

Calendar of Events

TUESDAY, JAN. 19

Laboratory Management Review
8:30 a.m.-1:30 p.m.

SATURDAY, JAN. 23

**Ronald E. Hatcher Science on
Saturday Lecture Series**
9:30 a.m. ♦ MBG Auditorium
[Using Physics and Chemistry
to Understand the Genome](#)
Mary Jo Ondrechen,
Northeastern University

UPCOMING

WEDNESDAY, JAN. 27

PPPL Colloquium
4:15 p.m. ♦ MBG Auditorium
[The MaRIE \(Matter-Radiation
Interactions in Extremes\) Project](#)
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

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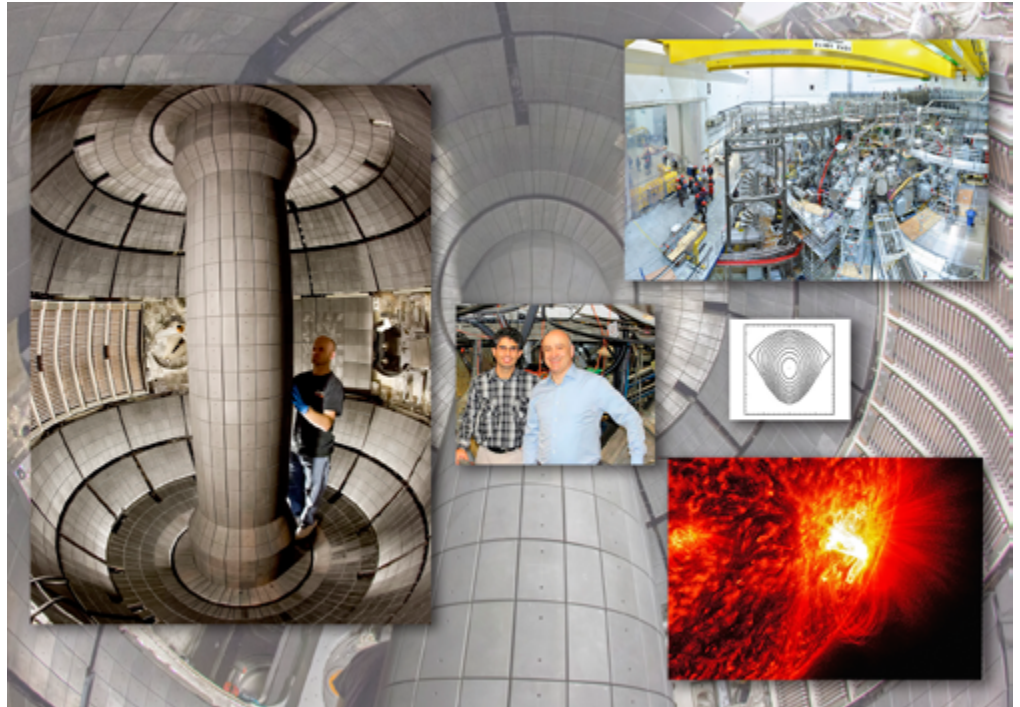
Princeton Research Day 8

Menu 8

Top-5 Achievements at the Princeton Plasma Physics Laboratory in 2015

By John Greenwald

From launching the most powerful spherical tokamak on Earth to discovering a mechanism that halts solar eruptions, scientists at PPPL advanced the boundaries of clean energy and plasma science research in 2015. Here, in no particular order, are our picks for the Top-5 developments of the year:



Collage of images from the top-5 achievements of 2015.

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Tracking the paths of the “Starlight Detectives” at Science on Saturday

By Jeanne Jackson DeVoe

When astronomer Isaac Roberts showed a photograph of the Andromeda Nebula to the Royal Astronomical Society, it caused a huge sensation. “There were audible gasps in the audience,” astronomer Alan Hirshfeld told the audience at the first Ronald E. Hatcher Science on Saturday lecture at PPPL on Jan. 9.

“The professional astronomers had never seen such a clear image of the nebula,” Hirshfeld said.

The year was 1888 and such photographs were unheard of. But Roberts was one of many “starlight detectives,” who pioneered the use of cameras and spectroscopy along with powerful telescopes to see space more clearly than it was ever possible with merely the naked eye, Hirshfeld said. These early discoveries led to our modern concepts of what the universe outside our galaxy looks like and the origins of the universe.

