The Washburn Observer

DEPARTMENT OF
Astronomy
UNIVERSITY OF WISCONSIN–MADISON

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Inside This Issue

How many times have you seen the Milky Way?

I don't mean in pictures, or in movies. I mean, how many times have you walked outside, looked up, and soaked in the diffuse, iridescent glow from billions of stars above you in full clarity?

For Nathan Eggen, an undergraduate majoring in astronomy at UW–Madison, he can count the number of times he has seen the Milky Way on one hand. And as the fingers tick up with each memory, Eggen begins to notice a connection. Nearly all of his encounters with the Milky Way occurred during his time diligently working at the WIYN 3.5-meter Telescope at Kitt Peak National Observatory (KPNO)—a secluded set of mountain ridges scattered with telescopes some 60 miles outside of Tucson, Arizona.

For many undergrads like Eggen, the chance to go astronomical observing ranks as a highlight of their undergraduate careers. Generally speaking, undergraduate researchers are involved in the less appealing aspects of academic research—such as literature searches and data mining. So, when presented with the opportunity to collect data first-hand at a multi-million dollar research observatory, few undergrads turn it down—myself included.

As a sophomore at The Ohio State University studying astronomy and physics, I was fortunate enough to have the opportunity to travel to KPNO and observe at the MDM 1.3-meter telescope. Having never owned even a small

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The Milky Way above the WIYN 3.5m and 0.9m telescopes at Kitt Peak National Observatory in Arizona. (Photo credit: Dr. Ralf Kotulla, Research Scientist at UW–Madison)

The Washburn Observer is the newsletter of the Department of Astronomy at the University of Wisconsin–Madison.

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Letter from the Chair

By this fall, I will have completed the standard 3-year stint as Chair of the Department of Astronomy. As such, this will be my last Letter from the Chair. Though I will continue to work hard for the department, I have full confidence in Professor Sebastian Heinz, the Chair Elect, to carry us forward.

In this issue, you'll find an essay written by Jake Parks—an astronomy major turned journalist—reflecting on his time spent gazing up at the Milky Way in the deep, dark skies above a modern observatory. This remarkable experience also comes to UW undergraduates who visit the WIYN telescopes on Kitt Peak as members of our department's observational research teams.

However, the vantage point of the professional astronomer is far from the only way to view the Milky Way. And I would like to think that everyone who studies astronomy here regards the Milky Way with changed perceptions. Some revel in realizing that the patches of night sky apparently devoid of light are actually glowing in infrared, x-ray, and gamma ray light, and that a supermassive black hole lurks within. Others enjoy reflecting on the tangled web of scientific discoveries and technological leaps that led us to our current picture of the Milky Way galaxy, and our place within it. I often marvel at my students' questions and the unique perspectives behind them. Students of natural and social sciences, arts, and humanities all have their own diverse viewpoints, which inevitably make me think anew about mine.

Modern astronomy, studied in depth, weaves together more strands of knowledge than you might think. Yes, astronomy majors study physics and math. But astronomy majors also learn to evaluate evidence, critique arguments, and separate chance coincidence from underlying cause. They learn powerful tools for visualizing information, extracting images from strings of numbers, and displaying information so that it comes to life. Astronomers learn to work with others, and to communicate intelligibly and passionately. And, to top it off, astronomers have the best canvas imaginable on which to hone their skills—the Universe itself.

Further proof of the versatility of an astronomy education is easily seen in the myriad of professions taken up by our graduates. Beyond the many career astronomers—some among the best in the world—we find Badger astronomers in fields such as business, law, medicine, computer science, education, and journalism. But whether our Badgers stay or leave, we hope that everyone who studies astronomy here makes our department their home.

Ellen Zweibel
Department Chair

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Charee Peters Gives Back

Charee Peters, an astronomy graduate student at UW–Madison, is no stranger to hard work. When she is not working with Professor Eric Wilcots on cataloging radio observations of violent and energetic astronomical events using the CHILES survey, she may be found outdoors sailing, rock climbing, or even playing roller derby under the alias SiouxperNova.

