The Washburn Observer

DEPARTMENT OF Astronomy
UNIVERSITY OF WISCONSIN–MADISON

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It's All Happening for Ryan Keenan

Inside This Issue

From fellowships and a postdoctoral position to awards for research and teaching, the past year has been an exciting one for recent Astronomy Department PhD Ryan Keenan.

Keenan received the UW-Madison Exceptional Service Award for going above and beyond the expectations for a teaching assistant in the classroom, in this case, with astronomy outreach programs. "I have a passion for education and public outreach in astronomy," says Keenan. "I believe it is our duty as scientists to convey our knowledge to the public in words anyone can understand."

Ryan Keenan rock climbing at Zion National Park in Utah.

His weekly five-minute English and Spanish "Radio Astronomy" program on Madison's community radio station WORT informs listeners about astronomical events and news. Keenan also regularly hosts public stargazing nights at UW-Madison's Washburn Observatory.

He has also presented astronomy programs to Spanish-only audiences at the UW Space Place as part of their Spanish-language outreach programs; done public lectures and stargazing shows in area state parks as part of the Universe in the Park summer program; made presentations and hosted astronomy exhibits at area elementary schools; brought telescopes to Jalisco, Mexico, in collaboration with the UW-Madison Center for Global Health; and mentored a high school student. "It is rare to find a scientist with both linguistic skills and an interest in public outreach, but Ryan is such a rare find," says Jim Lattis, director of the UW Space Place.

Keenan was also awarded the Astronomy Department's inaugural Stebbins Award. The award is for an exceptional research result in the prior year, such as a big discovery or particularly important findings. Keenan's research statement for the Stebbins Award begins, "Dark energy, if it exists, makes up roughly 75 percent of the total energy in the known Universe and could be considered the biggest 'problem' in astrophysics today." He goes on to say that while leading models of the universe invoke a large dark-energy component, some groups have developed alternative models that attribute the mysterious accelerating expansion of the universe to gravitational effects due to our location relative to large-scale structures of galaxies. These alternative models suggest that if we reside in a relatively under-dense region of the

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— Ryan Keenan

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Letter from the Chair

Bob Mathieu, Astronomy Department chair

Last week a UW undergraduate and I were at Kitt Peak and happened to run into Ron Oliverson (BA'75, Astronomy-Physics; MS'77, PhD'83, Physics). Ron and I had never met, but I had a feeling that this fellow had a connection to UW. It had something to do with his Rose Bowl cap, UW jacket, denim shirt with UW logo, and red T-shirt with Bucky Badger front and center.

We enjoyed connecting and sharing stories of UW astronomy past, present and future. And that is the best reason for our new newsletter. Around the world, our department is known among astronomers for our close community—with open doors, scientific connections without boundaries, friendships across career stages, and yes, lots of parties. Alas, it is the nature of academia that our friends become scattered across the universe and too often lose touch with us here in Madison.

Wonderfully, things keep changing here. We are now part of three consortia operating optical/infrared telescopes in both hemispheres, and also part of a consortium planning the largest radio interferometer ever built. A major instrumentation group is building spectrographs for our telescopes. Space instrumentation continues to be a Wisconsin forté, currently most notable for our Star Tracker 5000 that is guiding more and more NASA rockets and balloons. Six theoretical faculty and senior scientists explain all that the 12 observational faculty and senior scientists are seeing…until we find things that don't fit their explanations. And, of course, all of us have to run to keep up with the 32 graduate students and postdocs.

Education continues to be a cherished passion—from the French majors in our classrooms to the UW Space Place in South Madison, from the Universe in the Park program sending astronomers to state parks throughout Wisconsin to the high school teachers on Kitt Peak. And our undergraduate majors and NSF-funded summer students from around the country are a particular pleasure as they discover research with us and grow into young scientists.

We very much look forward to reconnecting with all of you, perhaps only through this newsletter, but even better, with a visit the next time you are in Madison, or on Kitt Peak!

Bob Mathieu

"Keenan" continued from page 1

universe, we could witness what looks like an accelerating expansion of the universe even when no dark energy is present. Keenan's dissertation work has shown that the observed local universe may, in fact, be under-dense on the scales required by these alternative theories.

