PHYSICS NEWS

MICHIGAN TECH DEPARTMENT OF PHYSICS NEWSLETTER

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NOTE FROM THE CHAIR

Detecting tiny nanoparticles using optical devices is a challenging task and, in general, it requires an understanding of complex quantum optics concepts. In a recent article published in Physical Review Letters (https://doi.org/10.1103/ PhysRevLett.122.153902), Associate Professor Ramy El-Ganainy and his collaborators proposed a new design paradigm that is based on the new notion of exceptional surfaces: surfaces that consist of exceptional points. These exceptional points are singularities that arise in non-Hermitian physics and can be understood by considering an imaginary violin with only two strings. Such a violin can produce just two different tones-a situation that corresponds to a conventional optical resonator. If the vibration of one string can alter the vibration of the other string in a way that the sound and elastic oscillations create only one tone and one collective string motion, the system has an exceptional point.

We are extremely pleased to welcome Assistant Professor Elena Giusarma and Research Assistant Professor Mauricio Reyes Hurtado to the department. Elena's work focuses on developing statistical inference methods in cosmology. Mauricio uses machine-learning models to design a presbyopia-correcting intraocular lens for eye care.

We will miss former professors Dave Chimino, Don Daavettila, and Phil Parks. They had long and distinguished careers at Michigan Tech. Many of you have memories of Dave drawing perfect circles on the chalkboard in Physics class. Don and Phil were instrumental in establishing the department's nuclear physics program.

River Leversee, 2019 Department Scholar, is an example of our commitment to providing undergraduates with a solid background in the principles of physics together with extensive research experience in state-of-the-art laboratories. Working at Lawrence Livermore National Laboratory, River has published an article on his work that determines the equation of state of polymer composites (https://doi.org/10.1063/1.5108677).

This year, many new graduates receiving BS, MS, and PhD degrees have successfully started careers with the federal government or industry. Nicholas Videtich, Kevin Bertschinger, and Colin Sheidler, who graduated from the photonics group (Suh, El-Gainainy, and Levy), have accepted positions at the Naval Surface Warfare Center. Kamal Chandrakar (Shaw), Neel Desai (Shaw), and Kevin Waters (Pandey) are working as postdoctoral fellows in federal laboratories. Nathan Schlorke and Taylor Kaminski have joined GE Aviation and ArcelorMittal, respectively.

This summer, Professor Petra Huentemeyer's research group hosted two high school teachers, Matt Laird (Lake Linden-Hubbell) and Heather Murphy (Hancock). During their six-week stay, Matt and Heather developed lesson plans related to topics in astronomy to facilitate student engagement and motivation in science (http://phy.sites.mtu.edu/RETlessonplans/).

Many of these 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 (https://www.mtu.edu/physics/giving/). Your continued support is deeply appreciated.

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

CURRENT RESEARCH



Elena Giusarma

Cosmology is a branch of astronomy that studies the origin, evolution, and composition of the Universe. The standard cosmological model, also known as the Lambda Cold Dark Matter (ACDM) model, satisfactorily reproduces the observations of Big Bang cosmology. It is able to explain a large variety of observables, from the anisotropies of cosmic microwave background (CMB) radiation to the large-scale

structure (LSS) of the Universe. The model can be described by a few free parameters representing fundamental quantities, such as the geometry of the Universe, the nature of dark energy, the amount of dark matter, and the sum of the three active neutrino masses. Determining the value of those parameters will improve our knowledge of fundamental particle physics and laws governing our Universe.

Over the past decades, studies of the CMB and LSS have contributed significantly to the establishment of the standard ACDM model. However, those research programs also have posed new questions in both fundamental physics and extragalactic astrophysics: How did the Universe start and how did it evolve? What are the masses and properties of neutrinos? What is the nature of dark matter and dark energy? Can we use cosmological observables to learn about fundamental particle physics? How does the spatial distribution of galaxies, quasars, and gas trace the underlying dark matter distribution?

Assistant Professor Elena Giusarma's research strives to address all of these questions by applying advanced statistical inference and computational methods to current cosmological data. In particular, she played a leading role in studying the effects of neutrino particles on different cosmological observables. She contributed to analyzing the most recent cosmological datasets and deriving among the most stringent constraints on neutrino masses in the literature, and she has been a member of two international collaborations: CMB Planck satellite and the Baryon Acoustic Oscillation Spectroscopic Survey.

