

Variable Winds on Hot Giant Exoplanet Help Study of Magnetic Field *by Alan Fischer*

PSI Senior Scientist Tamara M. Rogers has discovered that substantial variability in the winds on the hot giant exoplanet HAT-P-7b are due to magnetism, and used those findings to develop a new method to model the magnetic field of such an object.

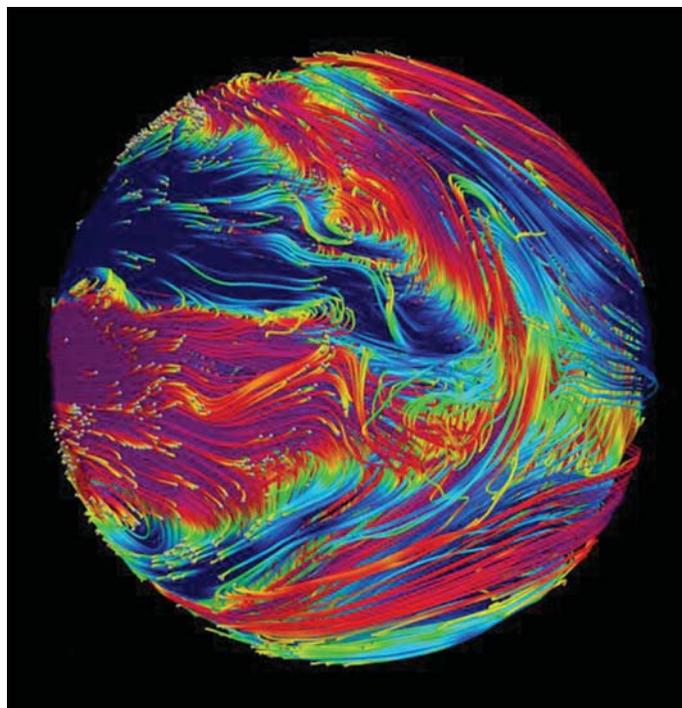
HAT-P-7b, found outside our Solar System, was discovered by the Hungarian Automated Telescope Network (HATNet) project in 2008. It is nearly 40 percent larger and nearly 80 percent more massive than Jupiter. It is tidally locked, meaning the same side of the planet faces its star continually, making the point on the planet's surface that is always closest to the star its hottest. HAT-P-7b orbits its star every couple of days, and is so close to the star that the dayside temperature is 3,500 degrees Fahrenheit while the nightside temperature is 2,160 degrees (1,340 degrees cooler).

This large day-night temperature difference drives strong eastward winds in the atmosphere and shifts the hottest temperature away from the point directly beneath the star on the dayside. However, this hot spot shifts significantly over time — even ending up on the west side of the sub-stellar point. This means that the winds are also changing significantly. The wind changes are caused by the planet's magnetic field.

“The extreme temperatures of HAT-P-7b ionizes alkali metals such as lithium, sodium, and potassium, which results in the coupling of the atmosphere to a deep-seated magnetic field. Magnetic forces are able to then disrupt the strong eastward winds, leading to variable and even oppositely directed winds,” Tamara said.

Tamara used a hydrodynamic model of the atmosphere in combination with a magnetohydrodynamic (MHD) model to reproduce the observed variations in the hot spot location. These models set a minimum value for the strength of the magnetic field of this planet at six times that of the Earth.

“Long timeline or multiple epoch observations of hot giant exoplanet phase curves coupled with MHD models of the atmospheres of these planets can be used to place constraints on the magnetic field strengths of other hot giant exoplanets,” Tamara said. “This will provide new insights into dynamo theory, planetary evolution and interpretations of star-planet magnetic interactions.”



This image shows a model of magnetic field lines in the atmosphere of an exoplanet (a planet that is outside of our Solar System) that is tidally locked (always presents the same side of the planet to the star they orbit, as our moon does.) Magenta lines represent positive magnetic field lines and blue represent negative longitudinal fields. The vantage point is looking onto the transition region between day and night sides. The image was produced by Tamara Rogers using the open source software VAPOR from the National Centre for Atmospheric Research (NCAR).

