# Physics News

MICHIGAN TECH PHYSICS DEPARTMENT NEWSLETTER

Fall 2005 Volume 7

## A note from the chair

*By Dr. Ravi Pandey*
*Professor and Chair*

Over the past decade, nanoscale science and engineering have emerged as a forefront of exciting research and technological applications. The intersecting fields of study that create this domain of science and engineering typify the rapid, multidisciplinary advancement of contemporary science and technology. The emergence of new forms of nanomaterials such as carbon nanotubes, nanowires, and precisely controlled quantum dots hold promise for future exciting technological developments.

Our department has been actively pursuing the research in the area of nanoscale science and engineering. This year, Prof. Yoke Khin Yap has been awarded the prestigious NSF CAREER Award for his project, "Synthesis, Characterization and Discovery of Frontier Carbon Materials." The NSF CAREER award is highly competitive and is selectively awarded to researchers for their dual commitment to scholarship and education. The details of the research activities of Prof. Yap's group can be viewed at ***phy.mtu.edu/yap/***. Also, the department, and specifically Prof. John Jaszczak, has led the effort to add an interdisciplinary minor in "Nanoscale Science and Engineering (Nanotechnology)" to MTU's undergraduate curriculum.

Our strategy to strengthen the undergraduate program in physics and applied physics has started showing its success in recruiting and retaining the students. We are pleased to note that the number of the students majoring in physics and applied physics is approaching 70. In Fall 2003, only 40 students were enrolled as physics majors. This increase can be attributed to a VIP treatment given to the prospective students visiting the campus by the chair and faculty members, and introduction of summer research fellowships. The department's endowment for summer research fellowships plays a very important part in this strategy, and we thank you for your continued support and interest in maintaining educational opportunities for our students.

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

## Current Research: Yoke Khin Yap

*By Yoke Khin Yap*

**CAREER: Synthesis, Characterization and Discovery of Frontier Carbon Materials:** The arrangement of carbon atoms differentiates a pencil lead from a pricey jewel. Pencil lead consists of graphite where carbon atoms are $sp^2$ hybridized for three covalent bonds. In diamonds, carbon atoms are $sp^3$ hybridized for four bonds in a tetrahedral configuration. Graphite is soft, semi-metallic, and dark (zero energy band gap), while diamond is super-hard, insulating, and transparent (band gap = 5.4 eV). In the past three decades, new carbon materials like fullerenes and carbon nanotubes (CNTs) have attracted tremendous research interest and have led to a Nobel Prize. Clearly, the change of bond hybridization and molecular packing among carbon atoms can make very exciting new materials.

Materials in the boron nitride (BN) system are structurally similar to the carbon solids. We have hexagonal phase-BN (h-BN), cubic phase-BN (c-BN), and BN nanotubes (BNNTs), which are analogous to the graphite, diamond and CNTs, respectively. However, these carbon and BN materials have different physical properties. For instance, graphite is a conductor while h-BN is an insulator.

Materials within the B-C-N triangular zone offer new vistas for materials research. They include thin films and nanostructures of carbon, or compounds constructed of multiple elements using B, C and N atoms: the smallest atoms that can form the strongest covalent bonds in solids. These materials are commonly called frontier carbon materials because of their flexibility to form various covalent bonds like those in pure carbon solids.

Within the first year of this project, we have obtained a breakthrough of growing boron nitride nanotubes (BNNTs). High growth temperatures (>1100 °C), low production yield, and impurities have prevented research progress and applications of boron nitride nanotubes (BNNTs) in the past 10 years.

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## Current Research: Yoke Khin Yap

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For the first time, we show that BNNTs can be grown on substrates at 600 °C. These BNNTs are constructed of high-order tubular structures and can be used without purification. The details of this work is now published in *Nano Letters* (*American Chemical Society pubs.acs.org/journals/nalefd/*).


**2005 Champs:** Armed with a thorough understanding of projectile motion, Team Fiziks hastened to take away the GSC Softball Championship for the second year in a row. Other teams tremble at the thought of playing against Fiziks.

# Research Sponsorship

Research funding in the department exceeded $700,000 since January. External sponsors include the National Science Foundation, US Department of Energy, Defense Advanced Research Projects Agency, Army Research Lab, Office of Basic Energy Sciences, City University of New York, and Michigan Space Grant Consortium. Michigan Tech funding includes the Research Excellence Fund.

# Awards and Achievements

Assistant Professor Yoke Khin Yap received the NSF CAREER award for his research on frontier carbon materials.

Assistant Professor Ranjit Pati was awarded the MTU Research Excellence Fund for his project, "Theory and Modeling of Molecular Electronics Devices for New Generation Information Processing Technology."