"I'm Native American, and that is something that I hold very dear," Peters said.

As a member of the Yankton Sioux Tribe, Peters is also heavily involved in supporting her fellow Native American and minority students as they pursue degrees in higher education.

After being recognized as the first in her tribe to earn a degree in physics, Peters inadvertently and cheerfully accepted the responsibility of acting as a role model for other Native Americans.

"Sometimes, the worst things that we see can be overcome if we have some solidarity," Peters said.

Partly in recognition of her work enhancing the visibility and support of minorities in the sciences, Peters was recently inducted into the prestigious Edward Alexander Bouchet Graduate Honor Society. Additionally, Peters is currently serving as one of only six graduate students on the American Astronomical Society's Committee on the Status of Minorities in Astronomy (CSMA).

As previously mentioned, Peters' academic work largely revolves around studying some of the most extreme events in the Universe. In addition to supernovae, Peters studies tidal disruption events—which occur when a black hole eviscerates a nearby star—and active galactic nuclei (AGN)—which are supermassive black holes in the central regions of some galaxies that produce enough light to outshine billions of stars.

By cataloging these short-lived events, Peters is able to investigate how various cosmic phenomena change in luminosity—or brightness—over time. With this information, Peters hopes researchers will ultimately be able to develop new ways to quickly classify and distinguish between various astronomical events.

Though Peters is currently sorting through the countless career paths available to professional astronomers (see page 7), when you consider her drive, compassion, and enthusiasm, there is no doubt she will go on to do great things.

Milky Way *continued from page 1*

telescope before, I was understandably nervous at the prospect of controlling a telescope so large it was owned by a consortium of five universities.

However, by midway through my first night—after receiving a crash course in observing from my advisor—I was controlling the massive telescope, analyzing spectral resolutions, and collecting data for astronomical research. Two days later, my advisor flew back to Ohio, while I remained at MDM for the rest of the week—just me, a mouse, and the stars.

Although the practical skills I gained while working at MDM observatory were absolutely relevant to my astronomical education, one of the most memorable aspects of my experience was simply the down time I had while the telescope was gathering long exposures—which would often take upwards of ten minutes. During this time, barring any issues, I was able to wander outside of the computer-packed control room and gaze up at the clear and endlessly deep sky.

However, it was not just the wondrous glow of the Milky Way that made my undergraduate observing trip such a powerful experience. Instead, one of the things that stuck with me the most was the connection I made with the subject of my study—the Universe. When I was outside of MDM observatory beneath the Milky Way, I didn't reflect on specific research questions. I reverted back to my childhood, and I reflected on the simple questions that made astronomy so appealing in the first place. What is that star? How big is that galaxy? What does a black hole actually look like?

While standing upon my secluded mountain ridge—disconnected both temporally and physically from human-induced noise, light, and sound—I could step back from my research and consider what I truly wanted to gain from my astronomical education. It was during these tranquil times when I realized that I did not want to spend the rest of my life continually honing in on a few specific astronomical questions. But rather, I wanted to broaden the scope of the questions I was asking, and then share what I learned with others.

And at the risk of sounding cliché, I earnestly believe that had it not been for my undergraduate observing experience at Kitt Peak, I may never have found my true passion for science journalism.

Departmental Awards and Honors

Astronomy graduate students **Alisha Kundert**, **Emily Leiner**, **Greg Mosby,** and **Claire Murray** were awarded L. Pat Bautz Travel Fellowships to cover the cost of attending international conferences and collaborations that are central to their research.

Department Chair Ellen Zweibel was awarded a Vilas Distinguished Achievement Professorship, which is given to "recognize professors whose distinguished scholarship has advanced the confines of knowledge, and whose excellence has also included teaching or service."

