## A Note from the Chair

#### By Ravindra Pandey

In the Milky Way Galaxy, the SS433 microquasar was recently found to be the source of the photons, which are about 25 trillion times more energetic than visible light. These high-energy photons were detected at the High-Altitude Water Cherenkov Gamma-Ray (HAWC) Observatory by Professor Petra Huentemeyer and her group. It was suggested that the high-energy g-rays were generated by electrons colliding with background microwave radiation left over from the Big Bang. These observations, offering a peek into the ancient universe, appeared in *Nature (nature.com/articles/s41586-018-0565-5*).

Raymond Shaw's substantial contributions in the fields of atmospheric physics, fluid turbulence, phase nucleation, and optics have earned him recognition as Michigan Tech's Distinguished Professor. In collaboration with several research groups, Professor Shaw led a team to establish a large turbulent cloud chamber facility at Michigan Tech (*phy.sites.mtu.edu/cloudchamber*), which is the first of its kind.

Yoke Khin Yap is a recipient of Michigan Tech's 2018 Research Award for significantly advancing understanding of structureproperty relationship of the boron-carbon-nitrogen nanostructures. His research group's discovery of superhydrophobic boron nitride nanotubes is widely considered a breakthrough, which opens the prospect of using the tubular structures as self-cleaning, anticorrosive coatings under rigorous chemical and thermal conditions.

Graduate students Chad Brisbois (Huentemeyer), Kevin Waters (Pandey), and Tyler Capek (Mazzoleni) were recipients of the US Department of Energy Office of Science Graduate Student Research Award. Chad and Tyler were hosted by Los Alamos National Laboratory and Kevin worked with one of our physics alumni, Eric Bylaska '90, at Pacific Northwest Laboratory. Several of our undergraduates recently returned from a spring trip to CERN, Geneva, Switzerland (*youtu.be/oaqRdZd6RMI*). CERN operates the largest particle physics laboratory in the world. Their trip was sponsored by physics alum Werner Vogt'66.

Congratulations to Heather Lewandowski '97, in receiving the Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction. Her contributions to systematic and scholarly transformation of advanced laboratories in physics were acknowledged by the American Physical Society. Lewandowski is associate professor of physics at University of Colorado Boulder.

Many of these achievements have been possible only with your encouragement and support of the department. As you decide on end-of-the-year donations, please consider a contribution to the department's endowment (*mtu.edu/physics/giving*). Your continued support is deeply appreciated.

Best wishes for a joyous holiday season and a happy and prosperous New Year.

# **Current Research**

Ramy El-Ganainy

Optics and photonics are playing an ever increasing role in our everyday life. From healthcare and industry to information technology and entertainment, optical innovations can be found everywhere. The rapid progress in optics and photonics relies on two main research themes: integration of new composite material and novel theoretical concepts. El-Ganainy's group in the Department of Physics at Michigan Tech is particularly focused on the latter.

Essentially, the group has been working to bring several quantum-inspired concepts to the realm of optics. More specifically, El-Ganainy has proposed to utilize the concept of supersymmetry to achieve global phase matching in laser arrays, which when coupled with carefully engineered dissipation can lead to single mode, phase-locked laser arrays that emit in the in-phase state. This proposal was recently implemented by a collaborating group at the University of Central Florida.

In another research activity, El-Ganainy's group has collaborated with a research team at University of Pennsylvania to study how the interplay between topology and non-Hermiticity can be used to engineer new microlaser devices with symmetry protected edge states. The details of this work have been published in *Nature Communications*.

An active area in El-Ganainy's group is optical sensors based on a certain type of singularities known as exceptional points (EPs). A collaboration team that involves El-Ganainy has recently presented a proof of concept for this new device in *Nature*. Currently, El-Ganainy's group is developing a new structure for EP-based optical sensors that combine fabrication robustness with operational sensitivity. Another related work is EP-based telemetry sensors, recently published in *Nature Electronics*. In this work, El-Ganainy et. al., present a new telemetry sensor that exhibits enhanced responsivity compared with current commercial devices.

A major theme of the work carried out in El-Ganainy's group is the study of open systems that lack the usual conservation laws. Recently, El-Ganainy and his PhD student, Qi Zhong, have developed a general formalism that deals with one of the peculiar features of these systems, namely the winding around non-Hermitian singularities (to be published in *Nature Communications*). Their work provides an insight into this process, which may be useful for optical engineers.

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### Awards and Achievements

Congratulations to Professors **Yoke Khin Yap** and **Raymond Shaw**. Yoke Khin was awarded the 2018 Michigan Tech Research Award. Raymond is a recipient in the inaugural group of Distinguished Professors, which recognizes outstanding faculty who have made substantial contributions to the University and their discipline. Raymond was also recognized by Michigan Tech's Vice President for Research Development in their "top research expenditure by college" list.

