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Michigan Tech Physics Department Newsletter

Physics News

A Note from the Chair

By Ravindra Pandey

Hello to our friends from the faculty, staff, and students of the Physics Department at Michigan Technological University. We have much to share with you. First, **John Jaszczak** and his collaborators have discovered a new mineral! Merelaniite, named for the region in Tanzania in which it was found, is composed of a layered structure rich in Mo, Pb, and S, with sheets rolled in scrolls like tobacco in a cigar (doi:10.3390/min6040115).

Our atmospheric physics group published a study in *Proceedings of the National Academy of Sciences* (doi:10.1073/pnas.1612686113), reinforcing that when it comes to climate change, clouds are the wild card. Every cloud droplet in Earth's atmosphere forms on a preexisting aerosol particle. Our researchers found that clouds with fewer aerosols have a wider variability in droplet size. This could have serious implications for weather and climate change. Read more in Current Research.

Raymond Shaw received the University's 2016 Research Award in recognition of his cloud physics research, which aims to better understand the relationship between clouds and atmosphere. His team designed and developed a cloud chamber that creates clouds by controlling the temperature, pressure, aerosol quantity, and water vapor. Shaw is now teaching a class of more than 400 freshmen students, showing our commitment towards maintaining excellence in teaching and research. Congratulations, Professor Shaw!

Donald Beck and **Maximillian Seel** have chosen to retire from the academic world. Beck and Seel joined Michigan Tech in 1980 and 1986, respectively. Beck was one of the few professors to receive continuous support from the National Science Foundation (NSF) for more than 30 years for his work on properties of Lanthanides. He was elected as Fellow of the American Physical Society for his groundbreaking work on relativistic correlation methodology in electronic structure theory. Seel helped the department gain national and international visibility in multiscale modeling of materials. He was a successful and well-liked administrator who provided strong leadership in the academic missions of the College of Sciences and Arts and the University. We wish them all the best in retirement.

Many of our achievements have been possible only with your encouragement and support. As you decide on end-of-the-year donations, please consider a contribution to the department's endowment. Your continued support is deeply appreciated.

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

Current Research

Raymond Shaw

The Michigan Tech cloud chamber laboratory came on line in spring 2014. Since then, researchers have been actively characterizing the chamber and testing first science ideas. The December 2016 issue of *Bulletin of the American Meteorological Society* will publish a paper introducing the cloud chamber facility to the world. The paper describes the chamber's capabilities with a sampling of illustrative results that demonstrate the broad range of collaboration involved in this project (http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00203.1).

In the meantime, an exciting scientific surprise has emerged from the cloud chamber work. The concept was simple: provide a constant flux of nanoscale aerosol particles into the chamber, where they would be exposed to a turbulent environment supersaturated with water vapor. Our researchers found the aerosol particles grew into ~10 mm-sized cloud droplets as they were carried around the chamber in random paths within the turbulent convection. When they grew large enough, they settled out of the chamber at terminal speeds of more than 1 cm per second. The end result, once transients died out, was a cloud existing in a dynamic steady state, with aerosol injection rate balanced by cloud droplet removal.

Most cloud chambers operate on the "expansion" principle, in which researchers achieve a water-vapor-supersaturated environment by reducing the pressure within the chamber, and therefore the temperature through adiabatic expansion. Clouds formed in this manner last only minutes or tens of minutes. While the Michigan Tech cloud chamber can form clouds in the same way, its unique mode of operation induces turbulent convection between a heated bottom surface and a cooled top surface. Both surfaces maintain a constant temperature and are coated with water within a glass-fiber matrix, providing boundary conditions fixed at the saturation water vapor concentration. Just as one sees a cloud form when breathing out warm, water-vapor-saturated air into the cold, high-humidity air of a UP winter day, the Michigan Tech cloud chamber produces clouds by mixing saturated air from the top (cool) and bottom (warm) boundaries. As a result, the chamber can maintain a cloud indefinitely, and the thermodynamic and turbulence conditions can be held constant in order to see exactly how other variables respond in isolation. In the constant-aerosol-

