PPPL PRINCETON PLASMA PHYSICS LABORATORY
A Collaborative National Center for Fusion & Plasma Research
U.S. DEPARTMENT OF ENERGY
WEEKLY
January 8, 2018

THIS WEEK

WEDNESDAY, JAN. 10

Council Café Lunch
12 p.m. ◆ PPPL Cafeteria
Terry Brog
Deputy Director for Operations

Colloquium
4:15 p.m. ◆ MBG Auditorium
Two-Dimensional Materials: Mechanical Stiffness, Strength and Reliability
Jeffrey Kysar, Columbia University

FRIDAY, JAN. 12

Employee Tour
10 a.m.
See page 6 for details.

SATURDAY, JAN. 13

Science on Saturday
9:30 a.m. ◆ MBG Auditorium
From Lemons to Lithium, Squeezing More Life out of Batteries
Craig Arnold, Princeton University

UPCOMING

MONDAY, JAN. 15

Martin Luther King Jr. Day
Laboratory Closed

TUESDAY, JAN. 16

Core Values Session
9:30 a.m. ◆ Room B318

WEDNESDAY, JAN. 17

Core Values Session
12:30 p.m. ◆ Room B318

THURSDAY, JAN. 18

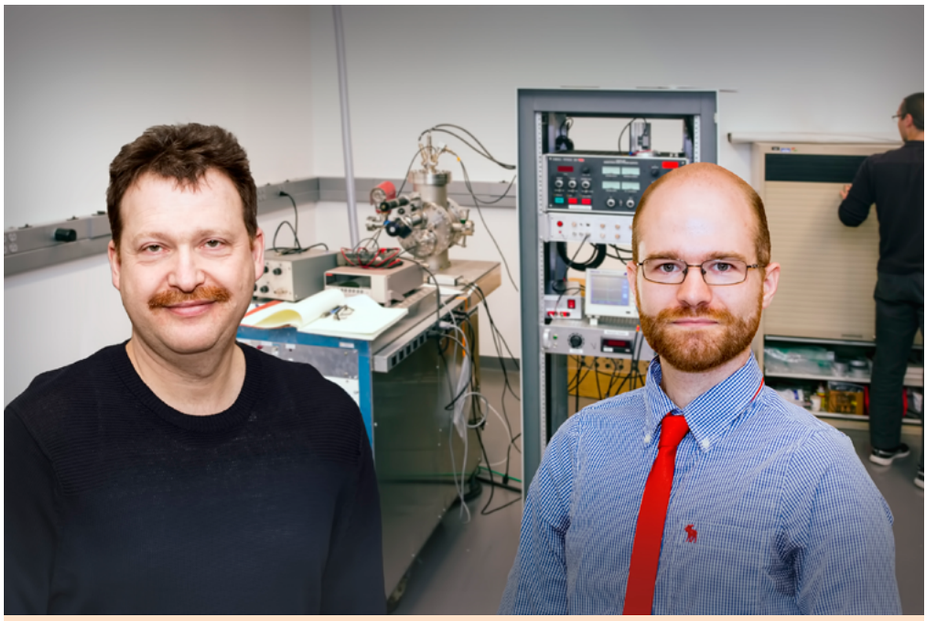
All-Hands Meeting
1 p.m. ◆ MBG Auditorium

INSIDE

Feathers and whiskers help prevent short circuits in plasma devices

By Raphael Rosen

Physicists at PPPL have found a way to prevent plasma — the hot, charged state of matter composed of free electrons and atomic nuclei — from causing short circuits in machines such as spacecraft thrusters, radar amplifiers, and particle accelerators. In findings published online in the Journal of Applied Physics, Charles Swanson and Igor Kaganovich report that applying microscopic structures that resemble feathers and whiskers to the surfaces inside these machines keeps them operating at peak performance.



Physicists Igor Kaganovich, left, and Charles Swanson. *(Photo by Elle Starkman)*

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Burning plasma is crucial to future U.S. fusion research, scientists conclude at national meeting

By Jeanne Jackson DeVoe

Creating a burning plasma, which is the mission of ITER, the international fusion experiment being constructed in France, is an essential step on the path to fusion energy, scientists meeting on the future directions for U.S. fusion research concluded in a national meeting last month. Continued U.S. participation in ITER will provide both critical science information and real-world fusion machine integration experience that the nation will need to develop fusion energy, the attendees said.

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Due to the Martin Luther King Day holiday, the next Weekly will be published Jan. 16.