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PPPL prepares for audit amid changes in environmental regulations

By Jeanne Jackson DeVoe

As PPPL's environmental staff prepares for an environmental audit next week, staff members are determining how to incorporate major changes in environmental requirements enacted by Presidential Executive Order last year. The order would dramatically reduce greenhouse gas emissions and increase the use of electricity from renewable energy. At the same time, staffers are preparing for changes in international environmental standards used to measure PPPL's progress.

The audit, from Jan. 25 to 29, will be no different than previous years. It will include many of the same areas addressed by President Obama's executive order, such as energy and

water use, reduction of greenhouse gases, and green purchasing, said Robert Sheneman, head of PPPL's Environmental Services Division. PPPL staff members should be prepared to answer any questions the auditor has and can prepare simply by reviewing the green badge cards on PPPL's environmental policy given to all staff members, he added.

"Things are changing," Sheneman said. "There are new goals and a new system. But in terms of the audit for this year, it's business as usual. We want you to have your card. We want you to know what you're supposed to know and what you're supposed to do."

PPPL will follow the lead of the U.S. Department of Energy in incorporating the mandates of President Obama's Executive Order 13693 for PPPL and other federally funded facilities. PPPL measures its progress in meeting its environmental goals through the certification process by the International Organization for Standardization (ISO), which requires an annual audit.


This year's audit will be based on previous ISO standards. However, the ISO issued new standards last summer and by the fall of 2017 PPPL will have to show how well it is meeting those new standards. The new standards are more focused on outcome and performance and have fewer requirements for procedures and documentation, Sheneman said. They also focus more on senior leadership's role and accountability. PPPL's environmental staff is analyzing how PPPL's existing programs fit with the new ISO standards, but staff will have to be trained before they can begin incorporating the regulations into PPPL's policies and procedures, Sheneman said.

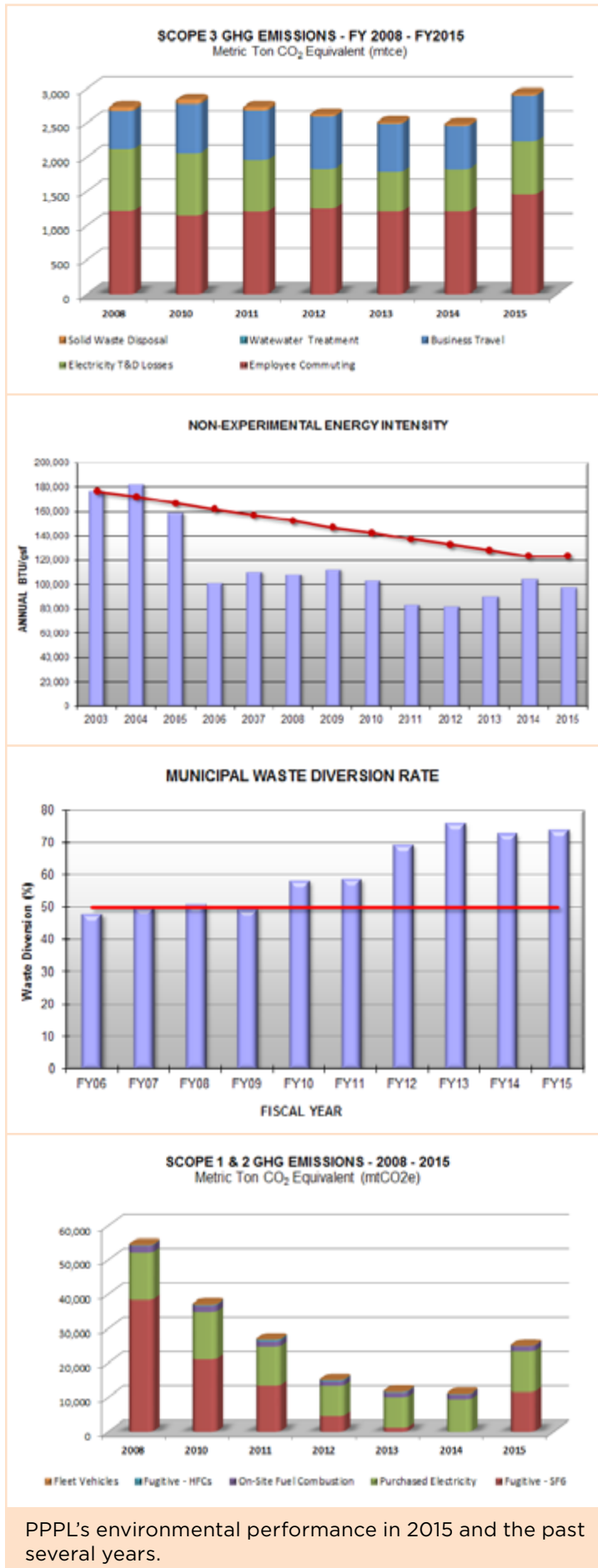
Meanwhile, PPPL's environmental staff also must determine how to meet new sustainability goals for federal agencies set by the executive order. Those goals include reducing direct greenhouse gas emissions by 50 percent by 2025, based on 2008 levels, and increasing the amount of electrical energy from renewable sources to 30 percent.

