PPPL PRINCETON PLASMA PHYSICS LABORATORY
A Collaborative National Center for Fusion & Plasma Research
U.S. DEPARTMENT OF ENERGY
WEEKLY
December 4, 2017

THIS WEEK

WEDNESDAY, DEC. 6

Council Café Lunch
12 p.m. ◆ PPPL Cafeteria
Charles Neumeyer
Head of engineering for the NSTX-U Recovery Project

Colloquium
4:15 p.m. ◆ MBG Auditorium
High Power Laser Activities at TRUMPF
Hagen Zimer, TRUMPF Photonics Inc.

UPCOMING

WEDNESDAY, DEC. 13

Council Café Lunch
12 p.m. ◆ PPPL Cafeteria
Scott Weidner
Princeton University assistant vice president for engineering

Tour Training
12 p.m. ◆ MBG Auditorium
See page 7 for details.

Colloquium
4:15 p.m. ◆ MBG Auditorium
Predicting Thermal Transport in Nanostructured Materials
Jennifer Lukes, University of Pennsylvania

THURSDAY, DEC. 21

PPPL Holiday Party
Details to come.

INSIDE

New NSTX-U recovery project manager Russ Feder cut his teeth on US ITER diagnostics

By Jeanne Jackson DeVoe

Engineer Russ Feder has been at PPPL for 17 years but his new position as the project manager of the National Spherical Torus Experiment-Upgrade (NSTX-U) Recovery Project is a homecoming of sorts.

Feder had worked on diagnostics for NSTX for several years before moving on. For the past nine years, he has been working on US ITER projects at PPPL, most recently as a project manager for US ITER diagnostics.

"I'm excited to work with a lot of people with whom I worked before, to just get reacquainted with a lot of PPPL staff," Feder said. "I know how important this is to the Lab, so I'm excited to be part of bringing it to successful completion."

Russ Feder *(Photo by Elle Starkman)*

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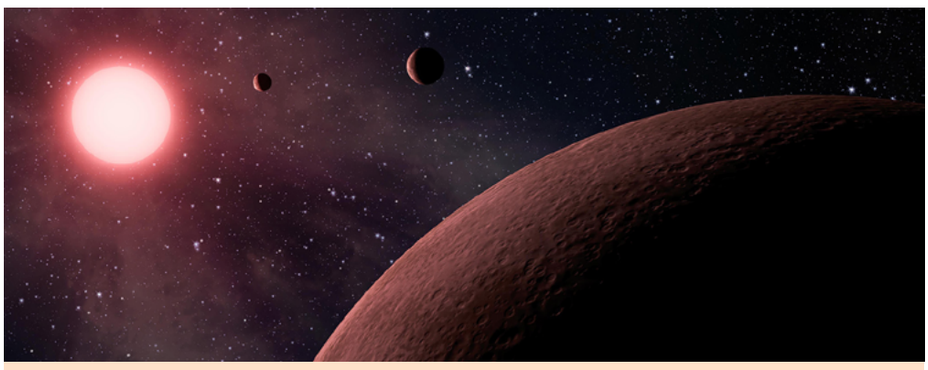
The answer is blowing in the stellar wind: Scientists reduce the chances of life on exoplanets in so-called habitable zones around red stars

By John Greenwald

Is there life beyond Earth in the cosmos? Astronomers looking for signs have found that our Milky Way galaxy teems with exoplanets, some with conditions that could be right for extraterrestrial life. Such worlds orbit stars in so-called "habitable zones," regions where planets could hold liquid water that is necessary for life as we know it.

However, the question of habitability is highly complex. Researchers led by space physicist Chuanfei Dong of PPPL and Princeton University have recently raised doubts about water on — and thus potential habitability of — frequently cited exoplanets that orbit red dwarfs, the most common stars in the Milky Way.



