



Summer 2011
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& Sarah Venditto

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Inside this issue:

Dr. Beecken Receives 3
USAF Research Grant

Joining the Workforce 4
with a Bethel Physics
Degree

ALPhA Immersion 7
Workshops

Physics Majors Intern 8
at 3M

Brandon Peplinski 9
and Jack Houlton
Give Award-winning
Talks

Jokes 10

Tips for Finding a Job 10
Post Graduation

The Coldest Place in Minnesota, Even in January

Student researchers in the physics department have recently used lasers and a magnetic field to cool and trap millions of lithium atoms at a temperature of a few hundred microkelvin (~0.0003 K). This temperature corresponds to lower than -272 C (-459 F) and is more than a factor of 100,000 colder than anywhere else on Bethel's campus. Such low atomic temperatures enable highly precise fundamental measurements. Laser-cooled atoms have been the gateway to relatively recent important discoveries in physics such as Bose-Einstein condensation [M.H. Anderson et al., *Science* **269** 198 (1995)], for which the Nobel Prize in physics was awarded in 2001. The Nobel Prize was awarded for laser cooling techniques in 1997.

A team of students has worked hard in the Bethel Physics department's atomic, molecular and opti-

cal (AMO) physics lab over the past few summers to build the laser cooling and trapping apparatus. The summer 2011 group included Dan Klemme ('13), Sarah Venditto ('14), Jack Houlton ('11, now at University of Colorado, Boulder in a physics Ph.D. program) and Associate Professor

Chad Hoyt. They spent long days aligning light beams from a home-built stabilized diode laser into an ultra-high vacuum chamber where they hoped to see a tiny (~0.5 mm) ball of glowing red cold atoms. On July 11 the team optimized the parameters in a complex system of mirrors, lenses,



A view of the trapped atoms in the vacuum chamber. Approximately ten million atoms are trapped by a combination of six intersecting red laser beams and a magnetic field. The red ball of atoms at a temperature of a few hundred microkelvin is approximately 0.5 mm across.

Story continued on page 2

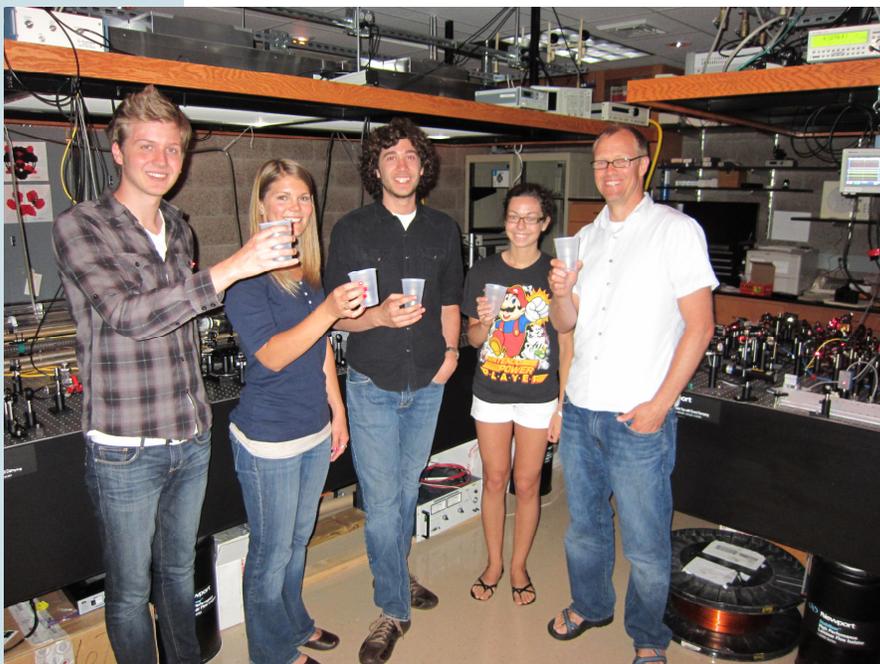
Recent Bethel Physics Grads Share Experiences Entering Workforce

During spring semester 2011, Dr. Beecken received an email from Bethel physics graduate Mark Gaalswyk containing information about job opportunities at Detector Electronics (Det-Tronics), the company where he works, and about

his career path since graduation. To quote Dr. Beecken, the email was "...almost worth gold." Mark also commented that, "I remember benefitting from other people's story of how they entered the workforce..." which inspired a

section in the PhysicsFocus on our graduates with the Physics or the Applied Physics degree. Also, be sure to look at on the back of the PhysicsFocus for tips on finding a job post graduation.