After receiving his PhD in February, Keenan took a Fulbright Fellowship to spend the coming year doing research and outreach at the Cerro Tololo Inter-American Observatory (CTIO) in La Serena, Chile. The year will be spent collaborating with Dr. Roberto De Propris on studies of galaxy evolution and work with CTIO's outreach division on Spanish-language outreach and education projects.

After Chile, Keenan has accepted a postdoctoral position at the Academia Sinica Institute for Astronomy and Astrophysics in Taipei, Taiwan, starting in spring 2012 to do further work in observational cosmology. These research collaborations in Taiwan will build on work that began in the summer of 2010 when Keenan spent two months in Taipei through the National Science Foundation East Asia and Pacific Summer Institutes program.

The *Washburn Observer* is the alumni newsletter of the Department of Astronomy at the University of Wisconsin-Madison.

475 N. Charter St. • Madison, WI 53706

Email: sanford@astro.wisc.edu
Website: www.astro.wisc.edu

Chair of the Department of Astronomy:
Professor Robert Mathieu

Editor: Barbara Sanford

Contact for gifts information:
Robert Mathieu
mathieu@astro.wisc.edu • (608) 262-8689

Christopher Glueck, UW Foundation
chris.glueck@supportuw.org • (608) 265-9952

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Please Keep in Touch

We'd like to hear from you. Please send us any news we can include in future newsletters or any changes in your contact information to: **sanford@astro.wisc.edu** or UW-Madison Department of Astronomy, 475 N. Charter St., Madison, WI 53706, Attn: Barb Sanford.

UW Spectrograph to Be Commissioned on SALT

The SALT Observatory in winter

It's an exciting time for Astronomy Department scientists Eric Hooper, Ken Nordsieck and Marsha Wolf. They're working in South Africa this spring to place the new Robert Stobie Spectrograph back on the Southern African Large Telescope (SALT) and commission the instrument.

The spectrograph first went on the telescope five years ago. However, more development work was needed for both the telescope and the instrument. At long last, everything is coming together, including soon, light from the most distant galaxies.

"This is big news for the Astronomy Department, the people and government of South Africa, and the consortium of 13 U.S. and international partners involved in the project," says Hooper. "Astronomy is a major focus of the South African government, and it contributed generously to the project, which has iconic status in South African society.

"Commissioning the spectrograph is like having a custom car and figuring out how it works," he continues."It's a one-of-a-kind custom-made instrument. By calibrating it and seeing what it can do and how well it performs, we'll come to totally understand it. Other scientists will benefit from knowing its strengths and how to use them, as well as its quirks and how to account for them."

UW-Madison is a principal partner in the international consortium that runs SALT, one of the world's largest single optical telescopes and the largest in the Earth's southern hemisphere. It is located in the South African Great Karoo, an exquisitely dark and dry site south of the Kalahari desert. Using a revolutionary mounting and guiding system, the telescope remains largely stationary, while the instrument platform above the mirror moves in order to track celestial objects across the sky.

"I'm expecting the unexpected — something spectacular."

— Ken Nordsieck

"SALT scientists are working together to look at colors of light in new ways," Hooper explains. "Using a part of the instrument called a Fabry-Perot tunable narrow band filter to finely sub-divide the rainbow of the incoming light, they can take pictures of the sky in many narrow ranges of color and scan through sub-shades to finely discriminate between structure and details at different wavelengths of light."

"The telescope has a relatively large field of view, a quarter the size of the full moon, so spectrographic imaging is the wave of the future," adds Nordsieck. "In addition, the polarization of light will be measured, allowing for the unraveling of magnetic fields and for three-dimensional views of things. There is also interest in high-speed, high-time resolution modes so that, for instance, during an eclipse we can watch the magnetic field change a hundred times faster than ever before and see the details of black holes and white dwarfs.

"The combined operating modes of the spectrograph are like a Swiss army knife with new tools that nobody ever came up with before," Nordsieck explains. "We will look at things in a new way and see how the modes interact. I'm expecting the unexpected—something spectacular."