Professor Sebastian Heinz was awarded the American Astronomical Society High Energy Astrophysics Division Mid-Career Prize for his groundbreaking work unveiling the nature of Circinus X-1.

Kurt Jaehnig was recognized as a Distinguished Instrumentation Innovator for his work on a wide range of instruments essential to the success of the UW Department of Astronomy. Jaehnig has worked on many projects over the years—from ground-based instruments used at KPNO (Arizona) and WHAM (Chile), to rocket-based instruments like those used in The Star Tracker 5000.

John Chisholm was selected as the Rodger Doxsey Travel Prize Winner at a recent American Astronomical Society (AAS) conference for his research using ISM metal absorption lines to study the ionization structure of gas flowing from galaxies. The Rodger Doxsey Travel Prize is designed to give outstanding graduates the opportunity to travel to an AAS conference and present their thesis dissertation.

Anna Williams was one of two UW graduate students selected to attend the Catalyzing Advocacy in Science & Engineering (CASE) Workshop in Washington, D.C. this April. The CASE workshop is run by a coalition of scientific societies, universities, and organizations with the goal of teaching promising science, math, and engineering students about science policy and advocacy.

Physics graduate student **Chad Bustard** was awarded an NSF Graduate Fellowship for his research work with astronomy professors Elena D'Onghia and Ellen Zweibel. Additionally, astronomy graduate students **Julie Davis** and **Ben Rosenwasser**—who are working with professors Eric Wilcots and Amy Barger, respectively—received Honorable Mention.

Leah Fulmer, an astronomy undergraduate working with Professor Jay Gallagher, was presented with The Fay Ajzenberg-Selove Award—which is given to support the research of undergraduate women majoring in astronomy or physics.

Cory Cotter—an astronomy undergraduate working with Elena D'Onghia and Ellen Zweibel—and **Leah Fulmer**—an astronomy undergraduate working with Jay Gallagher—both won Hilldale Research Fellowships, which provide undergraduates with both a student stipend and funding for their research expenses.

The Department of Astronomy is delighted to announce the **J.D. Fluno Family Distinguished Graduate Fellowship Fund**, which was established to cover the cost of tuition, fees, health insurance, and flexible funding for a new astronomy graduate student each year. The Fellowship—which is made possible through the generous support of Jere & Anne Fluno, and matched by Ab & Nancy Nicholas—will annually provide an early graduate student with the funding required to immediately dive into independent research.

Alumni News

Zack Briesemeister, an astronomy and physics undergraduate, was presented with the Lowell Doherty Award for Excellence in Astronomy—which recognizes a graduating senior's exceptional performance in astronomical research and in the classroom. Briesemeister will pursue a Ph.D. in Astronomy at UC-Santa Cruz starting this fall.

Einstein Postdoctoral Fellow **Blakesley Burkhart** (Ph.D. in Astronomy, 2014) was one of three finalists for the 2016 American Physical Society (APS) Outstanding Doctoral Thesis Award for her thesis, New Frontiers for Diagnosing the Turbulent Nature of the Multiphase Magnetized Interstellar Medium.

McDonald Postdoctoral Fellow **Natalie Gosnell** (Ph.D. in Astronomy, 2014) accepted a faculty position at Colorado College—her alma mater. While at UW, Gosnell worked with Professor Bob Mathieu studying the evolutionary histories of binary stars whose observations do not match theoretical predictions.

Departing Post-Docs

Aleks Diamond-Stanic has completed his Grainger Postdoctoral Fellowship with the Department of Astronomy. During his time at UW, Diamond-Stanic focused on studying how galaxies co-evolve with their central black holes, as well as the role feedback plays in regulating star formation. Diamond-Stanic has also been recognized for his support of students both inside and outside of the classroom—including his work mentoring astrophysics major and spoken word poet, Miona Short. Partly because of his commitment to working with undergraduate students, Diamond-Stanic concluded his successful job hunt by accepting a tenure track faculty position at Bates College—a small liberal arts college in Lewiston, Maine.

