



Spring 2021 Newsletter

Greetings Alumni, Friends, Students, Faculty and Staffs!

What a year! The good news is that the end of COVID is in sight. As more and more people get the COVID vaccine shots, we are all ready to get back to normal and back to in-person teaching/learning experiences. I want to thank our dedicated faculty and staff who have done an incredible job to assist our students over the past year. I also want to thank our students who rose to the occasion and met the challenges you all faced.

Last year, we welcomed Dr. Jesse Feddersen to the department. Jesse Feddersen is our newest Assistant Lecturer. Jesse Grosinger joined the Shared Business Center last year as well. Jesse Grosinger is a Senior Office Associate and handles mostly financial matters and purchase requisitions for the two departments. We also welcomed Rachel Dobjeleski in January, who is an Office Associate and will be dealing with all things related to graduate students, our website and department events. Thanks to A&S's support, the second WIRO Engineer, Andrew Hudson has also joined us.

After welcoming the largest class of freshman and transfer students two years in a row, we saw a dip in the enrollment last year.

We are not sure if this is related to COVID. On the other hand, data on prospective students for Fall 2021 look encouraging. We welcomed 6 graduate students to our program last year. The seventh student delayed his entry to Fall 2021 due to COVID. We are very happy that a number of our students were given prestigious awards for their academic and research achievements. For example, undergraduate student Julia Perlman has been offered a summer intern position at Las Cumbres Observatory. See a complete list of student awardees inside this newsletter.

P&A faculty continues to build a strong record of garnering external grants. The total amount of external research grants awarded to the Department was \$5,061,984 last year (2019-20), which is \$389,383 per faculty FTE. This makes P&A one of the most productive departments on campus in terms of research dollars generated per capita.

Patrick and Nora Ivers have decided to continue and increase their gifts to P&A and will donate another \$135K to the Department in the coming years. Their donation will also be matched with a UW matching funds of \$100K.



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An endowment has been set up in their names, which will give the Department a permanent annual income to be used for matching grants and graduate research fellowships. Thank you, Nora and Patrick!

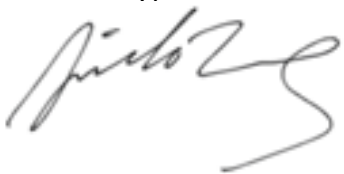
We completed the Strategic Accelerated Review at the end of last year and we are extremely happy to be included in this group selected for strategic development. P&A is poised to build on its recent successes in the emerging fields of astronomical data sciences and quantum materials and devices. In particular, investment to strengthen our programs and increase the number of research faculty in these two areas, is not only essential for the Department to approach national eminence but also advances UW's Land-Grant mission and President Seidel's vision of the four pillars.

On a sad note, Dr. Lee Schick, Professor Emeritus and former Department Head, has died of COVID-19 at age 84 on October 30, 2020 in Cheyenne. He will be missed by all.

Please let us know about updates on your career path (physics@uwyo.edu). We post these updates on our alumni page <http://physics.uwyo.edu/Alumni/alumni.html>. Also, please send us your email if you are interested in receiving an electronic copy of these newsletters.

I wish you a great semester and great year ahead.

Jinke Tang



Department Head

In Memory of Dr. Lee Henry Schick, Professor of Emeritus

A special bench dedication ceremony will take place **July 17th at 1pm by the front door of the PS Building.**

There will be a public memorial gathering **Sunday July 18th, 1-5PM @ Ivinson Mansion Stevens Center**

From Michele Schick:

"I am working with the Physics Department to set up a self-funded, small memorial scholarship in Lee's name. My goal is to have this available each fall semester to a deserving graduate student seeking an advanced degree in the area of physics. I have some specific criteria in mind, but have not thought everything out yet in detail. I know both of these things would make Lee very proud, humbled, and happy."

Send contributions to **Lee Schick's Memorial Bench Fund** or the **Memorial Scholarship** to:

UW Foundation
222 S. 22nd Street
Laramie, Wyoming
82070

or www.uwyo.edu/foundation

(Be sure to refer to the Lee Schick Memorial Bench)

You can read Lee's full obituary here:
<https://physicstoday.scitation.org/doi/10.1063/PT.6.4o.20201118a/full/>



UW Students Compile Largest-Ever Catalog of Quasars

A group of University of Wyoming students put together the largest quasar catalog to date as part of the Sloan Digital Sky Survey (SDSS). Quasar broad emission line regions are the clouds of hot, ionized gas that surround the supermassive black holes feeding in the centers of galaxies.

