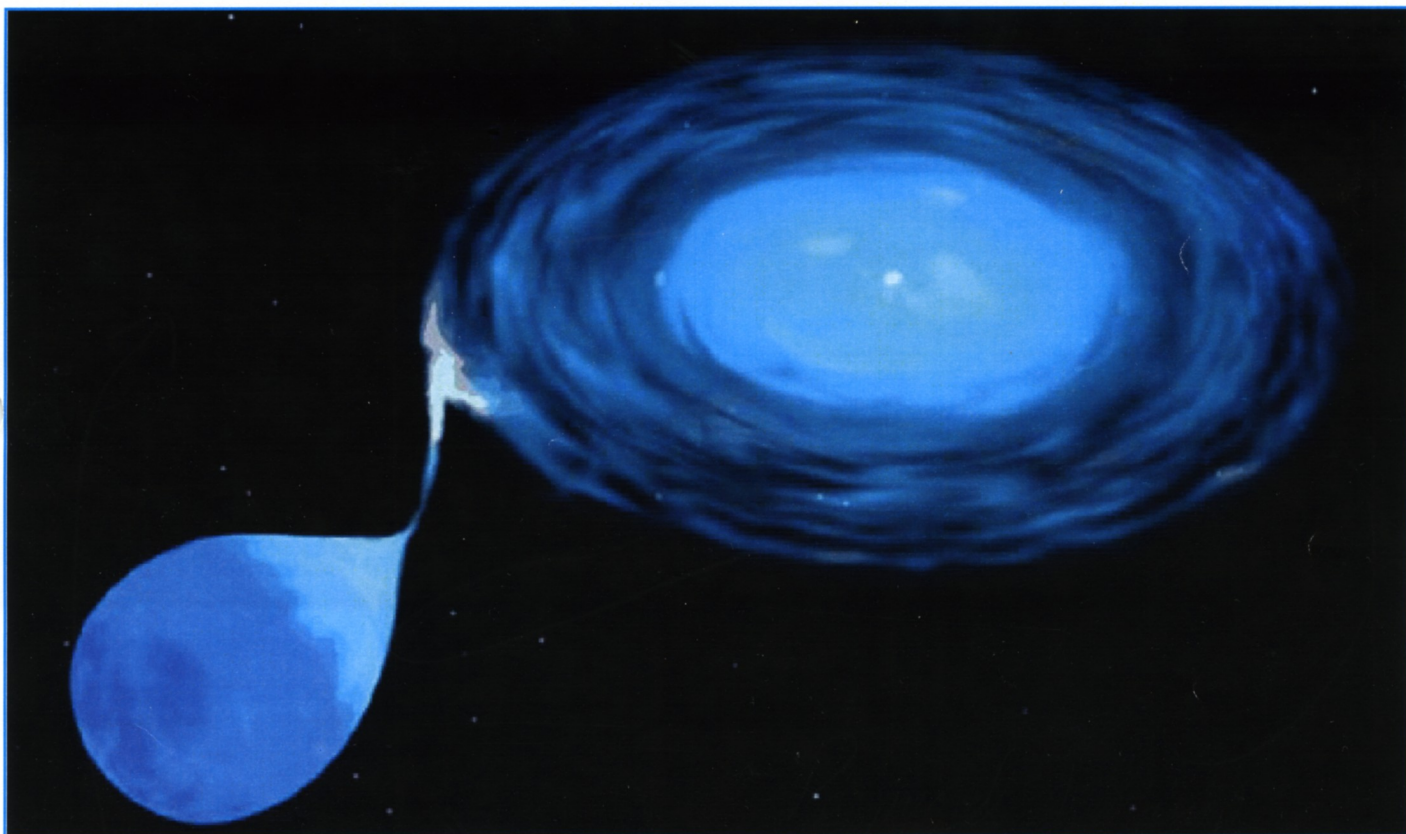


HOTLINE

The Princeton Plasma Physics Laboratory is a United States Department of Energy Facility

MRI Experiment Begins This Month at PPPL

May Shed Light on Star and Planet Formation



Accretion occurs in a binary star system when one star is paired with a sufficiently compact star such as a white dwarf, a neutron star, or a black hole. An accretion disk may form as the stellar envelop of the first star is captured by the denser star. (Space Telescope Science Institute, NASA)

by Anthony DeMeo

The formation process of stars and planets remains one of the big questions in astrophysical science. Presently, scientists do not understand the required conditions and the accretion, or matter collection process, involved in this formation. The Magnetorotational Instability (MRI) experiment at PPPL, however, may shed light on this mystery.