Welcome Graduate Students

Logan Jones: B.S. in Physics, University of Arkansas. Jones is interested in extremely distant, high redshift galaxies. Since the light from these distant galaxies was emitted billions of years ago, their study is vital to our understanding of early star and galaxy formation.

Erika Carlson: B.S. in Physics and Astronomy, Pomona College. Carlson is interested in stellar evolution and resolved stellar populations—which contain a wealth of information related to star and galaxy formation.

Kendall Hall: B.S. in Physics, California State University-Fresno. Hall is interested in the interstellar medium (ISM)—which is the gas, dust, and other matter that is present in the space between stars within a galaxy.

Camilo Machuca: B.S. in Astronomy, Georgia State University. Machuca is interested in galaxies and active galactic nuclei (AGN)—which are the extremely active and bright cores of some massive galaxies.

Welcome Visiting Faculty

Ken Sembach, Director of The Space Telescope Science Institute (STScI), will be the astronomy department's Whitford Lecturer the first week of November this year. Sembach earned his Ph.D. from the UW–Madison Department of Astronomy in 1992 under the supervision of Blair Savage. **Bryan Gaensler**, Director of the Dunlap Institute for Astronomy and Astrophysics, already visited the department this April as the Spring Whitford Lecturer, where he gave a talk entitled Radio Polarimetry and Cosmic Magnetism.

Professor Mateusz Ruszkowski of the University of Michigan and **Enrico Ramirez-Ruiz** of the University of California-Santa Cruz were selected as the astronomy department's Jeff and Julie Diermeier Distinguished Visitors this spring. Thanks to the generous support of Jeff and Julie Diermeier, the UW Department of Astronomy is able to cover the travel costs for departmental visits from astronomical experts around the globe.

Congratulations, Undergraduates!

FALL: **Tianyao Wu**

SPRING: **Zack Briesemeister, David Carr, Thomas Feigenson, Sean Greene, Cory Hawley, Jenni Heup, Kylee Martens, David Nestingen-Palm, David Pearson, Avinash Rajendra, Jennifer Witt**

Vilas Distinguished Achievement **Professor Bob Mathieu** was selected as one of only eleven Fellows for 2016 by the Wisconsin Academy of Sciences, Arts & Letters. The prestigious Fellows program—which elects Fellows from a statewide pool of nominees once every two years—was established to recognize Wisconsinites who demonstrate "extraordinary levels of accomplishment in their fields, as well as lifelong commitments to intellectual discourse and public service."

During his nearly 30 years at UW, Mathieu and his students have made numerous valuable contributions to astronomy. He and his students have measured the masses of brown dwarf stars, discovered the youngest binary stars, described how matter flows from protostellar disks onto these stars, explored the interactions between binary stars that power star cluster evolution, and defined new evolutionary pathways for how these stars exchange mass or collide during their interactions.

Mathieu is also the leader of the Center for the Integration of Research, Teaching and Learning (CIRTL), and the director of the Wisconsin Center for Education Research.

During Mathieu's graduate and post-doctoral education, he realized that he had learned very little about teaching—especially using research-based practices that increase the learning of all students. From this realization grew the seed that eventually became the Center for the Integration of Research, Teaching and Learning. Only ten short years later, CIRTL now represents nearly a third of the Ph.D. production in the country, with the CIRTL Network extending to 46 major research universities in the U.S. and Canada.

Research Highlights

How do Galaxies Chemically Evolve?

Professor Christy Tremonti was awarded a prestigious NSF CAREER Grant worth nearly $1M, which will fund her research over the next five years.

The CAREER Grant was established to support junior faculty of the highest caliber who demonstrate an ability to integrate outstanding research with excellent education. Using the award, Tremonti will gather spectroscopic data of several thousand galaxies from the MaNGA survey to measure galactic chemical abundances—particularly focusing on the oxygen-to-hydrogen ratios.