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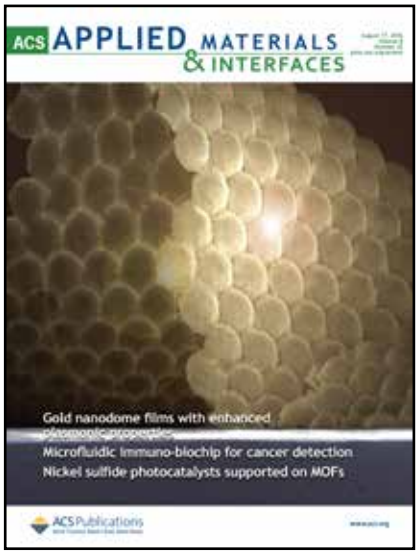
Research with Impact/In the News



Images from "Interfacial Mode Interactions of Surface Plasmon Polaritons on Gold Nanodome Films," co-authored by **Jae Yong Suh**, appeared on the August cover of *Applied Materials and Interfaces.* The accompanying article described a method to create centimeter-scale lattices of gold nanodomes in order to study their optical properties.

Nearly a thousand times thinner than a human hair, nanowires can only be understood with quantum mechanics. Using quantum models, Michigan Tech physicists have figured out what drives the efficiency of a silicon-germanium (Si-Ge) core-shell nanowire transistor. The study, published in *Nano Letters,* focuses on the quantum tunneling in a core-shell nanowire structure. **Ranjit Pati** led the work, along with graduate students **Kamal Dhungana** and **Meghnath Jaishi.**

John Jaszczak and **Paul Bergstrom** (ECE), along with former PhD student **Madhusudan Savaikar**, published "Physical Mechanisms Leading to the Coulomb Blockade and Coulomb Staircase Structures in Strongly Coupled Multi-Island Single-Electron Devices" in the May 24 issue of *ECS Journal of Solid State Science and Technology.*

The road to more versatile wearable technology is dotted with iron—specifically, quantum dots of iron arranged on boron nitride nanotubes (BNNTs). The new material is the subject of a study by **Yoke Khin Yap** published in *Scientific Reports*.

Yoke Khin Yap and his team's research into purifying water by removing nanoparticles has been widely publicized. News agencies that picked up the story include *The Daily Mining Gazette, Nanowerk, Phys.org, EurekAlert, ScienceDaily, Tech Times, R & D Magazine, Kurzweil,* and *Science World Report*.

Raymond Shaw's research using holography to study clouds has been covered by several national media outlets, including *Newswise, Smithsonian, Science Daily*, and *Science Newsline,* as well as *Motherboard* and *Phys.org.* An interview with Shaw appeared on National Public Radio's *All Things Considered.*

Science 360, an NSF science news website, featured among its headline research stories **Claudio Mazzoleni's** research into how carbon particles and sunlight interact, work that was published in *Nature Communications.*

Department Updates

Physics hosted a day-long symposium on May 16 to honor the contributions of **Don Beck** and **Max Seel** to the theory of atoms, molecules, clusters, surfaces, and solids. Research colleagues and collaborators, as well as former graduate students and postdocs, attended the event, which was followed by a retirement reception and dinner. Both Don and Max are appointed professor emeritus.

A $2 million gift has led to the establishment of the **Elizabeth and Richard Henes Center for Quantum Phenomena.** Appreciation is extended to **Jacek Borysow** and **Ravindra Pandey** for their role in securing this gift. Jacek serves as the Center's first director and made his media debut in an interview with ABC-10UP.

In April 2016, the Board of Trustees approved a name change for the PhD in Engineering Physics, which will now be known as the PhD in Applied Physics. This change broadens the program's scope to meet the needs of students who focus on interdisciplinary areas of engineering and science, including nanotechnology, photonics, plasmonics, and biophysics.

Physics hired two new office assistants at the start of the 2016-17 academic year. **Cindy Wadaga** hails from Baraga and brings years of accounting and payroll experience to her position. **Mary Birmingham** is new to Michigan Tech and the Copper Country, having moved from Iowa in the past year. Mary's biggest challenge is organizing physics colloquia!

Former master machinist **David Cook** passed away in February 2016. He served Physics from 1995-2005 as a machinist, safety liaison, and friend to faculty, staff, and students.

We will miss **Kathy Wollan**, who sadly passed away last month. Kathy was the department's graduate secretary for several years and provided a home-away-from-home experience for our international graduate students.

