PPPL PRINCETON PLASMA PHYSICS LABORATORY
A Collaborative National Center for Fusion & Plasma Research
U.S. DEPARTMENT OF ENERGY
WEEKLY
April 21, 2014

At PPPL THIS WEEK

TUESDAY, APRIL 22

Earth Day Grounds Clean-up at PPPL
10:30 a.m. ◆ LSB Lobby
Free lunch for volunteers

WEDNESDAY, APRIL 23

Earth Day at PPPL
LSB Lobby and MBG Aud.
10:30 a.m. to 1 p.m. - Displays
11 a.m. - Green Machine Awards
11:15 a.m. - Sustainability Policy & Planning in New York City
John Lee, NYC Mayor's Office

SUNDAY, APRIL 27

Communiversity Festival
1 p.m. ◆ Nassau St., Princeton

UPCOMING EVENTS

Apr. 28

Spitzer Lecture
4:30 p.m. ◆ Princeton University Peyton Hall
Experimental techniques in high-energy astrophysics
Fiona Harrison, Caltech

Apr. 29

State of the Lab
1:30 p.m. ◆ MBG Auditorium
PPPL Director's annual address
Stewart Prager, PPPL

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Café Menu page 5

Author Daniel Clery traces fusion's roots at PPPL colloquium

By Jeanne Jackson DeVoe

Journalist and author Daniel Clery wrote his book, "A Piece of the Sun" because there was so little awareness about fusion energy's future potential as a clean and abundant source of energy for generating electricity. "That was the motivation for the book," Clery said during a Colloquium at PPPL on April 14. "Many people don't even know fusion exists and it's got to be in the public consciousness again."

People will take notice once fusion proves that it can produce at least as much energy as it uses, Clery said. And the public would embrace fusion if more people "took climate change more seriously."

Clery's talk on the history of fusion energy, "The Many Faces of Fusion: All the Best Bits of Fusion's History in Roughly 45 Minutes," brought the author back to PPPL for the first time in three years. He spent a week at the Laboratory in 2011 and conducted numerous interviews at PPPL doing research for the book.

Daniel Clery

Clery, who joined Science magazine in 1993, has written for publications including Physics World and New Scientist, focusing on astronomy and physics. He studied theoretical physics at York University and lives just outside London.

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A promising concept on the path to fusion energy

By John Greenwald

Completion of a promising experimental facility at PPPL could advance the development of fusion as a clean and abundant source of energy for generating electricity, according to a PPPL paper published last month in the journal IEEE Transactions on Plasma Science.

The facility, called the Quasi-Axisymmetric Stellarator Research (QUASAR) experiment, represents the first of a new class of fusion reactors based on the innovative theory of quasi-axisymmetry, which makes it possible to design a magnetic bottle that combines the advantages of the stellarator with the more widely used tokamak design. Experiments in QUASAR would test this theory. Construction of QUASAR — originally known as the National Compact Stellarator Experiment — was begun in 2004 and halted in 2008 when costs exceeded projections after some 80 percent of the machine's major components had been built or procured.

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Part of a QUASAR coil and vacuum vessel.

PPPL segment of TV program to air April 22

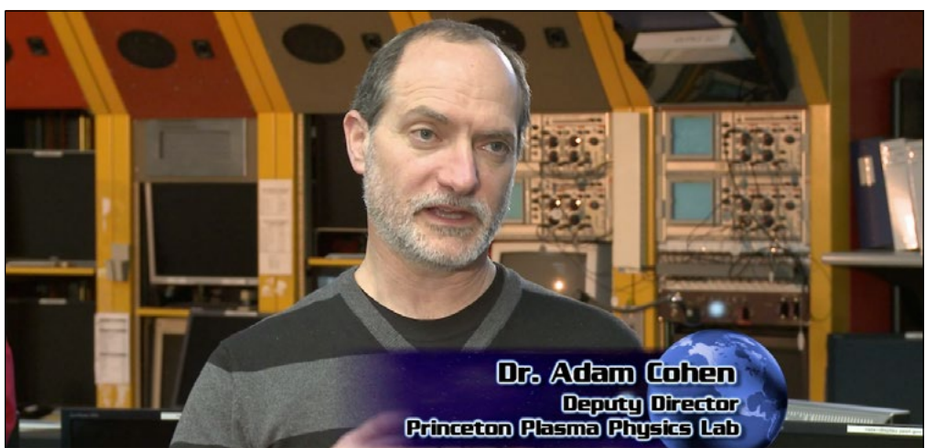
By Jeanne Jackson DeVoe

A segment on fusion energy filmed at PPPL as part of a television program on "Science and the Environment" produced by CUNY TV will air in New York City for Earth Day on April 22 and will be posted on the station's website the same day at http://www.cuny.tv/show/scienceandu/PR2002679.