Unlike hydrogen, elements like oxygen and nitrogen are only produced within the cores of stars, where the elements usually remain. However, when some of these stars explode as supernovae, the elements trapped within their cores are spewed outward into the surrounding space. By carefully tracing the amount of oxygen present in various galaxies, Tremonti will be able to investigate how galaxies chemically evolve over time.

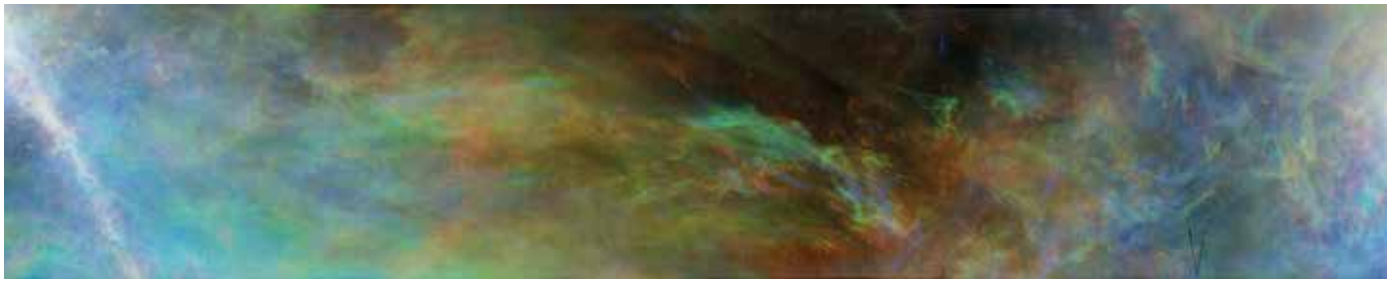
Tremonti's grant proposal also includes an educational component, which will involve building an interactive exhibit for UW's public outreach center—Space Place. Once complete, the exhibit will show visitors how survey spectra from MaNGA can be used to shed light on galaxies and galactic evolution.

Investigating the Halo of the Milky Way

Grainger Postdoctoral Fellow Aleks Diamond-Stanic recently co-authored a paper analyzing the gas flows present in the halo of the Milky Way, where many of the oldest stars in our galaxy reside.

In the high-resolution spectroscopic study—which is the first of its kind aimed at an extended background source—Diamond-Stanic and his fellow co-authors found evidence of a broad and diffuse gaseous disk of neutral hydrogen that is warped with respect to the plane of the Milky Way. The roughly 180,000 light-year wide disk—which is nearly twice as wide as the Milky Way—is important for future study as it may help explain how gas from the intergalactic medium accumulates over time.

The Grainger Postdoctoral Fellowship—which funded Diamond-Stanic's research—is supported by a generous gift to the department from The Grainger Foundation.



GALFA-HI Survey Pumps Out Data

The GALFA-HI (Galactic Arecibo L-band Feed Array HI) Survey was established for one primary purpose—mapping neutral hydrogen in and around the Milky Way Galaxy.

Using the 305-meter Arecibo telescope, the GALFA-HI survey will eventually gather data for approximately 13,000 square degrees—nearly one-third of the full sky. Additionally, the map will have a resolution of 4 arcminutes, whereas a full moon spans about 30 arcminutes.

Although the GALFA-HI Survey is a project which relies on international collaborations, researchers at UW–Madison have played a crucial role in compiling, processing, and analyzing the over 10,000 hours of data produced by the survey. In particular, Brian Babler—a research scientist with the astronomy department—has been key in handling the tremendous amounts of data produced by the GALFA-HI Survey.

By working tirelessly over the past two years to process the tsunami of information using sophisticated data pipelines, Babler has enabled countless other researchers to perform studies that would have otherwise been impossible. For example, thanks to Babler's contributions, researchers were able to take the first whole image of the entire Arecibo sky, a section of which is pictured above.

