The Washburn Observer

DEPARTMENT OF ASTRONOMY
UNIVERSITY OF WISCONSIN-MADISON

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The Great American Eclipse

"Breathe!" I had to remind myself. I was standing atop a hill in Sun Valley, Idaho, surrounded by family, friends, colleagues, and complete strangers, taking in the experience of my first total solar eclipse, transfixed by the ghostly glow of the solar corona. I had seen images of eclipses thousands of time, but this was the real thing. I was shivering from the cold, yet feeling ineffably exhilarated by a combination peace and alertness, somehow, in this instant, feeling connected to all of humanity through the natural spectacle that has stunned humankind for as long as we have been on this planet.

All around me, people were gasping at the short-lived beauty that had just revealed itself as the shadow of the moon raced across us, skies dark enough to see stars, revealing the wispy, translucent streamers of the corona, crowning the black void created by the Moon's shadow.

We had traveled over 1600 miles for these two minutes, and given the chance, I would do it again in a heartbeat. Like millions of other US citizens, UW-Madison Astronomers fanned out across the country to witness the eclipse, all in pursuit of clear skies. The stories they collected could fill a book. **Jim Lattis** led an excursion of 22 badgers to Nebraska, successfully chasing a cloudless patch of cornhusker country. **Bob Mathieu** and an expeditionary corps of the Astronomy Board of Visitors found clear skies at Lake Murphysboro State Park, IL. Groups of badger graduate and undergraduate astronomers made their way to Illinois, Wyoming, and Missouri, all successfully making it into the path of totality with clear skies above. Many others went to locations in Idaho, where long-term forecasts predicted the best chance of clear skies.

A solar eclipse occurs when the moon moves between Earth and Sun, casting a shadow on the Earth's surface. There are two parts of the shadow: The large, outer *penumbra*, where only part of the Sun is blocked. While you're inside this outer ring of shadow, you experience a partial eclipse, with the Moon taking a bite out of the Sun. The small core *"umbra"* of the Moon's shadow is a circle only about 50 to 100 miles in

Continued on Page 2

Left to right, top to bottom: UW Space Place team in Fairmont, NE; Radio Badgers in Stanley, ID; UW grad students in Fulton, MO; Astronomy Board of Visitors Expeditionary Corps in Lake Murphysboro State Park, IL.

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

"What is the best thing about being chair?", I am often asked. Hands down, it is the opportunity to work with our alumni and our Board of Visitors on keeping the department engaged and healthy

A year into the job, I have renewed appreciation for the amazing things our alumni do. **Ken Sembach** is featured in this issue on the facing page. His leadership at one of the premier astronomical centers of the world is impressive enough, but even more so during the lead-up to the launch of the James Webb Space Telescope. A Badger is just the right person for the job.

Andrew Afflerbach, CEO of **CTC Technology and Energy**, a company that his wife and he lead, is turning his science chops and his passion for technology and optimization into an entrepreneurial career in telecommunications.

Claudia Cyganowski, on the Astronomy faculty at the University of St. Andrews in Scotland, leads a group of scientists in a quest to understand the formation of stars and planets.

Bob Lindner, building on his postdoctoral work at UW to develop machine learning and big-data analysis tools, is taking on the question of how to improve outcomes in health care and co-founded VEDA Data, right here in Madison.

In short, Astro Badgers are knocking it out of the park within academia, in public service, and in private industry. Together with the fact that the 2010 Census found 100% employment among astronomy degree holders, becoming a Badger Astronomer doesn't just put you in great company, it is a great investment in your future as well.

With so many great alumni bringing the Wisconsin Idea to the rest of the world, it is sometimes hard to stay in touch. I have made it a priority to do better. We are kicking off the new year with an Astro Badger get-together at the Winter AAS meeting in Washington, DC. If you are an Astro Badger, you are invited! Please RSVP to chair@astro.wisc.edu if you would like to attend!

We are also introducing a monthly e-mail newsletter with event announcements, invitations, and other news. If you have signed up to receive our newsletter electronically, you are on the list. You can subscribe by sending an E-mail to newsletter@astro.wisc.edu

If you have some ideas about how we can better engage with you and other friends of the department, drop me a line. I would love to hear from you.

