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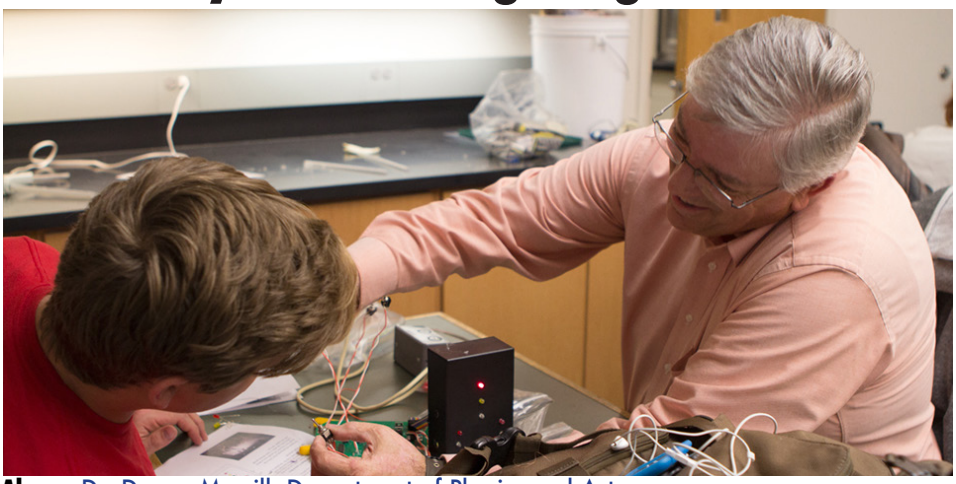
FACULTY newsletter

CPMS Physical and Mathematical Sciences

BYU's Physics Teaching Program Gains National Attention



Above: Dr. Duane Merrill, Department of Physics and Astronomy

BYU is gaining national recognition for producing more physics teachers than other colleges.

In 2014, BYU had 17 physics teaching graduates, which is more than double the number at any other university in the country.

BYU has also consistently outpaced other schools in this area for at least the past ten years. The Physics Teacher Education Coalition (PhysTEC) has recognized these numbers and awarded BYU a spot in its 5+ Club, which has 11 members this year.

According to the PhysTEC website, "The United States has a severe, long-term shortage of qualified physics teachers," so they have instituted the 5+ Club program to recognize universities that are producing teachers. Although this is the 5+ Club's inaugural year, PhysTEC went back three years to retroactively recognize all universities with more than five physics teaching graduates in a given year. BYU topped the list for at least the past five years, even though PhysTEC only recognized BYU on this year's list.

"They [PhysTEC] know what we're doing, and we appreciate their effort to share what we're doing with other people," said Duane Merrell, director of BYU's physics education program.

Merrell has spearheaded the program since he arrived at BYU in 2004, after teaching high school physics for 20 years. He graduated with bachelor's and master's degrees from Utah State University in 1985 and 1988, respectively. According to him, BYU has so many students who want to teach because of the strong culture of service here.

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Student's Nanocrystals Make Him a Wanted Man

From an underground lab on campus, an undergraduate student discovered how to harvest more energy from sunlight.

Stephen Erickson and fellow student Trevor Smith conducted and published research about how nano-sized crystals can improve solar panels.

Their lab experiments suggest that solar cells based on nanocrystals of titanium, iron, cobalt and manganese could achieve up to 38 percent solar energy conversion.

At the same time, Stephen is seeing even higher conversion rates with his graduate school applications. So far he's received offers to seek a Ph.D. from Harvard, Stanford, Caltech, Maryland, Colorado and UC Berkeley. And he credits his good fortune directly to the scientific work he's done as an undergraduate.

"When applying to top schools, everyone has good grades and test scores, so admissions committees weight research experience very heavily in their decision making process," Stephen said.

A Solar Power Problem

Solar panels provide reliable and clean energy, but they don't do it very efficiently. Most solar cells rely on silicon-based semiconductors, which harvest less than 29 percent of the available energy from sunlight. That's because silicon-based cells only convert a portion of the light spectrum into electricity. The light from wavelengths that are too long or too short is mostly unusable.

The Innovation

Chemistry professor Richard Watt is a high-energy guy with a high-energy name. For several years his research has centered on a protein called ferritin. Ferritin normally stores iron molecules. It's also hollow.

Watt and his students have been using ferritin as capsules in which they grow tiny crystals. The idea is to grow crystals that capture light that silicon misses.

Above: Stephen Erickson has conducted revolutionary solar research.

"We started off with one particle that could only absorb blue light and all the other light was wasted," said Watt, who mentored the students on the project. "The thought was if we could put another particle that could absorb red wavelengths and another that would absorb yellow and another green, we would be able to harvest most, if not all, of the energy from light."

That hope became possible when Watt joined forces with physics professor John Colton. In his lab, they can finely tune these nanocrystals to

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Announcements

Commencement
Thursday, April 23, 4 p.m.
Marriott Center
Faculty line-up north of ASB, 3:15 p.m.

