PHYSICS NEWS

MICHIGAN TECH DEPARTMENT OF PHYSICS NEWSLETTER VOL. 23 | FALL 2021

NOTE FROM THE CHAIR

Highly accurate measurement of atmospheric temperature is key to building better models for the evolution of atmospheric systems. This is because small thermodynamic fluctuations in the atmosphere can significantly influence model parameters important to the processes (e.g., nucleation rate) of cloud formation. Toward this end, **Carter Mashburn,** a senior undergraduate, has built a low-cost Raman spectrometer for remote atmospheric temperature determination. It was shown that analysis of the pure-rotational Raman spectra of molecular atmospheric gases could measure changes in atmospheric temperature as small as 0.75 Kelvin with high spatial and temporal resolution (*Applied Optics 2021* doi.org/10.1364/AO.419882). Carter's research project embodies our commitment to provide undergraduates a solid background in physics principles together with extensive research experience in state-of-the-art laboratories.

Research activities on aerosol and cloud processes have further been strengthened by a grant awarded by the National Science Foundation (NSF) to our atmospheric physics group. The grant will enable the Pi Cloud Chamber to be a user facility for the scientific community. Furthermore, the NSF-supported consortium led by **Dr. Shaw** will design a next-generation aerosol-cloud-drizzle-convection (ACDC) chamber. It will be a unique facility exploring chemical and physical interactions and evolution of aerosols, cloud droplets, and drizzle within turbulent clouds.

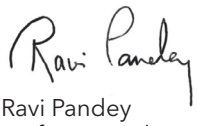
Dr. Black recently received Michigan Tech's Curriculum Development and Assessment Award, which recognized her contributions in reforming teaching methods and student learning assessments in introductory physics. And, in the Dean's Teaching Showcase for Spring 2021, **Dr. Borysow** was recognized as a great scholar who values teaching.

We will miss **Professor Emeritus Mike Wertheim,** who recently passed away. Mike was a well-respected scholar-teacher in statistical physics, and his seminal paper published in Physical Review Letters (1963) is still well-cited by the scientific community (doi.org/10.1103/PhysRevLett.10.321).

We are pleased to announce the formation of a student organization, Women in Physics, committed to inspiring women and underrepresented students in the department to participate in the academic community (facebook.com/wip.mtu).

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

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



Ravi Pandey
Professor and Department Chair
pandey@mtu.edu

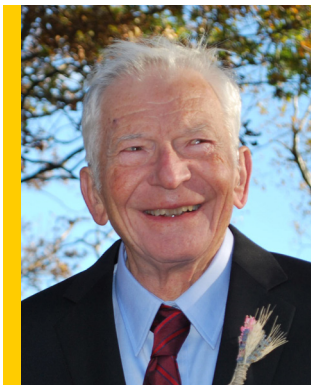
RESEARCH SPOTLIGHT

Professor Jacek Borysow recently celebrated 32 years at Michigan Tech, working in atomic and molecular physics. Early in his career, he worked with the leaders of the world, including Art Phelps (the "Godfather" of plasma physics), and 2005 Nobel Prize winners John Hall and Theodor Hansch in the field of laser spectroscopy. In collaboration with Manfred Fink, Borysow initiated anti-neutrino mass experiments to resolve the electron anti-neutrino mass to at least 0.5 electronvolts by measuring the endpoint energy spectrum of electrons from molecular tritium. The knowledge of the neutrino mass scale has a significant impact on astrophysics and cosmology.

Borysow holds multiple patents related to medical diagnosis using Raman spectroscopy. He led efforts to build a unique Raman spectrometer with a tiny laser diode and a multi-pass cell. The instrument can detect, in real-time, traces of hydrogen gas in an infant's breath at levels of a few parts per million to accurately diagnose lactose intolerance, which can be hazardous for newborns.

Recently, Borysow, in collaboration with **Professor Claudio Mazzoleni**, developed a highly accurate Raman spectrometer capable of measuring changes in atmospheric temperature (~0.01 Kelvin) with high spatial and temporal resolution. The spectrometer is based on a laser diode tuned to the resonant absorption line of ^{85}Rb isotope near 780.0 nanometers. A heated glass cell containing Rb atoms was used as an atomic absorption notch filter. It blocked up to 99.99 percent of the elastically scattered light and made it possible to resolve the pure-rotational Raman spectra of molecular atmospheric gases. The relative intensities of pure-rotational Raman transitions are then used to derive the atmospheric temperature. An NSF-MRI (Major Research Instrumentation) grant supports the work. The same spectrometer is capable of monitoring water concentration in the atmosphere with unprecedented precision.