Another way to stay in touch and show your support is to make a financial gift to the department. I am thrilled to announce a great opportunity to make your contributions go **twice as far**: The Astronomy Board of Visitors and the astronomy faculty have created a challenge grant, matching, **dollar for dollar,** all incoming donations to support the "High Fiber Diet", up to $25,000. We are so excited to help you make an even bigger impact. Any amount helps, so please consider a gift. Read more on **pages 3 and 5**.

And as always, if you are in town, please let us know and stop by for a visit.

Sebastian Heinz, Department Chair

Eclipse *Continued from page 1*

diameter. This core shadow moves across the globe at about 1200 miles per hour as the moon moves on its orbit, tracing out the *path of totality*. Within that path, you can experience a *true total eclipse*: The sky turns black, stars and planets appear, a band of twilight spans the horizon, the sun's corona, a wispy 10-million degree plasma halo surrounding the sun, becomes visible to the naked eye.

Path of the 2024 total solar eclipse (adapted from NASA)

Solar eclipses occur about twice a year *somewhere* on Earth. But most are only *partial* eclipses, never providing that thrill of totality. And even most total eclipses fall on oceans and uninhabited land. And because the path of totality is so thin, it takes planning or extreme luck find yourself inside. What made the 2017 eclipse so *"great"* was that it spanned across the entire continental US, placing it within a few hours' drive for hundreds of millions of people. The first such eclipse in the age of the internet, it became such a sensation that it lead to somewhat over-hyped predictions of apocalyptic traffic jams.

We hope you too had the chance to experience totality. But even if you couldn't make it or if it was cloudy where you were on August 21st, there is good news: *Another* great eclipse is coming to America in 2024. The path of totality will span from Texas to Maine, and this one will last an amazing 4.5 minutes, because the Moon will be closer to Earth then. Start planning your trip now. Trust me: it's going to be breathtaking.

Amount	What could it support?
$20	Sponsor field trip to Yerkes Observatory for an undergrad
$50	Print a conference poster for an undergrad student
$100	Lunch for visiting class of high school students
$500	Provide travel costs for one colloquium speaker
$800	Print one issue of the Washburn Observer
$1,000	Sponsor an undergrad to attend a scientific conference
~~$3,000~~ FUNDED	Purchase a new LED bulb for our planetarium
~~$5,000~~ FUNDED	Sponsor long-term visitor to department
$10,000	Equip new WIYN remote observing room
$50,000	High-Fiber Diet: An Integral Field Spectrograph for SALT
$80,000	Provide department share of start-up cost for new faculty
~~$1,000,000~~ FUNDED	Endow a named graduate student fellowship
$2,000,000	Endow a named postdoctoral fellowship

Ken Sembach at the Helm of Space Telescope Science Institute

The vibe at Space Telescope Science Institute (STScI) is an intriguing juxtaposition of museum-quality NASA relics and no-nonsense government decor. The enthusiasm the employees bring to work every day is mixed with a sense of ugency you would expect in an airplane cockpit.

At STScI, the stakes are always sky high (pardon the pun). But with the upcoming launch of Hubble's successor—the 9-Billion dollar James Webb Space Telescope (JWST), scheduled for launch in October of 2018—the stakes have reached stratospheric levels.


Ken Sembach, Director of Space Telescope Science Institute

Piloting STScI during this intense time is former UW Badger and Director of the Space Telescope Science Institute, Ken Sembach. "Obviously, [the upcoming launch is] causing some anxiety and some stress," Sembach said, "yet people are happy things are moving forward [...] That's one of the things that make the work really interesting," Sembach said. "It's that the people do have this real passion for the work, and they recognize they're part of something that they couldn't do themselves. They're a team of teams."

Sembach earned his Ph.D. in Astronomy from UW-Madison in 1992. At the time, the astronomy department at UW was relatively small with only a few dozen people; however, Sembach also recalls that they were incredibly collaborative. "I wouldn't trade it for anything, my experience there," Sembach said.