Non-Academic Careers

To the outsider, astrophysics can often be a very intimidating discipline. When a non-astronomer stumbles into a conversation between astronomers—which is admittedly rare—they are often lost in an endless abyss of esoteric and academic jargon. Perhaps this is why relatively few undergraduates gravitate toward astronomy.

For many of us, we can still picture our early years as undergraduates, when the opportunities and paths seemed endless. During this time, we were faced with some of the most important decisions of our lives, not least of which being our field of study.

As someone with a bachelor's degree in astronomy and physics, I know at least one major concern for many astronomy undergraduates is: what if I don't want to join the academic world after graduation—are there still options? Well, as you can probably guess by the fact that I'm writing this, there are absolutely non-academic career options available to those with astronomy degrees.

Take Attorney Scott McBride for example. During his undergraduate education in astronomy and physics at UW–Madison, McBride learned the valuable skill of digesting complex and dense scientific material. Within a few years, McBride went on to earn his law degree and started using his scientific background to specialize in the litigation and trial of complex technological and patent cases—sometimes worth hundreds of millions of dollars. McBride now serves on the Department of Astronomy's Board of Visitors, where he brings an outside perspective that helps shape our vision for a vibrant, strong department that will continue to serve a diverse set of students for decades to come.

Or there is Bob Lindner—who completed both his undergraduate and postdoctoral work with the UW–Madison Department of Astronomy. Lindner is now working as a data scientist at Earthling Interactive, where he is utilizing his astronomically-acquired skills to solve large-scale data problems related to forecasting and prediction. Considering that so many problems in today's world are finally approachable thanks to big data, it is no surprise that astronomers like Lindner—who are all too familiar with large datasets—are ready and willing to tackle them.

Considering so many problems in today's world are finally approachable thanks to big data, it is no surprise that astronomers like Lindner—who are all too familiar with large datasets—are ready and willing to tackle them.

Finally, consider Andrew Afflerbach, CEO & Director of Engineering at CTC Technology & Energy, and another member of the Department of Astronomy's Board of Visitors. Afflerbach—who earned his PhD from the UW astronomy department under the supervision of Professor Ed Churchwell—oversees all engineering work performed by CTC and specializes in emerging fiber optics, wireless technologies, and state of the art networking applications.

As Afflerbach sees it, scientific literacy and the ability to solve large-scale problems are not the only benefits of an astronomy education. Instead, the importance of an astronomy education partly resides in the fact that—despite the vastness of our Universe—astronomers are often faced with a paradoxical lack of information.

"Because astronomy is the ultimate big picture," Afflerbach said, "you have to—in many cases—make a lot of assumptions and analyses based on just a handful of photons. It's making generalizations from very small sample sizes and understanding the limitations of your sample and your analysis."

When you study the physics of our Universe, you do not only learn the daunting math and the obscure knowledge that many associate with astronomy. But rather, you learn how to absorb and communicate complex material; how to deal with both a deluge and a drought of information; and how to think critically, while working tirelessly towards a solution. And these skills—no matter what field you eventually fall into—will always be universally valued.

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Attn: Jake Parks

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Children take turns peering through a telescope on December 4, 2015, during the annual Family Science Night at UW Space Place. (Photo credit: James Lattis, Director of UW Space Place)

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BADGER ASTRONOMY

The Department of Astronomy is excited to announce that Washburn Observatory has reopened after being closed nearly two-years for dome repairs. The observatory, which was built in 1881, runs free public observing events hosted by graduate students on the first and third Wednesday of each month, and every Wednesday from June through August, weather permitting. With Washburn Observatory now open, the astronomy department is looking forward to hosting more public outreach events, as well as focusing on the much-needed renovations to the roof of Sterling Hall. (Photo credit: Bryce Richter)