Tamara's paper “Constraints on the magnetic field strengths of HAT-P-7b and other hot giant exoplanets” appears in *Nature Astronomy*.

This work was funded by an award to the Planetary Science Institute from the NASA Astrophysics Theory Program; the discovery was announced on May 15, 2017.

Inside this issue:

INTRODUCING PAUL HARDERSEN	2
OLEG ABRAMOV'S ROAD TO PSI	2
DOROTHY OEHLER, A RECENT ARRIVAL	4
TWO AWARDS FOR HENRY THROOP	4
DIRECTOR'S NOTE AND STAFF NEWS	5

Introducing Paul Hardersen

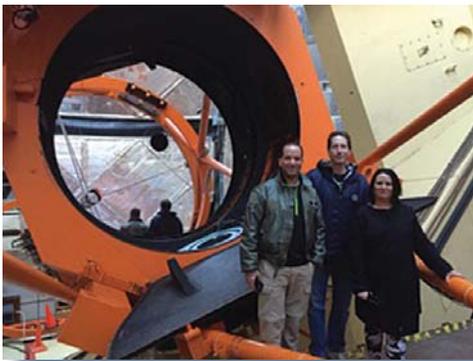
Paul Hardersen joined PSI on March 15, 2017, as a Senior Scientist. He came to PSI from the University of North Dakota (UND) Department of Space Studies, where he had been working as a tenured professor since August 2003.



Paul Hardersen with his children, I-r, Jasmine and Austin.

Paul points out that he is doing the “unthinkable” in giving up a tenured job for a soft money job since that it is the opposite of how most people view the planetary science field. However, after 12 years of North Dakota winters he had finally had enough and made a quality-of-life improvement. That and the onslaught of painful higher education budget cuts in North Dakota, due to the continuing oil bust, while tremendously enjoying his academic sabbatical this past year (read: Hatch Green chiles rule!), led him to exit the Great White North and happily embrace the Tucson Oven.

His science is primarily about main-belt asteroids, their surface mineralogies, possible meteorite analogs for individual asteroids, and what asteroids can tell us about the physical and chemical conditions during the formation epoch of the Solar System. Paul has been solely using the NASA Infrared Telescope Facility (IRTF) to obtain his asteroid NIR (near-infrared) spectral data, but that exclusivity will be vanishing soon as he expands his research



Above (from left): Savan Becker, Paul Hardersen, and Rachel Roberts at the NASA Infrared Telescope Facility. Photos: Paul Hardersen

Paul earned a Bachelor of Science in Geology from Iowa State University in August 1997, a Master of Science in Geology from Rensselaer Polytechnic Institute (RPI) in New York in 2001, and a Ph.D. in Geology from RPI in 2003.

His earliest interest in space science began as a child when he watched the last (he thinks) of the Saturn V rockets launch. He remembers sitting in front of the TV watching the launch by himself. It was either the Apollo 17 launch or the launch of Skylab.

Currently, he is working on a group of 31 inner- and outer-main

belt Vp-type asteroids and their near-infrared (NIR) reflectance spectra to deduce if they have basaltic surface compositions, determine if the HED meteorites are potential meteorite analogs, and to test the utility of the Vp taxonomic class in predicting a basaltic asteroid composition. This work is a part of a current NASA Planetary Astronomy Program grant.

In his spare time he pursues his foodie passions in cooking, baking, dining out, and traveling. He is also part of a start-up travel and social networking business. Paul and his wife, Sarah, will eventually become owned by two cats that they plan to adopt after they arrive in Tucson in late July. He also has curious interests in vampires, Joss Whedon movies, and lobster rolls. “Go figure. Scientists can be weird,” he said. To which we respond, “Here at PSI, we really do not judge!”

Welcome to the Institute, Paul!