Feathers and whiskers

continued from page 1

The physicists calculated that tiny fibers called "fractals," because they look the same when viewed at different scales, can trap electrons dislodged from the interior surfaces by other electrons zooming in from the plasma. Researchers refer to the dislodged surface electrons as "secondary electron emissions" (SEE); trapping them prevents such particles from causing electric current that interferes with the functions of machines.

This work builds on previous experiments at PPPL involving plasma thrusters, showing that surfaces with fibered textures can reduce the amount of secondary electron emission. Past research has indicated that surfaces with plain fibers called "velvet" that lack feather-like branches can prevent about 65 percent of the secondary electrons from escaping into the plasma. The velvet only traps half of such electrons, since if the electrons from the plasma strike the fibers at a shallow angle the secondary electrons can bounce away without obstruction.

"When we looked at velvet, we observed that it didn't suppress SEE from shallowly incident electrons well," Swanson said. "So we added another set of fibers to suppress the remaining secondary electrons and the fractal approach does appear to work nicely."

The new research shows that feathered fibers can capture secondary electrons produced by the electrons that approach from a shallow angle. As a result, the fractal fibers can reduce secondary electron emission by up to 80 percent.

Swanson and Kaganovich verified the findings by performing computer calculations that compared velvet and fractal feathered textures. "We numerically simulated the emission of secondary electrons, initializing many particles and allowing them to follow ballistic, straight-line trajectories until they interacted with the surface," Swanson said. "It was apparent that adding whiskers to the sides of the primary whiskers reduced the secondary electron yield dramatically."

The two scientists now have a provisional patent on the feathered-texture technique. This research was funded by the Air Force Office of Scientific Research and follows experimental work on plasma-wall interactions and wall materials effects in plasma thrusters done at PPPL by physicists Yevgeny Raitses, Nathaniel Fisch, Alexander Dunaevsky, Artem Smirnov, and David Staack. This research also builds on more recent work supported by the DOE and conducted by PPPL visiting students Marlene Patino, Chenggang Jin, and Angelica Ottaviano, who in the past year have published experimental findings on how secondary electron emission is affected by different materials with different surface structures, based on research they did with Raitses at PPPL.

Council Café Lunch

This Week:

Terry Brog,

Deputy Director for Operations

Wednesday, Jan. 10
12 p.m., PPPL Café

Submit your questions for Plasma 101 Lunch & Learn

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?

National fusion workshop

continued from page 1

PPPL scientists helped lead the national workshop on strategic directions for U.S. fusion research at the University of Texas-Austin Dec. 11 to 15. It was the second meeting aimed at bringing together the fusion community to tackle the big questions regarding the future of the U.S. fusion program and to contribute to a report by a National Academy of Sciences (NAS) panel on a strategic plan for U.S. burning plasma research. (See sidebar) It is the first time the fusion community has come together to discuss the strategic future of the national fusion program since the Snowmass meeting in Snowmass Village, Colorado, in 2002.

"The big picture game plan is to look at what direction we want to go in for fusion energy development as a country and as a community and then work backwards to figure out what science goals derive from that and what research is needed to reach those science goals," said Jon Menard, head of the NSTX-U Recovery Project and head of NSTX-U Research at PPPL. Menard, along with David Maurer, of Auburn University, and Mickey Wade, of General Atomics, organized the December workshop and a July workshop in Madison, Wisconsin.

A strong consensus of scientists at the Austin workshop was that the U.S. should pursue innovations to make future fusion power plants as attractive as possible, Menard said. These could include quasi-symmetric stellarators, high-temperature superconductors; innovations in plasma-facing materials such as the use of the liquid metal lithium; and physics advances leading to more compact configurations, including spherical tokamaks such as PPPL's National Spherical Torus Experiment-Upgrade (NSTX-U).

Menard said he and other physicists have recently worked on concepts for fusion energy devices that use high-temperature superconductors. These are "potentially game changing," Menard said, because they could provide a stronger magnetic field and high current density, which could provide better performance for more compact devices such as spherical tokamaks.

"There are many new ideas," Menard said, "so the long-term process will be to determine more clarity in the mission and supporting research and development that is needed, and then try to open some strategic wedges for resources going into new areas that can tell us whether some of these things that might be very innovative will actually pan out."