Stories found on page 4



The laser cooling and trapping research group celebrates achieving a magneto-optical trap with Sierra Mist from Royal Grounds. From left, Dan Klemme ('13), Jami Johnson ('11, now in M.Sc. program at Boise State), Jack Houlton ('11, now in a physics Ph.D. program at Boulder), Sarah Venditto ('14), Associate Professor of physics Chad Hoyt.

“A small number of undergraduate labs worldwide have achieved cold atoms in a MOT; to the group's knowledge, no other undergraduate groups have demonstrated a lithium MOT.”
-Dr. Hoyt

frequency-shifting devices, optical fibers, and a laser amplifier; with the lab lights out they looked into the chamber where six laser beams crisscrossed and saw cold atoms at their intersection (see picture). They had successfully built what's called a magneto-optical trap (MOT) [E.L. Raab et al., Phys. Rev. Lett. **59** 2631 (1987)].

The summer group estimated that they had trapped approximately ten million atoms in the MOT. Jessica Doehrmann, a senior who hopes to pursue a Ph.D. in AMO physics, has taken over the project during the fall semester and is building a system to precisely measure trapped atom temperature. Future researchers will add a second stage of laser cool-

ing using a new method called single-photon cooling [G.N. Price et al., Phys. Rev. Lett. **100** 093004 (2008)], which has the potential to

be applied to atoms and molecules previously unreachable by standard laser-cooling techniques. A small number of undergraduate labs worldwide have achieved cold atoms in a MOT; to the group's knowledge, no other undergraduate groups have demonstrated a lithium MOT.

Funding for this ongoing project has come from Bethel's Edgren Scholars program, an Alumni Grant, the Natural Sciences Division, Bethel University, the Minnesota NASA Space Grant Consortium, Creative Integration & Design, Inc. and the generous support of several private donors. See people.bethel.edu/~hoycha for more information such as pictures and a complete list of past student AMO physics researchers who have been essential to this project.



The Bethel Physics summer crew having fun freezing a banana with liquid nitrogen. Pictured: Bryan Wallin, Jack Houlton, and Sarah Venditto.

Dr. Beecken Receives United States Air Force Research Grant

Our very own Dr. Brian Beecken spent his summer helping the Air Force Research Laboratory/Space Vehicles Directorate design satellites and other spacecraft, such as unmanned space probes to Jupiter, so that they last longer. He has received a two-year award of \$80,271 from the Department of the Air Force. Dr. Beecken is developing a computer model for charge buildup in insulators on satellites in order to predict when the insulators are likely to discharge. Satellites high above the protective atmosphere and the earth's magnetic field are hit by high-energy electrons that burrow into the satellite's insulators and build up over time. When the insulators discharge, serious damage is caused and often the satellite fails.

Over the next two years, Dr. Beecken, who started this effort as a NASA Fellow during the summers of 1999 and 2000 working at NASA's Jet Propulsion Laboratory in Pasadena, Calif. and has also worked on it as an Air Force Fellow in Boston during the summers of 2008 and 2009, will partner with Bethel students to model the damaging effects of the electron radiation. Since 1999, he's worked with 7 Bethel students on this research, and this last summer he worked fulltime with junior physics major Bryan Wallin. Dr. Beecken



A classic shot of a young Dr. Beecken teaching in the general physics lab.

Photo by Dr. Peterson

has presented some of his preliminary results with former student researcher Jordan McIver ('09) at the 2010 International Spacecraft Charging Technology Conference in Albuquerque, NM, and was recognized as having the "Best Paper of the Session." Another paper was presented jointly with Bryan Wallin last July at an American Institute of Aeronautics and Astronautics conference in Honolulu, HI. Currently, a collaboration with Utah State University is being developed.

"Dr. Beecken's strong research record and involvement of students in his research makes it fitting that he should be awarded Bethel's first federal contract. His commitment to both research and teaching

courses in the physics major and in our general education curriculum are qualities that make Bethel such a great place for students to learn," says Deb Sullivan-Trainor, Bethel's associate dean of general education and faculty development for the College of Arts and Sciences and director of sponsored programs and research for the university. "I am pleased that this award will provide an opportunity for both Dr. Beecken and Bethel students to engage in research for the next two years."

