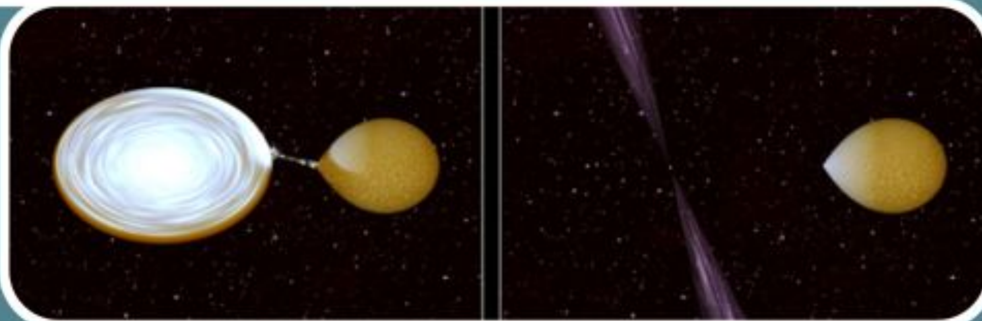
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Volume 8. Issue 1. Jan 2010.

Physics & Astronomy News

Pulsar Missing Link

See how a unique double-star system helps explain millisecond pulsars Page 3

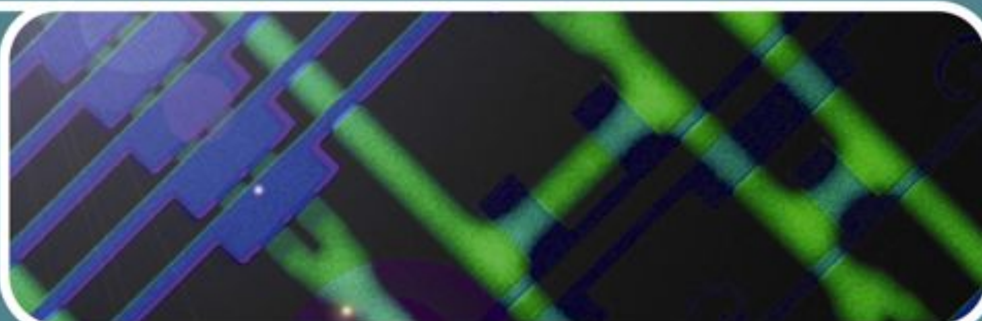


New Hebb Labs

Learn how the renovated Hebb laboratories get students talking and thinking Page 5

Microfluidics

Discover how microfluidic technology helps researchers study complex molecular dynamics Page 6



PLUS

Message from the Head . Edward Auld . The Human Orrery . Faraday Science Show . Summer Camps . Student Updates . Black-Hole Experiments . Thirty-Meter Telescope . Transitions . Faculty and Staff Awards . Quick News . Erich Vogt's Last Class .

Message from the Head

Since this is my first "Message from the Head" I would like to start by thanking Jeff Young for his outstanding leadership over the past six years. Jeff guided the department through a period of considerable change and growth that saw many new members joining the department. At the same time undergraduate enrolment has risen, our graduate student numbers have roughly doubled, and funding opportunities such as grants from the Canada Foundation for Innovation have fuelled growth in our research activities.

We are now entering what will surely be a challenging decade that is starting out with all levels of government as well as the university facing financial challenges. The task at hand for all of us is to nevertheless continue to innovate and excel in our research and teaching. There are many reasons to be optimistic about the department's future despite the pressures that we face, and these can be readily seen in the pages of this newsletter. For instance, there is currently a renaissance under way in the department's teaching activity. Funding from the Carl Wieman Science Education Initiative and other sources within the university have enabled us to bring the findings of modern research on physics education to our undergraduate courses. A key resource for this is a group of 'Science Teaching and Learning Fellows' (STLFs) who work alongside faculty members to develop new teaching methods and to assess their impact on student learning. An example appears here in an interview with Peter Newbury, an STLF working with several faculty members to develop ways to get students in our large astronomy courses to engage more actively in their own learning. Many other courses are undergoing similar changes, from our first year service courses all the way to our senior classes. Our commitment to innovative teaching is being recognized and supported in very concrete ways. The renovation of a floor of our Hebb teaching laboratories was funded jointly by the Faculty of Science and the UBC central administration and the success that we are already having with this modern space makes a good start towards the case for future infrastructure needs.

Another reason for optimism that can be gleaned from these pages is the incredible depth of talent that we have here. We are an unusually broad department with programs in physics, astronomy and engineering physics, coupled to research activity across this wide spectrum. This ranges from the highly applied work on microfluidics for biomedical research described in the article on Carl Hansen's laboratory to far-flung astronomical research such as Ingrid Stairs's work on pulsars. Our faculty members, postdoctoral fellows, staff and students are involved in everything from low temperature experiments on ultracold gases and quantum dots to the high-energy frontier that is about to open up at the Large Hadron Collider at CERN. They are involved in satellites being launched for astronomical observations and earthbound facilities such as beamlines at the Canadian Light Source and at TRIUMF. This diverse activity displays the capacity and commitment everyone in the department has to tackle the challenges that lie ahead.