The workshop also discussed key elements of a long-term U.S. fusion strategic plan in the context of two different scenarios: the United States continues as a partner in ITER and the country withdraws from the ITER project. PPPL engineer Chuck Kessel, along with Tobin Munsat, of the University of Colorado-Boulder, and Oliver Schmitz, of the University of Wisconsin-Madison, heads a working group examining the impact on technology and the U.S. fusion program if the United States loses access to ITER.

Different approaches to strategic plan

Four of the community working groups are looking at four different approaches to a strategic fusion energy plan with the goal of building a demonstration fusion energy plant:

1. Begin building a demonstration plant now based on present physics and technology. The working group considering this approach said there would be several challenges to pursuing this option and additional fusion experiments would likely be needed to provide the necessary research and development before such a plant is built.
2. Achieve critical technical milestones as soon as possible with the goal of optimizing the concept and developing technology for a fusion demo. This scenario "fundamentally changes the narrative that 'fusion doesn't work,'" said Nathan Howard, of the Massachusetts Institute of Technology, who presented for the group. Development of a DEMO could begin immediately and could be upgraded to high-temperature superconducting magnets.
3. Assess innovations such as spherical tokamaks (such as PPPL's NSTX-U) or quasi-symmetric stellarators, as well as such technologies as improved magnets or advances in computing before proceeding to a demo. Physicist David Gates, who heads the working group along with Earl Marmar, of MIT, and PPPL physicist Fatima Ebrahimi, gave the plenary talk on this concept. The group is charged with assessing the risks and benefits both of the various technologies and of taking this approach.
4. Develop several alternate concepts to the point where they can be compared and select a technology before proceeding to a demo. This group is looking at alternate fusion energy configurations that could potentially resolve challenges more quickly and cost effectively and lead to future innovations.

Jon Menard

Hutch Neilson

A key issue being addressed by another group headed by Ilon Joseph, of Lawrence Livermore National Laboratory, Francesca Turco, of Columbia University, and Hutch Neilson is developing a set of standards to evaluate various concepts. The group is charged with developing the principles, values, metrics, and criteria to set priorities in the strategic plan and evaluate performance.

Menard, along with Amanda Hubbard, of MIT, and Saskia Mordijck, of the College of William and Mary, is leading a group on the key strategic elements of a strategic plan. Other working groups are examining how to integrate material sciences with fusion science and plasma physics and analyzing the attractiveness of the fusion energy market.

"The theme that really stands out in a large way is innovation," Menard said. "A large part of the community wants to make fusion more attractive by reducing the size and cost of the devices. Hopefully that would lead to a lower cost of electricity and make it more attractive to electric companies."

After the Austin workshop, Menard stepped down from the Program Committee leadership to allow him more time to devote to the Recovery Project during this crucial phase of the recovery efforts. Hutch Neilson, head of PPPL's Advanced Projects and ITER Fabrication Departments, has agreed to take over Menard's community leadership position.

A science fan's delight: PPPL's Science on Saturday talks begin Jan. 13

By Jeanne Jackson DeVoe

For more than 30 years, PPPL has brightened up cold winter Saturday mornings with eclectic and engaging talks on a wide spectrum of science topics by top experts in the field. That tradition begins once again on Jan. 13 with the start of the Ronald E. Hatcher Science on Saturday Lecture Series.

The nine-week program is named for Ronald E. Hatcher, the beloved engineer who hosted the lectures from their beginning and who died in 2014. The series has a fan base ranging from high school and younger students to senior citizens. Several groups meet each week at the lectures and are on a first-name basis with Deedee Ortiz, the Science Education program manager, who organizes the program, and Andrew Zwicker, head of Science Education, who hosts the talks.

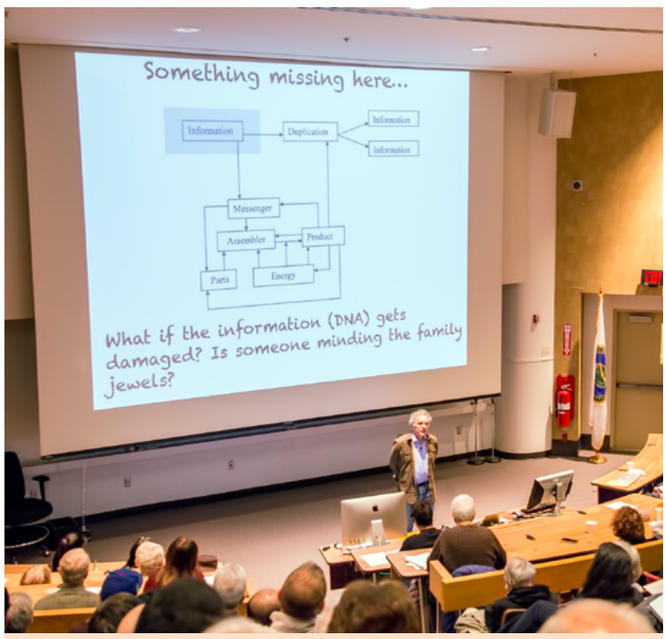
Andrew Zwicker, head of Science Education and Communications and Public Outreach, hosts the lectures. *(Photo by Elle Starkman)*