Heather Schnese contributed to this article.

**"His commitment to both research and teaching courses in the physics major and in our general education curriculum are qualities that make Bethel such a great place for students to learn."
-Deb Sullivan-Trainor, Dean**

Mark Gaalswyk

Mark Gaalswyk graduated from Bethel in December 2006 with a B.A. in Physics. He had applied and been accepted to the Masters program for Mechanical Engineering at the University of Minnesota (UMN) and was set to begin in January 2007. However, about a month prior to graduation, he handed out a few re-

sumes at a UMN career fair and received an offer a few weeks later to join an engineering rotation program with the United Technologies Corporation Fire and Security (UTCFS). Mark cancelled his Masters program and went to work for UTCFS where they rotated him between three companies over the next two years as a de-

sign and test engineer. The companies were Det-Tronics in Bloomington, MN (Flame and Gas Detectors), Forney Corporation in Dallas, TX (emissions monitoring systems), and Kidde R&C in Mebane, NC (Portable Fire Extinguishers).

Mark has now been back at Det-Tronics for about two years, initially working with the Flame and Gas detection team and then moving to the Compliance Engineering group about a year ago. The Compliance Engineering group is in charge of getting all the necessary third party approvals so that their products can be sold in hazardous locations and making sure the products are designed to meet those test requirements. "Approvals is a whole different world, but is challenging and new, which keeps me interested," said Mark. In fact, Mark also mentioned that they were looking to hire someone into his group, and the newest member turns out to be Laurel Bestland, who graduated from Bethel this past spring (more below).



Mark and his family in front of their home in Lakeville, MN

Laurel Bestland

Laurel Bestland graduated in May 2011 with a B.S. in Applied Physics and a B.A. in Mathematics. Near the end of June, she was hired by Det-Tronics as a Compliance Engineer. About 60% of Det-Tronics products are sold to customers outside the US. The company is growing and has a well known reputation in their industry for producing reliable products.

Laurel's job as a compli-

ance engineer is to test each product Det-Tronics makes (both new designs and revisions to previous models) to the regulation standards of agencies around the world to confirm the performance and quality of each product and its components. Each country they sell products to requires different product certifications. Laurel works with various engineering departments to design and per-

form tests on location and at offsite facilities in order to write formal test reports for each product manufactured that will satisfy necessary requirements. Those test reports are then sent to an agency for approval. If the model fails the approval or the tests before the report is sent in, the design of the model or test must be modified and the process repeated. Each of the tests performed must be wit-

Story continued on page 5

nessed by authorized personnel, which are the compliance engineers.

Laurel found this job through an email forwarded to her by Dr. Beecken from one of her now fellow compliance engineers and Bethel Physics alum, Mark Gaalswyk. As per their advice she sent her resume in and had a phone interview the next day. The following week Laurel had a three and a half hour personal interview with five engineers, took a test to show her abilities in problem solving, computational and electronic work, and was hired the week after. "I am overwhelmed with how blessed I

am by receiving this job," said Laurel as she recognized that the Bethel physics professors were an important influence in her getting this job. "The fact that I had more than 'cook book' lab experience behind me was an incredible asset..." she said. Laurel also credited the Career Services department at Bethel for assisting her in creating an attractive resume. Additionally, she included some information about technical theater work that she had done, which impressed interviewers and showed them that she was able to think globally and beyond the science perspective.

Josh Zierhut

Josh Zierhut began working for Measurement Technology Laboratories (MTL) in Bloomington, MN a few weeks before receiving his B.S. in Applied Physics in May 2011. His job title has been somewhat fluid since he works for such a small company, but most recently his boss introduced him as a Systems Engineer and Software Programmer.

MTL is mostly concerned with weighing masses, particulate matter on a filter, less than two and a half micrometers in diameter with 100 nanogram resolution. They use a wide variety of techniques to increase the accuracy of their measurements including a buoyancy correction to account for the buoyant force of the air that the filter displaces as it sits on a balance. They also use strips of Polonium 210 to neutralize static charge on the filter

that attracts it to the base of the balance, causing it to read heavier than it should.

