

Calendar of Events

JAN. 25–JAN. 29

**ISO Environmental Management
System audit**

WEDNESDAY, JAN. 27

PPPL Colloquium

4:15 p.m. ♦ MBG Auditorium

[Controlling the Production and Performance of Materials at the Mesoscale: The Matter-Radiation Interactions in Extremes \(MaRIE\) Capability](#)

Dr. Cris Barnes, Los Alamos National Laboratory

SATURDAY, JAN. 30

**Ronald E. Hatcher Science on
Saturday Lecture Series**

9:30 a.m. ♦ MBG Auditorium

[Dealing With Iran's Nuclear Program](#)

Professor Frank von Hippel, Princeton University

UPCOMING

SATURDAY, FEB. 6

**Ronald E. Hatcher Science on
Saturday Lecture Series**

9:30 a.m. ♦ MBG Auditorium

[Plastic Electronics](#)

Lynn Loo, Princeton University

WEDNESDAY, FEB. 10

PPPL Colloquium

4:15 p.m. ♦ MBG Auditorium

[Assessing First Wall Materials at the Atomic Scale and Energy Writ Large at Princeton](#)

Professor Emily Carter, Princeton University

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PPPL physicists simulate innovative method for starting up tokamaks without using a solenoid

By Raphael Rosen

PPPL scientists have produced self-consistent computer simulations that capture the evolution of an electric current inside fusion plasma without using a central electromagnet, or solenoid. The simulations of the process, known as non-inductive current ramp-up, were performed using TRANSP, the gold-standard code developed at PPPL. The results were published in October 2015 in *Nuclear Fusion*. The research was supported by the DOE Office of Science.

In traditional doughnut-shaped tokamaks, a large solenoid runs down the center of the reactor. By varying the electrical current in the solenoid scientists induce a current in the plasma. This current starts up the plasma and creates a second magnetic field that completes the forces that hold the hot, charged gas together.



Francesca Poli

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How are doughnuts to humans like “royal jelly” to bees? Biologist Shirley Tilghman explains

By Jeanne Jackson DeVoe

The same process that determines why certain bees become queen bees while others with the exact same DNA become worker bees also plays a role in how doughnuts eaten by a pregnant woman may influence whether her child becomes obese.



Molecular biologist Shirley Tilghman discusses epigenetics at the Jan. 16 Ronald E. Hatcher Science on Saturday lecture.

The reason for both is linked to the “Wild and Wacky World of Epigenetics,” the title of molecular biologist Shirley Tilghman’s talk at the Edward E. Hatcher Science on Saturday lecture series at PPPL on Jan. 16. Tilghman, a Princeton University professor and the president of Princeton University for 11 years until 2012, gave the second lecture in the nine-week free lecture at PPPL. (A downloadable schedule is available here: <http://www.pppl.gov/education/science-education/programs/ronald-e-hatcher-science-saturday-lecture-series>.)

“The field of epigenetics is a new way of thinking about how genes are passed from one generation to the next,” Tilghman said.

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Tokamaks without solenoids

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But spherical tokamaks, a compact variety of fusion reactor that produces high plasma pressure with relatively low magnetic fields, have little room for solenoids. Spherical tokamaks look like cored apples and have a smaller central hole for the solenoid than conventional tokamaks do. Physicists, therefore, have been trying to find alternative methods for producing the current that starts the plasma and completes the magnetic field in spherical tokamaks.

One such method is known as coaxial helicity injection (CHI). During CHI, researchers switch on an electric coil that runs beneath the tokamak. Above this coil is a gap that opens into the tokamak's vacuum vessel and circles the tokamak's floor. The switched-on electrical current produces a magnetic field that connects metal plates on either side of the gap.

Researchers next puff gas through the gap and discharge a spark across the two plates. This process causes magnetic reconnection — the process by which the magnetic fields snap apart and reconnect. This reconnection creates a magnetic bubble that fills the tokamak and produces the vital electric current that starts up the plasma and completes the magnetic field.