**Petra Huentemeyer** and **Claudio Mazzoleni** were promoted to the rank of Professor. **Michael Meyer** was promoted to principal lecturer and **Katrina Black** to senior lecturer.

**Ramy El-Ganainy's** article "Enhanced sensitivity at higher-order exceptional points" was published in *Nature*, August 2017; "Topological hybrid silicon microlasers" was published in *Nature Communications*, March 2018; "Non-Hermitian physics and PT symmetry" was published in *Nature Physics*, January 2018; and "Non-Hermitian photonics based on parity-time symmetry" will be published in *Nature Photonics*, December 2018.

**Issei Nakamura** made his *Tech Today* debut in December 2017 following his interview with Allison Mills, "Do the Room Temp Melt: Physics of Soft Materials."

John Jaszczak, A. E. Seaman Mineral Museum adjunct curator, in collaboration with the Museum's associate curator and executive director, designed and installed an award-winning Keweenaw exhibit at the annual Tucson, AZ, Gem and Mineral Show. Their "Classic Keweenaw Copper and Calcite Crystals" exhibit was awarded the Betty & Clayton Memorial Trophy.

**Claire Wiitanen** was nominated for the Staff Council's 2017 Making a Difference Rookie Award.

Several Graduate students received University and department awards. **Mohammad Teimourpour** and **Meghnath Jaishi** are recipients of the Graduate School's Outstanding Scholar Award. The Graduate School's Outstanding Teaching Award was presented to **Aeshah Khudaysh Muqri** and **Kevin Waters**. The annual graduate research oral and poster presentations were held in February and April 2018, respectively. **Binita Hona** received the oral presentation award; **Nurun Nahar Lata** received the poster presentation award. Additionally, **Shiva Bhandari**, **Teresa Wilson**, **Meghnath Jaishi**, **Dolendra Karki**, **Mingxiao Ye**, **Kevin Waters**, and **Janarjan Bhandari** were supported by Graduate School Finishing Fellowships.

Alumnus **Michael Larsen** presented the 2017 Ian Shepherd Award to co-recipients **Illiya Chibirev** and **Crystal Massoglia**. The award is presented annually to the most promising undergraduate seniors. Illiya was also named a Scholar Athlete by the Intercollegiate Tennis Association.

**Jon Berman**, undergraduate physics and mathematics major, was named the 2017 Department of Physics Scholar.

#### Outreach

The **Society of Physics Students** and the **Physics Department Demonstration Crew** were involved in several University and community events, including the Michigan Tech Preview Day, Open House, the UP Science Fair, and the UP STEM Festival.

Graduate student **Teresa Wilson** visited Barkell Elementary School in Hancock to give a presentation on astronomy and astrophysics to the fourth grade class.

In June 2018, CN Yang scholars from Nanyang Technological University visited the Pi Cloud Chamber and atmospheric physics group.



#### **Recent Degree Recipients**

#### 2018

Bishnu Tiwari, PhD Fan Yang, PhD Mohammed Hosain Teimourpour, PhD Shiva Bhandari, PhD

Michael Gerhardt, MS Sarita Karki, MS Ashfiqur Rahman, MS Jesse Anderson, MS Andrew Robare, MS Matthew Coel, MS

Illiya Chibirev, BS Owen Cruikshank, BS Daniel Johnson, BS Crystal Massoglia, BS Seth Nelson, BS Jonathan Zamaites, BS Novia Berriel, BS Paul Bosko, BS Stefan Friesema, BS

#### Destination

Brookhaven National Lab

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University of Arizona LAM Research Lab

#### Germany Michigan Tech Michigan Tech

University of Wisconsin-Eau Claire-Barron County

Duke University Montana State University Biomedical engineering Michigan Tech Michigan Tech Law school

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# **Recent Funding**

**Miguel Levy** is the principal investigator on a project that has received a \$82,445 research and development contract from the Air Force: Office of Scientific Research. The project, "Materials Processing for Heterogeneous Integration of Optical Isolators: Phase 2," is a two-year project.

StabiLux Biosciences, Inc., a company founded by **Yoke Khin Yap** has been awarded more than \$650,000 through America's Seed Fund, powered by the National Science Foundation (NSF) Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program, and the Invest Michigan's University Commercialization Fund.

**Dongyan Zhang** has received funding from StabiLux Biosciences, Inc., in the amount of \$198,944. This is for the two-year project "High Brightness Fluorophores II." Dr. Zhang is the co-PI of this STTR Phase II project funded by NSF.