"For 33 years, the Science on Saturday lecture series has brought some of the country's leading scientists to talk about their cutting-edge research with our local community, which is one of the most passionate, interested, science-loving communities around," Zwicker said. "The age of the more than 250 people that typically show up every Saturday ranges from 10 to nearly 90 and now we are seeing those that first attended a lecture as a child returning as an adult with their own children."

The free talks begin at 9:30 a.m. at PPPL's Lyman Spitzer Building, 100 Stellarator Road, Princeton. They last an hour and may end around 11:30 a.m., including time for a question-and-answer period and for meeting the lecturer afterwards. Many people arrive an hour-or-so early to enjoy a coffee and bagel and chat with fellow attendees.

Some dedicated fans have come to the series since it started and a number of groups have their own traditions and even favorite areas where they sit. "Some people only see each other once a year on Science on Saturday and they pick right up where they left off," Ortiz said. "I call them 'the originals.'"

The first talk of the year, by Craig Arnold of Princeton University, is entitled, "From Lemons to Lithium: Squeezing More life Out of Batteries." Other talks include a Jan. 20 talk on, "Improbable Research and the Ig Noble Prizes, by Marc Abrahams, editor of the Annals of Improbable Research and a March 3 lecture by Princeton neurobiologist Sam Wang on, "Looking Ahead a Split Second: How the Brain Learns Predictions in an Unpredictable World."



Robert Austin, a physics professor at Princeton University, discusses the "Physics of Cancer," at the Jan. 28, 2017 Ronald E. Hatcher Science on Saturday lecture. *(Photo by Elle Starkman)*

As always, there are talks focused on plasma science and fusion energy. Lecturers include Amitava Bhattacharjee, a Princeton professor and head of PPPL's Theory and Computation Department, who will describe astrophysical plasmas on Jan. 27 and Michl Binderbauer of Tri Alpha Energy, who will speak "On the Path to Clean Fusion Energy" on March 17.

A full schedule is available here. If you aren't able to make it to the lecture, you can watch it live through a link on that web page. (Please note there is no lecture Feb. 24 due to the U.S. Department of Energy's New Jersey Science Bowl®)

No pre-registration for the lectures is required. However, adults must show a government-issued ID such as a driver's license or passport at the security booth.

If a lecture is canceled due to inclement weather, a message will be left on the Science on Saturday Hotline at 609-243-2121.

Lucy Tian, left, and Elisabeth Peters, both seniors at Hopewell Valley Central High School, at a lecture last year. *(Photo by Elle Starkman)*

Staff begins moving into new office spaces in LSB Annex

A few people began moving into newly renovated office spaces in the LSB Annex just before the holidays and last week. The complete renovation of the Annex was a major project in the Infrastructure and Operational Improvements (IOI) project, along with the renovation of the C Site-Motor Generator Building, which is nearly completed.

Four Procurement staff members pop up in their new office spaces. From front, clockwise: Tori Sikkema, Don Howe, Dean Peterson, and Marissa Zara. *(Photo by Elle Starkman)*

Jim Graham, head of QA/QC, is surrounded by boxes as he works in his new office. *(Photo by Elle Starkman)*

A cubicle in the LSB Annex. *(Photo by Elle Starkman)*

Getting settled in their new digs were back left, Tatsiana Paulavets, back right, Ewa Kontor, and front, Jane Feng, all from accounting. *(Photo by Elle Starkman)*

Ronald E. Hatcher

Science on Saturday LECTURE SERIES

Jan. 13	**From Lemons to Lithium, Squeezing More Life out of Batteries** **Craig Arnold,** Princeton University
Jan. 20	**Improbable Research and the Ig Nobel Prizes** **Marc Abrahams,** Editor, Annals of Improbable Research
Jan. 27	**Astrophysical Plasmas** **Amitava Bhattacharjee,** PPPL

Saturdays at 9:30 a.m., MBG Auditorium

A snowy start to the new year

A nor'easter dumped four to six inches in the Princeton area on Jan. 4, causing PPPL to close down, except for emergency personnel, at 1 p.m. Princeton University was closed for the day. *(Photos by Jeanne Jackson DeVoe)*

The main entrance to the Lyman Spitzer Building.