Convocation
Friday, April 24, 8 a.m.
Wilkinson Student Center Ballroom
Faculty line-up WSC Garden Court, 7:30 a.m.

Funding & Publications Goals

Problem Solving in the Lab and the Classroom

Above: Dr. Mark Hughes joined the Mathematics Department as a visiting faculty member last fall.

Dr. Mark Hughes is a problem solver—that's why he's always been so interested in math.

However, now that Hughes is teaching here at BYU he has a new type of problem to solve: balancing research with teaching.

"I think you will find mathematicians who are interested in a lot of fields, but the common thread between them is that they like to solve problems," Hughes said. "They like to take what at the outset might be a complicated and a deep problem and dissect it piece by piece, seeing if they can figure out how to put it together."

Hughes received his bachelors in applied mathematics from the University of Calgary in 2006, his masters in pure mathematics from the University of Waterloo in 2008, and his PhD in mathematics from Stony Brook University in 2014. Hughes started working at BYU as a visiting assistant professor last semester after graduating with his PhD.

Despite his undergrad in applied mathematics, Hughes didn't always want to go into math. When he was in high school, he thought a career in mathematics was out of the question.

"In high school I was presented with the options of, 'If you like math, you can be an engineer, or if you are good in the sciences, you can become a doctor,'" Hughes said. "I didn't really know what other options were available if you were interested in studying math."

When he got into college, Hughes decided he would pursue a degree in physics.

"Originally I was interested in physics. I wanted to pursue that, but I knew that to do any high-level physics you needed to know a lot of math," Hughes said. "I decided to study applied mathematics for my undergrad degree, but I found that the courses I enjoyed most were not so much the applied math courses but more the pure math courses. I started taking more and more of those, and then when I applied for a masters program I decided that I wanted just to try and focus on pure mathematics instead of the applied route."

Now that he is here at BYU, Hughes is excited to teach, interact, and mentor the students in his classes.

"I have always enjoyed teaching," Hughes said. "I enjoy working with the students. When you have a student who is interested in understanding the concepts, when you can actually see when it clicks with them, and you see that they get it and actually understand it, then that's a satisfying feeling. You get to pass on that enthusiasm for math that is not as common as maybe it ought to be."

In addition to teaching, Hughes focuses his research on studying 4-manifolds, or four-dimensional shapes.

"I'm interested in how two-dimensional surfaces can be knotted or tangled and be arranged in four-dimensional space," Hughes said. "I use two-dimensional surfaces in four-dimensional spaces to uncover things about their geometry."

Throughout his schooling, teaching, and researching, Hughes has learned to apply his love of problem solving to his career.

"I think you need a good balance between (researching and teaching)," Hughes said. "I did research at a place in Germany, and . . . sometimes I'd hit a brick wall. I'd find that I wasn't making much progress. When I am working with students it can stimulate activity in my research. I think there has to be a mix of both. I learned to strike a balance, and it can be very rewarding."

By Mackenzie Brown

University 3MT: Temperature, Drifts, Antibiotics, and Batteries

Above: Jessica Alvey recieved third place in the University 3MT competition

Jessica Alvey, a graduate student in the Department of Statistics, placed third in the university-wide Three Minute Thesis (3MT) competition.

She competed with 13 other contestants at BYU's annual 3MT, where graduate students were tasked with presenting their thesis research in three or fewer minutes to a lay audience.

Students from 13 graduate programs explained their research to a large crowd and judges from several colleges in the Wilkinson Center's Varsity Theatre. Alvey's research uses statistical methods to predict missing temperature values. These values contribute to the study of long-term climate change.

"We want to take care of the planet on which we live," she said. "A key element of that is understanding these long-term trends in temperature. As we explore these methods of prediction, we plan for a better future."

The first place prize was awarded to Jennifer Craft, a civil engineering student whose presentation was titled, "Reducing Drifts in Buckling Restrained Braced Frame Buildings." Second place went to Philip Bennallack, who studies micro- and molecular biology. Bennallack presented on antibiotic biosynthesis.

This year was BYU's second year holding a 3MT competition.

"A big part of me is pleasantly surprised [with the award]," Alvey said. "I feel like this is going to become a really big tradition at BYU, and it's kind of cool to be a big part of that."

CPMS was also represented by the Department of Physics and Astronomy's Lawrence Barrett. His thesis research is an effort to create ultra-high capacity batteries.

Tyler Smith, the BYU Graduate Student Society president, said that this year's 3MT was a success.

"We've worked through a lot of kinks, and I feel like we've had a great event today with really phenomenal presenters," he said. "You can see the impact we're having on the world."

By Jennifer Johnson

Student's Nanocrystals

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capture very specific wavelengths of light. This lets them make combinations that work in a coordinated fashion.