Telescopes like SALT are large enough to peer back in time and study galaxies so distant that they formed shortly after the Big Bang. Because of its southern site, SALT also has one of the best views into the closest galaxies to our Milky Way, the Large and Small Magellanic Clouds. It is able to record distant stars, galaxies and quasars a billion times too faint to be seen with the unaided eye, as faint as a candle flame at the distance of the moon.

The construction of SALT was funded by a consortium of 13 international partners: National Research Foundation (South Africa); University of Wisconsin-Madison; American Museum of Natural History; Carnegie Mellon University; Dartmouth College; Rutgers University; University of North Carolina-Chapel Hill; Consortium of UK Universities and Institutions; Georg-August-Universitat Gottingen (Germany); Hobby-Eberly Telescope Board (international, including Penn State, Stanford University, University of Texas and Georg-August-Universitat Gottingen); Inter-University Centre for Astronomy and Astrophysics (India); Nicolaus Copernicus Astronomical Center (Poland); and University of Canterbury (New Zealand).

Science on a Shoestring

High above Arizona's Sonora Desert on Kitt Peak, the night sky is clear and ideal for stargazing, especially if viewed through the WIYN telescopes.

In May 2010, department scientists Marsha Wolf and Eric Hooper arranged for Madison East High School math, physics and astronomy teacher Evan Gnam and Richland Center High School English teacher John Heasley, along with UW-Madison pre-service teachers Derek Engebretson and Brandon Olszewski, to spend time at the WIYN Observatory learning firsthand about the telescope and the work of researchers there. These teachers are now opening the wonders of astronomy for their students.

While distant galaxies are an exciting area of study, equally wonderful is that the cost of this learning experience for six people was less than $4,000. Funding was provided primarily by the department, the school districts and the Department of Astronomy Board of Visitors.

The teachers made images of some of their favorite objects in the sky, such as nebulae formed by dying stars, globular and open star clusters, distant galaxies like the Whirlpool Galaxy and clusters of galaxies. In addition, they contributed to a UW-Madison research program to estimate the masses of black holes in distant galaxies and discern how they might have been connected to the history of the formation of stars over billions of years.

"We gave them a chance to share in this process so that they'd be better equipped to teach their students about science," says Hooper. "An important national issue in science education and literacy is the misperception that science is just a grab bag of disparate facts delivered by authority and whose validity depends on one's political persuasion. Rather, it is a somewhat systematic process by which almost childlike curiosity leads to greater understanding of the Universe and everything in it."

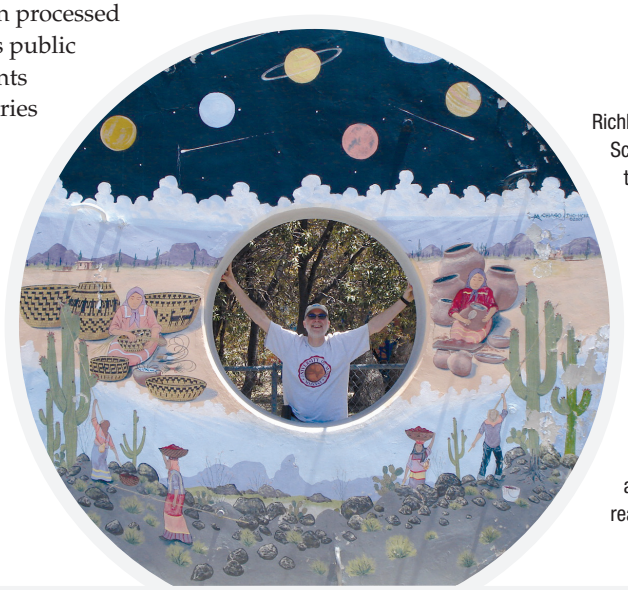
"I was wowed by the experience of typing in the celestial coordinates, having the 36-inch telescope slew precisely to its destination, collecting the photons that had traveled millions of years and seeing the Whirlpool Galaxy appear on the screen," reflects Heasley. "I understand better not only how astronomers gather data, but why they do it."