IN MEMORIAM



Professor Emeritus Mike Wertheim passed away September 24 in Madison, Wisconsin. Wertheim was a deep thinker, making fundamental advances in the theory of simple and polar fluids. He was on the editorial board of the Journal of Statistical Physics and was a Fellow of the American Physical Society.

Wertheim received his PhD in Nuclear Physics from Yale University in 1957 and began his professional career at Los Alamos National Laboratory. He joined Michigan Tech in 1990 as a professor of physics and retired in 2003. Prior to joining Tech, Wertheim worked at Universität Frankfurt, Germany; University of New Castle, UK; University of Alberta, Canada; and Rutgers University, US. Besides physics, Wertheim will be remembered for regular swimming in Lake Superior at McLain State Park during the summer months.

IMAGES IN PRINT

Twenty-two photographs of minerals taken by **Professor John Jaszczak** were published in the article *"Fluorite and other Minerals from the Suever Quarry, Delphos, Van Wert County, Ohio,"* written by John Medici and R. Peter Richards, which appeared in the November/December 2020 issue of Rocks & Minerals. One of Jaszczak's photographs of fluorite was featured on the cover.

AWARDS AND ACHIEVEMENTS

Professor Will Cantrell was appointed associate provost and dean of the Graduate School. **Professor Petra Huentemeyer** is the new director of the Earth, Planetary, and Space Sciences Institute at Michigan Tech. **Professor John Jaszczak** is the new director and curator of the A. E. Seaman Mineral Museum. **Kartik Iyer** joined the department as assistant professor.

Distinguished Professor Raymond Shaw was elected a 2020 Fellow of the American Physical Society—Division of Fluid Dynamics for "seminal contributions to the understanding of atmospheric turbulence's role in cloud processes, from droplet nucleation to growth through condensation and coalescence, using precise laboratory and atmospheric measurements and insightful theoretical work."

Associate Professor Ramy El-Ganainy was awarded the Humboldt Research Fellowship for Experienced Researchers in July 2020. The fellowship spans 18 months, divided over three years, during which time El-Ganainy will be hosted at Berlin's Humboldt University.

Associate Professor Jae Suh received a fellowship from the National Research Foundation of Korea under the Brain Pool Program, which will support his 2022-23 sabbatical leave.

Professor Ravindra Pandey was invited by the government of India to serve on the Vaishwik Bharatiya Vaigyanik (VAIBHAV) Summit, a global collective of overseas and resident Indian scientists and academicians, based on his work on DNA and protein conjugated graphene-based nanomaterials and DNA sequencing by nanopores.

Professor Robert Nemiroff was named Exceptional Graduate Mentor at the University's 27th annual Student Leadership Awards.

StabiLux Biosciences, a Michigan Tech spin-off company under the leadership of **Professor Yoke Khin Yap**, continues to find success. It was an innovation showcase finalist at the International CYTO convention and has received additional funding from the NSF to continue its fluorescent dyes research.

Senior Lecturer Katrina Black was selected to receive the 2020-21 Jackson Center for Teaching and Learning Instructional Award for Curriculum Development. She presented "Curriculum Design, Assessment, and Beliefs about Learning" on January 26. **Professor Jacek Borysow** was named to the Dean's Teaching Showcase in recognition of over 30 years of innovative courses developed for specific audiences.

In our doctoral program, **Jeffrey Kabel** was awarded the King-Chavez-Parks Future Faculty Fellowship to support academically and economically disadvantaged candidates pursuing faculty teaching careers in postsecondary education.

Qing Guo, Amit Acharya, and **Subin Thomas** received the Graduate School Outstanding Scholarship Award, while **Cameron Shock** and **Shreya Joshi** received the Outstanding Student Teaching Award. Joshi also received an Outstanding Service Award.

Susan Mathai and **Abu Sayeed Md Shawon** spent the 2021 spring semester on internship at Pacific Northwest National Lab. Shawon's poster presentation received first place at the 2021 American Meteorological Society Annual Meeting in Aerosol-Cloud-Climate Interaction Symposium. **Neerav Kaushal's** oral presentation placed first at Michigan Tech's Graduate Research Colloquium, and **Jeff Kabel** and **Cameron Shock** received top departmental oral and poster presentation awards.

Carter Mashburn was the recipient of the Ian Shepherd Award for outstanding senior undergraduate students, presented by **Mike Larsen '01 '06 (BS, PhD).** Mashburn also published his first paper in March 2021. Titled *"Raman Spectrometer for High Precision Temperature Sensing of Atmospheric Gases,"* it was coauthored by Borysow.