At MTL, Josh is in charge of the filter weighing software, which controls the motions of a robot that weighs filters, records filter weighing data and environment data in a database, creates reports for the Environmental Protection Agency, and many other things.

So far, Josh has had many opportunities to travel with his new job. He has traveled to Illinois to fix a weighing chamber made by MTL for a Fiat Powertrain. In California, Josh helped build a clean room for the California Air Resources Board where his biggest contribution was wiring the room with Ethernet and serial cables and setting up three massive granite weighing tables to minimize vibration. In Iowa, Josh fixed a robot



The detector pictured in center is a model X3301 multi-spectrum IR flame detector manufactured by Det-Tronics. This detector, mounted on an offshore oil platform, monitors the environment for IR emissions signals and outputs an alarm if the detected IR is consistent with an active flame. Pictured in the background is a flare stack used for burning excess or unusable product. The detector is pointed away from this flame source as it is not a fire of interest.

that had broken and to collect a list from the University of Iowa of bugs and advice on MTL's software. He also went to Indiana to perform some tests for Cummins Customer Information Center in their new wing of their building to see if the site would be suitable for weighing filters since they have 1,000 liter engines running nearby. Josh also hopes to go to London to do some database cleanup for Ford UK and write a new driver for a chilled mirror hygrometer for Perkins Engines. He may also go to Michigan in the near future.

"The fact that I had more than 'cook book' lab experience behind me was an incredible asset..."
-Laurel

**“The job is very exciting and I'm learning a ton every day.”
-Jeff Helget**

Jeff Helget

Jeff Helget, graduate of Bethel in May 2010 with a B.S. in Physics, now works as the lead mechanical engineer for a medical devices company called Exceleron Medical, Inc. The company is based in White Bear Lake, MN and specializes in compression stockings and garments, pulsed electromagnetic therapy, continuous positive airway pressure (CPAP) masks, and now the brand new filtration division of which he is the lead engineer. His division is designing and manufacturing various filters for different applications, from *high-efficiency particulate air* (HEPA) filters for oxygen concentrators to CPAP filters.

Jeff works with three other engineering consultants from sister companies associated with Exceleron. They design and review filter housings, set up and design

the manufacturing process, and build and test prototypes using various lab equipment to test for flow rates and filtration efficiency. They also design and review sound attenuation for hospitals so that machinery is muffled as much as possible because loud equipment is undesirable in that environment. Currently, they are finalizing their designs for their first three HEPA filters that will be used on oxygen concentrators. Prototypes are being made through the stereolithography process were tested this summer.

Jeff has also worked on designing steel cut dies to use with a large hydraulic Preco Press to cut filter media into various shapes, and he is also designing the equipment layout of the process of spooling the filter media through the press, extracting the cut-out filters,

placing them into a receptacle, and spooling the waste into a bin.

“The job is very exciting and I'm learning a ton every day,” said Jeff, shortly after starting his job as Exceleron. “They've given me quite a bit of responsibility, which can be a little bit overwhelming without the industry experience and the fact that I have a physics background and not an engineering one, but it's going very well so far and I'm loving it!”

Jeff heard about this job from a friend at his church that is the head of information technology for the mother company of Exceleron. This opened the door for an interview. Jeff said that “After searching for a year, it's exceedingly evident that it's not what you know, but who you know. Network, network, network!”

Brandon Brunkow

Brandon Brunkow graduated in December 2010 with a B.S. in Applied Physics. He is currently working on building his own financial practice with Northwestern Mutual. Brandon found Northwestern Mutual after looking at several different financial firms. They clearly stood out as the best. “I got the job by doing some simple LinkedIn networking and finding someone who worked there

and asking them to sit down with me and explain what they do,” said Brandon. “I loved the sound of it...” Peter Fanchi, who is also a Bethel grad and Northwestern Mutual representative, introduced Brandon to Scott Wolf, who is now their managing director in Edina.

Brandon works with people on an individual basis to make sure that their financial future is secure. This

can be protecting against financial risks that life has to offer by doing proper insurance planning. It also means saving for the future in appropriate tax-efficient vehicles. He does personal planning to inform families of what they need to know in order to make sure that they are not walking into a financial disaster, either right around the corner or 40 years from now.