Physics Outreach

Professor **Yoke Khin Yap** held a "Introduction to Nanotechnology" workshop for ninth and tenth grade students from L'Anse High School. The workshop was part of the outreach and education activities in Yap's NSF research grant.

Students from Barkell Elementary School toured the cloud chamber on March 10 as part of the school's Great Explorations program. **Will Cantrell** and graduate student **Sarita Karki** hosted the tour.

Teresa Wilson's blog, "This Month in Astronomical History," appears on the American Astronomical Society website, aas.org. Each month, she highlights an important discovery or memorable event.

Awards and Achievements

Our congratulations to **Raymond Shaw,** recipient of the Michigan Tech 2016 Research Award. He likened research to working "an incredibly diverse set of intertwined and nested puzzles."

Angela Small was the 2016 recipient of the Ian Shephard Award, presented by Will Cantrell. The award recognizes Physics' outstanding undergraduate senior.

Floyd Johnson is the 2016 Department Scholar. He was recognized for his work as lead coach in the physics learning center and as president of the Society of Physics Students (SPS). Floyd was instrumental in organizing an SPS trip to CERN and the Max Planck Institute during the 2016 spring break.

Department alumna **Heather Lewandowski** was inducted into Michigan Tech's Presidential Council of Alumnae. She is currently an associate professor and associate chair and director of the engineering physics program at University of Colorado Boulder.

Three faculty members were recognized for their years of service to the University: **Bryan Suits** (30 years), **Donald Beck** (35 years), and **Robert Weidman** (35 years). Thank you for your dedicated service!

Several graduate students received graduate school finishing fellowships. Fall 2015 recipients were **Boyi Hao, Joseph Niehaus,** and **Noopur Sharma. Ran Duan** received the fellowship in spring 2016.

Teresa Wilson and **Chad Brisbois** received Graduate School Outstanding Graduate Student Teaching Awards.

Hao Zhao, Ran Duan, and **Joseph Niehaus** received the Graduate School Dean's Award for Outstanding Scholarship.

Michigan Tech's SPS chapter was named a Distinguished Chapter of the **Society of Physics Students**. Our chapter has been named either an Outstanding or Distinguished Chapter every year since 2009.

Heather Lewandowski (top left) and other new Presidential Council of Alumnae inductees

Recent Degree Recipients

2016	Destination
Marwa Hefny Abdalmoneam (PhD)	California Polytechnic State University
Boyi Hao (PhD)	Lam Research
Joseph Daniel Niehaus (PhD)	Texas A&M
Noopar Sharma (PhD)	Pacific Northwest National Lab
Tolga Yapici (PhD)	Michigan State
Hao Zhao (PhD)	Michigan Tech
Md Mahfuzur Rahman (MS)	—
Mary Amanda Shaw (MS)	Michigan Tech
Joshua David Hallfrisch (BA)	—
Carlo Adam Knecht (BS)	—
Logan Scott Pauli (BS)	U. of Maryland, Baltimore County
Andrew Lloyd Robare (BS)	Michigan Tech
Angela Jean Small (BS)	U. of Maryland, College Park
James Robert Spaight (BS)	San Diego State University
Cody Alexander Trevillian (BA)	Organic Farming

Recent Funding

Petra Huentemeyer is the principal investigator on a project that has received a $170,000 research and development grant from NSF. The project is entitled "Investigating Large Scale Structures and Galactic Plane Morphologies at TeV Energies with the HAWC Observatory." This is the first year of a three-year project potentially totaling $510,000.

Raymond Shaw is the principal investigator on a project that received a $120,339 NSF research and development grant.

Will Cantrell is the principle investigator on a project that received an $84,673 NSF research grant. The project is entitled "Clouds: A Synergistic Experimental and Simulation Approach." This is the first year of a three-year project totaling $263,283. He is also the co-PI on the project "EAGER: Exploring Aerosol Indirect Effects in a Laboratory Cloud Chamber." This is the first year of a potential two-year project totaling $243,869.

Two faculty members received Michigan Tech Research Excellence Fund Awards in 2016. **Will Cantrell** received an infrastructure enhancement grant and **Jae Yong Suh** received a research seed grant.

Undergraduates **Kaelan Anderson** and **Kelci Mohrman** received Summer Undergraduate Research Fellowships for 2016.