Doug Bonn, Professor and Head

INSIDE

CONTACT US

Dept. of Physics and Astronomy
6224 Agricultural Road
University of British Columbia
Vancouver V6T 1Z1
604-822-3853
www.phas.ubc.ca

EDITORIAL INFORMATION

Editors:
Jeremy Heyl
heyl@phas.ubc.ca
Theresa Liao
communications@phas.ubc.ca

The Physics and Astronomy News is published once each year. The deadline for submissions to the January 2011 issue is 1 December 2010.

The newsletter is also available at our website, http://www.phas.ubc.ca; if you would like to receive your copy electronically, please let us know.

You are receiving this newsletter because you are an alumnus or alumna of the department, or because you subscribed to the newsletter. If you would like to be removed from the subscription list, please contact us at communications@phas.ubc.ca.

A Celebration of Ed Auld's Life

Professor Emeritus Edward Auld passed away on November 22. Ed will be sorely missed in the Department of Physics and Astronomy. Acting Head of Department and former Director of Engineering Physics Jeff Young delivered this tribute at Ed's Celebration of Life on 18 December 2009.

I don't take a lot of photographs or keep many mementos, I never have. Yet every day, I look up from my computer screen and see a faded image of Ed surrounded by "the class of '97". Until one year ago, it was a subconscious decision that kept that photo from enjoying a longer life deep within some drawer; it just happened to be there.

But when I moved offices, it certainly was a conscious decision to place this image front and centre. The reasons why are what I would like to share with you on this day of remembrance.

First, because it shows off the spontaneous, natural smile that always appeared on Ed's face while he enjoyed the company of students. The same smile, I might add, that you can see hanging on the third floor wall in Hennings, in his graduation photograph. I mention this because Ed was a staunch defender of having class photos displayed prominently in the department. Any suggestion that photographic records of our alumni might be better placed elsewhere, were immediately mercilessly quashed by 'Doc Auld'.

Ed was utterly committed to the well being of all past, present and future engineering physics students. Second, because the photo shows a group of students who are clearly enjoying their evening with Ed as much as he is! The love affair was most definitely mutual, because students could not help but appreciate the care and attention lavished upon them. What was best for the students' academic, social, leadership, or creative development came first; rules and regulations notwithstanding.

The outpouring of emotion from the students at the ceremony celebrating Ed's 18 years as Director of Engineering Physics will always stick in my mind.

Third, although the photograph was taken at a downtown restaurant at the end of term, it reminds me of the annual open house that the Aulds hosted for the engineering physics community during the term. Those were very special evenings, with every nook and cranny of their home filled with people talking or playing a variety of games, treats and beverages in hand.

The entire Auld family is an important part of the Engineering Physics community.

In reviewing these individual reasons why I keep this photo prominent, the common denominator is obvious. From most of my mentors and colleagues, I have learned how to do various things. While knowing how to do things well is important, many of us, and even some computers, can be easily trained to do things.

Ed was different, he taught me to understand the real reason why we do the things we do: to aid, in every way possible, the development of bright young students into well-rounded contributors to our society.

It is, in my experience, a small subset of people who have a powerful, altruistic purpose that drives everything they do. Ed was most certainly a member of this elite group.

To finish, I would like to share something I found on the internet. If you Google 'Ed Auld', the first page of hits has a link to the blog of an Engineering Physics alumnus, who states simply,

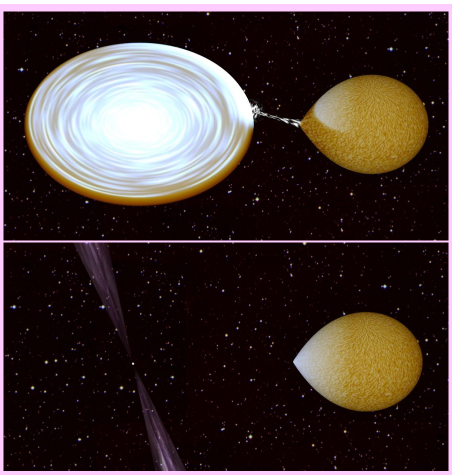
"Ed Auld made a big difference in my life. I'm gonna miss him",

and I hear hundreds of echoes.

Ed Auld is holding a photograph of Canadian astronaut Bjarni Tryggvason Photo Credit: Stephen Forgacs; UBC Archives

Pulsar Missing Link

In a June 12, 2009 *Science* article, scientists including UBC PHAS's Ingrid Stairs describe a double star system in which there is one "normal" (though low-mass) Sun-like star and one rapidly-spinning millisecond pulsar (a neutron star emitting beams of radio waves). Accretion of material onto the neutron star is thought to be the origin of the rapid rate of spin.



The upper panel depicts the system in 2000 while it was accreting. The lower panel shows after the accretion had ceased in 2009; the millisecond pulsar has turned on, connecting the millisecond pulsar to an x-ray binary. Credit: Anne Archibald and Joeri van Leeuwen

The millisecond pulsar, called PSR J1023+0038, or J1023 for short, was discovered in a 2007 survey by the National Science Foundation's (NSF) Robert C. Byrd Green Bank Telescope (GBT) in West Virginia. The astronomers retroactively found that the object had been detected by NSF's Very Large Array (VLA) radio telescope during a large sky survey in 1998, and had been observed in visible light by the Sloan Digital Sky Survey in 1999, revealing a Sun-like star. However when observed again in 2000, the object had changed dramatically, showing evidence for a rotating disk of material, called an accretion disk, surrounding the neutron star. By May of 2002, the evidence for this disk had disappeared.