Starlight shining on exoplanet *(Image courtesy of NASA/JPL-Caltech)*

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Joseph McBrearty, deputy director for field operations in the U.S. Department of Energy's Office of Science, tours PPPL

Joseph McBrearty, deputy director for field operations in the U.S. Department of Energy's Office of Science, toured PPPL during a Nov. 28 visit. After meeting with Pete Johnson, head of the Princeton Site Office, and his staff, McBrearty was briefed on the Infrastructure Operational Improvements (IOI) project. He then took a tour of PPPL that included the National Spherical Torus Experiment-Upgrade (NSTX-U) test cell, the LSB Annex and the C Site-MG building and other areas of the Laboratory before meeting with PPPL's leadership.

McBrearty, center, with from left, Russ Feder, project manager of the NSTX-U Recovery Project; David Carle, head of Facilities, Jon Menard, head of the NSTX-U Recovery Project; Martin Donohue, head of Engineering Services, and Tim Stevenson, head of operations for the Recovery Project, outside the NSTX-U Test Cell. *(Photo by Elle Starkman)*

Russ Feder, project manager for the NSTX-U Recovery Project, left, and Jon Menard, head of the Recovery Project, show McBrearty the NSTX-U center stack casing. *(Photo by Elle Starkman)*

Jon Menard, head of the NSTX-U Recovery Project, left, at the top level of the NSTX-U Test Cell, along with McBrearty and Tim Stevenson. *(Photo by Elle Starkman)*

McBrearty with protective shoes. *(Photo by Elle Starkman)*

Les Hill, head of the IOI Project, second from left, shows McBrearty, second from right, the C Site-MG Building with from left Terry Brog, deputy director for operations; Pete Johnson, head of the Princeton Site Office; David Carle, head of Facilities; and Martin Donohue, engineering branch head for Facilities. *(Photo by Elle Starkman)*

John Lacenere, head of AC Power Engineering, shows McBrearty the power plant. *(Photo by Elle Starkman)*

Physicist David Gates is named editor-in-chief of *Plasma*, a new online journal

By Larry Bernard

David Gates, principal research physicist and Stellarator Physics Division Head at PPPL, has been named editor-in-chief of *Plasma*, an online open access journal for plasma physics.

"I am excited to join the editorial board as editor-in-chief of *Plasma* and I look forward to helping advance the international research arena in plasma science," Gates said. "This is an outstanding opportunity to help promote the research of a vital area of physics and to open the door to communicating that research to the global community."

Plasma is an international, open access, peer-reviewed journal covering all aspects of plasma science, and is published quarterly online by MDPI, an online publishing company based in Switzerland. It is a cross-disciplinary scholarly journal of scientific studies related to all aspects of plasma science, such as plasma physics, plasma chemistry and space plasma. It publishes reviews, research articles, short communications and letters. Topics also include experimental and theoretical results, and progress of interdisciplinary and application sciences in this field.

David Gates *(Photo by Elle Starkman)*

Also known as the fourth state of matter, plasma is the most abundant form of visible matter in the universe; it is thought to make up 99 percent of what can be seen in the night sky. Plasma dominates the vast regions of interstellar and interplanetary space, but also can be found on Earth: lightning, neon signs, fluorescent light bulbs, a candle flame, some television and computer displays are all examples of plasma.

A Fellow of the American Physical Society, Gates has been studying plasma for 30 years. He came to PPPL in 1997 after four years at Culham Laboratory in Oxfordshire, England, to work on the National Spherical Torus Experiment. As head of the Stellarator Physics Division at PPPL, he leads collaborative efforts with the Wendelstein 7-X stellarator in Germany and the Large Helical Device stellarator in Japan. He is an expert in the areas of stellarator design, magnetohydrodynamics, and plasma control. A stellarator is a device to generate fusion reactions, which are fueled by plasma, to create energy like the sun and most stars.

Gates has contributed to more than 160 papers and is first author on 20 of them. He received his Ph.D. in applied physics from Columbia University in 1994 and his B.S. in math and physics from the University of Wisconsin-Madison in 1986.