The teachers are incorporating their experience into lesson plans. "I've been able to tell my students the story of how astronomers can learn so much from a 'handful' of photons," says Heasley. "I saw firsthand how researchers formulated a question, decided on the destinations for study, gathered light and then processed it. Sometimes public outreach events and news stories focus on the product, such as a finished picture from the Hubble. From my Kitt Peak experience, I'm able to tell the story of how an image came to be and the processes used to create it. I saw firsthand how scientific research was being conducted at one of the best laboratories."

"I've shown my pictures from the trip to each class," says Gnam. "They really appreciate seeing what a modern observatory looks like, and it's important that they see their teachers as continuous learners and partners in the scientific endeavor."

The WIYN Consortium owns and operates two telescopes at Kitt Peak National Observatory near Tucson, Arizona. The group includes UW-Madison, Indiana University, Yale University and the National Optical Astronomy Observatory for the 3.5-meter telescope. Several other partners are involved in the 0.9-meter telescope, including UW System schools Madison, Oshkosh, Stevens Point and Whitewater, plus the Wisconsin Space Grant Consortium.

This story, by UW Foundation senior writer Merry Anderson, appeared on the UWF website, supportuw.org.



Richland Center High School English teacher John Heasley stands inside the "giant bagel," a concrete replica of the mirror in the largest of the Kitt Peak telescopes. The mural doesn't appear on the real mirror.

If you wish to make a tax-deductible gift to the Department of Astronomy Fund, which allows the department to support special opportunities for students, staff and faculty, you may contribute online at supportuw.org/making-a-gift or send a check, payable to the UW Foundation, to: UW Foundation, U.S. Bank Lockbox, Box 78807, Milwaukee, WI 53278-0807. Questions may be directed to Department of Astronomy chair Bob Mathieu, mathieu@astro.wisc.edu, (608) 262-8689 or UW Foundation director of development Chris Glueck, chris.glueck@supportuw.org, (608) 265-9952.

Shocking News about a Neutron Star

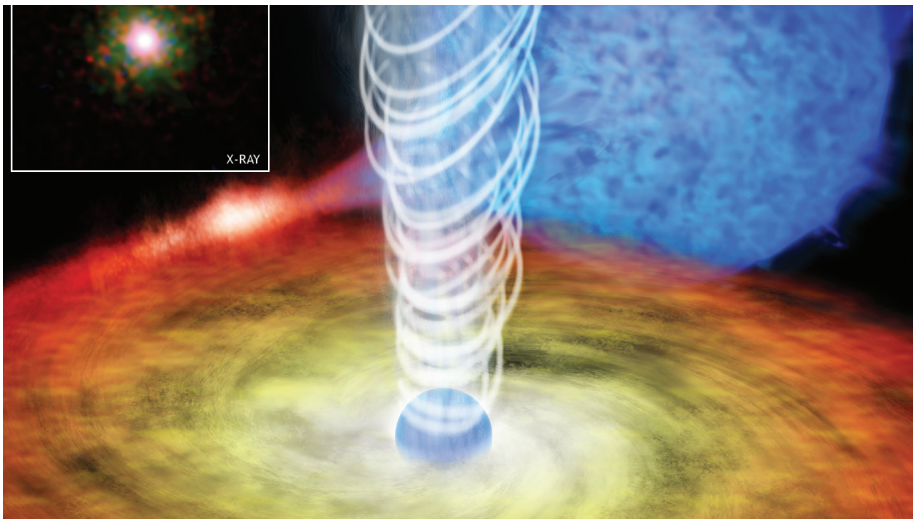
Neutron stars can make jets just about as efficiently as black holes.

This groundbreaking discovery was made by professor Sebastian Heinz, graduate student Paul Sell and an international team of astronomers who observed the influence that powerful jets from a neutron star have on nearby gas.

In a 27-hour X-ray observation with NASA's Chandra Space Telescope, Heinz and Sell imaged X-ray shockwaves at the end of jets originating from a neutron star, which is an extremely dense, collapsed core of an exploded star. Its mass is comparable to the Sun compressed to about the size of a city. One teaspoonful would weigh about as much as Mount Everest.

"A collision at this speed is bound to create some real havoc."