"This strange behavior puzzled astronomers, and there were several different theories for what the object could be," said Stairs. A similar type of binary system, with a normal star accreting matter onto a fast spinning neutron star, but not emitting radio waves, is known as Low-Mass X-Ray Binary (LMXB). J1023 appears to be the 'missing link' connecting LMXBs and millisecond pulsars: "...this thing has flipped from looking like an LMXB to looking like a pulsar, as it experienced an episode during which material pulled from the companion star formed an accretion disk around the neutron star. Later, that mass transfer stopped, the disk disappeared, and the pulsar emerged" explained Scott Ransom of the National Radio Astronomy Observatory (NRAO). The theory of binary stellar evolution predicts that the companion star should eventually turn into a white dwarf.

This collaborative research was accomplished by a large team which was led by Anne Archibald, a graduate student at McGill University, and included Ingrid H. Stairs (UBC), Scott M. Ransom (NRAO), Victoria M. Kaspi (McGill), Duncan R. Lorimer (West Virginia/NRAO), Maura A. McLaughlin (West Virginia/NRAO), and others.

Ingrid leads a team at UBC dedicated to finding and understanding pulsars and their companions. Current pulsar search work includes a large-scale survey at the 300-m Arecibo telescope in Puerto Rico, the drift-scan survey at the 100-m Green Bank Telescope that discovered J1023 and a new large-scale survey of the Northern sky, also with the Green Bank Telescope. Much of Ingrid's follow-up work involves pulsars in binary systems. Ingrid was on sabbatical leave at the Australia Telescope National Facility and the Centre for Astrophysics & Supercomputing, Swinburne University of Technology when J1023 was identified and followed up.

Source: NRAO Press Release.

Made You Think

Engaging Students in Their Learning An interview by Alice Cassidy, Editor, Tapestry

This is a story connecting events that took place in 1609 and in 2009 and connecting typical activities faculty members do. In this case, attending a conference and reading a journal article and connecting what more and more of us are doing: devising innovative, yet simple, ways to engage our student for enhanced learning. I asked Peter to explain.

As I walked through the Irving K. Barber lobby the week of January 19, 2009, I saw a sign "Astronomy class underway". What course was it and who takes it?

It was the tutorial component of Astronomy 310, a course for non-science majors. There are 280 students in total, with about two thirds of them from the Arts, a quarter from Commerce, and the remainder from a variety of other disciplines. We have four teaching assistants and three weekly 50-minute lectures. Every two weeks, groups of 40 students attend a 50-minute tutorial.

There were bright colours on the floor in concentric circles, and lots and lots of people gathered around. It looked pretty lively. What were they doing?

Students were building a human orrery. An orrery is a mechanical model where the planets orbit the sun when you turn a crank. In our version, students walking around the sun play the role of the planets in the solar system. Or, more accurately, the solar system as Galileo knew it. In commemoration of Galileo's first use of a telescope to explore the sky in 1609, the project is part of worldwide celebrations of 2009 as the United Nations-designated International Year of Astronomy.

We wanted to replicate what he saw, so our orrery includes only the planets visible to the naked eye, Mercury, Venus, Earth, Mars, Jupiter, and Saturn.

Has this course always included such activities?

No. For the fairly long time it has been offered, the tutorials involved worksheets and computer work. Students followed along on their own, filled out the worksheet, and left it to be marked. Recently, in my work as a Science Teaching and Learning Fellow (STLF), we started to think of more interesting tutorials that were also based on clearly defined learning goals. There is a grade associated with the tutorial and we want them to be as active and engaging as possible.

This course and Peter's position are supported by the Carl Wieman Science Education Initiative (CWSEI; http://www.cwsei.ubc.ca), a $12 million initiative headed by Nobel Laureate Carl Wieman aimed at systematically improving and scientifically measuring the effectiveness of undergraduate science education. Peter, who has been a STLF since April 2008, is no stranger to the course, having taught it at UBC as a lecturer in the past.

How did you first conceive of this activity?

The Armagh Observatory in Northern Ireland designed an orrery as an outdoor exhibit on the observatory grounds. I have never been there, but I read about it in Astronomy Education Review http://aer.noao.edu/cgi-bin/new.pl. Operated by the American Astronomical Society and fairly new (the first issues were published in 2002), this is one of the only journals dedicated to astronomy education research. And I figured there must be a way to use it in our course, so students could act out the roles of the planets.

What exactly were the students doing in the 50-minute tutorial?

First they built the orrery. The TAs, Ronald Gagne, Melanie Gendre, Martha Milkeraitis, and Thomas Pfrommer, gave a three-minute introduction on how to do it, then turned it over to the students. Once it was built, we asked for volunteers. So, one student might be a planet and hold up a stick with a picture of Saturn. The coloured markers on the floor are numbered to show how far each planet moves - every 16 days for the inner planets and 10 times slower, every 160 days for the outer planets. When the student stepped from marker to marker, they were acting out both speed and distance.