Physics Department Hosts Advanced Laboratory National Workshops

The Bethel Physics department was chosen to host recent 3-day workshops as part of the 2011 Advanced Laboratory Physics Association (ALPhA) Laboratory Immersions. The immersion program, which is supported by ALPhA, the National Science Foundation, and the American Association of Physics Teachers, was established to provide college and university faculty and staff with intensive hands-on experience in advanced experimental physics instruction.

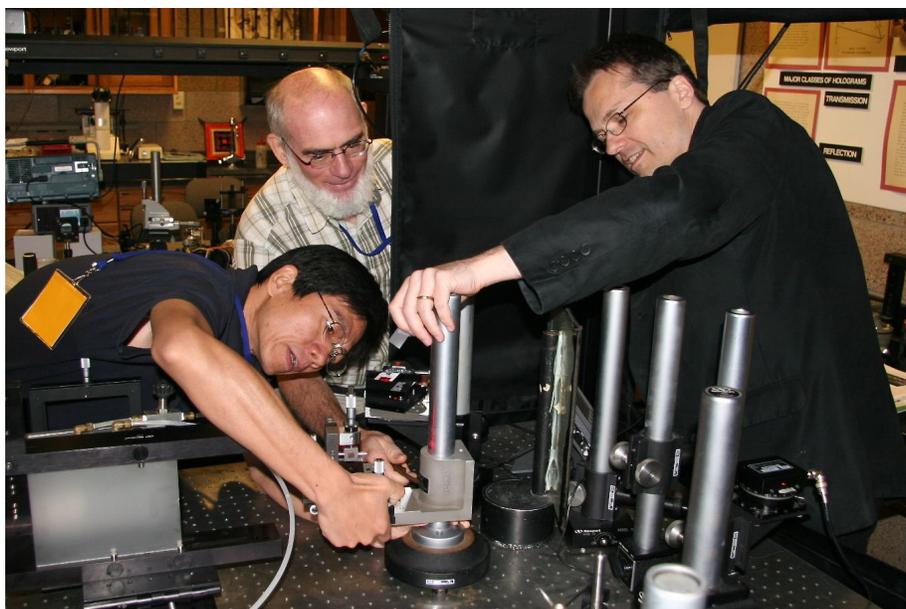
Bethel's invitation followed from its national reputation for advanced laboratory work and research in physics and engineering, with student project work starting in the first year of General Physics and progressing through advanced lab experiences in many upper-level physics courses. The Bethel ALPhA immersion included experiments that

have been topics of recent student projects. Workshop mentoring by Bethel professors included an "External Cavity Diode Laser" and "Laser Wavelength Meter" by Dr. Hoyt, "Holographic Measurements" by Dr. Peterson, and "Imaging of Shock Waves and Compressible Flows" by Keith Stein. In addition to the faculty mentors, undergraduate physics students Ben Heppner, Dan Klemme, and Sarah Venditto had important supporting roles in the overall success of the workshops.

The workshops included physics instructors from institutions like Carleton College, University of Pittsburgh, University of Texas, University of Minnesota, and seven other universities across the country. Other 2011 ALPhA immersions were being hosted at Cal Tech, Reed College, Colgate University, and the University of Rochester.



Sophomore Ben Heppner assists workshop attendees as they learn about compressible fluid flow.



Dr. Peterson's real-time holographic interferometry group does battle with spatial filters.

Photo by Dr. Peterson

Bethel Physics Students Intern at 3M as Technical Aides

This year the department had four students tell us about their experience working for 3M. Although most of what they do is company

proprietary, they were still able to share an overview of what they worked on while working as a Technical Aide. Some of them, including

Caleb Nelson (pictured below), also shared their stories in the Society of Physics Students Pizza and Research Talk Night this fall.

Caleb Nelson

Caleb works for Corporate Research and Development in the Corporate Research Materials Lab. He works with a lot of photosensitive material, so he spends many hours working in Red or Yellow Labs mixing chemicals and solutions and applying these layers (and other layers) onto substrates. Some of the work needs to be done in clean rooms as well, so he gets to suit up just like in the movies. He has also done quite a bit with waveguides and making "signs" that are clear except for certain letters or



Caleb presenting his work with 3M at the Society of Physics Students Pizza and Research Talk Night.

symbols that they sandblast into. His project involves a lot of electroplating, back-

side grinding, and flow rates.