The Physics Department Graduate Committee awarded the Best Oral Presentation to Kah Chun Lau ("First-Principles Study of Elemental Boron Nanoclusters & Nanotubes") and the Best Poster Presentation to Ankita Roy ("Hyperspectral Imaging Application in Nano-Tube Growing Process") during the departmental graduate research poster session.

Joshua Anderson received the 2005 Ian W. Shepherd Award for most outstanding physics graduate.

Physics graduate student Eli Ochshorn won first prize in the annual multi-disciplinary student research colloquium and competition sponsored by the Graduate Student Council and Sigma Xi last spring. Physics graduate student Vijaya Kayastha won second prize. Eli's advisor is Dr. Will Cantrell. His presentation was entitled "Towards Understanding How Water Freezes: An FTIR Study". Vijaya is part of the Yap Research Group in the Physics Department. His presentation was entitled "Fabrication of C-MEMS/CNTs Electrode Arrays for 3D-Microbatteries".

# Senior Spotlight

*Matt Davenport*

Matt has worked with Dr. Yoke Khin Yap the last couple of years as a research assistant. He was president of the Society of Physics Students last year and is Secretary this year. The notes from meetings that Matt posts to the SPS list are always fun to read. Here's an example: "I'd also like to have an SPS craft night some time between now and the end of the semester. We've got a lot of papers we need to get rid of and Dr. Cantrell suggested we make something out of papier mâché, which I think would be turbo awesome. What we would make is entirely up to your imaginations, although a bust of Einstein and Schrödinger's Equation are among my favorites right now."

# Events

The *Physics Picnic* was held at the Houghton Waterfront Park again on a beautiful summer day, with a large turnout of faculty, staff, grad students, undergraduates, their families and friends.

The *MTU Open House* held on Sept. 17, 2005, had a marvelous attendance again this year. Families of prospective students visited the Physics Booth at the Expo and toured the nanotechnology and night sky observing labs. A multimedia exhibit of the event is online in the Physics Gallery.

The Physics department sponsored an online exhibit of the department history for the *World Year of Physics 2005*. The website was researched and coordinated by Dr. Bryan Suits. It details the surprising chronology of Physics and the campus from 1885 to present day. It can be found at: ***phy.mtu.edu/alumni/history***.

## NSF and NASA Fund Freezing

Assistant Professor Will Cantrell's NSF-funded research is to study heterogeneous nucleation of ice in thin films with a goal of improving our understanding of the fundamental mechanisms of ice nucleation. His NASA grant is focused more on determining how high molecular weight organic compounds (*e.g.* from biomass burning) may affect ice nucleation processes in the upper troposphere. Gene Wicks worked as a teaching intern with Will last summer for the educational portion of that grant.

# Recent Degree Recipients

| **2005** | **Destination** |
|---|---|
| Vasyl Aleksenko, MS | |
| Alexei Dorofeev, PhD | Louisiana State University |
| Adam Webb, MS | |
| Joshua Anderson, BS | Iowa State |
| Chee Sheng Fong, BS | SUNY Stony Brook |
| Jack McCaffery, BS | |
| David Price, BS | Central Michigan Univ |
| Paul Schou, BS | Michigan Tech |

| **2004** | |
|---|---|
| Da Gao, PhD | University of Texas at Arlington |
| Teboh Roland, MS | University of Texas Med School |
| Aaron Wilson, MS | General Dynamics, Michigan |

# Senior Research

Matt Merlo and Victor Muzzin (Suits): "Restoration of the Radio Telescopes at the Amjoch Observatory"

Matthew Mosher (Nemiroff): "Using GPS Satellites as a Gravity Wave Detector"

Dan Cordell (Brad King - ME): "Characterizing the Ion Distribution of the Michigan Tech Segmented Anode Bismuth Hall-Effect Thruster"

Patrick Phelps (Nitz): "Comparison of Simulated Air Showers from Cosmic Rays with Data from the Auger Observatory"

Eric Domeier (Beck): "Transition Energies in Gadolinium IV"

Eric Carlson (Yap): "Alignment of Carbon Nanotubes on Substrates"

Adam Kaczynski (Kostinski): "Properties of Ice Crystals from 2D Projections"

Matt Davenport (Yap): "Films of Carbon Nanotube and Zinc Oxide Nanowires as Electric Materials"

**Have you seen our library's extreme makeover?**

**It's the John and Ruanne Opie Library.**

**Spud-O-Rama:** The Honors Physics students taking PH1160 - Mechanics - with Dr. Raymond Shaw get to study projectile motion using state-of-the-art grocery items. Using ignited hairspray as a propellant and classic Idaho potatos as projectiles, our students study projectile range as a function of muzzle velocity, angle, and air drag.