Carter Mashburn

Casey Aldrich was named the 2020 Physics Departmental Scholar and nominated for the Provost's Award for Scholarship.

Professor Emeritus David Nitz was selected as Excellent Initiative Professor at Radbaud University, Nijmegen, Netherlands.

Wellesley Pereira '03 (PhD) has been elected a Fellow of the International Society for Optics and Photonics (SPIE). Pereira is a scientist and mission lead working in a Space Vehicles Directorate at Air Force Research Laboratory, Kirtland, New Mexico.

GRADUATE SPOTLIGHT

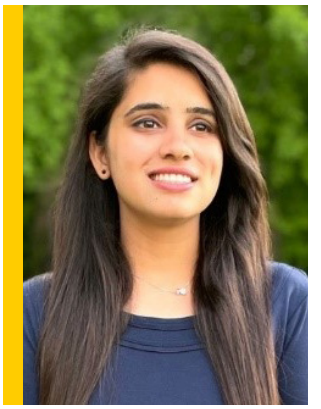
Abu Sayeed Md Shawon is a PhD candidate working with Will Cantrell. He joined Michigan Tech in fall 2015 and has been working in Michigan Tech's Pi Cloud Chamber since fall 2017. His research focuses on the aerosol-cloud interaction in a turbulent environment. This interaction between aerosol and cloud has a significant effect on Earth's radiative budget and hydrological cycle. He received accolades for his research, including the Student Poster Award at AAAR-2019 and first place in the Student Poster Presentation at AMS-2021. His recent publication was featured as the research spotlight at JGR: Atmospheres. He spent the last two semesters as a PhD intern at the Pacific Northwest National Laboratory. Currently, he is working there as a visiting researcher on an NSF supplementary fund.

In addition to his research duties, Shawon has served as a department representative and vice president of the Graduate Student Government. He was also the founding president of the Bangladeshi Student Association at Michigan Tech. He would like to thank his advisor, Dr. Cantrell, for his guidance and support; his committee members, Dr. Shaw, Dr. Mazzoleni, and Dr. Mike Larsen; his supervisor and host at PNNL, Dr. Swarup China; and his research group members at Michigan Tech. He would also like to thank the department chair, Dr. Pandey; and the department's faculty and staff for their support and encouragement.

SENIOR SPOTLIGHT

Trevor Kieft is a senior studying applied physics focusing on computational mathematics and a minor in mathematical sciences. He works as a coach in the Physics Learning Center and is a member of the Society of Physics Students. Over the past summer, he worked with Jacek Borysow and Claudio Mazzoleni to develop a Raman-based precision imaging system to remotely map water vapor concentrations within the Pi Cloud Chamber. Results of the research are being written for a scientific publication. Kieft's senior research project, also supervised by Borysow and Mazzoleni, is on extending the Raman system to map temperature simultaneously with the same apparatus. Upon graduation, Kieft plans to attend a physics graduate program in pursuit of a PhD. He is thankful for all the support and guidance of Drs. Borysow and Mazzoleni and the entire Michigan Tech physics department.

GRADUATE SPOTLIGHT



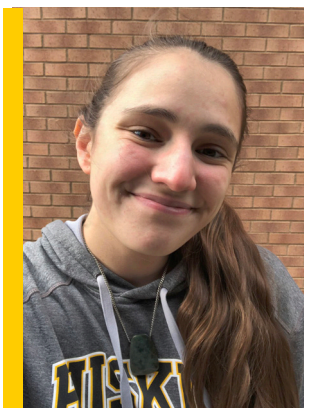
Geeta Sachdeva is pursuing a PhD in Applied Physics with Ravindra Pandey. She had an exciting summer—she worked at the Los Alamos National Laboratory and attended the Computational Materials Science Summer School at Texas A&M University. After these experiences, Sachdeva is more prepared and excited to finish her graduate studies at Michigan Tech.

Her thesis work, supported by NASA, is focused on the investigation of polymer composite materials. This project aims to analyze how chemical structure influences the polymer-carbon nanotube interaction and guide the design of resin systems for better performance, e.g., higher strength and higher modulus. A number of her findings have been published in a series of peer-reviewed journal articles.

Apart from the mechanical properties, Sachdeva has worked with the groups of Professors Heinz (Colorado State University) and Duin (Penn State University) to improve the force-field parameters of studied organic molecules by calculating their quantum-mechanical energy surfaces. She has also gained experience investigating the optical absorption properties of 2D materials, such as antimonene and borophene.