The lower parking lot.

A view from the front of the LSB.

A worker plows the main road into PPPL.

A view of the upper parking lot from behind the trailers in the upper parking lot.

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:	Jan. 12 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.

Food, photos and plenty of cheer at PPPL's annual holiday luncheon

PPPL's annual luncheon kicked off the holidays with a lunchtime feast, holiday treats, and photo booths where PPPL'ers could join with pals against backdrops of Times Square or other locations. PPPL'ers also received RISE lanyards and laminated cards. The party was organized by Stacia Zelick, PPPL's chief planning officer, along with Ricardo Marquez, Carol Austin, Sue Hill, and Tori Sikkema.

Daniel Stevenson, left, and Bill White get festive in their holiday gear. *(Photo by Elle Starkman)*

Drina Duryea, left, and Nicole Allen are all smiles at the luncheon. *(Photo by Elle Starkman)*

Dave McComas, Princeton University vice president for PPPL, poses with the Core Values team, who distributed RISE lanyards. From left: Jeanne Jackson DeVoe, Tori Sikkema, Margaret Kevin-King, Erik Gilson, and Alana Coleman. *(Photo by Elle Starkman)*

Enjoying their holiday lunch are, from left, Andrew DeCaro, Glen Anderson, Stanley Reece, and Gerard Coq. *(Photo by Elle Starkman)*

Jason Conklin, left, and Martin Umana don disguises for their holiday photo. *(Photo by Elle Starkman)*

Rich Hawryluk, PPPL's interim director, enjoys a laugh with Gerrit Kramer. *(Photo by Elle Starkman)*

Angela Powell, left, and Ana Marie Datuin line up at the buffet table. *(Photo by Elle Starkman)*

Ricardo Marquez was one of the organizers of the event. *(Photo by Elle Starkman)*

COLLOQUIUM

Two-Dimensional Materials: Mechanical Stiffness, Strength and Reliability

Jeffrey Kysar
Columbia University

Wednesday, Jan. 10
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 Jan. 8	Tuesday Jan. 9	Wednesday Jan. 10	Thursday Jan. 11	Friday Jan. 12
COMMAND PERFORMANCE **Chef's Feature**	**Pork and Bean Burrito** with Yellow Rice	**Chicken Parmesan** with Pasta Marinara	**Power Bowl**	**Jerk-Seasoned Pork Chops** with Pineapple Rice and Mango Salsa	**Bourbon Chicken** over Rice
Early Riser	**Blueberry Pancakes**	**Fried Bologna and Egg Sandwich**	**Tater Tot Breakfast Bake**	**Ham, Egg & Cheese French Toast**	**Biscuits and Sausage Gravy**
Country Kettle	**Chef's Choice**	**Chef's Choice**	**Pumpkin Bisque**	**Chef's Choice**	**Chef's Choice**
Deli Special	**Italian Hero**	**Cobb Salad Wrap**	**Lemon Rosemary Turkey Sandwich**	**American Hoagie** with Ham, Turkey, and American Cheese	**Italian Tuna Salad Wrap**
Grill Special	**Taco Cheesesteak**	**Chorizo Quesadilla**	**Grilled Fish Cake Sandwich**	**Grilled Margherita Sandwich**	**BBQ Turkey Melt**
Panini	**Cheddar Crab Melt**	**Roast Beef,** Mozzarella Cheese, Spinach and Tomato Pesto on Ciabatta Bread	**Meatball Parmigiana Hero**	**Corned Beef Reuben**	**NY Street Dog—** 2 Sabrett Hot Dogs with Sauerkraut, Red Onions & Mustard served with Fries

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**

The **PPPL WEEKLY** is published by the PPPL Office of Communications on Mondays throughout most of the year and biweekly during the summer, except for holidays.
DEADLINE for calendar item submissions is noon on WEDNESDAY. Other stories should be submitted no later than noon on TUESDAY.
Comments: commteam@pppl.gov ◆ **PPPL WEEKLY** is archived on the web at: http://w3.pppl.gov/communications/weekly/.

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