This current must be nurtured and fed. According to lead author Francesca Poli, the new computer simulations show that the current can best be sustained by injecting

high-harmonic radio-frequency waves (HHFWs) and neutral beams into the plasma.

HHFWs are radio-frequency waves that can heat both electrons and ions. The neutral beams, which consist of streams of hydrogen atoms, become charged when they enter the plasma and interact with the ions. The combination of the HHFWs and neutral beams increases the current from 300 kiloamps to 1 mega amp.

But neither HHFWs nor neutral beams can be used at the start of the process, when the plasma is relatively cool and not very dense. Poli found that HHFWs would be more effective if the plasma were first heated by electron cyclotron waves, which transfer energy to the electrons that circle the magnetic field lines.

“With no electron cyclotron waves you would have to pump in four megawatts of HHFW power to create 400 kiloamps of current,” she said. “With these waves you can get the same amount of current by pumping in only one megawatt of power.

“All of this is important because it's hard to control the plasma at the start-up,” she added. “So the faster you can control the plasma, the better.” 📺

Ronald E. Hatcher

Science on Saturday LECTURE SERIES

Jan. 30

Dealing with Iran's Nuclear Program

Frank von Hippel, Princeton University

Feb. 6

Plastic Electronics

Lynn Loo, Princeton University

Feb. 13

TBA

Edgar Choueiri, Princeton University

Feb. 20

No Science on Saturday due to DOE New Jersey Regional High School Science Bowl

Feb. 27

Brutal Efficiency: How Mating and Reproduction Influence C. Elegans Longevity

Coleen Murphy, Princeton University

Mar. 5

Reimagining the Possible: Scientific Transformations Shaping the Path Towards Fusion Energy

Ed Synakowski, DOE

Mar. 12

Taking the Universe's Baby Picture

David Spergel, Princeton University

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

Science on Saturday: Shirley Tilghman

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Almost 500 people attended the lecture with an overflow crowd in the cafeteria and several visitors watching from the lobby. The audience included PPPL Director Stewart Prager who came with his wife, Karen. "The talk was a homerun hit," Prager said. "As a physicist, I actually learned something about genetics!"

The field of epigenetics has changed dramatically in the past decade, Tilghman said. Researchers now have a better understanding, for example, of how identical bees differentiate. A worker bee is much smaller than the queen, it can't produce offspring, and it lives just three to six weeks. But a queen bee with the same DNA is much larger, produces hundreds of thousands of bee progeny, and lives for two years.

The reason for the differences, Tilghman said, is a factor outside the creatures' genetics that programs their development called "epigenetics." A larva that is destined to become a



Rachel Suchodowski, left, a 9th grader at Neshaminy High School in Langhorm, Pennsylvania with her friend Elizabeth Mele, right, a 10th grader at Stuart Country Day School in Princeton.



Thomas Joseph is a regular at the lectures.

queen is fed large amounts of something called "royal jelly" that causes the growing queen to develop differently than the worker bees, which are fed "worker jelly."

The same effect can be seen in humans where the "royal jelly" is doughnuts or other fatty foods that could affect a developing fetus and cause it to grow into an obese child or adult. "What's happening here is exactly what's happening with the bees and the ants and that is an environmental exposure," Tilghman said. "The embryo is sharing a placenta as the mother is eating that sugar and fat, and the embryo is responding." This creates a vicious cycle that could repeat itself over generations, she added.

Tilghman recounted how Gregor Mendel, the founder of genetics, used pea plants producing yellow and green peas to predict inheritance. (Mendel found the first generation always had yellow seeds and the second generation had a consistent three to one ratio of yellow to green seeds). Epigenetics, Tilghman said, explains what happens when the outcome of similar cross-pollination isn't consistent

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Shirley Tilghman takes a question.