“The Earth must have sufficient angular momentum so that it does not fall into the Sun under the influence of gravity,” said PPPL physicist Hantao Ji, who is the project’s

Principal Investigator. Angular momentum is the impetus of a body to keep rotating. “We also know that galaxies and solar systems have a preferred direction of rotation. Consequently, matter forming these systems must also have had net angular momentum, which must have been overcome by gravity for the matter to coalesce.”

Ji explained that the angular momentum prevents matter from falling into the star directly, so an accretion disk

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Edge-on views of an accretion disk around a young star at three different times. (By Hubble Space Telescope)

MRI

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is formed, which consists of matter losing its angular momentum and swirling into the core of the star. "For example, when our Sun was formed, the accretion process was very efficient in casting off angular momentum because most of the material comprising our solar system ended up in the Sun," he said.

Since angular momentum must be conserved, the lost amounts must be efficiently transported elsewhere. But how

does this happen, and where does the angular momentum go?

Star formation occurs in deep space and therefore is not directly observable, so the accretion process has been described only in theoretical models and in their resulting computer simulations. The unique PPPL apparatus will be the first anywhere to attempt a direct test of this widely postulated physical process in accretion disks.

The project's primary mission is to test the plausibility of a 1991 theory that indicates magnetorotational instabil-

Hotline

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ity (MRI), a disruptive plasma process, plays a major role in accretion. Unlike most PPPL experiments, MRI will not use an actual plasma. Ji and Princeton University Professor Jeremy Goodman, the principal collaborator for theory and astrophysics on the project, came up with a way to physically simulate an accretion disk with material “standing in” for the plasma, dust, and other materials.

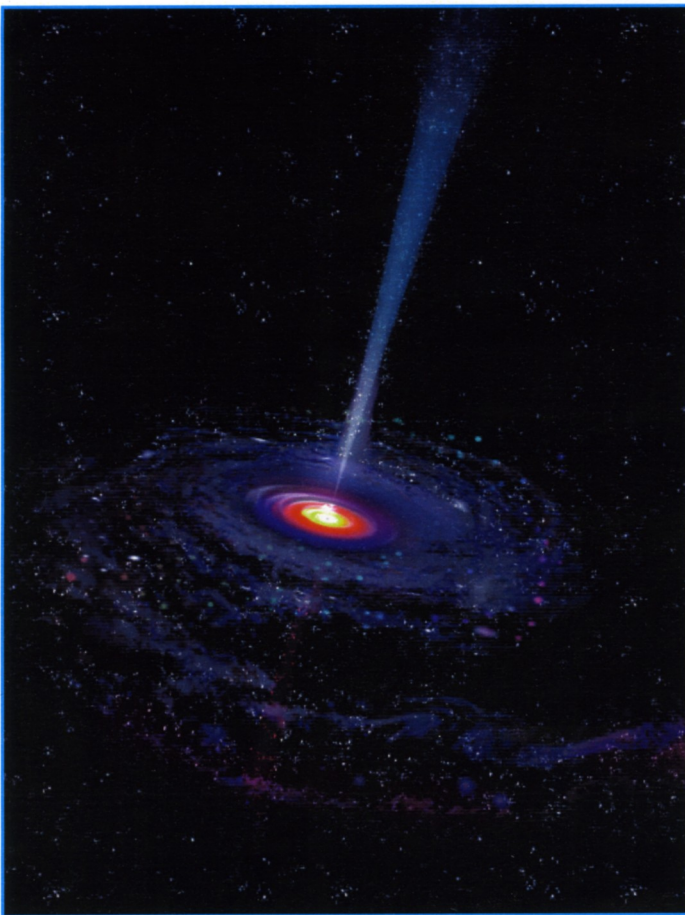
The system they are building consists of two concentric cylinders, each 28 centimeters in length, free to rotate independently about a common axis. The inner cylinder has a radius of 7 centimeters and is made of steel, and the outer cylinder has a radius of 20.3 centimeters and is made of plastic to allow visual inspection.