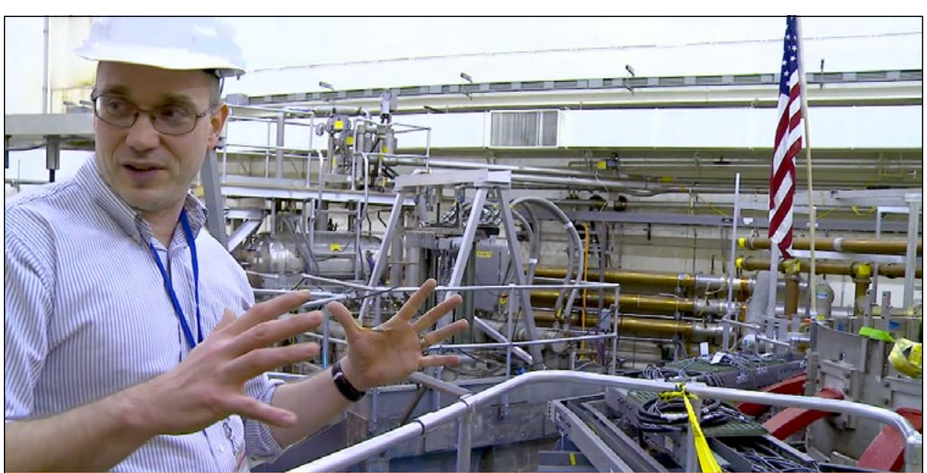
The show will be broadcast at 8 a.m., 2 p.m. and 8 p.m. on April 22 and rebroadcast on April 26 at 11:15 p.m. CUNY TV is digitally broadcast on channel 25.3 and reaches up to 35 miles from the city, and in New York and the five boroughs on cable channels 75 (Time Warner and Optimum), 77 (RCN) and 30 (Verizon FIOS).

The PPPL segment of the program for CUNY's monthly SCIENCE & U! series was filmed at PPPL in March when reporter Max Gomez, who is also the CBS medical correspondent, came to the Lab with two videographers. Gomez interviewed PPPL's Deputy Director for Operations Adam Cohen in the NSTX Control Room and physicist Stefan Gerhardt at NSTX-U. The video will include photos by PPPL photographer Elle Starkman.

CUNY reporter Max Gomez, who is also a CBS medical reporter, filmed a segment on fusion for a CUNY program that will be broadcast April 22. Above, Gomez at NSTX-U in a photo taken from the video. (Photo courtesy of Science & U! – CUNY TV)



The PPPL video segment includes an interview with Deputy Director Adam Cohen in the NSTX Control Room. (Photo courtesy of Science & U! – CUNY TV)



PPPL physicist Stefan Gerhardt gives an overview of the NSTX-U upgrade in the video. (Photo courtesy of Science & U! – CUNY TV)

Cohen, center, joined the conversation about NSTX-U with Gerhardt, left, and Gomez. (Photo courtesy of Science & U! – CUNY TV)

"The average person, even the educated person, knows so little about fusion and really doesn't even understand the difference between fission and fusion," said Gomez. "This was really meant to be a primer on what it is and what the future holds."

Gomez said he supported fusion as a student at Princeton University. "My deep-down hope would be to support funding to get this done," he said. "I think I ended up using one of the sound bites from Adam when I asked, 'So when is this going to happen?' and he said, "When do you want it to happen? It depends on how much money we get.'"

The segment on fusion energy will occupy several minutes of the program, which will look at topics that include work being done to control pine beetles in the New Jersey Pine Barrens, progress in cleaning up the Hudson River, and a local school that teaches kids about going green.