PPPL has won several awards for its environmental program and continues to meet or exceed federal goals in areas such as reducing non-experimental energy use, fleet management, solid waste management, and water consumption, Sheneman said. For example, 74 percent of PPPL's solid waste was recycled or composted in fiscal year 2015 and 86 percent of construction materials were recycled. PPPL also purchased more than \$59,000 in bio-based products in nine categories in the last fiscal year.

Other requirements of the executive order will be more challenging, Sheneman said. For example, the goal of reducing energy use will be difficult because the National Spherical Torus Experiment Upgrade uses a lot of electricity. That will also make it more challenging to reduce greenhouse gases. Creating more energy-efficient buildings likely will also be difficult because almost all of PPPL's buildings are more than 25 years old, he said.

While business travel has increased due to increased collaboration, PPPL might have to look at other ways to reduce greenhouse gases. One idea could be to encourage more employees to telecommute, Sheneman said.

"Not only are our goals changing but the management system we're using to work on those goals is also changing," said Sheneman. "So it will be a challenge." 



Top-5 Achievements of 2015

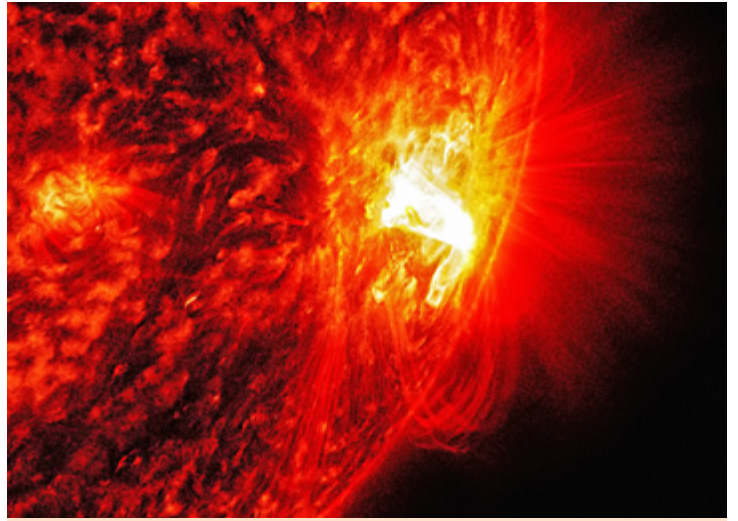
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1. Starting up the National Spherical Torus Experiment-Upgrade (NSTX-U)

PPPL completed construction of the NSTX-U, the Laboratory's flagship fusion facility, doubling its heating and magnetic power and making it the most powerful spherical tokamak in the world. The machine is shaped like a cored apple, unlike conventional donut-shaped fusion facilities, and creates high plasma pressure with relatively low magnetic fields — a highly cost-effective feature since magnetic fields are expensive to produce. The upgrade creates a flexible research platform that will enable physicists to directly address some of fusion's most outstanding puzzles.



Interior of the NSTX-U showing the completed center stack.



Solar flare at the peak of the cycle in October, 2014, with no observed eruptions.