Oleg Abramov’s Road to PSI *(in his own words)*

In July 2016, Oleg Abramov joined PSI as a Senior Scientist. Here is his firsthand account of what came before:

When I was 10, my grandpa took me to Star City near Moscow to meet cosmonauts and see how they trained. Even as a child, I was fascinated by space, and read library book after library book about how we might one day travel to distant worlds. I was hooked on the mysteries of the Solar System, and dreamt of someday blasting into orbit or beyond—of being a cosmonaut like Yuri Gagarin.



Oleg Abramov with his partner, Kirstin, in 2016 at New Zealand’s most active cone volcano, Whakaari/White Island. Photos: Oleg Abramov

Not long after that trip to Star City, my family emigrated to Brooklyn and I reoriented my sights to the U.S. space program, and planetary science in particular. I studied well in high school, though as the first person in my family to attend a U.S. university, I messed up the financial aid application and found myself unable to study at a university with an undergrad planetary science or astronomy program. I had always been interested in astrobiology, and pursued a Bachelor of Science in Biology, graduating from Clarkson University in 1998. To help pay for college, I spent a summer gutting fish in the rough Pacific seas of Alaska.

I had already applied to a Ph.D. program at the Lunar and Planetary Laboratory (LPL) at the University of Arizona (UA), but nei-

Continued on page 3

Oleg Abramov's Road to PSI (continued from pg. 2)

ther a bachelor's in biology nor Clarkson University were feeders for the well-known planetary science programs. I would apply several times to UA, eventually taking classes non-degree, before I was admitted.



Oleg setting up an aerial video camera for a flight over Flagstaff in 2014.

For my dissertation, I developed a computer modeling project that simulated hydrothermal systems in impact craters, and earned a graduate minor in Molecular and Cellular Biology. My modeling research helped me win UA's graduate student research competition, and I got my first taste of the interplay between politics and science when I presented my research to the Arizona governor and state legislators in Phoenix. In addition to my modeling work, I used UA's electron microscopy lab to look for biosignatures in samples from the Chicxulub impact crater, and lived in a trailer in the middle of nowhere doing nighttime fieldwork examining rock cores as part of the Chesapeake Bay Impact Structure Deep Drilling Project.

In 2006 after earning a Ph.D. in Planetary Science from UA, I got my first postdoctoral position at Southwest Research Institute in Boulder, CO, analyzing icy satellites based on data from Cassini and New Horizons, and also helping to establish a microbiology lab. I then moved to the University of Colorado Boulder on a NASA Postdoctoral Program (NPP) Fellowship, one I had secured while at UA, but was delayed due to the "Great Astrobiology Funding Cut of 2006." The NPP was followed by a Urey Fellowship at the Lunar and Planetary Institute in Houston, where I spent many days screening for zircons in Apollo lunar samples. I may not have made it to the Moon, but I got to hold some of it in my hands (in epoxy, with gloves, and all the sterile procedures, but it was the Moon of my childhood all the same).

Meanwhile, I trained as a skydiver and general aviation pilot, earning first a private pilot's certificate then an instrument rating, commercial license, and later becoming a Certified Flight Instructor. I love taking people up for joy flights, and especially observing geologic features and experiencing the atmosphere as we ride the winds and currents.

When I moved to Flagstaff, Arizona in 2011 as a Research Space Scientist at USGS, I found myself within striking distance of many incredible features for aerial observation. I practiced thermal mapping and GoPro videos in flight, interspersed with rugged hikes through the Grand Canyon with fellow PSI-er Dave O'Brien.

At USGS, I continued my work in modeling but also did fieldwork in the Australian Outback and Arctic Canada, plus spent time

working on the NanoSIMS ion microprobe at the University of Tokyo. I was also selected as one of the first six crew members for the HI-SEAS (Hawai'i Space Exploration Analog and Simulation) missions in Hawaii that explore the factors that may contribute to success in long-duration spaceflight and isolation. For four months, I lived high on the slopes of Mauna Loa, taking two-minute showers to conserve water and donning a spacesuit simulator for trips outside.