Sembach joined STScI in 2001 as a staff scientist. Compared to UW, STScI "was a different environment." Sembach said. "Suddenly, instead of being in a group of a few dozen, it was hundreds of people." He joined to build the ground system for one of the new instruments installed during the last service mission, the Cosmic Origins Spectrograph (COS)—with just one other person. "The instrument design had been put in place and it was being built," Sembach said, "but we were figuring out how to actually operate it."

In 2004, the scheduled servicing mission was canceled due to the Columbia disaster and STScI was suddenly faced with the possibility that one of the remaining three reaction wheels that keep the telescope stable could fail without the ability to replace it. Sembach was tasked with leading a team to solve the problem of how to operate a hobbled Hubble with just two reaction wheels, not dissimilar to riding blindfolded on a unicycle. And they did: "After a few years, we figured out how to do it. We prepared for it. And actually even put the observatory into that mode preemptively to preserve lifetime before that [servicing] mission was reinstated."

In 2007, Sembach became the project scientist for Hubble, leading up to the 2009 HST servicing mission. From 2009-2015, Sembach was promoted to head of the Hubble mission office.

"I was part of something very, very special, that many people don't get to experience—working in a team like that. And the satisfaction of knowing that you're really doing something great for the benefit of others. Not just something that you might think is good or interesting, but that thousands of scientists think is interesting. Millions of people and students and kids who might be inspired by the kinds of images Hubble's producing."

Continued on Page 6

Support Badger Astronomers

Your support creates exciting opportunities for students, staff, and faculty. The stories you've read about here happened because of gifts from readers like you. You can contribute online at **www.supportuw.org/giveto/astronomychallenge**, at **www.astro.wisc.edu/giving**, or by mail to: UW Foundation, US Bank, Lockbox 78807, Milwaukee, WI 53278-0807.

❍ **I would like my gift to support the"High-Fiber Diet" matching opportunity (112120005). Funds raised in excess of our goal may be used to support other future department instrumentation projects.**

Name/s_____Address_____

City_____State_____ZIP_____

Telephone_____E-mail_____

My/our contribution of $_____is enclosed. ❍ My company_____will match this gift.

❍ My matching gift form is enclosed. ❍ I have initiated the matching gift process on the company's website.

Please make checks payable to: University of Wisconsin Foundation-Astronomy

Please charge my gift of $_____to my ❍ Master Card ❍ Visa ❍ American Express ❍ Discover

Acct#_____Exp. Date _____ I would like this to be a ❍ one-time ❍ annual gift.

Name on card (please print)_____Signature_____Date_____

Questions about how your gifts may be used? Contact: Sebastian Heinz, chair@astro.wisc.edu, 608-890-1459, or UW-Foundation Director of Development, Troy Oleck, troy.oleck@supportuw.org, 608-308-5526. **Thank you for supporting Badger Astronomers!**

Department News

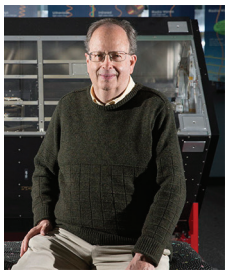
Recent Graduate

Claire Murray earned a Ph.D. for her work with **Professor Snežana Stanimirović** on the nature of interstellar clouds through the study of Hydrogen in emission and absorption. She is joining Space Telescope Science Institute (STScI) as a postdoctoral researcher. You can read more about what's happening at STScI on page 3.

Elena D'Onghia Awarded Tenure

Professor Elena D'Onghia was awarded tenure and promoted to Associate Professor. She joined the department in 2012, bringing expertise in numerical simulations and the study of galaxy structure and evolution. Her promotion rewards innovation in both her field and in the classroom, bringing undergraduates in hands-on contact with real science.

Jay Gallagher Retires



W.W. Morgan Professor of Astronomy Jay Gallagher retired this year after 26 years in the department. Anybody who knows Jay understands that he is irreplaceable. As former editor in chief of the Astronomical Journal, he is a walking encyclopedia of astronomical knowledge.

Jay is a Badger through and through. After he left Wisconsin for a while upon receiving his Ph.D. in Astronomy from UW-Madison in 1972, he returned in 1991 to join the faculty and has left an indelible mark on the department.