During a typical experiment, the space between the cylinders will be filled with a liquid metal, chosen because it is easy to maintain and interacts with the magnetic field in ways similar to plasma. The researchers have chosen a mixture of 67 percent gallium, 20.5 percent indium and 12.5 percent tin. The inner and outer cylinders will rotate independently in the same direction, but at significantly different speeds, 4,000 rpm and 533 rpm, respectively. The project is a significant engineering challenge since it requires two rotating disks at each end of the cylinders. The disks must be driven at different speeds by separate motors through six concentric pipes.

Experiments will be conducted with and without a magnetic field parallel to the axis of the cylinders. Researchers will measure the differences in the torque on the cylinders between both conditions. The magnetorotational instability, when it occurs in the liquid metal, will cause angular momentum to be transferred from the inner cylinder toward the outer cylinder, resulting in an increase in torque couplings between cylinders. This is equivalent to the transfer of angular momentum outward in an accretion disk, allowing matter to fall toward its center, forming a star. This result would support the hypothesis that MRI is responsible for the transport of angular momentum.

Accretion disks also form around massive black holes in the center of many galaxies and in binary star systems. Results from the PPPL experiments will help astrophysicists better understand these phenomena. Understanding transport phenomena in plasmas is important for basic plasma physics in general, and also for fusion plasmas in particular.

Staffing the MRI project are Ji, postdoc Michael Burin, and graduate students Ethan Schartman and Wei Liu, with technical and engineering support from Robert Cutler, Steve Raftopoulos, Phil Heitzenroeder, Chang Jun, and Lew Morris. The team is working in collaboration with Professor Goodman of the Princeton University Observatory. The work is being funded jointly by DOE, NSF, and NASA. ●



Above, at the MRI experiment are, from left, Bob Cutler, Michael Burin, Ethan Schartman, and Hantao Ji. The apparatus includes elaborate driving mechanisms for the concentric cylinders. At left is a rendering of an accretion disk around a massive black hole often thought to exist in the center of many galaxies. (NASA)

Stoltzfus-Dueck Attends Nobel Laureate and Student Meeting

Princeton University graduate student Timothy Stoltzfus-Dueck mingled with Nobel laureates and fellow physics students this summer as one of fifty-seven U.S. student participants at the Meeting of Nobel Laureates and Students in Lindau, Germany. Stoltzfus-Dueck, who is entering his third year of graduate work at PPPL, was nominated by Princeton University and sponsored by the U.S. Department of Energy to be part of the U.S. student delegation at the meeting. In Lindau, the American students were among 560 international participants from more than 20 countries who spent a week attending lectures and panel discussions by laureates.



Participants also attended open discussions, receptions, and dinners with laureates and other students.

“As I am in the process of choosing a thesis topic — the next step in focusing my research interests — I was paying particular attention to the opinions of the laureates regarding the most promising topics in physics for the next decades,” said Stoltzfus-Dueck. “The main insights I gained from discussions with the laureates were encouragement to pursue interdisciplinary research and applied research, and an increased appreciation for the unexpected ways in which new discoveries become apparent.”

Stoltzfus-Dueck explained that many of the laureates said they had stumbled across fundamental scientific discoveries while they were pursuing applied research.

Prior to heading to Lindau, the U.S. student participants met in Washington, D.C., where they got acquainted and discussed one another’s research. “I was surprised to find out how diverse and interesting the American delegation was. Our group cut across many disciplines and it was interesting to hear about the research the other American students were doing,” said the Princeton participant.

For Stoltzfus-Dueck, participation in the 54th annual meeting was an enlightening and enjoyable experience. “The interaction between the different fields encouraged my ongoing interest in interdisciplinary research. I greatly

enjoyed the trip to the Lindau meeting. It was also valuable to me to meet many students of science from varied fields, both American and international,” he said, adding that he also had a special task to carry out for the American delegation.