Additionally, Sachdeva has served the Women in Physics organization as a vice president and likes to play sports. She thanks her advisor, Dr. Pandey, for guiding her to conduct professional and analytical research and teaching her about several aspects of life by his deeds.

SENIOR SPOTLIGHT



Erin Casey Aldrich is a senior physics major. She has been a member of the Society of Physics Students and has pursued undergraduate research since the summer of her first year. She has focused on cataloging and analyzing gamma-ray bursts from NASA's Fermi satellite and their respective photons under the supervision of Robert Nemiroff. Aldrich's senior research, supervised by Issei Nakamura, uses the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) to determine the boiling point of a Stockmayer fluid model of water. After graduation, she plans to attend graduate school to pursue a higher degree in physics. She appreciates the opportunities afforded to her by Michigan Tech, and the kindness and support of the faculty, especially from Drs. Nemiroff and Nakamura.

Newsletter Coordinators: Katrina Black and Claire Wiitanen

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, please contact physics@mtu.edu. As always, we appreciate your continued interest in the Department of Physics at Michigan Technological University.

Gary P. Agin

Jeffery Allison & Liana Harden

Edward Augustyniak '94 & Monika Sujczynska

Theodore L. Bedore '72

John '69 & Louise Bretney

Ziyong Cai '88 & Ping Zhou

Russell '63 & Joan Compton

Konstantin '95 & Dessy Dinov

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David Nitz & Mary Marchaterre

Brenda & Samuel '63 (dec) Ochodnicky

Lin Pan '08 & Hong Wei Yu

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William '66 & Dorothy Roth

Joseph '70 & Susan Rowe

Suresh K. Sampath '98

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C. John '64 & Kathryn Umbarger

Roger '66 & Linda Urbaniak

SriramaSwaminat Venkataraman '98 & Kalpana Chandrasekharan

Larry '61 & Patricia Wittenbach

David E. Woon '84

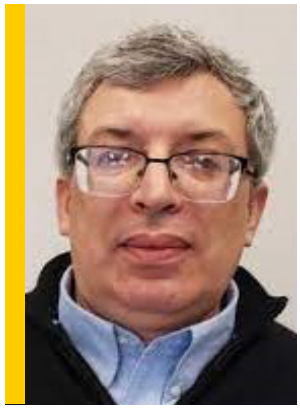
William E. Wuerthele '66

Charles '66 & Mary Zeigler

Ziyou Zhou '09 & Xiaoyue Huang '07

ALUMNI

Jacob Fugal '07 (PhD) is a senior research engineer at SeeReal Technologies, Dresden, Germany. He was an NSF/NASA graduate research fellow, receiving a PhD under the supervision of Raymond Shaw. In 2008, he joined the US National Center for Atmospheric Research (NCAR) to build HOLODEC with their Research Aviation Facility. In 2010, he joined the Max Planck Institute of Chemistry and the University of Mainz to lead development of the first software able to automatically find cloud particles in reconstructed holograms (the HALOHOLO project–the European version of HOLODEC). Currently, he is involved in building prototypes of 3D holographic displays for Volkswagen. Fugal enjoyed the scenery, the spirit of the country, and all the snow around Michigan Tech. While he is not working on cloud physics now, all the hardware and software skills he gained during his research project are very applicable as a research engineer



Peter Zapol '98 (PhD) is a senior scientist at Argonne National Laboratory and has been associated with the lab for most of his career. He received BS and MS degrees from the University of Latvia, Riga, and a PhD working with Ravindra Pandey on point defects in semiconductors. In the past two decades, Zapol has successfully addressed structure-property issues in materials for energy-related applications. Specifically, his research group has provided an atomistic view of the catalysis processes at the nanoscale, publishing highly cited papers in Physical Review Letters, Nature Nanotechnology, and Nature Materials, among others. In recent years, his work has led to the development of a new class of electrocatalysts based on 2D transition metal dichalcogenides. He is a Fellow of the American Physical Society.

MICHIGAN TECH UNIVERSITY PROFESSOR

Professor Robert Nemiroff is the 2021 Michigan Tech University Professor. During Nemiroff's 25 years at Tech, he has been a notable scholar, making substantial contributions through teaching, research, and service. He is a leading researcher in gravitational lensing and gamma-ray bursts and has received external funding every year—including an NSF CAREER Award (1997) and the Astronomical Society of the Pacific's Klumpke-Roberts Award (2016). In 2012, he received Michigan Tech's Research Award. While Nemiroff has taught courses at all levels, his iTunes University offering of Introductory Astronomy was the most downloaded course in any subject from any university, and his online course Extraordinary Concepts in Physics has run for over a decade. In the wider world, he is probably best known as co-creator and editor of NASA's Astronomy Picture of the Day, which averages over 1 million hits per day.