Science on Saturday: Shirley Tilghman

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Tilghman shares a laugh with Science Education Head Andrew Zwicker, who hosts the lectures.

with Mendel's principles. For example when the maize plant, which is usually purple, is crossed with a green maize plant, 100 percent of the offspring are green. The coloration is not due to a gene mutation but instead is caused by a failure of the purple pigment gene to switch on. This failure to switch on or off is epigenetics.

This switching on and off of certain genes also causes some diseases, Tilghman said. The vast majority of diseases are genetic diseases that are caused by a gene mutation directly inherited from both parents. But epigenetic diseases do not involve a mutation in the DNA sequence but rather a change in how the gene is packaged, Tilghman said. Some DNA sequences are packaged in a way that allows the gene to be expressed, which means it is open and can be switched on, Tilghman explained. Others are packaged in such a way

that they are closed and cannot switch on. "That's really at the heart of what epigenetics is all about," Tilghman said.

Tilghman cited the example of Beckwith-Wiedemann syndrome (BWS), which is only passed on through mothers and is silent in fathers. In this disease, the maternal gene that creates the insulin, which stimulates growth, fails to shut off as it normally would. As a result, the child gets two active copies of the gene. Children with BWS are born larger than other children and have an increased risk of cancer, especially during childhood. Tilghman said.

Epigenetics has also led to "a paradigm shift in thinking about cancer," Tilghman said. While most cancer is caused by mutations, epigenetic misprogramming seems to be involved in a number of cancers involving tumors. The cells are misprogrammed to produce a potent growth factor that helps tumors to reproduce quickly. On the other hand, the tumors will also reproduce rapidly if genes that suppress tumors are silent.

Tilghman aimed much of her talk at high school students in the audience. Chris Resch, an AP biology teacher at Montgomery High School, said the lecture demonstrated how useful scientific research is to his students. "It shows them that science isn't in a vacuum," he said. "It shows them science is actually applicable to real life."

Ruth Levy, from Plainsboro, a regular at the lectures, said she thoroughly enjoyed Tilghman's lecture. "She was incredible," Levy said. "I like her attitude, I like her caring, and I like her ability to have a human quality. This makes the learning much more vital."

The Science on Saturday lectures are held each Saturday at PPPL at 9:30 a.m., and seats fill up quickly, so plan to get there early. They can also be streamed live from home at https://mediacentral.princeton.edu/id/1_wdp1m3et. You can view archives of the lectures at <http://www.pppl.gov/sos-listing>. If Science on Saturday is canceled due to inclement weather or other emergency, an announcement will be posted on the PPPL website at pppl.gov and a message will be left on the Science on Saturday Hotline, (609) 243-2121. 📞



Vivien Schwartz, left, of Monroe Township, and friend Ruth Levy, of Plainsboro, have been regulars at Science on Saturday for more than 20 years.

Volunteers wanted for Mercer Science and Engineering Fair

Organizers of the Mercer Science and Engineering Fair are looking for scientists and engineers to volunteer as judges of fourth to twelfth-grade science projects during the fair next month at Rider University

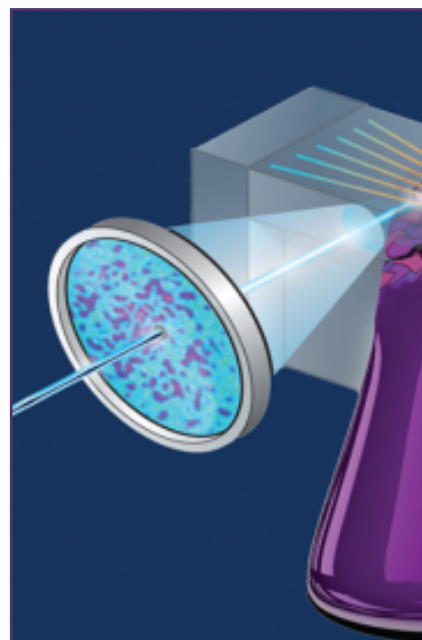
Students from Mercer County schools show off their original science projects at the fair from March 12 to March 15. Judging for the elementary division (grades 4 to 5) and the junior division (grades 6 to 8) takes place Sunday, March 12. Judging for the senior division takes place March 12 and March 13. Additional information about the fair is available at <https://mercersec.org/about/msef>.