And how else were they actively engaged?

We designed it so that during construction everyone had a specific job. Once acting out the roles of planets, some participated and the rest watched, laughing at poor Mercury flying around the sun and at Saturn and Jupiter who barely moved at all. Later, when we explored the solar system beyond Saturn, everyone walked past Uranus, Neptune, and Pluto and right out of the building past the clock tower to reach the spacecraft, Voyager. Many students were amazed how far they'd walked.

Also, assessment was a critical component of their involvement. After they explored the solar system as a group, each student filled in a worksheet. The questions were designed such that they had to go back and interact with the orrery model to answer the questions. And though they filled it in individually, they could work together. And they know they get marks for their work.

There seemed to be a lot more than the 40 students in the general area. What do you make of that?

Over the course of the week we ran it, we had the students and TAs from our course, plus about 100 spectators who were walking through, going up or down the stairs, and stopping to watch. They were accidentally engaged! As I said to myself, and would have liked to have said to them, "Aha, made you think!"

At our recent annual Learning Conference on the 4th floor of the Irving K. Barber Learning Centre, another open space, I noticed the same sort of effect. People were coming to the top of the stairs on their way somewhere else, but stopping for a bit to see what was happening on the stage.

In fact, it was my attendance at that conference and associated Celebrate Learning Week that planted the seed of the idea to run the orrery tutorial in a public space. When Gary Poole, Director of TAG, introduced special guest speaker Lee Shulman, he commented on the crowd forming at the edges.

Can you say a bit about how your work as an STLF connects research, teaching, and learning?

Science educators, in astronomy and elsewhere, are continually reminding us that it's not what the instructor does that matters - it's what the students do for themselves. With that in mind, I designed the orrery activity and the other tutorial activities so that the TAs guide and prompt, but the students do all the exploration and discovery for themselves. In addition to working with the course instructor, Harvey Richer, to create learning goals for the course and these tutorial activities, I am involved in a research project that is part of the CWSEI work. To see if the students learn anything from these activities, we ask them to answer questions about astronomy both before and after they do these new tutorial activities. Early findings are very positive, with up to a 50% increase in correct answers about the size of the solar system and motion of the planets after students have done the human orrery tutorial.

Thanks Peter. And I am certain your 280 students thank you too.

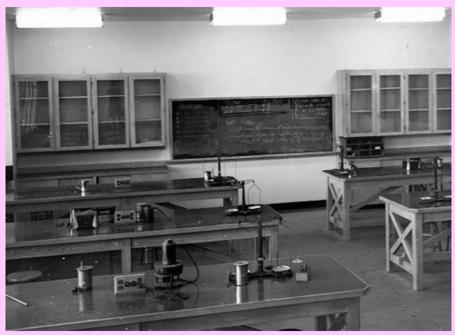
The complete article was originally published as Cassidy, Alice. 2009. Peter Newbury - "Made you Think: Engaging Students in Their Learning. An interview by Alice Cassidy. First published in Special Faculty Sharing Issue of Tapestry. 2009. Issue 54. Page 16. University of British Columbia; http://www.lead.ubc.ca/newbury.

Students revolving about the orrery.

Renovated Hebb laboratories bring student learning experience to the next level

After several months of renovation, the new Hebb laboratories welcomed their first group of student users in September, 2009. With evidence-based pedagogical technique of Peer Instruction built into the lab layout, new Hebb labs are our latest tools to encourage student thinking and learning.

"The main idea is to have the students decide for themselves how to approach an experiment," said Dr. Georg Rieger, course coordinator for Physics 100. The new lab benches (or "islands"), which accommodate 6 students in 3 groups of two, facilitate discussions not only between lab partners, but also between groups. "Students can freely exchange ideas with one another about the concept under study, and help each other learn about how science is done (collaboratively) and how conclusions are reached and come to be accepted (through peer review)," said Dr. James Day, course coordinator for Physics 107. With the new layout, TAs and instructors will be able to address the three groups at the same table simultaneously, as well as easily walk around to listen in on student discussions.



Physics laboratory in 1947

Other than the layout, the upgraded audio-visual equipments also enhance teaching and learning. Overhead cameras allow for small demos at the front to be projected onto two screens for all the class to see. In addition, the two projector screens can be used independently, giving instructors additional flexibilities in the materials presented (for example, one screen can be showing instructions and the other can be showing the spreadsheet students are to do analysis with). Access to wireless internet in the room enables students to bring their own laptops to the lab and run analysis using software that they are familiar with.

This renovation project was funded by the University Investment Fund and the Teaching and Learning Fund. A number of PHAS faculty and staff were involved in planning and supervising the construction and completion of the labs: Jeff Young, Doug Bonn, Jon Nakane, Fran Bates, Andrzej Kotlicki, Joseph O'Connor, Domenic Di Tomaso, Sing Chow. Many others contributed comments and ideas.

Acknowledgement: We would like to thank Drs. Georg Rieger, James Day, and Andrzej Kotlicki for contributing to this article.

