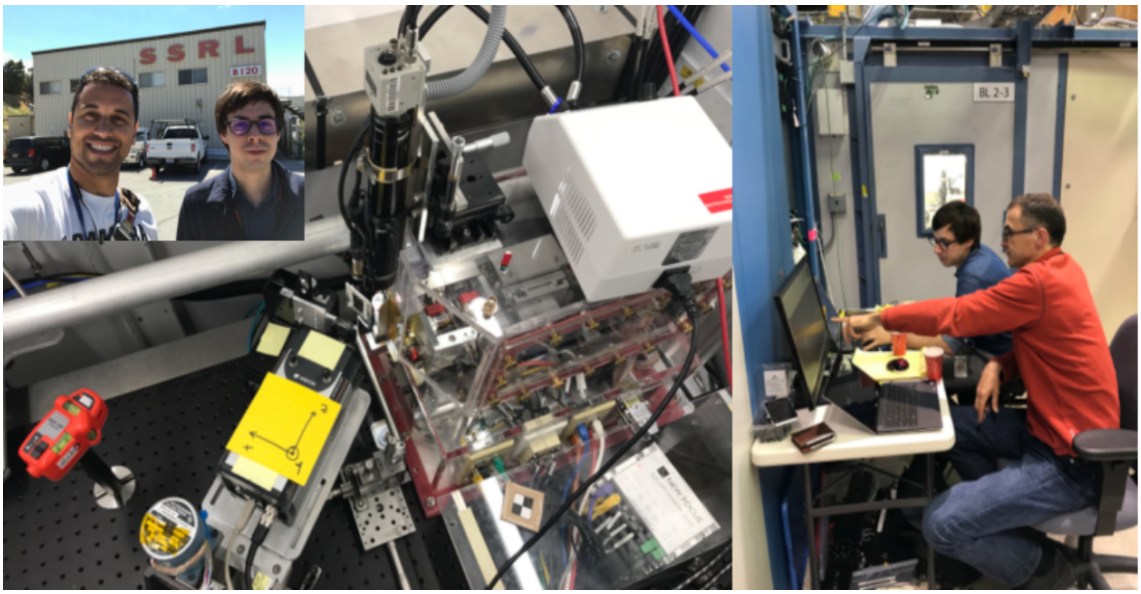
1. **Diamond B** was in South Africa and Namibia (May 16-June 1), visiting meteorite sites, the Sutherland observatory, and the Drimolen Cave and Sterkfontain Caves in South Africa, site of fossil discoveries of early human ancestors Australopithecus Africanus, dating back over 2 million years. Bill made a number of Facebook Live events that can be viewed on the SETI Institute FB site. The SETI Expedition Flag #1 was deployed at a several sites.

2. **Gulick VC and Glines NH** hosted the 9th Annual visit by the 7th and 8th graders and their teacher of Evergreen Middle School, Cottonwood, CA at NASA Ames on May 31, 2017. Students toured the NASA Ames Future Flight Central and listened to a talk by **Dr. Pascal Lee** about his children's book on Mars.

3. **Gulick** and **Natalie Glines** answered student questions about Mars, and gave talks and demos about their Mars work. The title of their presentation was "Water, Water Everywhere, But Not A Drop To Drink". Students gave

several individual team talks on fluvial landforms on Mars including outflow channels, gullies, streamlined islands, paleolakes, deltas, and other fluvial landforms based on over 60 HiRISE images that they had suggested and acquired over the past 9 years of working with **Dr. Gulick** and their teacher Mr Dennis Mitchell. Students handed out a calendar that they had made and anaglyph glasses to each of the attendees. The calendar contained 13 of the best HIRISE stereo images that they had acquired. After their presentation, the students presented their rovers that they had made during the year and discussed what they had learned from this experience. Group picture and press release will be included in the June 2017 update.

4. **Richards, J** (5/25). 88k tweet views as part of co-observing KIC 8462852 dimming event
5. **Sarrazin, P., Chalumeau, C. and F. Marchis** were at the SLAC SSRL 2-3 beam line to test the MapX instrument. Photos below.



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