“This is the release of the largest quasar catalog to date and possibly the largest for the next few years,” says Eleanor Lyke, a third-year UW graduate student from Oceanside, Calif., majoring in physics and astronomy. “The SDSS puts out a blog targeted for astronomy enthusiasts and undergraduates. I wrote a blog post on some of the ‘big picture’ surrounding our paper and where it fits into the cosmology research the SDSS is doing.”

Lyke was the lead and corresponding author of a paper, titled “The Sloan Digital Sky Survey Quasar Catalog: Sixteenth Data Release,” that was published Aug. 27 in *The Astrophysical Journal Supplement*, which is a peer-reviewed scientific journal of astrophysics and astronomy.

Alexandra Higley, a junior from Parker, Colo., double majoring in physics and astronomy/astrophysics; Jacob McLane, a third-year graduate student from Loveland, Colo., majoring in physics; and Danielle Schurhammer, a senior from Plainview, Minn., double majoring in physics and astronomy/astrophysics, were the other UW students involved. All were co-authors of the paper.

Adam Myers, a UW associate professor of physics and astronomy, and Lyke’s Ph.D. adviser, oversaw the work.

Other contributors to the paper are from Ohio State University, University of Utah, University of Washington, New Mexico State University, Penn State University, University of Pittsburgh and Durham University in the U.K.

The SDSS has created the most detailed three-dimensional maps of the universe ever made,

with deep multicolor images of one-third of the sky, and spectra for more than 3 million astronomical objects. The SDSS has been observing the skies from Apache Point Observatory in Sunspot, N.M., since 1998 and from Las Campanas Observatory in Vallenar, located in Atacama Region, Chile, since 2017. “I was the point person for the University of Wyoming team in collaboration meetings and for the quasar catalog project as a whole,” Lyke says.

The catalog work was coordinated through emails, online teleconferences and attending international conference meetings -- all under the umbrella of the SDSS-IV collaboration.

Lyke compiled the data from already-completed observations conducted by the SDSS. The SDSS targeted approximately 1.44 million objects from images that were highly likely to be quasars. However, the spectroscopic follow-up, the data Lyke worked with, showed not all of the objects were actually quasars. Many were actually stars and galaxies.

Out of the 1.44 million object images, just over 750,000 turned out to actually be quasars. Of that total, over 225,000 were newly discovered quasars.

“That was my team’s job, to separate the ‘incorrectly targeted’ non-quasars from the quasars,” Lyke explains. “Originally, I was only to take over the project compiling the catalog. However, another group responsible for visually inspecting a portion of the data -- about 20,000 spectra -- did not return for this last catalog.”

In the absence of any other volunteers, Lyke took on the part of visually inspecting the spectra. To complete this task, Lyke brought on Higley, McLane and Schurhammer to assist her.

“I trained them to look at and classify spectra. Then, we all worked on that part (visual inspections) together,” Lyke says. “We were all new to that part of the research and were

taking over from a group of veterans of the project who had been doing it for years. I'm very proud of how my team did, especially under such circumstances."

The team identified Damped Lyman Alpha quasars, which are distinguished by big dips in the light at certain wavelengths around the Lyman Alpha emission line(s). These emission lines are places where distant gas/dust clouds or other galaxies in front of the quasar have absorbed some of the light the team expected to see.

The group also identified Broad Absorption Line quasars, which are similar, but the absorbing clouds are usually in the same galaxy as the quasar. As a result, the absorption dips are in different places in the spectrum.

"In both cases, these 'shadow puppets' can give us information on the absorbing objects because we know what we should expect from the quasar itself, but what we see is different," Lyke explains.

The catalog was released to the public July 20 and has two primary uses, Lyke says. One, the cosmology research and analysis conducted with quasars, as part of the key project for SDSS-IV, required this catalog. That research needs the 3D position information of quasars across the sky, she says.

The team identified the first two coordinates for the quasars by their right ascension and declination coordinates. Redshifts, a measure of doppler shifting, were used to obtain the third coordinate. As an analogy, a redshift is similar to what happens to sound from a moving object -- such as a police siren driving past -- except with light.

And two, although the cosmology research doesn't involve studying the physics of quasars themselves, quite a bit of other research does study the physics of quasars, Lyke says.