In 2015, I went back to Russia to spend time with my ailing father. It wound up being close to a year of reconnecting with my brothers and other family members, some of whom I had not seen since I left over 25 years earlier.

After Dad recovered, I moved to Dunedin, New Zealand, to join my fiancée where she was pursuing a Master of International Studies at the University of Otago. We have come to love the Aotearoa lifestyle – the striking scenery, tramping (hiking) through Lord of the Rings' Middle-Earth, and friendly locals (both sheep and otherwise). We watch albatross fishing off the bluffs nearby, see penguins scurrying across empty beaches to their burrows, and get a hands-on education in shifting tectonic plates.

In addition to modeling, I continue to be interested in astrobiology, fieldwork, life in isolated and frontier environments, and UAV-based remote sensing. I also have a strong interest in human missions to and settlement of Mars.

At PSI, I conduct thermal and hydrothermal modeling of individual impact craters and impact bombardments, serve as a Co-Investigator on the E-THEMIS instrument for the upcoming NASA Europa Clipper mission, and train early-career scientists in using the codes I have written.

I welcome collaboration with fellow PSI-ers, and hope they'll drop me a line if they head down to the Land of the Long White Cloud. Noho ora mai*

(*That's Maori for "Stay well, Goodbye!")

PSI welcomes Oleg to our science staff!

Front page banner: NASA's Hubble Space Telescope unveiled in stunning detail a small section of the Veil Nebula —expanding remains of a massive star that exploded about 8,000 years ago. The entire nebula is 110 light years across and resides approximately 2,100 light years away in the constellation Cygnus, the Swan.

Credits: NASA/ESA/Hubble Heritage Team



Planetary Science Institute
NEWSLETTER
Summer 2017 Vol. 17, No. 2

Chris Holmberg, Editor and Writer
Alan Fischer, Writer and Photographer

Special thanks to Gil Esquerdo, Dianne Janis, Carol Neese,
and Elaine Owens.

Dorothy Oehler, A Recent Arrival



Dorothy giving Distinguished Alumna presentation at the Department of Earth, Planetary, and Space Sciences (UCLA).

Photos: Dorothy Oehler

In October 2016, Dorothy Oehler joined PSI as a Senior Scientist after 13 years at Johnson Space Center (JSC). Her work at JSC centered on characterizing microfossils of earliest life on Earth — as a guide to recognizing possible fragments of extraterrestrial microorganisms — and predicting settings on Mars where biosignatures could best be preserved. During her time at JSC, she was also a Participating Scientist on the Mars Science Laboratory mission (Curiosity rover), where she worked to interpret geological data.

Prior to JSC, Dorothy was a petroleum geologist, working for Conoco on “new ventures” in remote basins all over the world. She specialized in organic-rich source rocks and the subsurface formation, migration, and trapping of hydrocarbons. She has been able to apply that background to Mars, assessing potential sources of trapped methane on that planet as well as predicting settings in which organic biosignatures, if present, would most likely occur.

But Dorothy’s entry into the world of planetary science started one sleepless night in 2002, when she was roaming the Internet. She came across a website for the Australian Centre for Astrobiology (ACA), founded by an old friend and colleague, Malcolm Walter. She and Malcolm had worked together at the Australian Bureau of Mineral Resources, when she lived in Canberra in the 70’s. During that time, they had a wonderful month-long field trip into the Australian bush, with their share of harrowing experiences. However, she had lost contact with him after leaving Australia in 1976. So she hit the “contact me” button on the ACA’s website. They shared quick updates, then Malcolm asked if she’d like to spend a few months at the ACA in Sydney to work on a project, similar to what she had done for her doctorate at UCLA (microscopy of Precambrian organic microfossils). This was an opportunity she simply could not pass up, so off she went.