Giusarma's group is focused on developing new statistical inference methods to combine upcoming cosmological measurements and improve our knowledge of the history and composition of our Universe. The group is also interested in exploring a new approach based on deep-learning algorithms to accelerate the production of cosmological simulations. These simulations are a powerful tool to obtain rigorous theoretical predictions and analyze a large amount of cosmological data, but they are computationally expensive. The key advantage of the new approach suggested by Giusarma's group will be the ability to reduce the computational cost of generating cosmological simulations. The use of such an approach will be particularly useful in the near future where the need for fast numerical simulations will increase with the upcoming large cosmological surveys, such as Euclid and LSST.

RECENT FUNDING

Ramy El-Ganainy is the principal investigator (PI) on a three-year project that received a \$179,988 research and development grant from the National Science Foundation (NSF). The project is titled, "Collaborative Research: Non-Hermitian Wave-Mixing for Highly Efficient Nonlinear Light Sources."

Raymond Shaw is PI on a project that received a \$495,439 research and development grant from the US Department of Energy. The project is titled, "Entrainment and Aerosol Effects on Marine Boundary-Layer Clouds: An Investigation Using ACE-ENA Data from HOLODEC, G1, Pico and ACTOS." **Claudio Mazzoleni** is Co-PI on this potential three-year project.

Petra Huentemeyer is PI on a project that received a \$606,172 research and development grant from the NSF. The project is titled, "WoU-MMA: Tracing Cosmic-Ray Origin and Transport Using HAWC and Multi-Wavelength Data." This is a potential three-year project.

Raymond Shaw is PI on a project that received a \$25,840 othersponsored-activities grant from the NSF. The project is titled, "Workshop to Explore Science Opportunities and Concepts for a US Aerosol-Cloud-Microphysics Research Facility; Boulder, Colorado–Fall 2019." **Will Cantrell** is the Co-PI on this one-year project.

Issei Nakamura received a Michigan Tech Research Excellence Fund award.

Several graduate students were supported by Finishing Fellowships through the Graduate School: Janarjan Bhandari, Aeshah Muqri, Kevin Waters, Chad Brisbois, Neel Desai, Binita Hona, and Jinlin Zhang. Meghnath Jaishi and Binita Hona received a Henes Center Fellowship.

Conner Hawry and **Zackerie Hjorth** received 2018 Summer Undergraduate Research Fellowships (SURF), both under the supervision of Professor Yoke Khin Yap.



Petra Huentemeyer and **Henrike Fleischhack** hosted a Research Experience for Teachers summer program. During the sixweek program, high school teachers partnered with members of Huentemeyer's research group to create innovative high school lesson plans based on current work in astrophysics and gamma-ray astronomy. The lesson plans are available on the Research Experience for Teachers website: phy.sites.mtu.edu/ RETlessonplans

Students from the **Society of Physics Students** visited a physical science class at Houghton High School to present a variety of demonstrations. SPS and the physics demonstration crew also participated in the 21st Annual Western UP Science Fair and Science & Engineering Festival, held March 19, 2019.

John Jaszczak gave a lecture, "Magnificent Minerals and Microminerals from the Merelani Mines, Northern Tanzania," to the Walker Mineralogical Club in Toronto, Ontario, Canada.



SPS members Conner Hawry and Adam Krueger show the classic "loopthe-loop" energy demo at Houghton High School.

IN MEMORIAM

Former physics professors and Michigan Tech alumni, **David Chimino, Donald Daavettila**, and **Philip Parks** passed away in the summer of 2019. Chimino and Daavettila earned bachelor of science degrees in engineering physics from Michigan Tech; Daavettila went on to get his master's degree in nuclear physics. Parks attended Michigan Tech on a football scholarship and graduated with a BS degree in physics and a master's degree in Nuclear Physics.

Chimino was widely known for his ability to draw perfect circles on the chalkboard. Daavetilla was a friendly, familiar face at Husky hockey games, where he served as timing official for many years. Parks is remembered as a quiet, unassuming man who made many professional and community contributions. Combined, these professors served the Department of Physics and Michigan Tech for 117 years.



John Jaszczak was appointed interim chair of Michigan Tech's Department of Chemistry for the 2018-19 academic year. Jaszczak was also selected by David Hemmer, dean of the College of Sciences and Arts, as a member of the Dean's Teaching Showcase. Hemmer recognized Jaszczak's contributions to physics and the University, including large-class teaching, curriculum development, and assessment. Showcase membership qualifies Jaszczak for one of three new teaching awards from the William G. Jackson Center for Teaching and Learning.

Will Cantrell was appointed associate dean of the Graduate School, beginning spring 2019. This part-time position focuses on graduate program review and graduate student outcomes assessment.