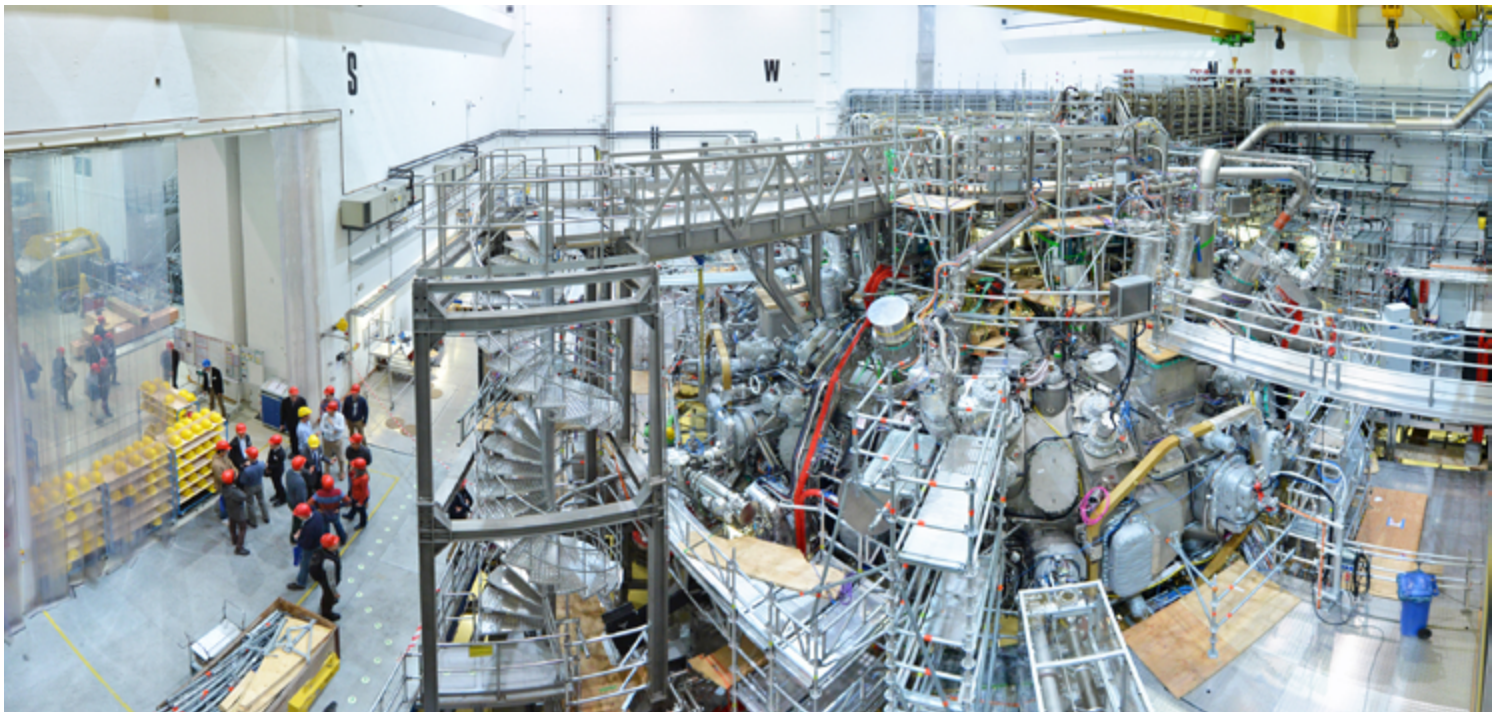
2. A mechanism that halts solar eruptions

Solar eruptions are massive explosions of plasma and radiation from the sun that can be deadly for space travelers and can disrupt cell phone service and other crucial functions when they collide with the magnetic field that surrounds Earth. Researchers working on the Magnetic Reconnection Experiment (MRX), the world's premier device for studying the convergence and separation of magnetic fields in plasma, have discovered a previously unknown mechanism that causes eruptions to fail. The findings could prove highly valuable to NASA, which is eager to know when an eruption is coming and when the start of an outburst is just a false alarm.