To volunteer, create an account online and check off judge to volunteer at <https://mercersec.org/help/BecomeAJudge>.

COLLOQUIUM

Controlling the Production and Performance of Materials at the Mesoscale: The Matter-Radiation Interactions in Extremes (MaRIE) Capability

Dr. Cris Barnes
Los Alamos National Laboratory



Wednesday, Jan. 27
4:15 p.m., M.B.G Auditorium, Lyman Spitzer Building

Announcing a new opportunity for undergraduates, graduate students and postdocs: Princeton Research Day

Juniors, seniors, graduate students and postdoctoral researchers are encouraged to present at the inaugural Princeton Research Day, a celebration of research and creative works to be held **May 5, 2016** at Frist Campus Center. Presenters will gain valuable experience in communicating across disciplines to a nonspecialist audience. Resources – including workshops, practice sessions and technical help – will be available to help presenters prepare for the event. Types of presentations include posters, talks, performances, exhibitions and videos. See researchday.princeton.edu for more information and to apply.

Applications will be accepted through Feb. 5, 2016

BROCK

MARK GAZO
Chef Manager



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 January 25	Tuesday January 26	Wednesday January 27	Thursday January 28	Friday January 29
COMMAND PERFORMANCE Chef's Feature	Ota-Ya Sushi	Vegetable Tikka Masala over Rice with Naan	Beef Stew served with Buttermilk Biscuit	Chicken Cordon Bleu served with Risotto	COMMAND PERFORMANCE Seafood Pasta with Shrimp, Scallops, Clams & Mussels
Early Riser	Raisin Bread French Toast	Bagel with Lox & Cream Cheese	WELLNESS WEDNESDAY Coconut Banana Steel-Cut Oatmeal Bowl	Cranberry Walnut Pancakes	Sausage Gravy & Grits served with 2 Eggs any style
Country Kettle	Vegetable Barley	Beef Noodle	Lentil	New England Clam Chowder	White Bean Escarole
Grille Special	BURGERLICIOUS Use it or Blue it Buffalo Turkey Burger Grilled Turkey burger with Melted Blue Cheese Crumbles, Sliced Celery, Shredded Lettuce, Tomato, Red Onion and Fiery Buffalo Sauce on a Grilled Brioche Roll (Available All Week)	Bratwurst & Sauerkraut on a Torpedo with German Potato Salad	Tuna Melt on Rye with Swiss Cheese & Tomato	Chicken Breast on French Bread with Broccoli Rabe & Aged Provolone Cheese	Grilled Cheddar, Apple & Spinach on Multigrain Bread served with Cranberry Sauce
Deli Special	Grilled Portobello Mushroom with Red Onion, Red Pepper & Provolone on Wheat Roll	Open-Faced Sloppy Joe	Peppered Ham & Muenster Cheese on Pumpernickel Bread	Tuna Salad Club Sandwich with Hard-Cooked Egg	Grilled Jerk Chicken with Grilled Pineapple, Peppers & Onion on a Kaiser Roll
Panini	Turkey, Ham, Salami, Pepperoni, Provolone, Cheddar & Banana Peppers on Sourdough	Tuna Salad Quesadilla with Cheddar & Avocado served with Corn Relish	Pulled BBQ Chicken Wrap with Pepperjack Cheese, Avocado & Tomato	Falafel on a Pita with Tzaziki Sauce	Cheeseburger Muffin served with Macaroni Salad

MENU SUBJECT TO CHANGE WITHOUT NOTICE

VEGETARIAN OPTION

WEEKLY

Editor: **Jeanne Jackson DeVoe** ♦ Layout and graphic design: **Kyle Palmer**

Photography: **Elle Starkman** ♦ Science Editor: **John Greenwald** ♦ Webmaster: **Chris Cane**

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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/>.