— Sebastian Heinz



An artist's illustration depicts the jet of relativistic particles blasting out of Circinus X-1, a system where a neutron star is in orbit with a star several times the mass of the Sun. The neutron star, an extremely dense remnant of an exploded star consisting of tightly packed neutrons, is seen as the sphere at the center of the disk. The powerful gravity of the neutron star pulls material from the companion star (shown as the blue star in the background) into a so-called accretion disk surrounding it. Through a process that is not fully understood, a jet of material moving at nearly the speed of light is generated. A high percentage of the energy available from material falling toward the neutron star is converted into powering this jet. Illustration courtesy: NASA/Chandra

The neutron star is part of a binary system of two stars called Circinus X-1, orbiting each other about 20,000 light years away from Earth, or about halfway across our Milky Way Galaxy. One light year is the distance that light travels in one year, or about 6 trillion miles.

In the process of consuming material from a normal companion star, the neutron star blasts super-heated matter into space along two narrow channels called jets. As the jets race away from the neutron star at close to the speed of light, they eventually collide with denser gas.

"A collision at this speed is bound to create some real havoc," Heinz explains. "The jets and the interstellar gas are heated by blast waves from the jets and radiate brightly, from radio wavelengths all the way to X-rays." In the case of Circinus X-1, this collision happens several light years away from the neutron star itself (almost a million times farther than the distance between the Earth and the Sun).

What's spectacular about Heinz's and Sell's discovery is that scientists can now study these interstellar shocks in great detail. No other neutron star or black hole within our own galaxy shows anything like this. A careful analysis shows that the shockwaves are only about 1,600 years old, a relatively recent phenomenon in astronomical terms, and that this neutron star is incredibly powerful.

"The jets of Circinus X-1 are thousands of times more powerful than the entire Sun," Sell explains. "Somehow, the neutron star can tap into the gravitational energy of the infalling material and accelerate the jet with incredible efficiency. If your car's engine was able to accelerate your car at the same fuel efficiency that Circinus X-1 accelerates material along its jets, your car would get gas mileage of about 2 billion miles per gallon."

"Jets have long been known to exist in a wide variety of black holes, but what makes them is still a mystery," says Heinz. "Some theories suggest that they are made by tapping into the rotation energy of a black hole, similar to a giant flywheel that stores energy. In the case of the black hole, this energy is stored in a giant vortex of space-time that is constantly dragged around the black hole. Neutron stars have powerful jets similar to black holes, but there is no vortex effect, so something else must be powering the jet."

Discovering that a neutron star has the same tricks up its sleeve as a black hole does, when it comes to making jets, challenges scientists to explain this in their models. Knowing that these structures can exist around neutron stars also encourages them to make more observations and explore new avenues with other neutron stars. "The possibility of making exciting, important discoveries to better understand how the world and the universe works at a fundamental level is what motivates me every day at work and is what science is all about," says Sell.

A more detailed and technical accounting of this observation can be found in the *Astrophysical Journal Letters*, 2010, p. L194.

Sterling Hall Shows Off Department's New Face

The Astronomy Department's new main office has a comfortable seating area and an informative, attractive display of astronomy history, instrumentation, research, teaching and outreach.

Psychologists and astronomers may be a match made in heaven, but unfortunately, we'll never know.

Back in 2005, when department chair Eric Wilcots and professor Bob Bless met with the Psychology Department and architects for six months about Sterling Hall's renovation, it was proposed that the Astronomy and Psychology departments share the building. Psychology's research animals would be housed in the basement.

However, the Psychology Department soon realized that it couldn't fit into Sterling, so in fall 2006, plans changed. The plan evolved to totally gut only the new wing, built in 1959, and remodel it for the department. The historic wing, built in 1917, would get a cosmetic facelift. In 2009, the department moved from the new wing to the old wing. Then, a little over a year later, the department moved back into the new wing in summer 2010.

"This is the first space specifically designed for the Astronomy Department since the Washburn Observatory was built back in 1878," Bless reminds us.