3. First plasma on Germany's Wendelstein 7-X

On Dec. 10, 2015, the Wendelstein 7-X (W7-X) stellarator produced its first plasma after 10 years of construction. PPPL, which leads the United States' collaboration in the German project and will conduct research on it, joined the worldwide celebration of the achievement. The Laboratory designed and delivered five barn-door size magnetic coils, together with power supplies, that will help shape the plasma during W7-X experiments. The Lab also designed and installed an X-ray diagnostic system that will collect vital data from the plasma in the machine. Stellarators are fusion facilities that confine plasma in twisty — or 3D — magnetic fields, compared with the symmetrical — or 2D — fields that tokamaks produce.

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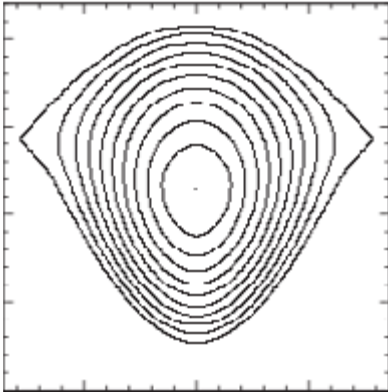
The W7-X stellarator in Greifswald, Germany.

Top-5 Achievements of 2015

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4. Enhanced model of source of density limit

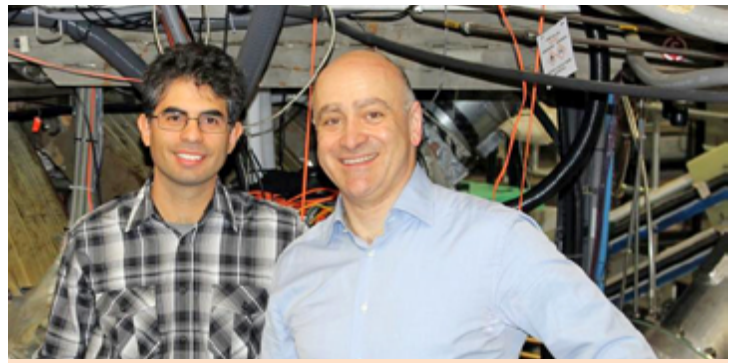
Physicists have long puzzled over a mystery called the density limit — a process that causes fusion plasmas to spiral apart when reaching a certain density and keeps tokamaks from operating at peak efficiency. Building on their past research, PPPL scientists have developed a detailed model of



Magnetic island geometry revealing the mechanism for the density limit. (Reprinted with permission from Phys. Plasmas 22, 022514 2015)


the source of this limitation. They've traced the cause to the runaway growth to bubble-like islands that form in the plasma and are cooled by impurities that stray plasma particles kick up from the walls of the surrounding tokamak. Researchers counter this heat loss by pumping fresh heat into the plasma, but even a tiny bit of net cooling in the islands can cause them to grow exponentially and the density limit to be

reached. These findings could lead to methods to overcome the barrier.



Physicists Carlos Paz-Soldan and Raffi Nazikian advanced understanding of the control of heat bursts.

5. Breakthrough in understanding how to control intense heat bursts

Scientists from General Atomics and PPPL have taken a key step in predicting how to control potentially damaging heat bursts inside a fusion reactor. In experiments on the DIII-D National Fusion Facility that General Atomics operates for the DOE in San Diego, the physicists built upon previous DIII-D research showing that these intense heat bursts — called edge localized modes (ELMS) — could be suppressed with tiny magnetic fields. But how these fields worked had been unclear. The new findings reveal that the fields can create two kinds of responses, one of which allows heat to leak from the edge of the plasma at just the right rate to avert the heat bursts. The team also identified the changes in the plasma that lead to suppression of the bursts. 

Ronald E. Hatcher

Science on Saturday LECTURE SERIES

Jan. 23	Using Physics and Chemistry to Understand the Genome Mary Jo Ondrechen, Northeastern University
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

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Hirshfeld, a professor of physics at the University of Massachusetts-Dartmouth and an associate of the Harvard College Observatory, traced the origins of modern astronomy and the precursors of powerful telescopes like the Giant Magellan Telescope in Chile, a massive 80-foot-diameter device that will be completed in 2021. The lecture was based on his book, “Starlight Detectives: How Astronomers, Inventors, and Eccentrics Discovered the Modern Universe,” (New York Literary Press, 2014).

The first tool astronomers used was their own eyes, Hirshfeld said. “The human eye is a horrible astronomical instrument but it was all we had for hundreds of years,” he said.