Hebb laboratory just before the renovation

Hebb laboratory after the recent renovation.

Mastering Microfluidics: Small, Powerful, Precise Tools for Biomedical Research

by Mari-Lou Rowley

Biophysicist Carl Hansen develops microfluidic technology to help biomedical researchers study the complex molecular dynamics in cellular networks and cell-to-cell variations in cellular response. These tiny but powerful tools can monitor and modulate single cells en masse — eventually leading to advanced diagnostics and treatment.

Recognizing and understanding the interplay of environmental influences with an organism's genome and development is a critical aspect of systems biology. Another is coming to terms with heterogeneity. No two cells are the same. Even if they are identical genetically under the same conditions, they behave differently, and traditional chemical screening techniques cannot detect these cell-to-cell differences.

Some Biomolecular Basics

Genomics: The study of genes and their function in an organism's entire genome, or all the hereditary information encoded in deoxyribonucleic acid (DNA).

Proteomics:The study of the structure and function of all proteins encoded by the genome of an organism.

Polymerase Chain Reaction (PCR): A powerful technique in which DNA polymerase is used to amplify a piece of DNA by in vitro (test tube) enzymatic replication. PCR is used in molecular biology to generate millions of copies of a DNA piece in order to decipher the sequence, analyze the function of genes, and perform genetic manipulations for the study of genomics and proteomics.

Biological systems are very different from physical systems, explains Carl Hansen, UBC assistant professor in biophysics and biotechnology. The heterogeneity, or variability, of cells makes them very difficult to measure and analyze. If you look at an average of cells in a sample, you don't capture what is happening in small but often critical populations of cells, which may have a critical effect on the whole system. "It is becoming increasingly clear that reductionism doesn't work. Understanding gene function requires us to address the surrounding network architecture," he says.

To help biomedical researchers decode the complex interaction of genes and proteins that create and sustain living systems, Hansen has to think big and work small. Big, in terms of being at the forefront of systems biology, an emerging research field that studies the interacting networks of genes and proteins comprising all organisms, from a yeast cell to a human being. Small, in terms of developing microfluidic tools that allow researchers to isolate and study the reactions and interactions of single cells in different biochemical environments simultaneously (see text box).

"Soft" Plumbing Yields Firm Results

The field of microfluidics was spawned by the integrated circuit (IC) industry, using the same micromachining tools that create microchips in the production of miniature fluid channelling devices. The most common application of this technology is inkjet printing. Since its emergence, the field has promised to revolutionize molecular biology, DNA analysis and proteomics.

However, hard materials such as silicon and glass used to build microchips are not well-suited for making hermetically sealed valves required for manipulating the nanolitre volumes of solution needed for analyzing cells. "Electronics is all about moving charge around, so a transistor is the fundamental technology," Hansen explains. "Molecular biology is about moving fluids around, so a valve, or fluid switch, is a fundamental component from which larger functionality can be built."

Hansen and his lab are developing multilayer soft lithography (MSL) which uses replica moulding of non-traditional "soft" materials to create highly integrated networks with thousands of active valves, pumps and logic gates. "The reason MSL is so robust and reliable is because the whole device is soft – about 100,000 times softer than silicon. Even if I had an imperfection nearly the size of the channel itself, I just close the valve and it deforms around it to make a seal."

Not only is it reliable, but MSL is cheap and fast — from computer design of a device to working prototype takes a few days. "Once we have a valve, or fluid switch, we can put three of them together and make a pump to move fluids along a channel. Once we have a pump, we can make a mixer," says Hansen. "We can also make valves in binary structures, so we can control a large number of channels with a small number of valves to allow fluidics multiplexing. This is similar to addressing one of 6 million transistors in a Pentium chip with only 64 pins." MSL is the technology platform behind all of the research projects in Hansen's lab. Their work exploits new capabilities in microfluidics to further a broad range of biological and biomedical research, including stem cell science, medical diagnostics, proteomics, single cell analysis, and genomics.

High-Throughput Single Cell Analysis of Protein Signalling

Understanding how cells interact and communicate with each other (cell signalling) is one of the most complex problems in molecular biology. Particularly challenging for signalling studies is the ever-present cell-to-cell heterogeneity, which cannot be captured in genomic analysis, where typically a large ($> 10^6$) number of cells are observed simultaneously. Multilayer soft lithography (MSL) is poised to revolutionize next-generation DNA sequencing and analysis – tools crucial for genomics and proteomics.

UBC biophysicist Carl Hansen is developing technologies that couple live-cell microscopy with microfluidic control over the chemical environment. His group's current device can monitor eight strains, or genetic mutations, simultaneously in 32 different chemical environments. "We can do 256 live-cell imaging experiments and generate millions of data points in a day, and that allows us to ask new and quantitative questions about how gene knock-outs affect cellular response and variability under conditions of time-variant stimulus."

Through joint funding of Western Economic Diversification Canada, Genome BC, and UBC, the Hansen lab is currently building a dedicated nanofabrication facility that will allow for both the prototyping and production of microfluidic devices. This lab will be the only facility of its kind in Canada, and, along with Stanford, one of only two in North America.