"This catalog will be used by those researchers as a list of known quasars with non-SDSS data included all in one file," she

says. "These SDSS quasar catalogs, and especially this last one, are widely used in the field of quasar research."

The previous catalog, called DR14Q, was released in May 2018 and already has 148 citations linking back to it, Lyke says. (1)



Two UW Faculty Members Receive DOE Grants to Research Alloys, Quantum Computer Materials

Dilpuneet Singh Aidhy is studying high entropy alloys that are potential materials for large structural applications, while Jifa Tian is researching a solution to create materials and understand the fundamental physics for future quantum computers that can process problems classic computers cannot.

Both University of Wyoming faculty members' research projects received a boost earlier this month. Their projects are two of 31 for which the U.S. Department of Energy (DOE) granted \$21 million in total Established Program to Stimulate Competitive Research (EPSCoR) funding.

"These alloys are potential materials for large structural applications due to their vastly superior mechanical properties over conventional alloys," says Aidhy, an assistant professor of mechanical engineering. "In particular, these alloys have shown potential to break away from the ductility versus strength trade-off."

In conventional alloys, if the strength is

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increased, the ductility decreases. In these high entropy alloys, both can be increased simultaneously, he says.

“Our work will develop a fundamental understanding of atomic and electronic-level processes that lead to achieving high strength and high ductility in high entropy alloys,” Aidhy says. “In particular, we will elucidate the role of electronic charge density on twinning in high entropy alloys.”

Aidhy will collaborate with Ames Laboratory and use its complementing techniques to advance scientific understanding.

Aidhy’s grant is for \$375,000 over three years. The grant will fund two graduate students and one undergraduate student, he says.

Tian, an assistant professor in the Department of Physics and Astronomy, says that, in classical computers, information is processed based on two resistance states called “0” and “1” states. However, a quantum computer uses quantum bits, or qubits, to encode information as “0,” “1” or a coherent superposition of both. This enables quantum computers to process enormous combinations of states at the same time and in a much shorter timeframe.

“Majorana particle, the only particle that is its own antiparticle, is one of the most compelling quests in condensed matter physics because of its potential for creating qubits to build future quantum computers,” Tian explains. “In this project, we are looking to realize and manipulate such Majorana particles in a simple materials system, 2M tungsten disulfide (WS₂), at the atomic scale. Here, 2M stands for a monoclinic structure with two layers per unit cell.”

The project is in collaboration with the following co-principal investigators: TeYu Chien, an associate professor of physics and astronomy; Jinke Tang, department head and professor from physics and astronomy; Brian Leonard, an associate professor of chemistry; and John Ackerman, an adjunct professor in chemical engineering.

Tian’s grant totals \$750,000 over three years and includes funding for four graduate students and, potentially, some undergraduate students.

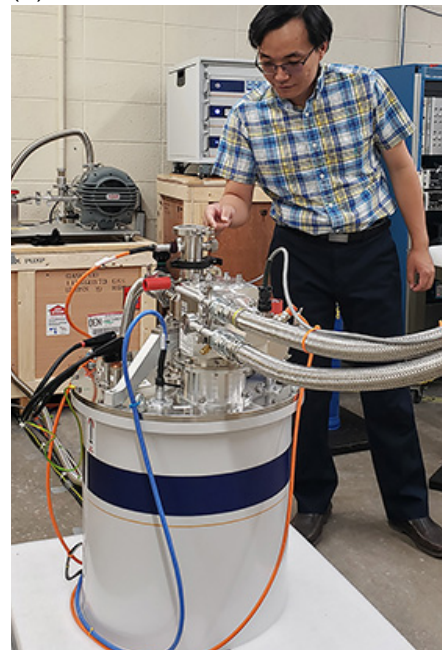
Tian says the research will help UW build strong partnerships with Argonne National Laboratory, Lawrence Berkeley National Laboratory and Sandia National Laboratories; and develop competitive capabilities in the field of topological superconductivity in condensed matters.

Under the DOE program, university researchers from EPSCoR states partner with researchers at DOE national laboratories on topics of common interest. Subjects include fundamental research in chemistry and materials science, advancing solar energy and battery technologies, studies in particle physics and other areas.

Funding totals approximately \$21 million with fiscal year 2020 funding for DOE EPSCoR projects lasting up to three years in duration. Projects were chosen by competitive peer review under a DOE funding opportunity announcement for EPSCoR-state-national laboratory partnerships.