Dorothy discovered she still loved that type of work but was even more interested in what Malcolm told her about planetary science and particularly Mars. He subsequently introduced her to colleagues at JSC so she could continue her work with him using facilities at JSC. There she also developed a collaboration with Carlton Allen, then Manager of Astromaterials Curation, who taught her much about planetary data, and she began to view Mars exploration as the ultimate “new venture” and to use her petroleum background accordingly.

Today, Dorothy continues research on both early Earth life and Mars, with a major paper recently completed on potential abiotic and biotic sources of Martian methane and locations where that methane could still be present in the subsurface.



Dorothy and John Oehler in China; Dorothy with giant pandas.

On the personal side, Dorothy enjoys music, dance, art, and animals. She played classical guitar for a few years and supports several animal welfare charities. She married her husband, John, in Kathmandu, Nepal many years ago while he was a Peace Corps volunteer and she was working for the U.S. Information Service after getting her bachelor's degree. Later, John also worked for Conoco as an international exploration geologist. He now writes thrillers for which she creates the cover art.

With the recent arrival of Dorothy Oehler, PSI welcomes yet another wonderful scientist to our staff!

Two Awards for Henry Throop by Alan Fischer

PSI Senior Scientist Henry Throop has been awarded the 2017 Carl Sagan Medal for excellence in public communication by the Division for Planetary Sciences (DPS) of the American Astronomical Society, and the Avis Bohlen Award for a Foreign Service Family Member by the U.S. State Department for his volunteer efforts. Both awards recognize Henry’s talent for connecting with people through his educational talks. Henry has given more than 200 presentations across the developing world at schools, science festivals, planetariums, and community centers. He has brought his telescopes for night sky observing across the world, from rural African villages to Indian megacities.



Henry Throop receiving the Avis Bohlen Award at the U.S. State Department Photo: Henry Throop

The Sagan Medal citation says, “The DPS awards the Carl Sagan Medal for excellence in public communication by an active planetary scientist to Henry B. Throop (Planetary Science Institute) for his efforts to kindle interest in worlds beyond Earth throughout the developing world. His presentations in South Africa, India, Namibia, Botswana, Nepal, and Mexico reach audiences who might otherwise not be exposed to planetary science. He closely collaborates with teachers and works with a diverse group of students and the public to stimulate their curiosity and show them how they can explore the world around them. With his engaging personality and genuine interest in interacting with students and teachers in far-flung places, he presents a positive face for science using planetary exploration as a driver.”

continued on page 6

Director's Note

One word comes to mind: *Babies!* PSI has enjoyed a small population boom over the past few months. Nothing brings as much joy to a community as new little ones. Congratulations to Ryan, Sarah, Elisabeth, Matt, and Pasquale and their families!

Mark V. Sykes
August 2017



PSI Associate Research Scientist **Elisabeth Adams** and her husband Jonathan Foster added a daughter to their family on May 11. Harriet Sallie Foster-Adams weighed 7 lbs, 1 oz and measured 19 inches.



Big brother Calvin is adapting well to his new little sister. He is very keen on trains and frames everything in railroad terms. Evidently, the baby box she sleeps in during the day resembles a train car so when the baby cries Calvin says, "Hopper car noisy!"

PSI Research Scientist **Matt Siegler** and his wife Dr. Rita Economos had their second child, Juniper (June) Rae Economos on June 19, coming in at 8 lbs, 14 oz and about 21 inches in length.

Juniper has Matt's wife's last name, and their son, Jack, was given Matt's last name. She came into the world less than a day after the death of her incredible, 103-year-old great grandmother, Helen Fuchsen, who will be dearly missed, but lived an amazing life — "one generation pushes the next forward."



Candice Hansen-Koharcheck, PSI Senior Scientist and Deputy Principal Investigator of HiRISE, is co-author of the recently published book, "Mars: The Pristine Beauty of the Red Planet." This beautiful book shows Mars' captivating landforms in art-like images taken by the most powerful camera ever sent to another planet. The 425 page book features close to 200 carefully selected photographs taken by the University of Arizona-led HiRISE camera, which has been orbiting Mars on NASA's Mars Reconnaissance Orbiter since 2006. These images are from an active mission, making this more than just a very pretty coffee table book.