His scientific achievements are simply too numerous to list, with over 1000 papers to his name. Yet, Jay's legacy goes well beyond his scholarly record. A great example of Jay's impact is his dedication to mentorship at all levels. He has overseen 26 Ph.D. theses. He is a champion of equality and diversity in astronomy and, in recognition received the 2016 Slesinger award. We are as thankful for his kind, compassionate service as we are in awe of his scientific oeuvre.

As emeritus professor of astronomy, we hope to see him in the department frequently for years to come. Enjoy your retirement to the utmost, Jay!

Snežana Stanimirović Elected Fellow of the AAAS

Professor Snežana Stanimirović was elected a fellow of the American Association for the Advancement of Science (AAAS). Founded in 1848, AAAS includes nearly 250 affiliated societies and academies of science, serving nearly 10 million constituents.

Election as a AAAS Fellow, a tradition begun in 1874, is recognition by peers for distinguished contributions to advance science or its applications. Snež was elected "*for pioneering radio studies of interstellar gas in the Milky Way and the Magellanic Cloud and improving understanding of transitions between phases and the role of interstellar turbulence.*" Congratulations, Snež!

Please Stay in Touch

We'd like to hear from you.

Please send any news that we can include in future newsletters or any changes in your contact information to newsletter@astro.wisc.edu or UW-Madison, Astronomy Department, 475 N. Charter St., Madison, WI 53706, attention: Newsletter

Please tell us if you prefer to receive an electronic copy of the newsletter.

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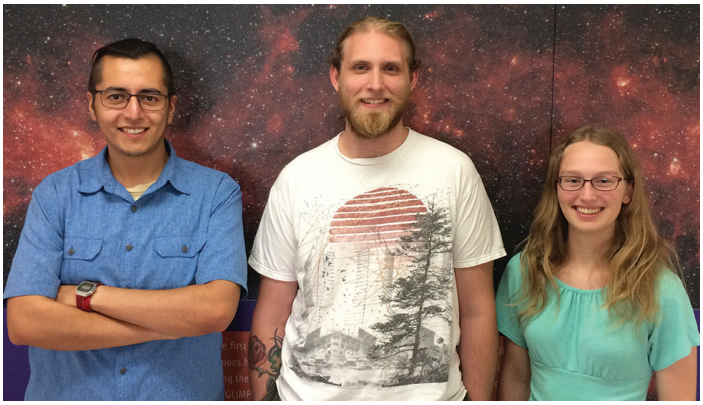
Arrivals: New Postdocs

Adam Schaefer is joining us from Sydney University in Australia, where he received his Ph.D. for his work with Prof. Croom, analyzing the spectra of hundreds of galaxies from the SAMI survey. Here at UW Madison, he will join **Professor Christy Tremonti's** galaxy evolution group. He will bring his expertise in working with multi-object integral field spectra of galaxies and in modeling galactic evolution to bear on more SAMI data, on the massive sample of 10,000 galaxies observed by the SLOAN IV MaNGA survey and, we hope, on observations with the "High Fiber Diet" IFU for SALT (see page 5, across).

Siyao Xu is a new **Hubble Fellow**. She works on understanding magneto hydrodynamic (MHD) turbulence and its effects on questions like supernova explosions, star formation, cosmic ray propagation, and interstellar scattering.

In Madison, she will apply her experience in the theory of MHD turbulence in partially ionized gases to the star formation problem, with the purpose of understanding both the density and magnetic field structure on different length scales in molecular clouds. "The advanced understanding on MHD turbulence can bring us new insights into many long-standing astrophysical problems," says Siyao.

Department News



Arrivals: Welcome, Graduate Students!

Aaron Lopez, B.S. in Applied Physics, **University of California - Santa Cruz**. Aaron is working with **Professor Rich Townsend** studying oscillation modes of stellar interiors. The goal of their work is to map instability strips -- regions of a stellar parameter space where oscillations may arise spontaneously.