“The projects announced are collaborative DOE lab-academia efforts that will simultaneously advance science and technology, as well as strengthen America’s research infrastructure and capabilities,” says Paul Dabbar, the DOE’s undersecretary for science. “Both EPSCoR states and the national laboratories benefit strongly from these very productive, innovative research partnerships.”

(2)



Jifa Tian, UW Assistant Professor of Physics (UW Photo)

Updates from the Harry C. Vaughan Planetarium

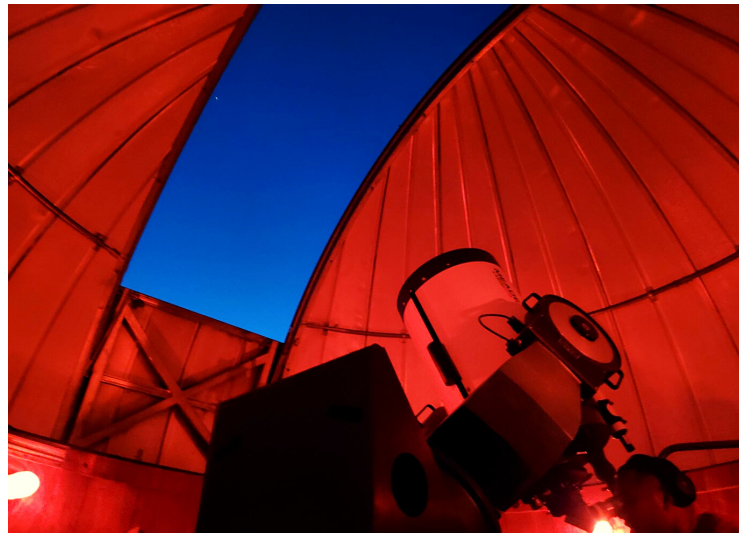
This year at the Harry C. Vaughan Planetarium we did our best to adapt to difficult circumstances. Cancelling our in-person schedule in the Spring 2020, we transitioned to online programs and outreach visits during the summer. We partnered with Albany County Public Libraries for their summer reading program with online films and virtual star parties throughout the season.

In the early fall, we completed an upgrade to our theater systems with new graphics cards for our system to allow better performance and new planetarium software with exciting features. The planetarium also received a grant from the ASUW and partnered with CSIC to construct an experimental VR system that could be used in the theater. So far, the system is used for content production and virtual/online show broadcasting, but as we transition to more in-person experiences we'll start to invite students to use it to produce and project their science, tech, engineering, artistic, and mathematical projects into the full-dome theater environment.

We've partnered with Wyoming NASA Space Grant for a myriad of events including International Observe the Moon Night, which was smoked-out due to the raging Mullen Creek fire on September 26th. Despite the fire, we did manage to meet up with members of the public and pass out Science Kitchen take-home moon kits and let folks observe the surface of the moon with touch thanks to a 3D-printed map of the Aristarchus Crater. More successful events included visits with scouting groups across the state for outdoor star parties with our 8" portable telescopes.

The planetarium also produced two short presentations for Wyoming middle and high school students on the topics of "Native American Astronomy" and "Observing Wyoming from Space".

We began to welcome back in-person audiences in September with private programs for families and small groups.



Free public observing night at the S.T.A.R. observatory

By November, we had started offering reduced capacity public shows with reservation requirements.

With the new year and new semester our public shows have increased in number and popularity along with a variety of in-person and online K-12 outreach events with multiple weekly offerings. We broadcasted a live, online "Stump the Astronomer" program for Wyoming State Science Fair participants followed up by an "Astronomy Jeopardy" in early March.

For this year's World Language Day, we did an online presentation of "Astronomy of Folklore" for many high schoolers who participated with the Languages Department. Recently, in-person visits from the Civil Air Patrol, home-school groups, and elementary schools have resumed. With the help of Society of Physics Students we've been able to open up our STAR rooftop observatory for students and the public twice this March. We also continue to do the vital maintenance and upgrades to bring the 16" Meade telescope on the roof of the Physical Sciences building into the 21st century.