Petra Huentemeyer and **Henrike Fleischhack** hosted the fifth Fermi-VERITAS-HAWC workshop (http://phy.sites.mtu.edu/ fvh/) May 16-17, 2019. The workshop brings together people working in gamma-ray astronomy to exchange results and plan collaborative projects.

"Life and Color," an exhibition of paintings by **Miguel Levy**, was shown at the Copper Country Community Arts Center's Kerredge Gallery in Hancock.

Atmospheric science experts Lynn Mazzoleni (Chemistry) and **Claudio Mazzoleni** traveled more than 8,000 miles to the National Institute of Technology Calicut (NIT) in the southern Indian state of Kerala. Invited by Ravi Varma, associate professor of physics at NIT, and sponsored by the Global Initiative for Academic Networks, their three-week trip was punctuated by local cultural experiences sandwiched between several academic lectures.

Jesse Nordeng was recognized for his 20-year service to Michigan Tech.

Several graduate students received awards from the Graduate School. Janarjan Bhandari, Dolendra Karki, Chad Brisbois, and Kamal Chandrakar received the Outstanding Scholar Award. Nicholas Videtich and Lisa Eggart received the Outstanding Teaching Assistant Award.

River Leversee was named the 2019 Department of Physics Scholar.

Nathan Schlorke received the 2019 Ian Shepherd Award, presented annually to the most promising senior. Alumnus *Dan Cordell* '06 (BS, Physics) presented the award.

Alumna **Heather J. Lewandowski**, associate professor of physics at the University of Colorado Boulder, received the prestigious American Physics Society Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction. Lewandowski received a bachelor of science degree in physics from Michigan Tech in 1997 and was inducted into the Presidential Council of Alumnae in 2016.

STAFF SPOTLIGHT

Mauricio Reyes joined the physics department in fall 2019 as a research assistant professor. In addition to teaching, he is involved in carrying out an analysis of data sets using deep-learning models to understand how massive neutrinos affect cosmological simulations. His projects include the development of new intraocular lens optical designs using machine-learning models to correct cataracts and



presbyopia. He also works with optical isolators.

Reyes graduated from the University of Valencia, Spain, in 2017 with a PhD in physics. His doctoral work included a modal analysis of refractive index sensors using an iterative Fourier method. Also, he has worked with natural language processing, chaos theory in optics, and artificial intelligence.

Before coming to Michigan Tech, Reyes worked as a data scientist with autonomous robots at a Silicon Valley-based startup and was an Insight Data Science Fellow at Insight in New York City. Away from the job, Reyes enjoys playing soccer, electronics, and cycling.

DEGREE RECIPIENTS

STUDENT	DESTINATION
Janarjan Bhandari, PhD	The Hormel Institute, University of Minnesota
Neel Desai, PhD	Postdoctoral Fellow, Brookhaven National Lab
Dolendra Karki, PhD	Postdoctoral Fellow, Physics, Michigan Tech
Brandon Blasiola, MS	His House Christian Fellowship,
Michael Foetisch, MS	PhD, Applied Physics, Michigan Tech
Colin Sheidler, MS	Naval Surface Warfare Center
Nicholas Videtich, MS	Naval Surface Warfare Center
Ziwei Qian, MS	Chinese Academy of Sciences
Kaelan R. Anderson, BS	Milwaukee Tool
Sam J. Groetsch, BS	PhD, Physics, Michigan Tech
Taylor M. Kaminski, BS	ArcelorMittal
Nathan S. Schlorke, BA	GE Aviation
Robert J. Stenger, BA	Lake Linden High School

GRADUATE SPOTLIGHT



Binita Hona, a PhD candidate working with Petra Huentemeyer, joined Michigan Tech in fall 2014. Her research focuses on particle acceleration in the Cygnus star-forming region and associated gamma-ray emissions. Hona uses data collected by the HAWC Observatory in Sierra Negra, Mexico, to investigate the contribution by that stellar association to the observed galactic cosmic-ray density. Hona's poster presentation on her research won the best student poster at the 8th International

Fermi Symposium, held in Baltimore, Maryland, in October 2019.

Hona received a Graduate School Finishing Fellowship for spring 2019, a Henes Fellowship for summer 2019, and a Miles Fellowship for fall 2019. She thanks her advisor Petra Huentemeyer, post-doc Henrike Fleischhack, and her research group for guidance and support throughout her studies. She also thanks the department chair Ravindra Pandey, the Henes Foundation, and the physics department faculty and staff for their support and encouragement.