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.

Gary P. Agin
Anonymous
Edward Augustyniak '94 & Monika Sujczynska
Wilma & Keith (dec) Baldwin
William '63 & Jeanine Bazzett
Theodore L. Bedore '72
James '67 & Janet Bohren
John '69 & Louise Bretney
Ziyong '88 & Ping Cai
David '64 & Mary Carlson
Michael C. Coleman '69
Cynthia Cooper '18 & Will Cantrell
Jerry '62 & Olive Cupal
Valerie A. DeCamp '11
Konstantin '95 & Dessy Dinov
Ramy El-Ganainy
Michael Friesema '80 & Jenean Larsen
James '68 & Lynne Gekas
Kenneth '79 & Lynn Genutis
Kyle J. Gorkowski '11
Thomas '63 & Dona Gould
Joel H. Graber '87
Thomas Gray '91 & Normaleena Gray
Steven M. Handlovits '89
Frank '58 & Shirley Hastedt
Heidelberg Inst for Theoretical Studies
Thomas '92 & Heidi Hintz
Marlene & Peter (dec) Houle
Xiaoyue Huang '07
Kevin & Lisa Hyder
Stanley '70 & Christine Jefferson
Joe '60 & Ann Jenney
Philip Kaldon '88 & Deborah Morrow
David R. Kalliainen
Esther & Rolland (dec) Keeling
Peter A. Kiefer '02
James M. Kilpela '59
James '66 & Kathleen Kortge
Joyce & Arne '52 (dec) Koskela
Jason A. LaCosse '95
Jack '62 & Kaethe Labo
Samuel C. Lambert '62
Norman '61 & Sara-Jo Larsen
Edward M. Leonard '12
Ronald '56 & Judith (dec) McKee
Paul '71 & Joanne Michaels
Thomas '76 & Margaret Mohr
Dale '68 & Lauren Mukavetz
Matthew P. Nerem '12
David Nitz & Mary Marchaterre
Samuel '63 & Brenda Ochodnicky
Harold W. Paul '75
Upendra '95 & Vaidehi Puntambekar
Jeremy D. Rogers '99
Joseph Roti Roti '65 & Stephanie Pagano (dec)
Suresh K. Sampath '98
Maximilian & Mary Ann Seel
Kate Shepherd
Patricia Shepherd '80
James '63 & Janice Strahl
Glen J. Tauke '72
Steven L. Tomsovic '80
Alfred '69 & Deborah Trapanese
C. John '64 & Kathryn Umbarger
Anton '60 & Karin Usowski
Srirama Swaminat Venkataraman '98 & Kalpana Chandrasekharan
Werner '66 & Tamara Vogt
David E. Woon '84
William E. Wuerthele '66
Charles '66 & Mary Zeigler
Chunguang Zheng '97 & Yi Fu '98

Current Research *continued from page 1*

injection experiment, for example, we can observe how various cloud properties, like mean and variance of the droplet diameter, respond to different aerosol injection rates. Polluted clouds (clouds with high aerosol injection rates) have smaller droplets, while clean clouds (those with relatively low aerosol injection rates) have larger droplets. That's the result we expected, but it turns out there's more to the story.

The response of cloud droplets as they grow in a turbulent environment also leads to changes in the variance, or width, of the droplet size distribution. The width is crucial, because different sized droplets have different terminal fall speeds (due to the balance between gravitational force and the size-dependent drag force). The resulting speed differential allows for collisions between droplets, and collisions are what cause much of our rain to fall. The details are described in a paper published in November by *Proceedings of the National Academy of Sciences*.

Other studies are in the works. For example, in a twist on the steady-state experiment, we might ask, what if we turn off the aerosol injection? How long does the cloud persist and how do its properties change with time? And how does the cloud "cleanse" the atmosphere by removing aerosols during that transient response? One can think of it as an idealized version of what happens when polluted air from a populated continent is carried over the clean ocean, and clouds steadily cleanse the atmosphere, ultimately leading to clouds that exist in the "clean-cloud" regime mentioned above. The cloud chamber collaboration will continue to explore these and other questions with this exciting, unique new facility.

Students from Barkell Elementary took a moment to be silly during their tour of the cloud chamber in March.