Council Café Lunch

This Week:

Charles Neumeyer, Head of engineering for the NSTX-U Recovery Project

Wednesday, Dec. 6
12 p.m., PPPL Café

Next Week: Scott Weidner

PPPL'ers celebrate Inventor Hall of Fame

More than 50 people celebrated the inauguration of the Inventor Hall of Fame at the back of the Melvin B. Gottlieb Auditorium with cake and coffee on Nov. 20.

The Inventor Hall of Fame includes 25 inventions and patents by PPPL staff members and collaborators in fiscal year 2016. These range from a new type of crystal spectrometer for laser-produced plasmas to a car seat ejection system for self-driving vehicles.

Laurie Bagley, head of Technology Transfer, and Aileen Pritch, an administrator in Procedures, Publications, and Technology Transfer, organized the event. They were assisted by Larry Bernard, head of Communications, along with photographer Elle Starkman, who took the inventor's photos, and graphic artist Kyle Palmer, who created the plaques and the display.

"This highlights the contributions last year that we're really quite proud of," said Mike Zarnstorff, PPPL's deputy director for research at the event. "The thing to take away from this is to act on your ideas and patent your ideas. We have to act on our ideas in order to bring them forward to the people who need them."

The cake honoring the inventors and some of the plaques in the Inventor Hall of Fame.
(Photo by Laurie Bagley)

Laurie Bagley, head of Technology Transfer, left, and Aileen Pritch, Procedures, Publications, and Technology Transfer administrator, organized the event.
(Photo by Elle Starkman)

Inventors at the celebration included, from left, Ken Silber, Kevin Lamb, George Ascione, and Cathy Saville *(Photo by Elle Starkman)*

Michael Zarnstorff, deputy director for research, says inventors are key to the success of the Laboratory.
(Photo by Elle Starkman)

Enjoying cake are , from left: Tom Egebo, Nevell Greenough, and Robert Mozulay.
(Photo by Elle Starkman)

Engineer John Mitchell at the celebration.
(Photo by Elle Starkman)

Feder named NSTX-U recovery project manager

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Richard Hawryluk, PPPL's interim director, said Feder's experience on US ITER will be invaluable as he assumes the position of second-in-command to Jon Menard, the head of the Recovery Project and deputy Recovery Project head Stefan Gerhardt. Charles Neumeyer will serve as the project engineer and Stefan Gerhardt will continue as Systems Engineering and Integration head. "We're very pleased about Russ's appointment," Hawryluk said. "He'll bring his experience from ITER to bear and support Jon, Stefan and Charlie in a major way."

In addition to Feder assuming his new position, other major changes are: Larry Dudek will become the construction manager of the project, and Frank Jones will head the work control center. Neway Atnafu was named the responsible engineer in charge of the test cell, and Mike Jaworski will assume a new role as the responsible engineer for plasma-facing components.

Managing cost and schedule

As the project manager, Feder has broad responsibilities to balance the delivery of the technical scope with tight cost and schedule constraints.

Feder will also work closely with the U.S. Department of Energy and the Princeton Site Office and will help shepherd the project through numerous design reviews between now and April. These will provide a baseline before the project goes into final design, procurement and fabrication for improvements on the device designed to ensure it operates reliably. Neumeyer and Gerhardt will focus on ensuring thorough and successful engineering design reviews and managing systems integration issues.

"I think there's a strong team of engineers and a very strong management team right now," Feder said. "I think it's going to be an exciting, very busy year. But I'm 100 percent sure we can be successful."

PPPL must not only address issues on NSTX-U, but must also prove that it can undertake new experiments in the future, Feder said. "We want to get back to the point where we have multiple major projects," he said. "We have to be aspirational."

Feder's most recent work for US ITER was project manager for US ITER diagnostic tools. He handled all aspects of project management, including cost and schedule, procurement, and communications. He was previously head of engineering for the port plugs that the United States is developing for ITER. He also worked on engineering for ITER diagnostic systems and diagnostic port plugs.