Digital PCR for Advanced Diagnostics

Accurate clinical diagnosis and prognosis of disease such as cancer requires the ability to detect and measure the abundance of certain strains of nucleic acid – either DNA or RNA – in cellular tissues. Digital polymerase chain reaction (PCR) is the current gold standard technology in molecular biology. "PCR is a very powerful tool but limited in its ability to detect rare mutations or resolve small differences between molecules because it picks up background noise or sample contamination," explains Hansen. "You have to be a wizard to reliably amplify a single molecule in a conventional format in a macroscopic volume."

For Hansen, a macroscopic amount of liquid is much smaller than test-tube sized. Conventional PCR uses 96 wellplates, in which every reaction is around 50 microlitres. Even so, it is extremely difficult to amplify a single molecule, and conventional reagents at that small volume are expensive – roughly $1.00 per assay.

Hansen and his lab are developing digital PCR technology that that uses microfluidics to reduce sample volumes exponentially, and thereby improve accuracy. The state-of-the-art in digital PCR is a device sold by Fluidigm, which uses soft valve technology to allow for reactions in ten nanolitre volumes at a density of approximately 10,000 reactions per chip.

In terms of many diagnostic problems, however, this is not enough. Hansen's group is working with industry partner Fluidigm to improve the economy, precision and sensitivity of digital PCR by going 1,000 times smaller – to ten picolitre volumes, or the volume of roughly ten cells – with 1 million "wells" on a single chip. Compartmentalization of a single molecule in a 10-picolitre well results in a highly effective concentration, which facilitates amplification and detection of each molecule. "Conventional PCR can detect a 30 percent difference in molecules of a sample. With digital PCR at ten-picolitre volumes, we can unambiguously detect a 1-percent difference," says Hansen. "In areas of cancer research, metagenomics, pathogen detection, and prenatal diagnostics, this precision translates into early detection and the ability to see very rare molecules."

Hansen's research has applications in several fields, including biomarker discovery, drug development, environmental genomics, personalized medicine, and stem cell research. "One thing I like to stress is that we are working on applications, so we know most of our projects will work in principle before we start," he says. "We have been very fortunate at UBC to have access to a group of outstanding life science researchers who see the potential of this technology. In my mind, this is the most important ingredient for success."

Reprinted with permission from an article by science writer and poet Mari-Lou Rowley (Pro-Textual Communications), published in Issue 2, 2008 of Synergy, Journal of UBC Science.

Safe Detection of Down's Syndrome

Down's syndrome is one example of a diagnostic application for digital PCR. Children with Down's syndrome have an extra copy of chromosome 21, resulting in impaired cognitive ability, physical growth and development. Depending upon the age of the mother, between one in 100 to one in 1,000 fetuses will test genetically positive for Down's syndrome. In amniocentesis, currently the definitive test for Down's syndrome, fetal cells are collected from the amniotic sac inside the uterus. It is an invasive and dangerous procedure for both mother and child.

Clinicians and researchers have discovered that during the first trimester of pregnancy, between 2 to 6 percent of DNA cells from the developing fetus end up in the mother's blood stream. The ability to detect small imbalances in chromosome number within a large background of maternal DNA raises the possibility of non-invasive testing. Very recently, two strategies have been advanced for this purpose. The first is based on shotgun sequencing of DNA, which is expensive. The second is based on detecting unique sequences of RNA arising from genetic variability between the mother and the fetus, which is difficult to generally apply and requires more complex biochemistry. "In principal, by performing millions of reactions in pL volumes, digital PCR provides an economical test to directly measure DNA differences in the abundance of less than 1 percent," says Hansen. Ultimately, this work could lead to a simple, economical, and highly accurate blood test for Down's syndrome.

Quick News continues here from page 11.

MOST NASA Guest Observer

The MOST (Microvariability & Oscillations of STars) microsatellite recently finished observing a target proposed by astrophysicist Dr. John Monnier of the University of Michigan. Monnier, the first NASA "Guest Observer" to use MOST, is an expert in taking 'pictures' of stars through a technique known as interferometry.

NASA, the operator of a number of space telescopes, all of which are larger than MOST, recognised that MOST's unique abilities would be of benefit to American astronomers. Thus a collaboration between the MOST teams, the Canadian Space Agency, and NASA was established to allowed NASA guest observers use of the Telescope.

Bruskiwich recognized

Graduate student **Patrick Bruskiewich** has been awarded a Certificate of Recognition from Federal Member of Parliament Marc Garneau. M. Garneau you may remember is a former astronaut and head of the Canadain Space Agency. The award recognizes Patrick's many contributions to government debate and public issues, including the recent controversy surrounding our satellite program and Radarsat-2.

Alumni awarded

Frans Pretorius (a student of Matt Choptuik) has won the APS Aneesure Rahman Prize for Computational Physics for his work on the collision of two black holes.

Helge Seetzen (a student who worked with Lorne Whitehead) was awarded NSERC's 2009 Innovation Challenge grand prize.

Unruh named Perimeter Chair

Bill Unruh, has joined Stephen Hawking and other eminent physicists as a Distinguished Research Chair at the Perimeter Institute. The citation points to Bill's "seminal contributions to our understanding of gravity, black holes, cosmology, quantum fields in curved spaces, and the foundations of quantum mechanics, including the discovery of the Unruh effect."