Credit: Alan Fischer

"Mars: The Pristine Beauty of the Red Planet" is published by UA Press and is available in bookstores and online.

Congratulations to all our scientists!

PSI Staff News: Five Baby Girls and a Book

PSI Associate Research Scientist **Ryan Clegg-Watkins** and her husband Matt Watkins had their first child on May 10, Alexis Madison Watkins. She weighed 5 lbs, 1 oz and was 20.5 inches long. Unfortunately, Alexis spent the first few days of her life in the neonatal intensive care unit (NICU) because she punctured some holes in her lungs taking her first breath. Thankfully, she recovered quickly and is now amazing the doctors with how well she is doing! Mom and baby are getting used to the routine of daily life now.



PSI Research Scientist **Sarah Sonnett** and her husband Brandon welcomed their second daughter, Jane, on May 25. Vital statistics: 6 lbs, 15 oz, 19.5 inches, and a good sleeper!

Big sister Djuna (22 months) constantly wants to hold her. Sweetly, the girls have matching birth marks. Their parents feel very lucky!



PSI Senior Scientist **Pasquale Tricarico** and his wife Caroline announced the birth of their third child, Juliette.

She weighed just under 6 lbs, measured 17.75 inches, and was born on July 19, which also happens to be Pasquale's birthday—an event with less than 0.3% probability, thus statistically significant. Pasquale wishes to acknowledge the referees (and older brothers) Louis and Arthur.



1700 E. Ft. Lowell Rd., Suite 106
Tucson, AZ 85719-2395
Phone: 520/622-6300
www.psi.edu

Follow Us  
Newsletter Published Quarterly

Two Awards for Henry Throop (cont'd from page 4)

PSI Senior Scientist David Grinspoon, who nominated Henry, said, "One thing that really distinguishes Henry, and makes him especially worthy of this award, is that he has put vast amounts of creativity and energy into education and outreach activities in other countries where many students have not had the kind of exposure to planetary science that students have in the U.S.



Henry Throop with students in Limpopo Province, South Africa, in 2013. Photo: Ephraim Manamela (U.S. Embassy)

"Through his articulate and winning communication style, engaging personality, and genuine interest in interacting with far-flung and nontraditional audiences Henry has acted as an effective international ambassador for our community," David said.

"I am grateful to the DPS for this honor. I've been lucky to be able to talk about astronomy with students and the public around the developing world," Henry said. "Astronomy is both tangible and mysterious: you can see the night sky from anywhere, but it's far enough away that it's not immediately obvious how it all works. I love bringing people along on the journey of exploration that we do so they can understand the Solar System, and answer for

themselves the same questions that scientists do.

"The work that we do as scientists is only valuable if the public knows about it. I have seen over and over again that students and the public are just as curious and excited about exploring the Solar System as we are as scientists. With more and more countries developing strong research programs, it's important to keep building science education and awareness across the world," Henry said.

Henry's research focuses on the outer Solar System, and he has published more than 60 articles in scientific journals on topics including the rings of Saturn and Jupiter, planet formation and astrobiology. He is a member of the science team for NASA's New Horizons mission, which in 2015 made the historic first flyby of Pluto, and is continuing onward through the Kuiper Belt. Henry was a co-discoverer of Pluto's smallest moon, Styx, in 2012. He is a frequent consultant to NASA and the National Science Foundation.

Bravo, Henry!

Henry lives in Mumbai, India. The Avis Bohlen Award was presented by the American Foreign Service Association, the association representing the U.S. State Department.

Henry joins other PSI scientists who have won the Sagan Award: David H. Grinspoon (2006), Larry A. Lebofsky (2000), and PSI Founder William K. Hartmann, who received the inaugural award in 1998.