Highlighting the many building improvements, Wilcots points out that the department now has a main building entry, right into the front office, with a welcoming lobby and a prominent exhibit area. There are open areas with benches on every floor so that people can congregate and talk. The library was made into an especially inviting space for undergraduates. Classrooms and labs were expanded. The elevator goes all the way up to the seventh floor so that everyone can enjoy the refurbished planetarium, which also has a new attractive waiting area. Each floor has a different color scheme, right down to the pattern in the floor tiles, to add interest to the design. Men's and women's bathrooms on each floor meet ADA standards and are four times larger. And there is now adequate storage space for servers and computers, enabling the department to double its computer use.

"There were plenty of headaches and worries along the way, but in the end the renovation was fun," says Wilcots. "I got a kick out of being an architect."

Bob Mathieu became department chair and department administrator Gary Van Ryzin joined the department just when the renovation project began. "There was never a dull moment," Van Ryzin recalls.

The remodeling project, directed by contractor J. P. Cullen & Sons, began later than expected, so the move out of the new wing into the old wing was made in late summer rather than spring. However, the cooling system in the new wing was dismantled in June. Temperatures reached 88 degrees with the windows open. The computer cluster experienced problems. Advanced equipment was pushed to the edge of shutdown. Holes in the floor were drilled and chiller hoses hooked up from the basement to the fifth floor. It was an imperfect solution, chilling the building to 66 degrees. Staff wore sweaters and coats.

The move delay meant that the reinstallation of the hot water was also backed up several weeks to November 2009. October was a chilly month with no heat, and some offices were 52 degrees.

"This is the first space specifically designed for the astronomy department since the Washburn Observatory was built back in 1878."

— Bob Bless

People worked in their coats and used space heaters, but since the remodeling of the 1917 wing was only cosmetic, the electrical circuits had not been updated. With 10 amps of power per office, circuits blew when heaters were plugged in. Data transmissions were interrupted and hallways were darkened almost on a daily basis. When the heaters were plugged into other walls, it brought other computers down. "Memories of blackouts and the loss of large computer programs are still fresh in my mind," says Van Ryzin.

"The move involved a major reshuffling of department functions, from Sterling to Chamberlin, Chamberlin to Sterling, and Sterling to Sterling," Mathieu explains. "We moved the whole department twice in 14 months. All went as smoothly as it could, and to the credit of our department community, everyone was relaxed and collegial throughout."

Mathieu invites everyone to come see our beautiful new building. He notes that the department has gone from three floors in Sterling to five, as well as still having the sixth floor of Chamberlin. "It's nice having enough space for all of our undergraduates," he says. "The only remaining problem is where to put the foosball table that I promised to the graduate students."

Barger Named New Vilas Associate

Professor Amy Barger has been selected by the UW-Madison Graduate School for an appointment as a Vilas Associate.

The award is based on Barger's discovery of a population of "late blooming" galaxies that only recently have begun forming stars. This exciting discovery means that we can now obtain clues about the first stages of galaxy formation and chemical enrichment in the universe by studying in detail a large sample of such relatively nearby galaxies. We can also explore whether or not these newly forming galaxies contain an initial small amount of metals from the formation of the Universe.

Amy Barger

During her Vilas Associate appointment, Barger and her colleagues will search for a large sample of such galaxies using the innovative One Degree Imager (ODI) for the Wisconsin-Indiana-Yale-National Optical Astronomy Observatory (WIYN) telescope. Since the University of Wisconsin has 26 percent of the telescope time on WIYN, they have a tremendous opportunity to conduct large surveys that can yield enormous scientific returns.

Barger plans to undertake a shallow narrowband survey over a wide area that will cover a substantial fraction of the northern sky. She has named it the ODI Spectral Survey Experiment (ODISSE), since it will be an exploration of unknown scientific territory. The award will enable her to carry out a pilot study using the Subaru Telescope on Mauna Kea in Hawaii, one of the few telescopes with narrowband capabilities. The data obtained will enable her to optimize the ODISSE observing strategy to maximize the science returns. The excitement generated from the early science results will be instrumental in carrying out the full ODISSE survey.