Joshua Oppor, B.S. in Physics and Astronomy, **University of Washington.** Joshua will be working with **Professor Matt Bershady** and **Marsha Wolf** to develop next-generation integral field units (IFUs) for the 11-meter SALT telescope in South Africa (see "High Fiber Diet", below), as well as a 5000-fiber system feeding two clusters of optical spectrographs, forming the core of the next-generation SDSS program called the Local Volume Mapper.

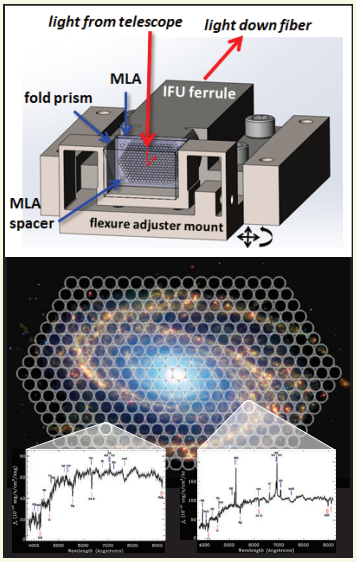
Catherine Witherspoon, B.S. in Physics, **James Madison University.** Catherine is joining **Professor Eric Wilcots** and the CHILES (Cosmos HI Large Extragalactic Survey) conducting a 1000 hour-long survey using the Very Large Array to study the evolution of neutral hydrogen in galaxies over the past 4.6 billion years of cosmic evolution. She will research how the gas content of galaxies has evolved as a function of the stellar mass.

Departmental Awards and Honors

2017 was another year to be proud of as a Badger astronomers. We had many awards and recognitions, including the following:

- **Jay Gallagher** was honored by the UW Mentoring Program for his contributions to equity in science by receiving a **Dorris Slesinger Award** for Excellence in Mentoring.
- **Professor Amy Barger** is one of 11 **Kellet Fellows** recognized by the University for their outstanding scholarship and contributions to the university.
- **Erin Boettcher** and **Dhanesh Krishnarao** were awarded **Bautz Travel Fellowships** to attend international conferences in Bonn, Germany and Paris, France, respectively.
- Professor **Rich Townsend** was part of a team that won the **Third Annual Mashable + Games for Change People's Choice Award** for their online educational video game "At Play in the Cosmos." Read more on page 7.
- Astronomy graduate student **Dhanesh Krishnarao** was awarded the **2017 Fluno Fellowship** in recognition of his work in characterizing the structure of the Milky Way. The Fluno Fellowship is given to outstanding graduate students to afford them independence in pursuing their scientific goals.
- **Snežana Stanimirović** was awarded a **UW Vilas Fellowship** to study the nature of molecular and atomic interstellar gas.
- **Julie Davis** received an **NSF Graduate Fellowship** to study the radio sky using the massive data set collected by the CHILES project. These competitive fellowships fully support a graduate student for three years.
- The **WHAM** Team celebrated the 20-year anniversary of the unique WHAM telescope with the public release of the **first ever** spectroscopic map of ionized hydrogen of the entire sky.
- Astronomy major **Cory Cotter** received a **Goldwater Fellowship** for his work with Ellen Zweibel on galactic winds.
- **Ben Hoscheit** & **Leah Fulmer** received the 2017 **Doherty Award** from the UW-Madison Astronomy Department.
- **Chad Bustard** won the 2017 **Jansky Award** for Astronomy and Physics graduate students for his work with **Professor Ellen Zweibel** on Cosmic Ray driven winds.
- Badger alumna **Blakesley Burhart** received the 2017 **Trumpler Prize** for best Ph.D. thesis from the Astronomical Society of the Pacific.

Help Us Put SALT on a "High Fiber Diet"



We want to build a new instrument for SALT and **we need your help**! Our **Washburn Labs** team has come up with an ingenious design that converts the Robert Stobie Spectrograph into an Integral Field Spectrograph, feeding light through 274 fibers, each creating a spectrum from a different part of a galaxy. At $50,000, this is an affordable way to give SALT a new instrument.