During the opening social in the Inselhalle on the island of Lindau, Stoltzfus-Dueck presented a vase to Countess Sonja Bernadotte of Wisborg, Sweden, and Mainau Castle, Germany. Countess Bernadotte heads the Committee of the Meetings of Nobel Prize Winners in Lindau, which organizes and conducts the events. Since 1951, Nobel Laureates in chemistry, physics, and physiology and medicine convene annually in Lindau to have open and informal meetings with students and young researchers. The meetings rotate by discipline each year. This year focused on physics.

Stoltzfus-Dueck received a bachelor’s degree in physics and music from Goshen College in Goshen, Indiana, in 1999, and began graduate work at Princeton in 2002. At PPPL, his research experience includes edge turbulence theory on the National Spherical Torus Experiment and experimental investigation of electron dynamics in magnetic reconnection. Stoltzfus-Dueck is a Fusion Energy Science Fellow. In his spare time, he sings in the community chamber choir at Westminster Choir College and is training for a marathon. ●

Think Green: America Recycles Day Events at PPPL

PPPL is celebrating its seventh America Recycles Day (ARD) this year. Tom McGeachen and Margaret Kevin-King, a.k.a. ChefRE and ChefCYCLE, respectively, need your help. As part of the ARD observation, a 20-cubic-yard dumpster is in the lower parking lot near the entrance for the recycling of the following items:

Mixed Paper	Computer Paper	News Paper
Magazines	Catalogs	Junk Mail
Posters	Notebook Paper	Post-it Notes
Photo Copies (all colors)		
(Staples are Okay.)		

Try this exercise: Fill your blue office paper recycling containers with the above items and bring them to the dumpster. Try to make three trips each week to the dumpster. ChefRE and ChefCYCLE are monitoring how many 20-cubic-yard dumpsters the Lab can fill in four weeks. Clean out the extra unneeded paper in your offices and filing cabinets. *Remember: please do NOT recycle items that are quality or important records.* PPPL had a trash recycling rate of 49 percent in FY04. Let's try to make it 55 percent in FY05.



Photo by John Bennevich

Margaret Kevin-King (left) and Tom McGeachen, the PPPL recycling "chefs," drop materials into the Lab's special recycling dumpster.

Other ARD events this fall include the **Lab-wide Office Clean Up** November 22-24 and the **ARD Celebration** scheduled for Wednesday, December 1, in the MBG Auditorium. The presentation, "How All PPPL'ers Can Reduce Energy Usage and Trash Generation, Save the Lab \$\$\$, and Prevent Pollution," will feature the renowned ChefRE and ChefCYCLE. ●

Maintenance Group Celebrates Safety Record

In October, the Lab's Maintenance and Operations Division celebrated 100,000 consecutive hours without a recordable injury. The 100,000 work-hours cover from May of 2003 to October of 2004.

"I'm very impressed by the manner in which the maintenance staff members have been incorporating safety considerations into their day-to-day jobs. It's very challenging, especially with the diverse type of work and workplaces that they deal with. But the staff does take this very seriously everyday, and it pays off in the long run. The 100,000 hours and 17 months are a pretty remarkable milestone," said Jack Anderson, Head of ES&H and Infrastructure Support.



The Division's 40 employees are composed of maintenance technicians, supervisors, clerical support staff, janitors, system and project engineers, and administrators. To celebrate the milestone, Maintenance and Operations Division Head Carl Potensky and Manager Shawn Connolly treated the staff to a pizza-and-soda party at the Facilities Building on October 29. The group is at left, with a banner to mark the occasion. Holding the banner, created by PPPL's Greg Czechowicz, are Anderson at left and Potensky at right. ●

AC Power Team Completes Major Maintenance Project



The five-year check-up of the main power yard at PPPL was completed earlier this fall. The crew who worked on the project, made up of PPPL'ers and subcontractors from Scott Testing, are (from left) Art Wise, Dick Debonis, John Lacenere, Joe Boyce, Charlie Brightbill, Colin McFarlane, Peter Blackburn, Cory Kilpatrick, Carl Bunting, Steve Tureikas, Harry Krotz, Ray Camp, and Russell Sorbello. Not pictured is Don McBride. Congratulations, team! ●

UNITED WAY CAMPAIGN AT PPPL — Mark Your Calendars! The PPPL 2004 United Way Campaign meeting for all staff is scheduled for Wednesday, December 8, at 10:30 a.m. in the Auditorium. The event will include a presentation, refreshments, and raffle prizes. The campaign theme this year is, "What Matters ...Results You Can See." Later that day, there will be a United Way party in the Lobby at 3:30 p.m. Everyone is welcome.