Ali Bramson Works and Plays Hard

In her senior thesis, astronomy and physics undergrad Ali Bramson takes an interesting look at using social networking algorithms to understand the large-scale structure of the Universe.

Ali Bramson befriends glyptodon at the UW-Madison Geology Museum.

Like checking each light bulb on a string of holiday lights, Bramson traces the structure of the Universe. Groups of galaxies form the "bulbs" that follow the "strings" of large-scale filamentary structure. By looking at the structure within groups of galaxies, she wants to understand how they fit into other, larger structures in the Universe. She feels that current galaxy grouping techniques don't do a good job of determining how these structures relate to one another. To do this, she is using social networking algorithms, originally developed to model social interactions seen at a karate club when a dispute split the club in two. She is applying these algorithms to astronomy to find out how galaxy groups connect to each other.

Bramson has been part of the UW Undergrad Research and Mentoring (URM) program for most of her undergrad career and has been working with astronomy professor Eric Wilcots for the past two years.

She spent last summer at the Search for ExtraTerrestrial Intelligence (SETI) Institute in Mountain View, California, where she looked for signs of ongoing geologic activity on Jupiter's moons and found changes to the surface of the planet's closest moon. SETI is a National Science Foundation Research Experience for Undergrads (REU) program.

In 2009, Bramson did a summer internship program at the Arecibo Observatory in Puerto Rico, the world's largest and most sensitive radiotelescope. This was also an REU program funded by the NSF. Using the actual shape of asteroid 25143 Itokawa (known from the Hayabusa mission) in combination with the shape predicted from radar data from the telescope, she was able to improve ground-based shape modeling methods for asteroids.

Come December, she will graduate from UW-Madison with a BS degree in astronomy and physics and a computer science certificate.

"UW offered me so many research opportunities," says Bramson. "The department's planetary astrophysics class was my favorite. It was how I knew I was interested in planetary science."

Bramson wants to pursue her PhD in planetary science at the University of Arizona's Lunar and Planetary Laboratory. Specifically, she's interested in image processing and planetary surfaces.

In Wilcots' words, "Ali bleeds Bucky Badger." She has season tickets to Badger football, basketball and hockey games, plus a lot of red gear. Her dad is a UW alum, and her parents also have season tickets. "I've been going to Badger games my whole life," says Bramson. "I even got Christmas presents from Bucky instead of Santa."

Bramson helped write the lyrics for and stars in the YouTube music video, "SETI Gurls," a science twist on the popular Katy Perry song, "California Gurls." View it at: youtube.com/watch?v=wb5QWXenpXo.

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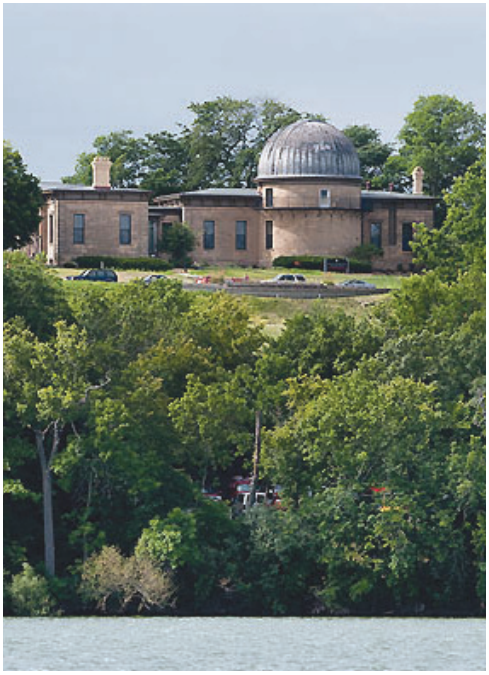

Pictured from Lake Mendota, the recently renovated Washburn Observatory sits atop Observatory Hill.
Photo: Jeff Miller, University Communications

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Sterling Hall
475 North Charter Street
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Two junior astronomers scope out images at Laura Trouille's *From Earth to the Universe* exhibit at Monona Terrace, hosted by the UW Space Place, as part of U.S. Bank Eve on December 31, 2010. More than 500 people walked through the exhibit. Trouille is a department alumna who now teaches at Northwestern University.