Over the next six months, we are raising funds to make this "High Fiber Diet" for SALT a reality and we have exciting news: The Astronomy Board of Visitors and the faculty have pledged to **match** all incoming gifts that support the High Fiber Diet, up to $25,000! Every dollar you contribute will automatically turn into two. **Funds raised in excess of our goal may be used to support other future department instrumentation projects.** We aim for first light in 2019.

"Sometimes private funding is the best way to cut through red tape and follow up a scientific spark. I believe in my colleagues and will always feel I own a small piece of this" explains **Professor Ellen Zweibel** about why she contributed.

Will you pitch in so we can give SALT 274 new sets of fiber eyes? To find out how, see the contributions form on **page 3**.

Zach Pace Loves Wisconsin's Dark Skies

Zach Pace at Yerkes Observatory

One clear mid-November night in 2000, seven year old Zach Pace watched his parents drag a mattress and a pile of blankets out to their driveway in Buffalo, NY, so they could all view the spectacular Leonids meteor shower.

Although he did not know it at the time, this was the night that catalyzed his interest in astronomy and led him to where he is today—at UW-Madison as an astronomy graduate student.

Pace's interest in extragalactic astronomy stems from his interest in origin stories. "It is a fascinating question to ask how anything began."

His research focuses on "star-forming galaxies," but he thinks of it in the sense that all galaxies were star-forming galaxies at some point. "So if we look at galaxies that are forming stars now, that might tell us how currently ordinary, quiescent galaxies looked in the past."

He loves astronomy so much that he is not content with keeping his enthusiasm all to himself. Pace devotes generous chunks of his free time living the Wisconsin Idea, spending nearly twenty days of his summers traveling across Wisconsin, showcasing the cosmos through UW's Universe in the Park (UitP) program.

UitP, one of our most popular public programs, is built on a simple idea: the best environment to introduce the general public to astronomy is outside, under dark skies. Now in its 21st year, the program is entirely supported by the generous support of **Anne and Jere Fluno**.

Although Pace typically does UitP sessions closer to Madison, on July 14, 2017, he traveled nearly four hours northeast to host his first UitP session at Newport State Park. And no park encapsulates UitP's idea better than Newport, the first state park in Wisconsin to be named a **Dark Sky Park** by the International Dark-Sky Association in June 2017.

When he arrived, Pace first noticed that there were no street lamps or ground lighting. At Newport, all the campsites are backpacking sites only. "At Newport, once the sun set, the sky turned crystal clear and pitch black," Pace said. "The skies were just pristine. I haven't seen anything like it before."

During the session, Pace and his visitors were treated to a spectacular view of the Milky Way stretching across nearly the entire sky. "At that point," Pace said, "the moon had not risen yet. So, essentially, the only lights that were visible were coming from the sky, and the one, little red LED light on the telescope."

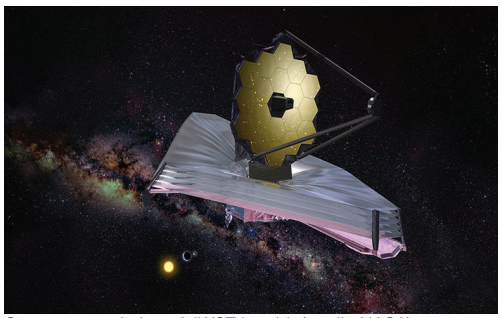
During his lead-in presentation during sunset, Pace showed the Hubble ultra-deep field and highlighted an extremely distant, heavily red-shifted galaxy to explain that, about 13 billion years ago, this galaxy was forming stars, neatly tying his presentation back to his own research.

Pace tries to work by analogy, saying "I try to build an understanding of a complicated system step-by-step. One of my favorite phrases is, 'can we agree that this happens?' And if not, let me spend a few minutes justifying it. And then once they get that, it's time to inject another piece into the puzzle."

"I try to really impress upon the people who are there that science is fun and that it really works," says Pace. "One of my main goals when hosting UitP is to make you love astronomy as much as I do."