PPPL Holiday Ornaments Are In

PPPL holiday ornaments are now available at the Plasma Hutch. The orange-and-white plastic bulbs with the PPPL logo are \$4 each. Stop by the Plasma Hutch on Fridays from 11:45 a.m. to 12:30 p.m. to make your purchases. Hurry while supplies last! ●



Watch Your Step

This season, falling leaves and acorns can cause slippery conditions on walking surfaces, including parking lots. This can create hazardous conditions, particularly when wet weather hits. Please use special care when walking in areas near trees and when getting in and out of cars. ●



Spotlight

Name: John Jenner

Position: Receiving and Mailroom employee, with responsibility for staffing the stockroom, making deliveries, conducting inventories, and assisting with various Warehouse operations.

Quote: "I came to PPPL three-and-a-half years ago to work in the Mailroom as a temp and I've been here ever since. Right now I'm a term employee."

I like the environment at the Lab. People here are really nice, and I have a lot of fun with them. I enjoy coming to work. Really, the best thing here is the people. I also like the variety of my job, from running the stockroom — filling orders, taking care of customers, and ordering new stock — to taking inventory, and delivering shipments and mail to staff. I'm a little too energetic to sit in one place all day."

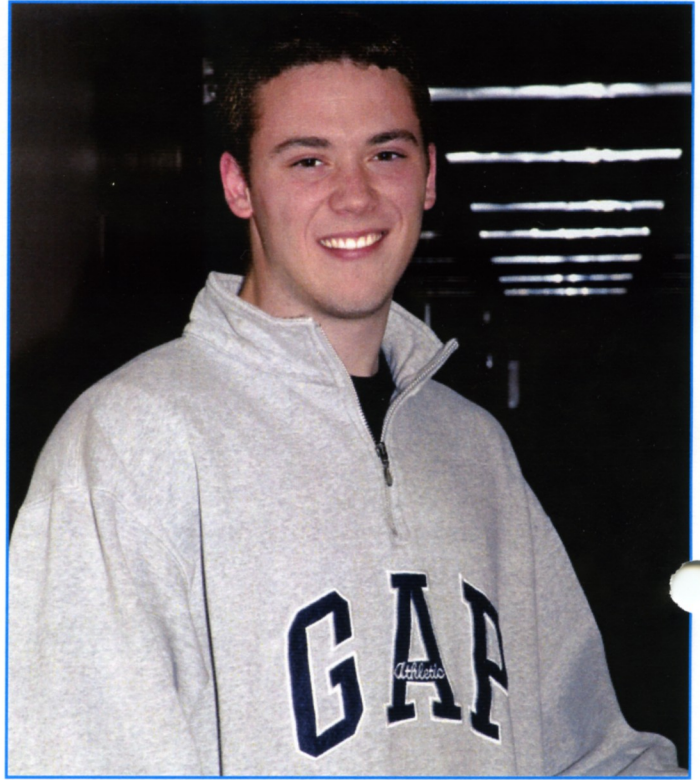
Other interests: "I love working out at the gym, watching football — the Eagles rule — and learning."

I love sports in general, but especially football. I watch a lot of games on TV and often go to see the Eagles at the Lincoln Financial Stadium in Philadelphia.

I'm also interested in learning, with my latest focus being on electrical studies and computers. I just started electrician training classes at Bucks County Technical School to see if I might be interested in becoming an electrician. I also love learning computer programs and am always playing

on the computer at home and during my breaks at work." John also enjoys helping his mom, PPPL'er Fran Cargill take care of the rest of the family, which includes his three younger brothers — all at home.

So what is it that keeps him smiling throughout the day? "That's just me. I try not to let things bother me. I look at the good, not the bad." ●



Welcome to PPPL

Please welcome Cynthia Murphy, who recently came on board as the Executive Assistant to Deputy Director Rich Hawryluk. Prior to accepting the position at PPPL, Cynthia had worked at Princeton University's main campus for fourteen years, serving in both academic and administrative offices. She can be reached at ext. 2484 or via e-mail at cmurphy@pppl.gov. ●