Veronica Figero, 13, of Burlington Township, came to the lecture with her grandfather, Richard Machel, of Princeton Junction.



Astronomer Alan Hirshfeld discusses the “starlight detectives” who pioneered modern astronomy during the first Ronald E. Hatcher Science on Saturday lecture at PPPL on Jan. 9.

Galileo Galilei revolutionized astronomy in the 16th century by giving astronomers a much better view of the solar system with his development of some of the earliest telescopes. Two hundred years later, telescopes were getting bigger and better but were still limited by what the human eye could see, Hirshfeld said.

Revolutionizing astronomers’ toolkit

The next revolution in the astronomer’s toolkit came with the development of the camera and “that is where the trail of the starlight detectives takes off,” Hirshfeld said.



A member of the audience looks at the lights through a diffraction grating lens.

The first working photographic process developed by Louis Daguerre, and introduced as the daguerreotype in 1839, swept through the world, Hirshfeld said. He added that it is hard to imagine today how a photograph of the moon caused such a sensation when it was displayed at the World Exposition in London. But photography was a relatively new art at the time and people had never seen such a thing. “People were astounded at having the moon,” Hirshfeld said. “It inspired people.”

It took a few decades for astronomers to use photography, and it was amateur astronomers who ventured into this area. Andrew Ainslie Common, an English sanitary engineer, began attaching a camera to his telescope in the 1880s. When he took a photo of the Orion Nebula, it was perhaps the first time a camera captured objects in space not visible to the human eye.

Common set up his telescope in the backyard of his home outside London, but at some point, astronomers realized that a mountaintop observatory would capture better images. Common eventually sold his reflector to British politician Edward Crossley who gave it to the Lick Observatory in Mountanside, California, Hirshfeld told the crowd.

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Science on Saturday

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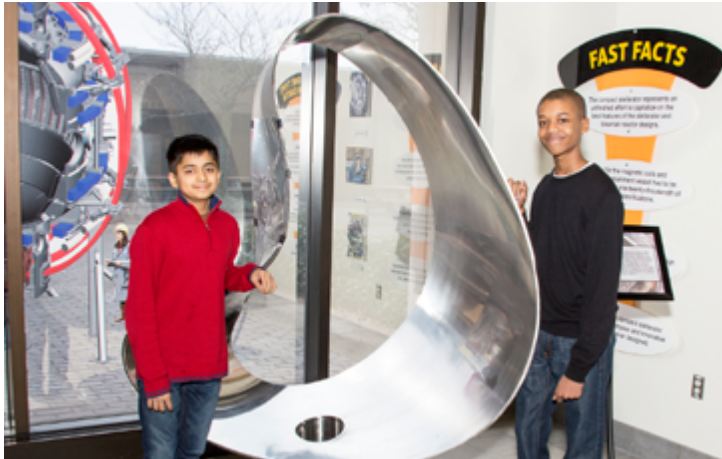
When the Lick Observatory, the world's first modern mountaintop observatory, began operating in 1888, scientists observed spiral nebulae that changed their concept of the universe, Hirshfeld said. Until then, scientists believed the universe was empty outside of our galaxy. But with clearer photos, astronomer James Keeler estimated there were many thousands of unrecorded nebulae in the sky. (Scientists now believe there are more than 1 million). That observation meant that the universe was anything but empty.

The invention that made astronomy high-tech

But what propelled astronomy into "a modern high-tech science," Hirshfeld said, was the development of the first spectroscope in the 1860s by Robert Bunsen, a German chemist who invented the Bunsen burner, along with physicist Gustav Kirchhoff. The two were the first to devise an instrument that could identify elements by the colors or spectra of the light waves coming from the elements.

Hirshfeld demonstrated how the spectroscope works by passing out small diffraction grating lenses. The lens looks like a photographic slide but it acts like a prism to disperse light from different elements into its component wavelengths, with different elements breaking down into different colors.

The spectroscope allowed scientists to analyze the elements of the sun and other objects in space. It led to the discovery by William and Margaret Huggins in the 1860s that the stars are composed of the same elements found on earth.



Arjun Argowal, left, and his friend, John Weaver, both 13, of Lawrence Township, said they enjoyed learning some of the history of astronomy.