Profile: Ken Sembach *Continued from page 3*

His success propelled him first to deputy director of STScI, before being promoted to Director of STScI. Although Sembach greatly enjoys his current position, he freely admits that it takes some sacrifices. "As director," Sembach said, "you have to be willing to give your life over to the job. You have to be able to step away from the nitty-gritty details of the science, while still remaining engaged and informed about the broader goals. There are different ways to do science. I can enable more science by doing the kinds of work that I'm doing," Sembach explained, "which allows hundreds or thousands of people to do science." Sembach added, "Maybe I'm taking the approach that [Hubble] itself has taken—this broader brush, democratization of science approach."


Computer rendering of JWST in orbit (credit: NASA)

At 27 years old, Hubble continues to enable amazing science. Its successor, JWST, is getting ready for a nerve-wracking launch and deployment: The primary mirror has to unfold, and the tennis-court sized sun shield has to unfurl. It's a complex ballet and at roughly 1 million miles' distance, no servicing mission could come to its rescue if things were to go wrong. Like Hubble before it, JWST aims to be the premier space observatory for the next decade. By observing the cosmos in infrared light, JWST will peer straight through interstellar dust that plagues observations of dense gas in the visible band. It will look back to some of the oldest moments in the universe with a resolution nearly 4 times better than the most advanced ground-based observatories. Watching the universe turn on the lights, the birth period of galaxies, seeing planet systems form, searching for signs of life on exoplanets: Those are some of the questions JWST will address. "But the most interesting things to learn will be the things we haven't even thought about yet." says Sembach.

Recently Sembach returned to UW-Madison for the first time in many years as the Whitford Lecturer. "It was great to come back. And to see some of the people I knew there," Sembach said, "In a couple of instances, I could hear somebody before I saw them, and I knew who it was just from the voice, after all these years. Like Joe Cassinelli. He has a great, great laugh," Sembach recalled, "And when I heard that laugh, I knew it was him immediately". We look forward to many happy returns to Wisconsin of this amazing Badger Astronomer and can hardly wait for the exciting new era of space astronomy JWST will bring about.

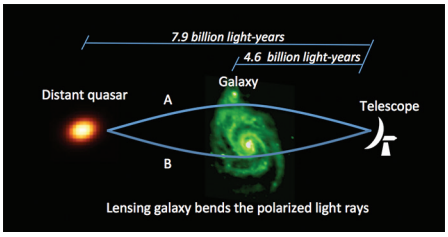
Innovations in Research and Teaching

Gravitational lensing reveals ancient cosmic magnetic fields

UW Astronomers were part of a team that measured the magnetic field strength in a far-away galaxy, using a newly developed technique that involves gravitational lensing.

The work was performed by a team of astronomers including Badger alumna **Sui Ann Mao** from the Max Planck Institute for Radio Astronomy in Bonn, Germany, and **W.L Kraushaar Professor of Astronomy and Physics, Ellen Zweibel**.

By comparing the different light paths from a background quasar (a brightly shining black hole even farther away than the galaxy) around the lens, they were able to tease out how the polarization of the light was changed by the gas inside the galaxy, revealing the strength of the galactic magnetic field.



The light left the galaxy five billion years ago, showing that large scale magnetic fields were created quickly, through the so-called dynamo mechanism. "This measurement provided the most stringent tests to date of how dynamos operate in galaxies," says Ellen Zweibel

SALT digs up hot gas above M83

Galaxies contain gas at different temperatures and states. These so-called phases range from cold, molecular gas found in dense clouds, to hot, ionized plasma that fills most of the volume of a galaxy. Understanding how much gas is there, where it is, and whether and how it is moving is important for understanding how a galaxy formed and how it is evolving.

UW grad student **Erin Boettcher**, working with **Professors Ellen Zweibel** and **Jay Gallagher**, used the Robert Stobie Spectrograph (RSS) on the Southern African Large Telescope (SALT) to study the dynamics of gas that is about 1000 degrees Kelvin hot, and ionized. What's special about this gas is that it does not reside in the Galaxy itself, but is sitting above and below the disk. They found from the spectra they took that this so-called extra-planar diffuse ionized gas (eDIG) is supported by turbulence, and

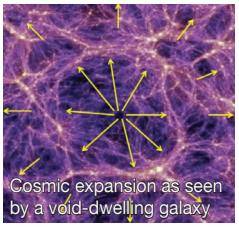

M83 (credit: Hubble Heritage Team/NASA/ESA)

that it is likely in a state that is not static (that is, it is not simply staying put) but also not collapsing or exploding. This is one of the first times researchers have been able to study this gas in galaxies that are oriented face-on, as seen in the beautiful image of M83 above.