Feder joined PPPL in 2000. He first worked on decommissioning the Tokamak Fusion Test Reactor (TFTR). The huge vessel had been filled with concrete and PPPL engineers developed a cutting tool employing diamond beads on a wire to cut it up.

Second generation PPPL'er

The engineer is a second-generation PPPL'er. His father, Howard, worked at PPPL as a draftsman in the 1970s when Feder was growing up in Bensalem, Pennsylvania, outside Philadelphia. Howard Feder returned to PPPL for a few years as a designer on NCSX.

A Princeton resident, Feder is married to Rebecca, who has a human resources consulting business. They have two boys, Justin, 10, and Brandon, 12.

Feder received bachelor's degrees in mechanical engineering and economics from Rutgers University. He earned a master's degree in mechanical engineering from Rensselaer Polytechnic Institute and a second degree in nuclear engineering from Penn State University. He also received an optical engineering certificate from Stevens Institute of Technology and a certificate in project management from Rutgers University. He has been selected to attend the DOE's Project Leadership Institute next year, executive training through Stanford University's Project Management program.

Before coming to PPPL, Feder analyzed equipment on nuclear submarines for the General Dynamics Electric Boat Company from 1994 to 1997. He went on to work for the Stein Seal Company on the design and testing of shaft seals for turbo machinery from 1997 to 2000.

Feder said he takes pride in telling people that he works at PPPL. "It's a cool place to work and the technical challenges for engineers are amazing," he said. "We're doing something that really could benefit the world and developing a power source that will someday be a game-changer."

Submit your questions for Plasma 101 Lunch & Learn

101 Lunch & Learns for staff start in December. Please submit your questions about fusion energy, plasma, or any of the science we do here in the box in the LSB lobby.

Sample questions:
What is plasma?
How is what we do different from "nuclear power?"
Why don't we have fusion energy on the grid yet?

Exoplanets

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Impact of stellar wind

In two papers in *The Astrophysical Journal Letters*, the scientists develop models showing that the stellar wind — the constant outpouring of charged particles that sweep out into space — could severely deplete the atmosphere of such planets over hundreds of millions of years, rendering them unable to host surface-based life as we know it.

"Traditional definition and climate models of the habitable zone consider only the surface temperature," Dong said. "But the stellar wind can significantly contribute to the long-term erosion and atmospheric loss of many exoplanets, so the climate models tell only part of the story."

To broaden the picture, the first paper looks at the timescale of atmospheric retention on Proxima Centauri b (PCb), which orbits the nearest star to our solar system, some four light years away. The second paper questions how long oceans could survive on "water worlds" — planets thought to have seas that could be hundreds of miles deep.

Two-fold effect

The research simulates the photo-chemical impact of starlight and the electromagnetic erosion of stellar wind on the atmosphere of the exoplanets. These effects are two-fold: The photons in starlight ionize the atoms and molecules in the atmosphere into charged particles, allowing pressure and electromagnetic forces from the stellar wind to sweep them into space. This process could cause severe atmospheric losses that would prevent the water that evaporates from exoplanets from raining back onto them, leaving the surface of the planet to dry up.

On Proxima Centauri b, the model indicates that high stellar wind pressure would cause the atmosphere to escape and prevent atmosphere from lasting long enough to give rise to surface-based life as we know it. "The evolution of life takes billions of years," Dong noted. "Our results indicate that PCb and similar exoplanets are generally not capable of supporting an atmosphere over sufficiently long timescales when the stellar wind pressure is high."