# Thanks!

We extend our deepest appreciation to friends and alumni who have made recent gifts or pledges directly to the department. The response has been OUTSTANDING.. We appreciate your continued interest in the Department of Physics at Michigan Technological University.

**Alumni**

Scott & Carrie Aitken '74
Kent & Patricia Barlow '57
Louis & Dianne Marie Bartalot '71
George L. Bennis '88
Nathanael & Katrina Black '03
Robert & Faye Brooke '57
David & Mary Carlson '64
Charles & Sue Casanova '64
Roy L. Cloutier '53
Paul & Leslie Cupal '73
Carl & Phyllis Dahlman '53
Jane & Scott Darin '91
Mark D. Dewing '93
Konstantin & Dessy Dinov '95
Andrew R. Drews '84
Thomas & Judith Essig '63
John & Eugenia Evans '50
Adam C. Figon '88
Walter & Edith Gabriel '48
James & Dianna Gibson '63
Thomas & Normaleena Gray '91
Timothy & Carol Gump '72
David & Sharon Hansen '69
Frank & Shirley Hastedt '58
Lee & Brenda Herron '62
Thomas & Ellen Herron '55
Loren & Kathleen Isley '60
Mark W. Jacobs '83
Philip Kaldon & Deborah Morrow '88
Paul & Peggy Kaptur '76
Walter & Margaret Kauppila '64
Robert & Linda Kirkpatrick '60
Lorraine & Robert Klemm '70
Arne & Joyce Koskela '52
Thomas & Renee Kugler '84
Jack & Kaethe Labo '62
Samuel & Carol Lambert '62
David & Sandra Lazarus '52
Eugenia & Robert Lind '64
Ronald Liptak & Carolyn O'Hara Liptak '66
James & Mary Love '63
Robert & JoAnn Matheson '49
Dennis & Jacqueline McCal '74
Robert & Judi McEachen '68
David & Terri McLaughlin '61
Ronald & Hermine Meyer '64
Jeffrey & Suzanne Morris '84
Dale & Lauren Mukavetz '68
Patrick J. Northrop '84
Samuel & Brenda Ochodnicky '63
Gary & Charlotte Palmgren '76
Philip & Judith Parks '55
John & Valorie Parry '74
Peter & Jill Pietila '63
Lynn & Luis Sa '80
Ramakrishnan Bashyam & Harini Sampathkumar '96
Allen & Joyce Pudvan '57
Upendra & Vaidehi Puntambekar '95
Mary J. Repar '75
William & Alicia Riegel '65
Mark & Gail Shebuski '72
William & Carla Siskaninetz '88
Joseph & Stephanie Roti Roti '65
Joseph & Susan Rowe '70
Bradford & Roseann Smith '77
Burris & Katherine Smith '64
Sanjay Sood '92
Timothy R. Symons '93
Donald & Carolyn Szenina '73
John & Carol Taylor '59
Michael & Mary Ellen Teneyck '64
Michael & Tami Thom '94
John P. Thyren '94
C. John & Kathryn Umbarger '64
Bruce & Linda Webb '63
William & Kathleen Wilson '78
Jerry D. Winegarden '79
Helmut & Mary Winter '70
Larry & Patricia Wittenbach '61
Robert C. Yoder '67
Charles & Mary Zeigler '66

**Friends**

Keith & Wilma Baldwin
Winifred & Frank Blackford
Thomas Blanchard & Eve Dziak-Blanchard
Dow Corning Foundation
Kari & Eric Duffin
Paul & Elsie Hinzmann
John & Sherry Jaszczak
Maria Kelso
Mary Marchaterre & David Nitz
Edward & Nina Nadgorny
Kathleen S. Wollan

# Graduate Spotlight

*S. Gowtham*

"Learning the need, power and importance of computers in Physics, and predicting experimentally verifiable properties of new materials via computations is exciting to me. From not knowing anything in linux to being able to build/maintain a beowulf linux cluster (with much help from CEC) has definitely taught me many things." -*sg*

# Department Update

Master Machinist Dave Cook retired this fall. Dave is an excellent machinist/engineer, without whom the CONtinuous CAMeras (CONCAMs) used by the global Night Sky Live Observatory would not exist. Dave is living in Escanaba, Michigan, where he now focuses on fishing, hunting, wood carving, and consulting work. We will miss his talents and his very specialized practical jokes.

The department was fortunate to find a skilled machinist to replace Dave Cook. Jesse Nordeng has joined us as a Master Machinist, transitioning from the Mechanical Engineering-Engineering Mechanics Department to Physics.

Physics instructor Mike Meyer took over the position of Demo/Lab Coordinator after Jerry Hester found a new position out of the area. Assisting Mike is new Lab/Systems Associate Marvin Manninen.