The Future

As they write in the journal Nanotechnology, the researchers are still looking to fill a gap that silicon normally covers on the light spectrum. If they can grow a nanoparticle similar to silicon, the theoretical conversion rate climbs to 51 percent. The team also needs to design solar cells that can house four or five different types of crystals. In the lab experiments thus far, they've tested one material at a time.

Stephen's future includes graduating in April as a double major (physics and mathematics). He'll also make a tough decision on where he'll enroll for grad school.

Mentored research opportunities are a big reason why BYU is ranked so highly as a Ph.D. launch pad. According to the National Science Foundation, BYU ranks fifth in the country for the number of graduates who go on to receive doctorate degrees.

By BYU News

Teaching Moment

Dr. Jessica Purcell's teaching tip is to learn the students' names and to learn from other respected teachers. She makes an effort to call on students by name and personalize the learning experience for them.

"I love my students," Purcell said. "I try to show this by the way I interact with students in and out of class, by how I show respect for their input, their thoughts and contributions, their approach to their own learning. Our accomplishments are not what make us worthy human beings. And I need to remind my students of this, and to show them I know they are of great worth, regardless of their performance, by the way I treat them. Learning their names is just a little slice of love I can give them."

Physics Teaching Program

Continued from page 1

"I think we have more [future] teachers here than anywhere else because of that mantra, 'Enter to learn, go forth to serve,'" Merrell said. "The students here are seeing things larger than just salaries. They see things and say, 'I could be a change for good.'"

He said that both inspirational high school teachers and experiences unique to Latter-day Saints influence these students' decision to become teachers as well.

"I think missionary service has a lot to do with it," he said. "They go out, they learn to teach, they love people, and they see a need."

Merrell himself is the embodiment of this altruistic attitude. From his pre-BYU career as a physics teacher at Emery High School in Castle Dale, Utah to his service as the executive director of the Utah Science Teacher Organization, Merrell takes education seriously. Further, he works with all of his students individually from the time they enter the program until they complete their student teaching assignments.

"We take the kids that want to come, and we work with them," he said. "We take whoever comes in, and we try to make it possible for them to do this."

Merrell also said that BYU and CPMS have been great facilitators for the physics teaching program here.

"The school is invested," he said. "There's a culture that education is important at BYU."

By Jennifer Johnson

College Publications

Chemistry & Biochemistry

Hansen, L.D., Quinn, C., and Transtrum, M. K. (2015). Enzyme kinetics determined by single-injections isothermal titration calorimetry. *Methods*, Vol. 76, pp. 9–28

Nordin, P., Qaders, K., Rogers, C., and Woolley, A.T. (2015). 3D printed microfluidic devices with integrated valves. *Biomicrofluidics* Vol. 9, ID:016501.

O'Neill, K., Pagaduan, J.V., Ramsden, M., and Woolley, A.T. (2015). Microchip immunoaffinity electrophoreses of antibody-thymidine kinase 1 complex. *Electrophoresis*, Vol. 36, pp. 813–817.

Computer Science

Barrett, W. A., Bauer, K. (2015). Intelligent Pen: A Least-Cost Search for Tracing of Handwriting. *FHTW2015*.

Jones, M. D., Stephens, D. C., Hintz, E. G. B., Hintz, M. L., Lawler, J., and Bench, N. (2015). Learning the Constellations: From Junior High to Undergraduate Descriptive Astronomy Class. *American Astronomical Society, AAS Meeting #225*, 240.09.

Mathematics

Bakker, L. and Simmons, S. (2015). A separating surface for sitnikov-like n + 1-body problems. *J. Differential Equations* Vol. 258(9), pp. 3063–3087.

Mathematics Education

Jones, S.R. (2015). Areas, anti-derivatives, and adding up pieces: Integrals in pure mathematics and applied contexts. *The Journal of Mathematical Behavior*, Vol. 38, pp. 9–28.

Jones, S.R. (2015). Calculus limits involving infinity: The role of students' informal dynamic reasoning. *International Journal of Mathematics Education in Science and Technology*, Vol. 46(1), pp. 105–126.

Physics & Astronomy

Bergeson, S. D., Diaw, A., Lyon, M., and Murillo, M.S. (2015). Using higher ionization states to increase Coulomb coupling in and ultracold neutral plasma. *Physical Review E* Vol. 91, ID:033101.

Blotter, J. D., Hendricks, D. R., Johnson, W. R., and Sommerfeldt, S. D. (2015) Active structural acoustic control of clamped flat plates using a weighted sum of spatial gradients. *Shock and Vibration*, Vol. 2015, ID628685.

Hansen, L.D., Quinn, C., and Transtrum, M. K. (2015). Enzyme kinetics determined by single-injections isothermal titration calorimetry. *Methods*, Vol. 76, pp. 9–28

Jones, M. D., Stephens, D. C., Hintz, E. G. B., Hintz, M. L., Lawler, J., and Bench, N. (2015). Learning the Constellations: From Junior High to Undergraduate Descriptive Astronomy Class. *American Astronomical Society, AAS Meeting*, 225, 240.09.

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