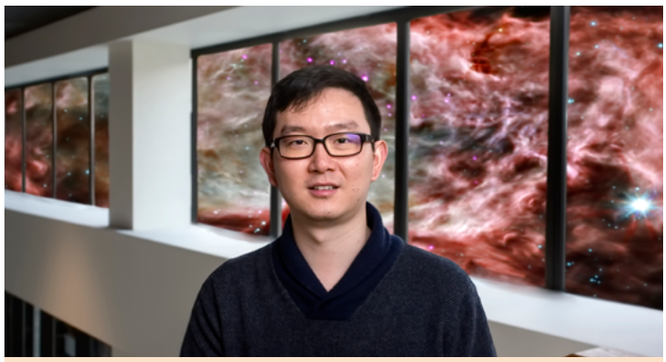
"It is only if the pressure is sufficiently low," he said, "and if the exoplanet has a reasonably strong magnetic shield like that of the Earth's magnetosphere, that the exoplanet can retain an atmosphere and has the potential for habitability."

Evolution of habitable zone

Complicating matters is the fact that the habitable zone circling red stars could evolve over time. So high stellar wind pressure early on could increase the rate of atmospheric escape. Thus, the atmosphere could have eroded too soon, even if the exoplanet was protected by a strong magnetic field like the magnetosphere surrounding Earth, Dong said. "In addition, such close-in planets could also be tidally locked like our moon, with one side always exposed to the star. The resultant weak global magnetic field and the constant bombardment of stellar wind would serve to intensify losses of atmosphere on the star-facing side."

Turning to water worlds, the researchers explored three different conditions for the stellar wind. These ranged from:

- Winds that strike the Earth's magnetosphere today.
- Ancient stellar winds flowing from young, Sun-like stars that were just a toddler-like 0.6 billion years old compared with the 4.6 billion year age of the Sun.
- The impact on exoplanets of a massive stellar storm like the Carrington event, which knocked out telegraph service and produced auroras around the world in 1859.



Space physicist Chuanfei Dong. *(Photo by Elle Starkman; background image of flame nebula courtesy of NASA/JPL-Caltech)*

The simulations illustrated that ancient stellar wind could cause the rate of atmospheric escape to be far greater than losses produced by the current solar wind that reaches the magnetosphere of Earth. Moreover, the rate of loss for Carrington-type events, which are thought to occur frequently in young Sun-like stars, was found to be greater still.

"Our analysis suggests that such space weather events may prove to be a key driver of atmospheric losses for exoplanets orbiting an active young Sun-like star," the authors write.

High probability of dried-up oceans

Given the increased activity of red stars and the close-in location of planets in habitable zones, these results indicate the high probability of dried-up surfaces on planets that orbit red stars that might once have held oceans that could give birth to life. The findings could also modify the famed Drake equation, which estimates the number of civilizations in the Milky Way, by lowering the estimate for the average number of planets per star that can support life.

Authors of the PCb paper note that predicting the habitability of planets located light years from Earth is of course filled with uncertainties. Future missions like the James Webb Space Telescope, which NASA will launch in 2019 to peer into the early history of the universe, will therefore "be essential for getting more information on stellar winds and exoplanet atmospheres," the authors say, "thereby paving the way for more accurate estimations of stellar-wind induced atmospheric losses."

Scientists spot potentially habitable worlds with regularity. Recently, a newly discovered Earth-sized planet orbiting Ross 128, a red dwarf star that is smaller and cooler than the sun located some 11 light years from Earth, was cited as a water candidate. Scientists noted that the star appears to be quiescent and well-behaved, not throwing off flares and eruptions that could undo conditions favorable to life.

Collaborating with Dong on the PCb paper were physicists from Harvard University, the Harvard-Smithsonian Center for Astrophysics, the University of California, Los Angeles, and the University of Massachusetts. Support for the work came from a NASA Jack Eddy postdoctoral fellowship for Dong through the Princeton Center for Heliophysics, led by Prof. Amitava Bhattacharjee, head of the PPPL Theory Department who serves as Dong's postdoctoral advisor, and the Max Planck-Princeton Research Center for Plasma Physics, jointly financed by the DOE Office of Science and the National Science Foundation. Collaborating on the water world research were scientists from the University of Michigan, the Harvard-Smithsonian Center for Astrophysics and Harvard University. The NASA Jack Eddy postdoctoral fellowship supported Dong.

Thank you PPPL recyclers!