**Ramy El-Ganainy** is the principal investigator on a project that has received a \$82,500 research and development grant from the University of Central Florida. The project is titled "Supersymmetry in Optics and Photonics." This is the first year of a three-year project potentially totaling \$165,000.

**Raymond Shaw** is the principal investigator on a project that has received a \$185,703 research and development grant from the NSF. **Will Cantrell** is Co-PI on the project "Laboratory Studies of the Effect of Turbulence on Aerosol-Cloud Interactions." This is the first year of a possible three-year project potentially totaling \$719,035.

**Raymond Shaw** is the principal investigator on a project that has received a \$43,000 grant from NASA.

Jae-Yong Suh received a 2018 Seed Grant Award from the Michigan Tech Research Excellence Fund.

**Tyler Capek** and **Kevin Waters** received DOE Fellowships. Tyler is at the Los Alamos National Lab for the fall 2018 semester to study changes in the atmosphere that occur from particles in wildfire smoke. Kevin spent the spring 2018 semester at Pacific Northwest Lab on bio-functionalized nanomaterials.

Kamal Chandrakar was awarded the prestigious NASA Earth and Space Science Fellowship beginning fall 2017 semester, renewable for the 2018-19 academic year. His project is "Aerosol Indirect Effects on Optical Properties of Turbulent Clouds."

**Illiya Chibirev** and **Owen Cruikshank** received 2017 Summer Undergraduate Research Fellowships for their projects "High Spatial and Temporal Resolution Temperature Measurements of Atmospheric Gases Using Noninvasive Raman Spectroscopy" and "Investigating the Nucleation of Supercooled Water by Droplet Vibration and Contact Line Movement."

# **Images in Print**

A photomicrograph illustrating a growth spiral on a natural graphite crystal, taken by John Jaszczak, was published on the cover of Volume 93, Issue 1 of *Rocks and Minerals.* 

Molybdenum Disulfide crystals synthesized by graduate student Jinlin Zhang, appeared on the cover of Nanotechnology 28(29). "Enhanced Second and Third Harmonic Generations of Vertical and Planar Spiral MoS2 Nanosheets," authored by Zhang et. al., was a featured article in the issue.

Microanalytical and metrology instrumentation supplier CAMECA held an international competition soliciting images to consider for its 2018/2019 calendar. CAMECA selected a composite image of the new mineral merelaniite by John Jaszczak and colleague John Spratt (Natural History Museum, London) as the January 2019 image.









# **Two Top Tens**

A *Frontier Review* article published by **Yoke Khin Yap** was one of the Top 10 most downloaded articles published in *Environmental Science: Nano* in 2017. The article, entitled "Water Purification: Oil-water Separation by Nanotechnology and Environmental Concerns" was co-authored by **Chee Huei Lee, Bishnu Tiwari**, and **Dongyan Zhang.** 

The Pierre Auger Observatory, of which **David Nitz** and **Brian Fick** are both a part, received international recognition as one of the Top Ten Physics World 2017 Breakthroughs of the Year. In "Observation of a large-scale anisotropy in the arrival directions of cosmic rays above  $8 \times 1018$  eV," which appeared in *Science*, the Pierre Auger Collaboration has found that ultra-high-energy cosmic rays appear to originate from sources outside the Milky Way.

Content editors: Katrina Black and Andrea Lappi



**Thanks!** We extend our deepest appreciation to friends and alumni who have made recent gifts or pledges to Michigan Tech. Did we miss your contribution? If so, contact physics@mtu.edu. As always, we appreciate your continued interest in the Department of Physics at Michigan Technological University.

#### Anonymous

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# Staff Spotlight

Greg Kinney



Greg Kinney is assistant research engineer for the Michigan Tech cloud chamber facility. In addition to managing the laboratory space, he provides scientific and engineering support to the students and faculty of the Pi-chamber group.

Greg graduated from Michigan Tech in 2016 with a BA in physics. Extending from his undergrad, Greg focuses on developing and implementing scientific instru-

mentation into the cloud chamber. His projects include the development of a pumped counterflow virtual impactor, a differential mobility analyzer, and an automated aerosol dilution system.

Before coming to Michigan Tech, Greg worked as an oilfield pipe and casing inspector in Traverse City, Michigan, where he also spent a season working as a water plant operator. Away from the lab, Greg enjoys building electronics as well as getting outdoors to hunt, fish, and camp across the Upper Peninsula.