Faraday 2009: Toys

Winter is a season of celebration — celebrating the coming of a new year, the end of exams, and the time to spend with family and friends. Once every year, the Physics & Astronomy Outreach program puts on the year-end Faraday Science Show - founded in the spirit of physicist Michael Faraday's "Children's Christmas Lectures" at London's Royal Institution. In this we celebrate scientific discoveries, and share the excitement of physics phenomena through simple explanations and fun demonstrations.

This year, on a cold but sunny afternoon, more than 320 children and parents showed up for the Faraday Show. The theme surely got many kids excited - the Physics of Toys. The show started with Dr. Rachel Moll discussing how Newton's cradle works through the transfer of energy. Dr. Andrzej Kotlicki then followed with many cool remote control toys, such as the car that climbs walls, a huge helium filled silver blimp, and a hovercraft. Dr. Chris Waltham together with a volunteer from the audience demonstrated how a toy like "speak and spell" can pronounce letters from the alphabet. The show ended with Dr. Janis McKenna talking about bubbles — their shapes, sizes, and colours. Prompted by our questions, many kids gave good explanations on how their favourite toys work. Of course, we had some wonderful graduate student volunteers helping out as well, setting up many hands on activities for those who arrived early.

The Faraday Science Show is an annual event, and we look forward to sharing our excitement for physics with more children in the coming years! For more information about the Faraday Show, visit http://www.phas.ubc.ca/outreach.

Janis McKenna launches some bubbles into the audience.

Learn Science in a Social and Fun Environment – Phenomenal Physics Summer Camp

Children are born with a sense of awe and wonder about the world around them. Hands on science activities and learning science in a social and fun environment are powerful ways to foster their natural curiosity and stimulate their interests in science.

This year, 120 children from Grades 2 to 10 participated in the annual Phenomenal Physics Summer Camps, organized by the Physics & Astronomy Outreach Program. Students engaged in fun scientific activities designed to encourage thinking and experimenting. They experimented with electricity, designed hovercrafts, constructed Martian habitats, conducted chemistry experiments and played with tornado tubes and musical instruments. We didn't forget to ensure everyone had the opportunity to enjoy some physical activities, such as pool sessions (some with scuba diving) and outdoor games. All camps concluded with a physics science show and liquid nitrogen ice cream party.

The Phenomenal Physics Summer Camps team includes certified teachers, physics faculty, graduate students and high school volunteers. Camps are run annually during July and August. To learn more about the summer camp program, or other events and programs run by the Physics & Astronomy Outreach Program, visit http://www.phas.ubc.ca/outreach. Registration for 2010 camps will open in March 2010. Sign up for the Outreach Program Newsletter on our website to receive the latest information about the summer camp program.

We would like to thank Rachel Moll, Summer Camp Coordinator 2006-2008, for contributing to this article.

Launch a bottle rocket on a sunny day.

Learn about fluids by building tornado tubes.

Make liquid nitrogen ice cream.

Undergraduate Studies

At this year's CAP University Prize Examination two Physics & Astronomy students fared exceedingly well. Placing first, nationwide was **Cedric Lin** a 3rd year Honours Computer Science and Physics Program student. **Alan Robinson** (BSC (Honours Physics), Year 4) placed 5th overall.

Cedric Lin was also the UBC high scorer on the 2008 Putnam exam for the third year in a row, this time placing in the top 15 in the entire competition (out of a total of 3,627 participants).

Some other honours garnered by our undergraduate students are:

Faculty of Science Achievement Award
Alan Robinson

Wesbrook Scholar
Farzin Barekat

Thomas and Evelyn Hebb Memorial Scholarship
David Macneill and Oren Rippel

Dorothy Gladys Studer Memorial Scholarship
Farzin Barekat

Gordon Merritt Shrum Memorial Scholarship
Cedric Lin

Physics and Astronomy Undergraduate Scholarship
Mohammad Bavarian

W.H. Macinnes Scholarship in Physics and Mathematics
Dennis Huang

Paul Sykes Scholarship in Astronomy
William Gunton (2008W)
Chenchong Zhu (2009W)

Bruce Marshall Prize
Si Fang Chen

Arthur Crooker Prize
Chenchong Zhu

Canadian Undergraduate Physics Conference - First Prize Talk
Ashley Cook

Canadian Undergraduate Physics Conference - Second Prize Poster
Ronald Gagne

Engineering Physics

At last year's Christmas party faculty, staff and grad. students volunteered to honour and thank Jeff Young for his years of service as the director of engineering physics and then as the head of department. The twenty-minute skit took hours of planning and rehearsals. We would like to recognize Bryce Burger, Doug Bonn, Francis-Yan Cyr-Racine, Stephanie Flynn, Charles Foell, Kim Tkaczuk Fugate, Derek Gagnier, Bridget Hamilton, Javed Iqbal, Salena Li, Janie McCallum, Jon Nakane, Hailong Ning, Ron Parachoniak, Mary Ann Potts,Philip Stamp, Mya Warren, and Bernhard Zender for all their hard work.