GRADUATE SPOTLIGHT



Tyler Capek, a PhD candidate working with Claudio Mazzoleni, joined Michigan Tech in fall 2014 after obtaining bachelor's degrees in mathematics and physics from the University of Wisconsin-River Falls. Capek's research focuses on the remote measurement of temperature and humidity through Raman spectroscopy, as well as the measurement of the optical properties of atmospheric particles called aerosols. The results of Capek's experiments in Mazzoleni's Environmental

Optics Laboratory and Jacek Borysow's Atomic and Molecular Laser Spectroscopy Laboratory were published in Molecular Physics in collaboration with Massimo Moraldi of the University of Florence in Italy.

Capek received the 2016 DeVlieg Fellowship, as well as the 2018 Department of Energy Science Graduate Student Research Fellowship, through which he spent the fall 2018 semester at the Los Alamos National Laboratory studying the optical properties of aerosol in humidified environments. Capek also took part in the second Aerosol, Cloud and Trace Gases Research Infrastructure field campaign in Northern Italy during the summer of 2017.

Capek thanks his advisor, Claudio Mazzoleni, as well as his committee, which includes Borysow, Will Cantrell, and Alex Kostinski, for their guidance and support. Capek is also grateful to department chair Ravindra Pandey and the physics department faculty and staff.

SENIOR SPOTLIGHT



River Leversee is a fourth-year physics major with a minor in math. He has worked with the Michigan Tech Math Lab and is vice president of service for the Order of Omega Honor Society.

Leversee recently began working with Alex Kostinski on applying the Q transform to fit noisy data. As an intern at Lawrence Livermore National Laboratory, Leversee worked in the materials science division with high pressure in diamond anvil cells. His work included research on

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rotationally induced chemical reactions of organic compounds under high pressure and resulted in a paper on the equation of state of the polymer bonded explosive LX-17 up to 8 GPa.

After graduation, Leversee plans to continue his studies in graduate school with the goal of eventually attaining a PhD in physics. He also plans to continue his work at Lawrence Livermore while he finishes his education. Leversee is thankful for the support he has received from Kostinski, Elissaios Stavrou, and the physics department.

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SENIOR SPOTLIGHT



Adam Krueger is a fourth-year physics major with a minor in math. He is the president of the Society of Physics Students and previously served as its vice president. Krueger has been a member of the physics demonstration crew since his second semester at Michigan Tech and was the Orientation Team Leader for the incoming class of 2024 physics students.

Krueger's senior research, supervised by Ramy El-Ganainy, is on the thermalization of

waveguide arrays. He spent one summer in the AFRL Scholars program at Kirtland Air Force Base (AFB) in Albuquerque, New Mexico, working on the miniaturization of vacuum chambers for inertial navigation sensors, and another summer adapting a CNT furnace to grow monolayer MoS2 at the Naval Surface Warfare Center.

After graduating, Krueger plans to attend graduate school to pursue a PhD in theoretical or computational physics with the intention to return to military or national labs.

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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 **BAE Systems** Ramakrishnan Bashyam '96 & Harini Sampathkumar Theodore L. Bedore '72 **Benevity Community Impact Fund** Jacek Borysow & Katherine Cocciarelli John '69 & Louise Bretney Ziyong Cai '88 & Ping Zhou Cynthia Cooper '18 Daniel I. Cordell '06 Konstantin '95 & Dessy Dinov Eric '83 & Kari Duffin **Episcopal Diocese of Northern Mich** Brian & Janna (dec) Fick James '68 & Lynne Gekas Thomas '63 & Dona Gould Joel H. Graber '87 Frank '58 & Shirley (dec) Hastedt Stanley '70 & Christine Jefferson Joe '60 & Ann Jenney Walter '64 & Margaret Kauppila James '59 & Carole Kauppila Peter A. Kiefer '02 Joyce & Arne '52 (dec) Koskela Jack '62 & Kaethe Labo Jason A. LaCosse '95 Samuel C. Lambert '62 Edward M. Leonard '12 Robert '61 & Eugenia '64 Lind Ronald '56 & Judith (dec) McKee Paul '75 & Mary Meernik Ronald '64 & Hermine Meyer Paul '71 & Joanne Michaels Thomas '76 & Margaret Mohr

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Undergraduate students pose outside Building 33 at CERN during a spring 2019 trip. Pictured from left to right: (standing) Conner Hawry, Kenny Ritz, Cas Tuson, Noah Wilson, Megan Morganstern, Jack Harris, Ezra Cotter, Jon Berman, Alan Larson, and Jonah Haw; (kneeling) Jason Lehto and Carter Mashburn. The group was accompanied by Professor Claudio Mazzoleni.