When Edwin Hubble arrived at the Mount Wilson Observatory in Pasadena, California, in 1919, he was able to use the Hooker Telescope, a 100-inch telescope that was the world's largest telescope at the time, as well as photography and spectroscopy.

Hubble's research showed that the Andromeda Nebula was too distant to be part of the galaxy and was actually another galaxy, proving that there is a universe beyond the Milky Way. "It really solidified the idea that we live in a universe of galaxies," Hirshfeld said. Hubble truly revolutionized astronomy when he found that the farther apart galaxies are from each other, the faster they move away from each other, Hirshfeld said. He put forth the concept that the universe began with a single burst of energy and has been expanding ever since, which formed the basis for the Big Bang Theory. Astronomy "became a cutting edge science" in the 1920s "largely due to the unheralded role of the starlight detectives," Hirshfeld concluded.



Carol Wintermute, left, with friends Graydon Vanderbilt, center, and Dolores Cantrell, all of Princeton Windrows retirement community in Princeton, comes to the lectures every week.

The Science on Saturday crowd gave Hirshfeld a warm round of applause. Among them was Alan Lapinsky, a physics teacher at Princeton Day School, who said he would use some of the information in his own classes. "It was an interesting talk," he said. "I always learn new things I can cover in my classes."

John Weaver, a seventh grader at Lawrence Middle School, was equally enthusiastic. "I found it super interesting," he said. "I learned a lot about the past of space exploration."

"You always learn something astounding," said Carol Wintermute, who has been coming to the lectures for the past few years with two friends from the Princeton Windrows retirement community in Princeton. "You get hooked. You really do."

Shirley Tilghman will be Jan. 16 lecturer

The next lecture on Jan. 16 is by molecular biologist and former Princeton University President Shirley Tilghman. She will discuss "The Wild and Wacky World of Epigenetics," which involves the study of how external factors can regulate how genes switch on and off.

A full schedule is available at <http://www.pppl.gov/education/science-education>. The lectures can also be streamed live from home at https://mediacentral.princeton.edu/id/1_rqmmkznx.

The free lectures are held each Saturday through March 12 at 9:30 a.m. at PPPL, 100 Stellarator Road, Princeton. Doors open at 8:15 a.m. with refreshments for early birds. Plan to come early to the lecture because seats fill up quickly.

If Science on Saturday is canceled due to inclement weather or other emergency, a message will be left on the Science on Saturday Hotline at (609) 243-2121. 📞

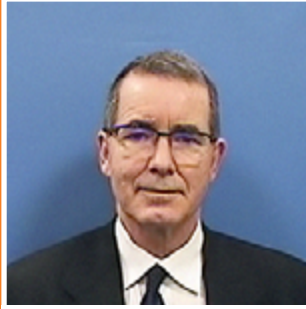


Sahiti Tholeto, 14, of West Windsor, is also a regular at the lectures.

PPPL Welcomes New Employees!



LARRY BERNARD
Director of
Communications
Communications



CASEY COLLINS
Senior subcontract
administrator
Business Operations



JASON CONKLIN
Building maintenance
technician
DEPARTMENT



RON GRABSINKY
Building maintenance
technician
Engineering



**JESSICA
GUTTENFELDER**
Neutral beam
mechanical engineer
Engineering



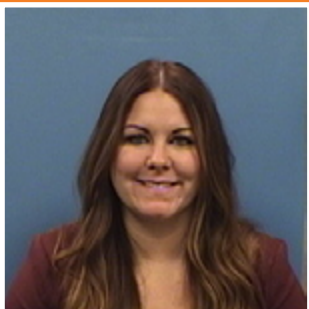
EERO HIRVIJOKI
Associate research
physicist
Theory



MANISH KUMAR
Project engineer
Engineering



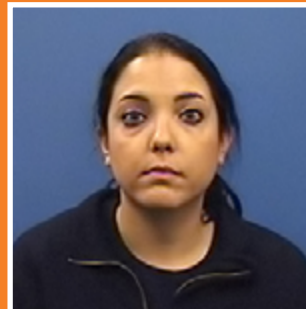
IFY IWUOHA
Construction safety
engineer
ES&H