PPPL collected 2,575 pounds of electronics in the Unicor home electronics recycling drive for America Recycles Day this year. That's 480 pounds more than last year!

Thank you! *—The Green Team*

Tour Guide Meeting & Training

Are you a physicist, engineer, graduate student, or knowledgeable staff member who would like to tell visitors about PPPL's research? Sign up to be a tour guide! Please contact Jeanne Jackson DeVoe, jjackson@pppl.gov, ext. 2757, if you're interested.

There will be a general tour meeting for all tour guides with a pizza lunch followed by a tour training for new tour guides on Wednesday, Dec. 13 at noon in the MBG Auditorium.

Holiday Party

Save the Date: PPPL's holiday party is Dec. 21!

Stay tuned for details.

Tour the Laboratory on an employee tour!

Who: PPPL Staff

What: See the NSTX-U Control Room, test cell, and other areas of the Laboratory on an employee tour.

When: Dec. 8 and the second Friday of each month at 10 a.m.

Where: Meet in the LSB Lobby

Why: Learn more about our research and mission

How: Sign up here.

COLLOQUIUM

High Power Laser Activities at TRUMPF

Hagen Zimer
TRUMPF Photonics Inc.

Wednesday, Dec. 6
4:15 p.m., M.B.G. Auditorium, Lyman Spitzer Building

BROCK

NICK PETTI
Chef Manager

Café at PPPL

BREAKFAST ..... 7 a.m. • 10 a.m.
CONTINENTAL BREAKFAST ..... 10 a.m. • 11:30 a.m.
LUNCH ..... 11:30 a.m. • 1:30 p.m.
SNACK SERVICE ..... until 2:30 p.m.

	Monday Dec. 4	Tuesday Dec. 5	Wednesday Dec. 6	Thursday Dec. 7	Friday Dec. 8
COMMAND PERFORMANCE Chef's Feature	**Roast Pork** with Barley Wild Rice Pilaf and Vegetable	**Pasta Bowl** with Garlic Breadstick	**Roast Beef Au Jus** with Mashed Potatoes	**Chicken Pot Pie**	**Fish and Chips**
Early Riser	**Bacon, Egg and Cheese English Muffin**	**Mexican Breakfast Burrito**	**Scrapple and Eggs**	**Cinnamon-Raisin Pancakes** with Homemade Apple Compote	**French Toast Sticks**
Country Kettle	**Manhattan Clam Chowder**	**Vegetable**	**Chicken Noodle**	**Tomato Soup**	**Chili Bean**
Deli Special	**Autumn Chicken Salad Wrap**	**Caribbean Ham Hoagie**	**Cajun Egg Salad Wrap**	**Turkey Sloppy Joe**	**Spicy Crab Wrap**
Grill Special	**Black Bean Quesadilla**	**Burgerlicious Old Macdonald Burger**	**Bacon, Arugula and Fried Green Tomatoes**	**Ham and Cheese Pizza Roll**	**Greek Chicken Cheesesteak**
Panini	**Cheddar Crab Melt**	**Fried Flounder Hero** with Cajun Remoulade	**Pastrami and Swiss** on Marble Rye	**Chipotle Roast Beef Melt**	**Breaded Chicken Cutlet** with Ham, Swiss Cheese, Lettuce & Honey Mustard Ciabatta

MENU SUBJECT TO CHANGE WITHOUT NOTICE

HEART HEALTHY VEGETARIAN OPTION

WEEKLY

Editor: **Jeanne Jackson DeVoe** ◆ Layout and graphic design: **Kyle Palmer** ◆ Photography: **Elle Starkman** ◆ Science Editor: **John Greenwald** ◆ Science Writer: **Raphael Rosen** ◆ Webmaster: **Chris Cane** ◆ Communications Director: **Larry Bernard**

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Comments: commteam@pppl.gov ◆ **PPPL WEEKLY** is archived on the web at: http://w3.pppl.gov/communications/weekly/.