Graduate Spotlight

Gaoxue Wang

Gaoxue Wang is a PhD candidate in the Department of Physics, working under the supervision of **Ravindra Pandey.** He joined Michigan Tech in fall 2013, after finishing his master's degree in condensed matter physics at Lanzhou University. His research interests lie in the physics and chemistry of materials. Gaoxue's PhD work focuses on the theoretical modeling of two-dimensional materials using density functional theory. He has published several papers in peer-reviewed journals, such as *Nanoscale*, *2D Materials*, *Nanotechnology*, and *Wiley Interdisciplinary Reviews: Computational Molecular Science*. Gaoxue recently finished a summer internship at Los Alamos National Laboratory. In fall 2016, he received a finishing fellowship from the Graduate School.

Gaoxue is grateful for the guidance and encouragement of his advisor Ravindra Pandey, and acknowledges all the support from the Physics Department. Gaoxue plans to finish his degree in fall 2016, and his long-term goal is to pursue a career in academia.

Faculty Spotlight

Katrina Black

After graduating from Michigan Tech in 1999 with a BS in Physics, **Katrina Black** has come full circle and joined the department as a lecturer. She earned her PhD in Physics Education Research at the University of Maine, where she focused on modeling how students in upper-level mechanics extract implicit boundary conditions from written descriptions of physical situations, and incorporate them into their problem solutions. She did postdoctoral work with the Maine Center for Research in STEM Education as part of the Maine Physical Sciences Partnership, a collaboration between the University of Maine and over 30 middle and high schools throughout the state. She facilitated middle school, high school, and university faculty in the selection process of a research-based physical science curriculum for grades 5-9.

Katrina teaches a number of physics courses in the department, but especially enjoys getting to know new physics majors in the introductory laboratory sequence. Concurrently, she's revising the intro-lab sequence to meet departmental goals for improving student skills in error analysis, maintaining lab notebooks, and scientific writing. She also serves as newsletter content coordinator.

Senior Spotlight

Ben Manning

Ben Manning is a fourth-year physics major with a minor in computer science and a focus in secondary education. During his time at Michigan Tech, Ben has had many opportunities for research and leadership development in the department. Through these experiences, Ben has acquired a fond interest for teaching principles of science and technology.

During his time in the Physics Department, Ben has been involved in two research projects under **Jae Yong Suh,** the first of which was creating gold nanoparticle monolayers using the Langmuir–Blodgett Method. The second project involved fabricating vanadium dioxide using pulse laser deposition and heat processing.

Ben has also been deeply involved with teaching and outreach in the department. He has worked with the physics demo crew—the students who help with demonstrations in physics lectures and set up the physics teaching labs—since his first year at Michigan Tech. He's been a teaching assistant for PH1091, Physics Behind Music, and PH2230, Electronics for Scientists, and he is currently the teaching lab manager, where he directly oversees the setup of all of the teaching labs in the department. Involved in a variety of outreach projects, Ben's most recent is a series of video demonstrations of physical principles that will be a teaching resource for underprivileged schools.

After graduation, Ben intends to teach high school in the Midwest and pursue a secondary degree in science education.

Staff Spotlight

Doug Wilken

Douglas Wilken is the department's new laboratory associate. His duties include coordinating the lecture demonstration team, improving and developing new demonstrations, and lab and course instruction.

Doug comes to us from corporate America, where he split his time between process engineering, product life cycle support, developing functional and predictive models of product performance, and determining failure modes. He escaped the family farm in 1981, graduating from Bethel University (BA Physics, 1985) and Michigan Technological University (MS Physics, 1988; PhD Applied Physics, 1993).

He was a postdoctoral research associate at the University of Florida, developing hardware and predictive models in the field of medical magnetic resonance imaging, and also served as an adjunct professor of both physics and electrical engineering at St. Cloud State University in Minnesota.

Michigan Technological University

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SPS students at the Max Planck Institute, from left to right: Owen Cruikshank, Colin Sheidler, Andrew Robare, Patrick Sage, Jonathan Zamaites, Logan Pauli, Robert Innis, Stefan Friesema, Floyd Johnson, Angela Small, Sam Groetsch, Nick Videtich, Ben Manning. Picture taken by Petra Huentemeyer, who accompanied the students.