Associate Professor Raymond Shaw has returned from sabbatical leave, where he did research at Cornell University and Leipzig, Germany.

In the past year, visiting faculty and researchers have included Dr. Johana Chirinos Diaz, Dr. Amir Jalali, Dr. Walter Nadler, Dr. Mark North, Dr. Roberto Orlando, and Dr. Ralph Scheicher.

# Sabbatical Enrichment

Professor Raymond Shaw took a sabbatical leave last year to concentrate on his turbulence research. During Fall 2004 Dr. Shaw was a Visiting Professor in the Department of Physics and the Sibley School of Mechanical and Aerospace Engineering at Cornell University. While there Dr. Shaw and MTU Physics graduate student Ewe Wei Saw studied how small particles interact with a turbulent flow using a technique known as phase-Doppler interferometry. By measuring the Doppler shifted light scattered by a particle as it traverses the point at which two laser beams intersect, it is possible to determine the speed and size of the particle. The experiment was carried out in a 15-meter-long wind tunnel with sprays for injecting particles into the flow. Air entering the tunnel is actively mixed with an array of flaps that are randomly rotated, and therefore is highly turbulent. Qualitatively the random movement and mixing of particles in turbulence is analogous to that of atoms in a gas. Dr. Shaw is interested especially in the collision rate inside this "particle gas": for example, this may help us understand the way cloud droplets collide and coalesce to form rain drops in a turbulent atmosphere. The experiments provide strong evidence that collision rates are increased as particles interact with violent fluid eddies, being flung out of vortices into more quiescent regions of the flow.

Dr. Shaw spent Spring 2005 at the Institute for Tropospheric Research in Leipzig, Germany, where he and graduate student Ewe Wei Saw took the phase-Doppler interferometer out of the laboratory and into the clouds. Using an instrument payload (called ACTOS) suspended on a 150-meter-long tether from a helicopter, simultaneous measurements of cloud droplet properties and atmospheric turbulence were made with the highest resolution ever attained in clouds. The early data analysis tends to confirm the view that emerged from the controlled laboratory experiments at Cornell: highly turbulent regions show signs of strong interaction with droplets, and therefore enhanced collision rates. Unlike the laboratory, however, turbulence in clouds is found to be extremely intermittent, with much higher chances of encountering patches of turbulence much more vigorous than the mean. This may imply that the earliest raindrops to form in a cloud originate in small pockets of highly turbulent air at the edges or tops of clouds. There's something to think about next time you take a bumpy plane ride through a turbulent cloud!

*Clockwise:* Helicopter; instrument payload: ACTOS; view from the helicopter, looking down on ACTOS, in the clouds; ACTOS takeoff.

# Nano Minor

Starting this fall, MTU students have the opportunity to work toward a new academic minor in Nanoscale Science and Engineering (Nanotechnology). Nanotechnology seeks to understand, control and use the novel properties that arise in materials when they have dimensions on the order of one to 100 nanometers ($10^{-9}$ meters) in size. In this highly interdisciplinary field, students will explore the scientific fundamentals, potential applications, and also the societal implications of what some call the next industrial revolution. Applications of nanotechnology are already making their way into the marketplace, in markets ranging from the consumer electronics industry to stain-resistant clothing, to new medicines. Students start the minor with an introductory survey course in nanoscale science and technology taught by Associate Professor John Jaszczak (Physics) and Professor Bruce Seely (Social Sciences). As part of the minor, students are required to take nanotechnology-related courses outside of their major in an area of their interest, and complete three credits of nano-related research either on campus or off campus through internships or co-op. For more information about MTU's nanotechnology research and education programs, check out *nano.mtu.edu* .

*There are many things in Quantum Mechanics that will cause you to squirm, and they should.*
-Bob Weidman, Quantum Physics I

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Michigan Technological University
1400 Townsend Drive
Houghton, Michigan 49931

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# Michigan Tech Physics Alumni - Stay Updated

We would like to stay in touch. Please tell us about yourself and whether you would like your information posted on the web.

| | Post on the Physics website? Yes | No |
|---|---|---|
| **Name** _____ | ☐ | ☐ |
| **Current position/employer** _____ | ☐ | ☐ |
| **Degree and year** _____ | ☐ | ☐ |
| **Address** _____ | ☐ | ☐ |
| **Phone** _____ | ☐ | ☐ |
| **Email/website** _____ | ☐ | ☐ |
| **Other information** _____ | ☐ | ☐ |

Feel free to attach information. If you would like to make a donation to the Physics Department, please make checks payable to the Michigan Tech Fund - **Department of Physics**. You can return this form and your donation to:

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