-Max Gilbraith, planetarium coordinator

For planetarium updates and questions, email planetarium@uwyo.edu or visit <https://www.uwyo.edu/physics/planetarium>

Faculty & Student Awards

Undergraduate Awards

A&S outstanding graduates:

2020: Bryant Beau Jerome & Aylin Marie McGough-Peker

2021: Zia Macdermid & Rachel Tenney

A&S BoV Student Service Awards:

Alex Schultz

Graduating Senior Awards:

2020: Bryant Beau Jerome

2021: Zia Macdermid & Jarred Grant

Undergraduate Cinnamon Scholarship:

2020:

Jarred Louis Grant, Tim Faltermeier, Isabella Pope & Michael James Lindman

2021:

Brock Parker, Timothy Shrode, Stacy Kirkland & Shannon Boland

Wyoming NASA Space Grant Undergraduate Research Fellowship:

James Quenon for "Cupric Oxide Nanowire and its Efficacy for Arsenic Removal from Ground Water"

Michael Lindman was selected for the **Summer REU program in West Virginia**

Undergrad Julia Perlman has been offered a summer intern position at **Las Cumbres Observatory**

Graduate Awards

Outstanding Graduate TA's:

2020:

Lucas Napolitano & Noah Cowper

2021:

Jordan Bartlett, Afiq Suhaimi & Josh Walker

NASA Space Grant Graduate Research Fellowship:

2020: Noah Cowper

Jacob McLane

2021: Lucas Napolitano

Ashley Piccone

A&S Dean's Graduate Scholars Proposal:

Dinesh Baral has been selected for funding (\$2000) on "Visualizing the Spin Texture in EuO/Fe₃GeTe₂ Heterostructure"

Wyoming NASA EPSCoR MSE Graduate Research Fellowship:

Dinesh Baral

Faculty/Staff Awards

A&S Faculty Research and Creative Activities Grant:

Jifa Tian
Adam Myers
Mike Brotherton
Michael Pierce
Jinke Tang

Thumbs Up Award from College of Arts & Science Dean's Undergraduate Council for TeYu Chien

Thank you and Congratulations to Henry "Chip" Kobulnicky for his **URDM and WGE awards!** TeYu Chien also contributed to the proposal

Tip of the Hat:

Max Gilbraith, planetarium coordinator
We have received wonderful feedback from planetarium guests about the shows Max puts on and how well he interacts with the kids/guests and engages with them. Max is also great at helping with any of the classes or experiments that need to utilize the planetarium. We are happy to have Max on our team!



Aysenur Bicer was awarded Top Professors of 2020 by UW Cap and Gown Chapter of Mortar Board !

Members of the University of Wyoming's senior honor society recently honored their "Top Profs" at the 41st annual Top Prof Night, which was a virtual celebration this year.

Members of the Cap and Gown Chapter of Mortar Board selected professors who have positively influenced their lives at UW. These professors go beyond normal classroom expectations to help their students succeed.

During the virtual event, many faculty members noted that the nominations were particularly meaningful, given the unusual semester due to the ongoing pandemic.

Mortar Board is the premier national honor society recognizing college seniors for outstanding achievement in scholarship, leadership and service. Mortar Board provides opportunities for continued leadership development; promotes service to colleges and universities; and encourages lifelong contributions to the global community. (3)

Dr. Jesse Feddersen accepts role as Society of Physics Students (SPS) Faculty Advisor

Current Student Officers:

President - Alex Schultz
Vice President - Brock Parker
Secretary - Michael Lindman
Treasurer - Silba Dowell

SPS meets every other Wednesday and has hosted free public observing nights at the S.T.A.R. observatory several times a month this semester

Cowboy State Daily with Planetarium Coordinator Max Gilbraith: Newly Discovered Comet Could Be Brightest In Decades

Night sky watchers in May could be rewarded with a look at a bright new comet as well as the Eta Aquarids meteor shower, a University of Wyoming staff member said.

The SWAN Comet, officially designated as C/2020 F8 SWAN, was discovered by an amateur Australian astronomer in December 2019, and UW Planetarium Director Max Gilbraith said it could be one of the most memorable comet-viewings in recent history.

“It might be brighter than the planet Venus and have a huge, beautiful tail visible with binoculars or a small telescope,” Gilbraith said. “Comets are hard to predict, but it could be the best comet we’ve had for 20 years.”

Early morning, around 4:45 a.m., is the best time to catch a glimpse of SWAN along the northeastern horizon. Comets can be the size of a small town and are composed of frozen gases, rock and dust, orbiting the Sun like “cosmic snowballs,” according to NASA.

“This comet is on a parabolic path around the Sun,” Gilbraith said. “Once the Sun pulls it in with its gravity, it will fling it back out of the Solar System entirely.”