CUNY TV is the largest university television station in the country with a potential audience of 7.3 million homes.

QUASAR

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"This type of facility must have a place on the roadmap to fusion," said physicist George "Hutch" Neilson, the head of the Advanced Projects Department at PPPL.

Both stellarators and tokamaks use magnetic fields to control the hot, charged plasma gas that fuels fusion reactions. While tokamaks put electric current into the plasma to complete the magnetic confinement and hold the gas together, stellarators don't require such a current to keep the plasma bottled up. Stellarators rely instead on twisting — or 3D —magnetic fields to contain the plasma in a controlled "steady state."

Stellarator plasmas thus run little risk of disrupting — or falling apart — as can happen in tokamaks if the internal current abruptly shuts off. Developing systems to suppress or mitigate such disruptions is a challenge that builders of tokamaks like ITER, the international fusion experiment under construction in France, must face.

Main line of fusion development

Stellarators had been the main line of fusion development in the 1950s and early 1960s before taking a back seat to tokamaks, whose symmetrical, doughnut-shaped magnetic field geometry produced good plasma confinement and proved easier to create. But breakthroughs in computing and physics understanding have revitalized interest in the twisty, cruller-shaped stellarator design and made it the subject of major experiments in Japan and Germany.

PPPL developed the QUASAR facility with both stellarators and tokamaks in mind. Tokamaks produce magnetic fields and a plasma shape that are the same all the way around the axis of the machine — a feature known as "axisymmetry." QUASAR is symmetrical too, but in a different way. While QUASAR was designed to produce a twisting and curving magnetic field, the strength of that field varies gently as in a tokamak — hence the name "quasi-symmetry" (QS) for the design. This property of the field strength was to produce plasma confinement properties identical to those of tokamaks.

Hutch Neilson

"If the predicted near-equivalence in the confinement physics can be validated experimentally," Neilson said, "then the development of the QS line may be able to continue as essentially a '3D tokamak.'"

Such development would test whether a QUASAR-like design could be a candidate for a demonstration — or DEMO — fusion facility that would pave the way for construction of a commercial fusion reactor that would generate electricity for the power grid.

A close-up view of part of a QUASAR coil and vacuum vessel.

Earth Day Events

Tuesday, April 22 (Rain Date April 24)

PPPL CLEAN-UP. Volunteers meet in LSB Lobby at 10:30 a.m. Please wear comfortable clothes and shoes! Lunch in Mod VI for volunteers at 11:45 a.m.

Wednesday, April 23

10 A.M. TO 1 P.M. Earth Day Displays: LSB lobby, including raffle. Win power strips, LED lightbulbs, rechargeable batteries with charger and other green goodies.

11 A.M. Green Machine Awards

11:15 A.M. Special Earth Day colloquium, "Sustainability Policy and Planning in New York City," by John Lee, Deputy Director for Buildings and Energy Efficiency in New York's Office of Longer Term Planning and Sustainability. There will be a pizza lunch in the auditorium for audience members after the presentation.

SAVE THE DATE!

STATE OF THE LABORATORY ADDRESS

Date: Tuesday, April 29, 2014

Time: 1:30 p.m.

Place: MBG Auditorium

After Dr. Prager's presentation, the Kaul Prize and the Distinguished Engineering Fellow Award will be presented.

Refreshments to follow - All Staff are invited to attend

Daniel Clery

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Telling stories about fusion energy

His aim in writing "A Piece of the Sun" was to make fusion understandable to the general public, Clery said. He wanted to tell the many exciting stories about the development of fusion energy that he had uncovered in his research. His talk traced the history of fusion to the 19th century, when scientists debated the age of the sun and how it managed to keep burning.

Einstein's special theory of relativity played a key role in the development of fusion energy by demonstrating the equivalence of mass and energy, Clery said. Einstein himself became world famous after British astrophysicist Arthur Eddington led an expedition to Principe, Africa, in 1919 that photographed the bending of starlight around the sun during a solar eclipse, confirming a prediction of Einstein's theory of general relativity.

Soviet physicist George Gamow, the first scientist to theorize that two atomic nuclei could get close enough to fuse, returned to the question of how the sun gets its energy in 1938, Clery said. Gamow, who defected to the United States and joined George Washington University, convened a conference to discuss the question. The conference drew physicists Hans Bethe, Charles Critchfield, and Edward Teller, among others, and came up with the sequence of nuclear reactions that powers the sun.