RECENT FUNDING

Associate Professor Issei Nakamura received an NSF CAREER Award for his proposal on coarse-grained theory and simulation on ion-containing liquids. This is NSF's most prestigious award in support of early-career faculty who have potential to serve as academic role models in research and education, and to lead advances in the department and University missions. He joins previous department recipients Nemiroff, Shaw, Yap, and Pati.

Professor Alexander Kostinski is the principal investigator on a project ("Theoretical Support for Gas-Gun Experiments: Towards Mutual Suppression of Shockwave Instabilities") that has received a $88,165 research and development contract from the Lawrence Livermore National Laboratory.

Distinguished Professor Raymond Shaw is the principal investigator on a three-year project ("Collaborative Research: Experiment of Sea Breeze Convection, Aerosols, Precipitation and Environment (ESCAPE)") that has received a $270,735 research and development grant from the NSF.

Professor Petra Huentemeyer is the principal investigator on a three-year project ("WoU-MMA: The Southern Wide-Field Gamma-Ray Observatory (SWGO): R&D for a Next-Generation Ground-Based Survey Instrument for VHE Gamma-Ray Astronomy") that has received an $860,003 research and development grant from the NSF.

Qing Guo and **Subin Thomas** were awarded Graduate School Finishing Fellowships. Guo and **Tyler Capek** received Henes Center Fellowships.

Several undergrads also received fellowships. **Renato Pinto Reveggino** was awarded a Michigan Space Grant Consortium research fellowship for his project, "Multiple Wavelength Measurements of Volcanic Ash Absorptivity and Single-Scattering Albedo." **Reed Downs** ("Extinction of Light by Water Droplets in a Turbulent Cloud") and **Noah Wilson** ("Non-invasive Breath Analysis for Testing Blood Glucose Levels in Diabetics") received 2020 Summer Undergraduate Research Fellowships for their projects.

NEW GRADUATE CERTIFICATES

The department has added four new graduate certificates: Advanced Computational Physics, Big Data Statistics in Astrophysics, Frontiers in Materials Physics, and Frontiers in Optics and Photonics. The graduate certificates are narrower in scope than a master's degree and are based on 9 credits of coursework.

Advanced Computational Physics develops foundational skills for advanced computational topics and their application to scientific problems in the student's research area. Big Data Statistics in Astrophysics focuses on techniques for handling the vast data sets that modern astronomical observations produce, including an introduction to data mining and machine learning. Frontiers in Materials Physics focuses on skills needed in the fields of electronic and photonic devices, and quantum computing and communication. Students learn about low-dimensional materials, quantum materials, and more, with the option to choose more application areas. The Frontiers in Optics and Photonics certificate develops skills in optics, photonics, and wave propagation applicable to the fields of telecommunication, optical computing, and quantum sensing, among others.

DEGREE RECIPIENTS

STUDENT	DESTINATION
Amit Acharya, PhD	SGS Frontier, TX
Tyler Capek, PhD	Carrier Inc., Minneapolis, MN
Qing Guo, PhD	Postdoctoral Fellow, Washington State University
Manpreet Boora, MS	PhD in Applied Physics, Michigan Tech
Rishi Babu, MS	PhD in Physics, Michigan Tech
Lucas Simonson, MS	PhD in Applied Physics, Michigan Tech
Reed A. Downs, BS	AmeriCorps
Zoe D. Gaertner, BS	Perceptron, Grosse Ile, MI
Jack E. Harris, BS	Nuclear Program, US Navy
Jonah M. Haw, BS	Graduate Program, University of Idaho
Conner N. Hawry, BS	KBR Inc., Houston, TX
Aleister W. Kerr, BS	Graduate Program, Michigan Tech
Michelle R. Kline, BA	–
Alan Larson, BS	Graduate Program, Michigan Tech
Carter R. Mashburn, BS	Graduate Program, University of Colorado, Boulder
Adam T. Sanchez, BS	Graduate Program, University of Notre Dame
Cas J. Tuson, BS	Graduate Program, University of Idaho
Wolfgang K. Vallazza-Margl, BS	Graduate Program, University of Arizona
Noah F. Wilson, BS	General Motors, Chandler, AZ

Michigan Technological University

Physics News
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After a long hiatus, Women in Physics (WIP) has reorganized and is a registered student organization at Michigan Tech. WIP is committed to inspiring women and underrepresented students in the physics department to participate in the academic community. The club welcomes undergraduate and graduate students and plans a slate of academic and social events.