Are we living in a bubble?

You have probably heard about dark energy, which causes our universe to expand at an accelerating rate, and those Nobel-Prize-worthy supernova explosions whose dimness first indicated the existence of dark energy. Turns out, there's a major wrinkle in this story: Supernovae measurements of the expansion rate are higher than other cosmological measurements imply. UW researchers have just ironed out this wrinkle.

Most galaxies in the universe are in dense groups and clusters, while most of the volume of the universe is empty. These are the "*cosmic voids*." But even in those void regions, galaxies and groups of galaxies exist.


Cosmic expansion as seen by a void-dwelling galaxy

Most galaxies in the universe are in dense groups and clusters, while most of the volume of the universe is empty. These are the "cosmic voids." But even in those void regions, galaxies and groups of galaxies exist. Observations by **Professor Amy Barger's** group indicate that the Milky Way and our entire neighborhood is likely located in such a void.

Using these observations, UW undergrad **Ben Hoscheit** re-calculated the cosmic expansion from the perspective of a void-dweller. "If you're living inside this void, you're going to see things being pulled away from you, towards the more dense regions of the universe," he said. The new calculation brings supernovae back in line with the other measurements and imply that there is less dark energy than originally thought. Ben, now a grad student at Caltech, has won multiple prizes for his work, including the Department of Astronomy's Doherty award. In June, he led a press conference on this work at the AAS meeting.

At Play in the Cosmos

"How can I make learning about astronomy fun for today's students?" That was the question **Professor Rich Townsend** asked himself last year when planning to teach the large intro lecture, Astronomy 103. It so happened that Rich ran into **Mike Beall**, Leader of the UW Gear Learning Team, who was working on a new video game called "At Play in the Cosmos," geared to exactly the audience taking our course. They collaborated on rolling out the game as a learning tool to over 400 students in the fall semester of 2016.

Students loved it, it improved learning outcomes, and we've been using it again in the summer and fall semesters of 2017. The game is a hit not just with UW students: Michael, Rich, and the team won the **Third Annual Mashable + Games for Change People's Choice Award**. "It's the first complete educational video game that uses high-quality, realistic art and sound with a compelling story to introduce non-science college majors to astronomy," says Beall.

"As a gamer, I knew immediately that this will be a great way to build enthusiasm and love of learning among students," says Townsend. He was right.

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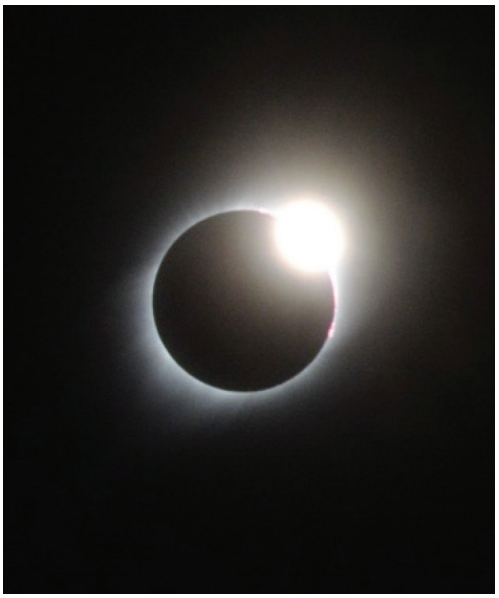

The “diamond ring” effect at the end totality during the August 21, 2017 Great American Eclipse, as the Sun is just beginning to re-appear. Red prominences and the corona are visible in this image as well. Taken near Ravenna, NE by Kyle Cudworth, WI

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A birds-eye view of 46 Badger Astronomers. “What a great-looking bunch of colleagues!” says Ellen Zweibel (first row, right).