While there could be an opportunity for viewers to catch the comet as it passes Earth on a trajectory leaving the Solar System, he explained the comet could just as easily break apart or succumb to the Sun’s gravity.

If a single bright comet isn’t enough reason to climb out of bed in the wee hours of the morning, the Eta Aquarids meteor shower is also gracing night skies throughout May. Named as a result of the meteors appearing to originate from Eta Aquarii, one of the brighter stars in the constellation Aquarius,

the meteors are likely particles from the tail of Halley’s Comet, Gilbraith explained.

Although the show of shooting stars takes a backseat to the Perseid meteor shower later in the year, he said sky watchers might still see a meteor every few minutes.

“You will catch meteors all through the night if you really look for them,” Gilbraith added. “If you look to the east around 4 a.m. to 5 a.m., you’ll definitely see some of those meteors.”

In the evening, Venus is visible to the west, but most planets appear in the morning, with Jupiter and Saturn hanging in the south and Mars shining to the southeast. (4)



The SWAN comet (Getty Images)

UW Researchers Resolve Controversy Over Energy Gap of a Van der Waals Material

Previously controversial values of the energy gap of a van der Waals material -- chromium tribromide -- were reported based on various optical measurements. A University of Wyoming faculty member and his research team used scanning tunneling microscopy and spectroscopy measurements that clearly reveal a much smaller energy gap value and resolved the controversy.

“Our results settled a long controversy on one important material property -- the energy gap of the material,” says

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TeYu Chien, an associate professor in the UW Department of Physics and Astronomy. “Our scanning tunneling microscopy and spectroscopy measurements clearly revealed that the energy gap is around 0.3 electron volt (eV), which is much smaller than those measured by optical methods, which ranged from 1.68 to 2.1 eV.”

Chien says his team’s data further explain those previous optical measurements as being the transitions from various conduction and valence band features rather than detecting the energy gap of the material.

Van der Waals materials are made up of strongly bonded two-dimensional layers that are bound in the third dimension through weaker van der Waals forces. For example, graphite is a van der Waals material that is broadly used in industry in electrodes, lubricants, fibers, heat exchangers and batteries. The nature of the van der Waals forces between layers allows researchers to use Scotch tape to peel the layers into atomic thickness.

Chien is the corresponding author of a paper, titled “Small Energy Gap Revealed in CrBr₃ by Scanning Tunneling Spectroscopy,” that was published Dec. 8 in *Physical Chemistry Chemical Physics*, an international journal for the publication of cutting-edge original work in physical chemistry, chemical physics and biophysical chemistry. The paper has been selected into the journal’s “hot articles,” a theme collection featuring the hottest work published in *Physical Chemistry Chemical Physics*. This work also will be featured on the outside front cover of the upcoming print edition.

Dinesh Baral, a UW graduate student from Nepal, was the lead author of the paper. He carried out the experimental works on scanning tunneling microscopy and

spectroscopy measurement, and data analysis. Other researchers who contributed to the paper are Assistant Professor Jifa Tian, Professor Yuri Dahnovsky and Jinke Tang, a professor and department chair, all from UW’s Department of Physics and Astronomy.

Graduate students involved with the research included Zhuangen Fu and Aaron Wang, both from China; Uppalaiah Erugu, of India; Rabindra Dulal and Narendra Shrestha, both of Nepal; and Andrei Zadorozhnyi, of Russia.

Since the first isolated graphene -- atomically thin graphite -- in 2004, various van der Waals materials with properties of metal, semimetal, semiconductor, insulator and superconductor have been confirmed. The magnetic van der Waals materials did not join the graphene family until 2017.

Chromium trihalides are one family of the key van der Waals magnetic materials and have been used to explore the potential for spintronic applications, in which the magnetic moment of the electron is used for computing and information storage rather than using the charge properties of the electrons for conventional electronics.

Because van der Waals materials have very weak interlayer interactions and relatively stronger intralayer atom-to-atom bonding, this allows researchers to peel them and stack them for any combination of materials at atomic thickness.

“This peeling of the van der Waals materials is like peeling the onion skins, but at the atomic level,” Baral explains.