"The job has been an excellent experience so far. More than anything, it has been beneficial to break out of the classroom to experience and observe the 'real' working world."

-Ben Stein

Ben Stein

Ben works in the Display and Graphics Business Lab at 3M. He tells us, "The job has been an excellent experience so far. More than anything, it has been beneficial to break out of the classroom to experience and observe the 'real' working world."

As far as the science goes, he does most of his

work in electronics and computer science with some work in optics. He mentioned that, "Google and Wikipedia are an absolute Godsend when it comes to solving problems." Ben has also developed some stronger lab practices and learned a good amount of electronic theory. Also, the job has

given him many great opportunities to learn even more of LabView, plus Java, and even Android programming.

Ben said that, "All in all, the job has been great for me. Though I feel like I contribute to the company, I have also spent lots of time learning and developing as a worker."

Matt Robbins

Matt is currently exploring different things that can be done using 3M projectors, projection films, and mirror films. 3M is hoping that these things can be used in advertising for large companies although there could be other applications as well. For a while, he also worked

on outdoor displays that have increased brightness in sunlight. He works with one other technical aide and his boss, who is a research specialist. The other technical aide and Matt both work on trying to make different ideas work through experimentation. They build a lot

of prototypes and take optical measurements. He also has his name on an invention which could become a patent down the road. He tells us, "It has been good to experience what research is like at a large company and how the business side of things affects the research."

Tim Peterson

Tim is working in Corporate Research and Process Labs (CRPL), more specifically in the Laser Processing group. They have a variety of different laser systems that are used for different proc-

esses including cutting, micromachining, microwelding, marking, drilling, etc. Tim has gained good technical experience in optics, machine vision, and prototyping for production sys-

tems. He tells us, "I am enjoying my time at 3M and having fun working with some cutting-edge laser systems."

Jack Houlton and Brandon Peplinski Awarded for Outstanding Talks

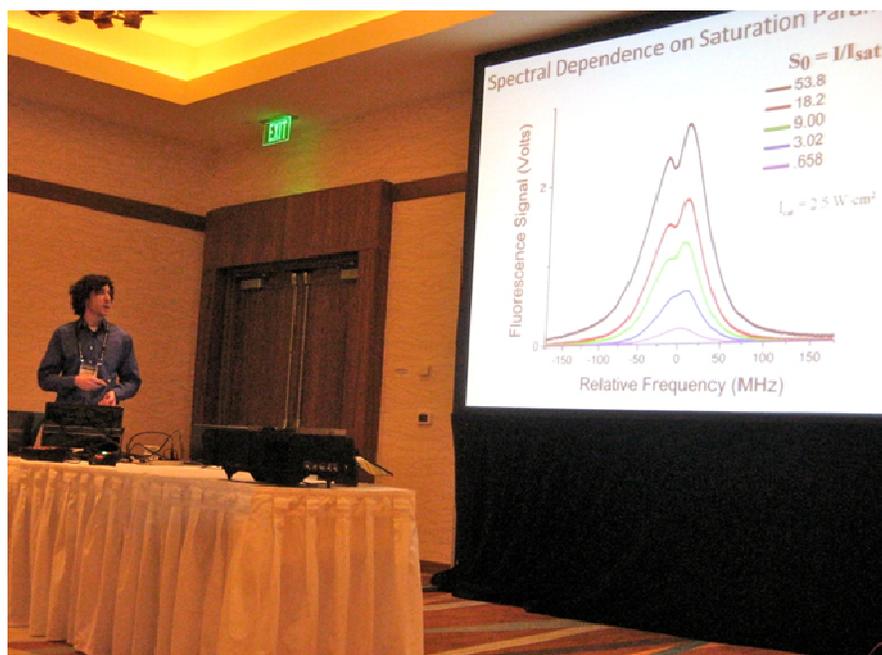
On April 30, 2011 a paper presented by Jack Houlton at the National Meeting of the American Physical Society (APS) in Anaheim, CA was awarded the national first prize for "Outstanding Presentation of Undergraduate Research." On that same day, Brandon Peplinski also presented that same paper and won the "Best Student Presentation Award" at the Minnesota section of the American Association of Physics Teachers meeting at Saint Mary's University in Winona, MN. A faculty judge described Brandon's presentation to Dr. Chad Hoyt, in the following note: "We were frankly impressed with his ability, his level of comfort making the presentation, and his broad-based understanding of the various pieces of the project ... he did a great job."