Spy arrest prompts secrecy

British authorities clamped down on fusion research after 1950 when Britain charged physicist Klaus Fuchs with spying for the Soviet Union. The German-born Fuchs had fled the Nazis in 1933 and had worked on the Manhattan Project in the United States and on atomic research in Britain. He was arrested after the United States cracked Soviet codes that identified him and was imprisoned in Britain until 1959 before immigrating to East Germany. Fuchs' arrest caused Britain to move fusion research to government laboratories, where researchers built a big "pinch" fusion device in 1957 code-named ZETA for Zero Energy Thermonuclear Assembly.

Meanwhile, the Soviet Union kept pouring money into fusion research. The Soviets even provided gold to line the walls of a tokamak for research, Clery said. But the experiment failed and the gold vanished.

Argentina too got into fusion research. Dictator Juan Peron claimed in 1951 that a scientist there had produced fusion in a device called a "thermotron," Clery said.

Clery also visited the Magnetic Reconnection Experiment where graduate student Clayton Myers, right, showed him around.

Arturo Dominguez, right, a postdoctoral fellow in the Science Education Department, shows Clery the Remote Glow Discharge Experiment in the Science Education laboratory during Clery's tour of PPPL before the Colloquium.

Lyman Spitzer and the stellarator

The claim proved false but inspired Princeton astrophysicist Lyman Spitzer to cofound "Project Matterhorn" in 1951 to develop fusion energy. Spitzer and colleagues built the first stellarator in the form of a figure-eight device themselves. At around the same time, English physicist Edward Tuck won funding for fusion research at the Los Alamos National Laboratory. Other researchers worked on a magnetic-mirror concept to produce fusion at Lawrence Livermore National Laboratory.

All the countries working on nuclear fusion confronted the problem of trying to get the plasma hot enough for the fusion reaction to take place, Clery said. But there was no way to measure the temperature until British researchers hit upon the idea of using a laser. The day after Neil Armstrong and Buzz Aldrin landed on the moon on July 21, 1969, a British team measured temperatures hotter than 10 million degrees Centigrade in a Soviet fusion device. "Suddenly, the world of fusion was changed — everyone wanted to build tokamaks," Clery said.

The fervor to develop fusion energy got a boost in 1973 when OPEC cut off oil supplies to the United States, Canada, Japan, the Netherlands, and the United Kingdom. Governments "decided they had to invest in fusion energy," Clery said. The enthusiasm led to the construction of the Tokamak Fusion Test Reactor at PPPL and the Joint European Torus in Britain.

Collaborating with the Soviets

After U.S. President Ronald Reagan and Soviet General Secretary Mikhail Gorbachev met at a summit in 1985, the two countries agreed to "work together to build a fusion reactor for the benefit of all mankind," Clery said. The agreement led to ITER, the international fusion facility now under construction in France. After Congress halted U.S. funding for ITER in 1987, the United States rejoined the project in 2003, when China and South Korea also became members.

The decision of where to site ITER was highly contentious, Clery said. In the end, the European Union persuaded the Japanese to agree to locate ITER in Cadarache, France, "by making many concessions – monetary and otherwise." Among them was the appointment of a Japanese scientist as the first ITER director-general.

Now the price tag for ITER has at least tripled and the 2020 completion date for construction is likely to be pushed back, Clery said. And Congress is reevaluating U.S. participation in ITER. Clery would like to see the project move forward. "I'm hoping all these issues will be resolved," he said. "I'm hoping that we'll make fusion come true."

COLLOQUIUM

SUSTAINABILITY POLICY & PLANNING IN NEW YORK CITY

JOHN H. LEE, NYC MAYOR'S OFFICE

Wednesday, April 23

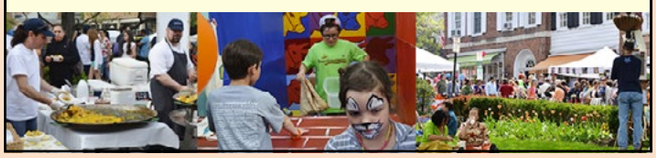
11:15 a.m. • MBG Auditorium

Volunteer for PPPL's Communiversity booth on April 27!