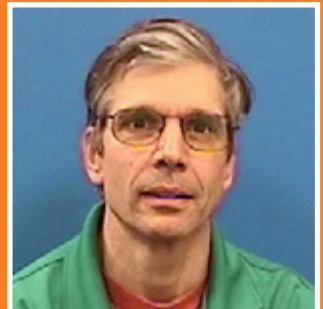
ERIN MULRYNE
Staff accountant
Business Operations



JASON NIATAS
Building maintenance
technician
Engineering



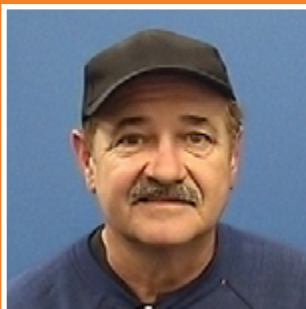
ERIN RUHL
Emergency services
officer
*Best Practices
and Outreach*



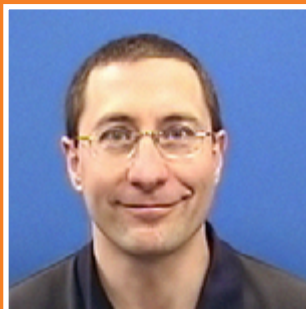
MARC SIBILIA
Senior engineer
Engineering



WILL SLOYER
Cryogenic operator
Engineering



VAN SNYDER
Building maintenance
technician
Engineering



BRIAN TOMASKO
Building maintenance
technician
Engineering

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 18	Tuesday January 19	Wednesday January 20	Thursday January 21	Friday January 22
COMMAND PERFORMANCE Chef's Feature	Fettuccine with Chicken, Broccoli, Mushrooms, Tomatoes & Artichokes	Ziti with Wild Mushrooms, Ricotta Cheese, Mozzarella & Marinara Sauce	COMMAND PERFORMANCE Mac & Cheese Bar Choose from a variety of ingredients to top your Mac & Cheese	Meatloaf with Smashed Cilantro Potatoes, Roasted Carrots & Gravy	Lemon Pepper Salmon served with Risotto and Garlic Sautéed Broccoli Rabe
Early Riser	Chicken & Cheddar Omelet served with Hash Browns	Tex Mex Scrambled Eggs with Shredded Beef, Pepperjack & Tomato in a Corn Tortilla	Sausage Hash Brown Bake	Egg McMuffin with Ham served with Hash Browns	Sausage Gravy & Biscuits served with 2 Eggs any style
Country Kettle	Kielbasa Soup	Vegetable Chili	Chicken Rice	Minestrone	Crab Bisque
Grille Special	BURGERLICIOUS BBQ Beef in a Blanket Grilled Beef Burger with Cheddar Cheese, Bacon Blanket, Crispy Onion Straws, Dill Pickle Chips and Chipotle BBQ Sauce on a Brioche Roll (Available All Week)	Corned Beef Reuben on Rye	Fish Taco with Pickled Slaw, Cilantro, Chipotle Sour Cream	Grilled Texas Toast with Prosciutto, Chicken, Swiss Cheese & Dijonnaise	Vegetarian Quesadilla
Deli Special	Egg Salad & Provolone with Arugula & Tomato on French Bread	Veggie Burger on a Wheat Roll served with Soy Bean Hummus & Pita Chips	Italian Hoagie with Prosciutto, Capicola, Fresh Mozzarella, Lettuce, Tomato & Marinated Red Peppers	Salad Nicoise-Grilled Tuna with Herbed Potatoes, Kalamata Olives, Cherry Tomatoes, Green Beans & Hard-Cooked Egg	Turkey , Blue Cheese, Avocado, Bacon, Lettuce & Tomato on a Kaiser Roll
Panini	Pork Roll & American Cheese on a Kaiser Roll served with Disco Fries (Gravy & Cheese)	Grilled Salmon with Citrus Spinach Salad	Ham, Smoked Turkey, Pastrami , American Cheese, Pesto, Onion & Tomato on Focaccia Bread	Eggplant Parmesan Sub	Chipotle Roast Beef with Blue Cheese, Onion, & Tomato on Ciabatta Bread

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**

The PPPL WEEKLY is published by the [PPPL Office of Communications](http://pppl.gov/communications) on Mondays throughout the year 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/>.