The paper, *Lithium atomic beam spectroscopy and phase sensitive detection using a diode laser*, follows from work in Bethel's atomic, molecular, optical (AMO) physics laboratory as directed by Dr. Chad Hoyt, Associate Professor of Physics at Bethel. In addition to Dr. Hoyt, other co-authors of the paper included Bethel students Lau-

ren Otto and Daniel Klemme and Professor of Physics, Dr. Thomas Greenlee. Another Bethel physics faculty member, Dr. Keith Stein, collaborated on the results presented at the conference. This work with undergraduate majors in Physics and Applied Physics has been supported by continuing funding from the Minnesota NASA Space Grant Consortium and Creative Integration & Design, Inc.

Jack Houlton's travel to the conference was funded

by a national award from Society of Physics Students, the Future of Physics Days (FPD) Travel Award. Both Jack and Brandon recently graduated with a B.S. in Physics in May 2011. Jack has accepted a Fellowship and Tuition Waiver at the University of Colorado, Boulder where he will be pursuing a Ph.D. in Physics. Brandon has accepted an offer to join the Biomedical Engineering Ph.D. program at the University of Minnesota with full funding.



Jack Houlton presenting at APS conference in California.

Photo by Dr. Peterson

Bethel University Physics & Engineering Newsletter

Newsletter article and photo submissions to Dr. Beecken (beeabri@bethel.edu) or Dr. Stein (k-stein@bethel.edu) are welcome and appreciated.



JOKES

A farmer is having problems with his chickens. They are all getting very sick and he doesn't know why. After trying all conventional means, he calls a biologist, a chemist, and a physicist to see if they can determine the cause. The biologist looks at the chickens, examines them a bit, and says he has no clue what could be wrong. The chemist takes some tests and makes some measurements, but he can't come to any conclusions either. So the physicist tries. He stands there and looks at the chickens for a long time without even touching them. Then, all of the sudden, he starts scribbling away in a notebook. Finally, after several gruesome calculations, he exclaims, "I've got it! But it only works for spherical chickens in a vacuum."

<http://cas.bethel.edu/dept/physics/>

Job-finding Tips from Bethel Physics Grads Who've Done It

"Many of the Detector Electronics openings say that some experience is required, but that is not always true. If a job requires say, 1-5 years experience, it's a pretty safe bet that a good candidate with no experience would get hired as long as their degree background matches the description; if, on the other hand, the job description is asking for 10+ years experience, 0 years probably won't cut it. I think it is a good idea for potential job seekers to apply for the job that is the best fit at each company they are interested in. I would discourage though, applying for multiple jobs at the same company, at the same time – that is pretty easy to spot and I think the resume is really only going to get one good look anyway."

-Mark Gaalswyk

"I would suggest to everyone to utilize the free services of Career Services. They helped me whip my resume into shape so well that one of the engineering managers I interviewed with said my resume looked very impressive. I assure you that majority of the credit of that was due to how it was laid out. Use their services. They're very helpful and you will not regret it. Also, I had on my resume, almost by accident, some information about some technical theatre work that I've done. That got more than one remark and gained me brownie points. The artistic component portrayed my ability to think beyond science and see things from different perspectives. A global thinker. Put different things like this on your resume if you can. Various jobs

and other things are assets to you and will show the company you're able to think beyond the science perspective. Companies will appreciate this ability because it is profitable for them to have more global thinkers within employees."

-Laurel Bestland

"Never rule out a job based on your major! I was a physics major now working in finance and absolutely loving it. I would say that I value the education that Bethel has to offer because it prepared me to be a holistic person capable of performing many different tasks in a diverse career. I undervalued a liberal arts education until I graduated and now comparing my skills and knowledge to individuals that came from non-liberal arts background I can

see that I am more capable of adapting to new situations and learning information in many formats.

"Don't underestimate the power of networking! When I was applying for positions I got around 10/11 of my interviews by simply going LinkedIn and finding places I would like to work and seeing if anyone I knew worked there. The other one was from a post on monster.com and ended up being some sort of sales scheme."

-Brandon Brunkow

"After searching for a year, it's exceedingly evident that it's not what you know, but who you know. Network, network, network!"

-Jeff Helget