#### Atmospheric Sciences Program Celebrates 10th Anniversary

Fall 2017 marked the ten-year anniversary of the interdisciplinary atmospheric sciences program. Within the physics department, students work with professors Will Cantrell, Alex Kostinski, Claudio Mazzoleni, and Raymond Shaw on questions related to the physical properties of the atmosphere, including cloud physics, nucleation, and atmospheric aerosols.



Pico Mountain in the Azores, home of Pico Mountain Observatory.

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#### Graduate Spotlight Neel Desai

## **Senior Spotlight**

Kaelan Anderson



Neel Desai is a PhD candidate working with Raymond Shaw in the Atmospheric Sciences Program. He joined Michigan Tech in fall 2013 after finishing his Master's in Aerospace Engineering from University of Michigan, Ann Arbor and his undergraduate in Mechanical Engineering from University of Mumbai. His research focuses on experimental measurements of cloud droplet growth in a turbulent environment. These experiments

are conducted in the Michigan Tech Pi-Chamber and include some airborne measurements as well. The research has been published in the *Journal of Atmospheric Sciences* and *Journal of Geophysical Research*.

Neel has received the Graduate School Finishing Fellowship for fall 2018 and would like to thank his advisor Raymond Shaw, his committee members including Will Cantrell and Claudio Mazzoleni, and the cloud chamber group for guidance and support throughout his studies. He would also like to thank Ravindra Pandey and the physics department for support and encouragement during his PhD years.



#### Jinlin Zhang

Jinlin Zhang is a PhD candidate working with Jae Yong Suh and Yoke Khin Yap. She joined Michigan Tech in summer of 2015. Her research interests lie in linear and nonlinear optical properties of low dimensional materials including novel metallic films and transition metal dichalcogenides, which are promising for applications in nanophotonic and nanoelectric devices. She does fabrication, characterization, and simulation of these mate-

rials. She is also interested in building setups for detecting optical properties of materials. She has published several papers in *ACS Applied Matererials & Interfaces* and *Nanotechnology*; two papers were highlighted as the journal's cover images. She is also passionate about teaching and has more than three years of experience as a teaching assistant in the PH1200 lab at Michigan Tech. Jinlin's long-term goal is to pursue an academic career in optical physics, extending what she has learned from Michigan Tech.

Jinlin is thankful for Jae Yong Suh and Yoke Khin Yap for their guidance, and the group members who have helped her during research work. She is also grateful to the department chair, Ravindra Pandey, and the physics department for their support.



**Kaelan Anderson** is a fifth-year applied physics major with a focus in electrical engineering and a minor in computer science. In his free time, he focuses on climbing, hiking, surfing, and other outdoor adventures.

During his time at Tech, he has participated in research in the environmental optics laboratory under Claudio Mazzoleni, spending one summer working on a photoacoutisic array for measuring aerosols,

and a second summer managing the Pico Mountain Observatory, in the Portuguese Azores. The next two summers were spent with Milwaukee Electric Tool Co. working as an embedded systems intern. His main tasks included inertial sensor development, software platform development, hardware communications, and continuous integration development. He also spent two academic years as an apprentice machinist under Master Machinist Jesse Nordeng. Last year, he spent a semester abroad learning modern and traditional farming techniques in New Zealand.

After graduation, Kaelan will be returning to Milwaukee Tool as an embedded systems engineer, with intentions to go on studying and contributing to environmental sustainability.

#### Taylor Kaminski



**Taylor Kaminski** is a fourth-year applied physics major with a focus in material science and engineering and a Spanish minor. She has worked on the demo crew and is the community outreach officer in the Society of Physics students.

Taylor has been involved in multiple research projects. She worked with Will Cantrell finding aerosol efficiencies for contact freezing supercooled droplets, tested a simple method to measure soot production

in improved and traditional cook stoves in rural/remote villages in Peru with Claudio Mazzolini, and is currently working with Jae Yong Suh doing quantum optics, where she has made dimer and single periodic nanoparticle arrays at Argonne National Lab.

She has also been in the Aerospace and Advanced Metalworks Enterprises, has had two internships, and will be working as a metallurgical engineer with ArcelorMittal. She plans to pursue a Master's in Metallurgy and eventually a PhD in Physics. She is very thankful for the support and mentoring she has received from the physics community.

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Students and faculty traveled to Switzerland to visit CERN during spring 2018, sponsored by department alumnus Werner Vogt. Pictured here from left to right: (back row) Kaelan Anderson, Paul Bosko, Adam Krueger, Matt De Mario, Zackerie Hjorth, Nick Videtech. (Front) Professor Jacek Borysow, Taylor Kaminski, Michelle Kline, Nathan Schlorke, Daniel Johnson, Owen Cruikshank