We need your help! Please volunteer for an hour or two on Sunday, April 27 from 1 p.m. to 6 p.m at PPPL's Communiversity booth.

This is a fun event in downtown Princeton that draws thousands of visitors. Volunteers help with demonstrations, talk to the public, and hand out brochures and prizes.

Please fill out this online form to volunteer.



Site Protection Division • TIP • OF • THE • WEEK •

UPDATE TO PLAINSBORO TRAFFIC REGULATIONS

Scudders Mill / Campus Road Traffic Light

PPPL'ers who use this intersection may have noticed that some motorists are unsure as to the appropriate response to a red right-turn arrow signal.

Plainsboro Police have provided the following advisory regarding red right-turn arrow signals at traffic lights in Plainsboro.

- Vehicles must stop at a red right-turn signal.
- The vehicle must remain stopped until given the green right-turn arrow signal to proceed.
- Any turn on a red arrow is prohibited.

The State of New Jersey and the Motor Vehicle Commission depend on local authorities for specific interpretations regarding law enforcement of traffic signals.

Maple Avenue Speed Limit Reduction

The speed limit on Maple Avenue has been reduced to 25 MPH. New speed limit signs have been erected in the area to reflect the speed limit change.

The Plainsboro Police Department will be conducting an education enforcement awareness campaign along Maple Avenue for the next 30 days.

Any questions concerning the new speed limit may be directed to the Plainsboro Police Traffic Safety Bureau at 609-799-2333.

BROCK Café at PPPL Menu

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.

*— **MARK GAZO**, Chef Manager*

	MON. APR. 21	TUE. APR. 22	WED. APR. 23	THU. APR. 24	FRI. APR. 25
COMMAND PERFORMANCE CHEF'S FEATURE	 Rotini Pasta with Turkey Bolognese Sauce and Garlic Bread	 Cheese Ravioli Marinara with Arugula, Mushrooms & Sun-Dried Tomatoes	 Stuffed Peppers with Mashed Potatoes	 Pulled BBQ Pork with Corn on the Cob, Coleslaw and Beans	 English-Style Fish & Chips with Tartar Sauce & Malt Vinegar
EARLY RISER	Cheesy Grits with Country Sausage Gravy	Hungry Man Breakfast-2 Eggs, Meat, Pancakes & Potatoes	Herbed Egg White Omelet with Tomatoes served with Baby Greens	Challah French Toast	Eggs in Purgatory
COUNTRY KETTLE	Mushroom Hummus Soup	Chicken Rice	Tomato Tortilla Soup	Split Pea with Ham	Turkey Chili
GRILLE SPECIAL	Grilled California BLT Burger with Caramelized Onions & Avocado	Bratwurst & Sauerkraut Torpedo served with German Potato Salad	Grilled Tuna Melt with Swiss Cheese, Onions and Tomato on Rye	Grilled Chicken Breast Gyro	Veggie Burger With Mushrooms, Cheese, Arugula on English Muffin
DELI SPECIAL	Mediterranean Veggie Wrap	Roast Beef with Onion, Arugula, Cheddar & Horseradish Sauce	Ham, Muenster Cheese, Bacon, Tomato & Spicy Mayo Torpedo	Seafood Salad Croissant	Chicken Saltimbocca Panini
PANINI	Smoked Ham, Swiss Cheese, Sliced Pear & Honey Mustard on Ciabatta	Popcorn Shrimp Parmesan Torpedo	Grilled Chicken on Ciabatta Bread	Crispy Falafel with Yogurt and Cucumber Salad	Italian Meatball Sub with Provolone Cheese

MENU SUBJECT TO CHANGE WITHOUT NOTICE

VEGETARIAN OPTION

CLICK HERE FOR A PRINTABLE WEEKLY MENU

WEEKLY

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The **PPPL WEEKLY** is published by the PPPL Office of Communications on Mondays throughout the year except for holidays. Deadline for calendar item submissions is noon on Thursday. Other stories should be submitted no later than noon on Wednesday. Comments: commteam@pppl.gov ◆ **PPPL WEEKLY** is archived on the web at: http://w3.pppl.gov/communications/weekly/.