Scanning tunneling microscopy and spectroscopy is an imaging tool capable of measuring atomic resolution images, along with the electronic properties in that scale. Chromium tribromide flakes were peeled off from bulk crystal into atomically thin thickness and transferred onto a conducting

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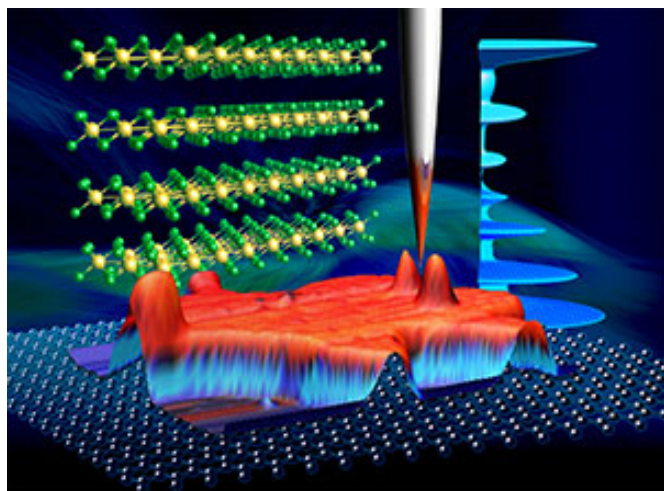
substrate, such as highly oriented pyrolytic graphite, for the study.

“The understanding of the energy gap of chromium tribromide resolves the existing controversy for the scientific community,” Chien says. “This also is the key in better controlling the spintronics devices involving chromium tribromide.”

The results of the study will provide researchers a better understanding of this important material for applications in spintronics and quantum materials, Chien says.

“Materials having such properties have potential applications in engineering at minimizing the size of the electronic and spintronic devices toward atomic level,” he says.

The project was funded by the U.S. Department of Energy, Office of Basic Energy Sciences, the Division of Materials Sciences and Engineering, and EPSCoR (Established Program to Stimulate Competitive Research). Baral was supported by an Energy Graduate Assistant Fellowship from UW’s Office of Academic Affairs. (5)



UW Researchers Turn Coal Powder into Graphite in Microwave Oven

“Finite graphite reserves and environmental concerns for the graphite extraction procedures make this method of converting

coal to graphite a great alternative source of graphite production,” the scientists wrote. Using copper foil, glass containers and a conventional household microwave oven, University of Wyoming researchers have demonstrated that pulverized coal powder can be converted into higher-value nano-graphite.

The discovery is another step forward in the effort to find alternative uses for Wyoming’s Powder River Basin coal, at a time when demand for coal to generate electricity is declining due to concerns about climate change.

In a paper published in the journal *Nano-Structures & Nano-Objects*, the UW researchers report that they created an environment in a microwave oven to successfully convert raw coal powder into nano-graphite, which is used as a lubricant and in items ranging from fire extinguishers to lithium ion batteries. This “one-step method with metal-assisted microwave treatment” is a new approach that could represent a simple and relatively inexpensive coal-conversion technology.

“This method provides a new route to convert abundant carbon sources to high-value materials with ecological and economic benefits,” wrote the research team, led by Associate Professor TeYu Chien, in UW’s Department of Physics and Astronomy.

Others involved in the project were Professor Jinke Tang in the Department of Physics and Astronomy; Associate Professor Brian Leonard in the Department of Chemistry, and Professor Maohong Fan at the School of Energy Resources and Department of Chemical & Petroleum Engineering.

While previous research has shown that microwaves can be used to reduce the moisture content of coal and remove sulfur and other minerals, most such methods require specific chemical pretreatment of the coal. In their experiment, the UW researchers simply ground raw Powder River Basin coal into powder. (6)

Excerpts and Text from the Following Articles:

Pg. 3

- (1) <https://www.uwyo.edu/uw/news/2020/08/uw-students-compile-largest-ever-catalog-of-quasars.html>

Pg. 4

- (2) <http://www.uwyo.edu/uw/news/2020/07/two-uw-faculty-members-receive-doe-grants-to-research-alloys,-quantum-computer-materials.html>

Pg. 8

- (3) <https://www.uwyo.edu/uw/news/2020/11/uw-mortar-board-honors-top-profs.html>

Pg. 9

- (4) <https://cowboystatedaily.com/2020/05/11/newly-discovered-comet-could-be-brightest-in-decades/>
- (5) <http://www.uwyo.edu/uw/news/2021/01/uw-researchers-resolve-controversy-over-energy-gap-of-a-van-der-waals-material.html>

Pg. 11

- (6) <http://www.uwyo.edu/uw/news/2021/01/uw-researchers-turn-coal-powder-into-graphite-in-microwave-oven.html>