We would also like to recognize the award winners for the Engineer Physics Project Fair 2009.

Roy Nodwell Prize
Walker Eagleston, Christopher Eagleston and Will Motz

Edward G. Auld Prize
Milenko Despotovic, Dorian Gangloff and W. Lloyd Ung

Eric Roenitz Prize
Shawn Hanna and Kenneth Ng

Graduate Studies

Some honours garnered by our graduate students are:

Faculty of Science Achievement Award
Mya Warren

Dante Ciccone Memorial Scholarship in Astronomy
Thomas Pfrommer

NSERC Vanier Scholarship
Stephan Ettenauer

NSERC Canada Graduate Scholarship (Doctoral)
Erika Chin, Ramandeep Gill, Mark Ku, Sergey Zhdanovic

NSERC Postgraduate Scholarship (Doctoral)
Thomas Hammond, Nahid Jetha, Eric Mills, Alexander Morriss-Andrews

NSERC Canada Graduate Scholarship (Masters)
Charles Clements, Natasha Holmes, Liam Huber, Todd Mackenzie, Wai-Hin Ngan, Alan Robinson, Bretta Russell-Schulz, Jared Stang, Andrew Wilson

NSERC Postgraduate Scholarship (Masters) Barry Chai, Jacob Cosman, Ryan McKenzie, Warren Ung,

UBC's Pacific Century Graduate Fellowship Matthew Hasselfield, Gilad Rosenberg

UGF/Four Year Fellowship Si Chen, Joshua Grimes, Tyler Hughes, Raveen Kumaran, Chang Wei Loh, Chloe Malbrunot, Dominic Marchand, Ali Mohazab, Brad Ramshaw, Jonathan Rosen, Stephen Swedish, Zhihuai Zhu

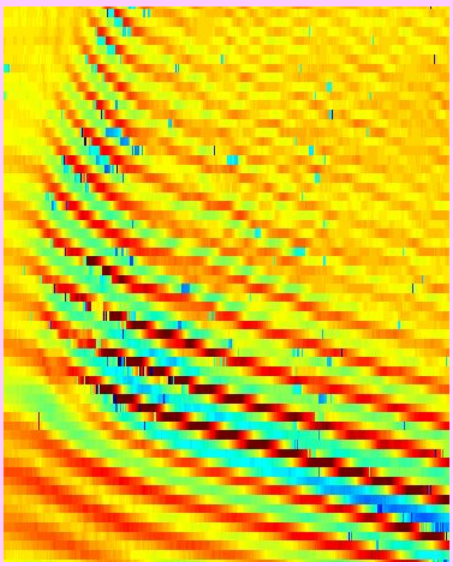
UGF Martha Milkeraitis, Sanaz Vafaei

Black-Hole Experiments

by Silke Weinfurtner

In 1981 Bill Unruh showed that the equation of motion for sound waves in a convergent fluid flow is given by the same mathematical expression as for a wave equation in an metric spacetime geometry. It is possible to set up sonic horizons in transsonic flows, and thus in principle to mimic experimentally the black-hole evaporation process. Almost 30 years later we (Bill Unruh, Matt Penrice, Mauricio Richartz and Silke Weinfurtner) have started a joint project with the Civil Engineering Department (Greg Lawrence and Ted Tedford) to set up an experiment at the University of British Columbia to find out if indeed it is possible to detect (traces) of black hole radiation.

Instead of looking at sound waves we focus on surface waves on water flowing over an obstacle. The flow velocity increases as the water flows over the top of the obstacle the propagation speed of the surface waves decreases as the depth of the fluid decreases, and we are able to set up a region of supercritical flow in which the fluid flows faster than the velocity of those surface waves. The region of supercritical flow is bounded by an analogue of black and white-hole horizons. Surface waves inside the critical region are dragged downstream even if they are trying to move upstream, and therefore surface waves can only enter the supercritical region from the black hole horizon. A wave propagating upstream in the region beyond the "white-hole" horizon" cannot pass the white-hole horizon. For our experiment we generate shallow-water waves or long-wavelength surface waves, and send them upstream toward the white-hole horizon.



Waves travel from the right to the left and then bounce off the white-hole horizon.

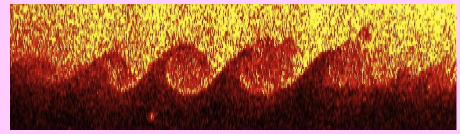
They slow down, and are compressed as they travel toward that horizon, until their wavelength becomes so short that the upstream velocity of the waves is less than the fluid flow velocity. These short wavelength waves then are swept away from the that horizon by the fluid flow. There turn out to be two possible such short wavelength waves — called positive and negative norm waves, which roughly correspond in this case to waves with positive or negative phase velocity. The creation of the negative norm waves is the classical counterpart to the quantum Hawking radiation one would expect to be emitted by a black hole.

The main purpose of our experiment is to check the robustness of Hawking radiation against the model dependent deviations as they arise in our water analogues. The effective field theory for surface waves is an example of how quantum field theory arising from the full theory of quantum gravity could change at small scales. While it is very unlikely that our toymodel is teaching us details of how actual field theories might look like at small scales, the robustness of the black hole evaporation process against the model specific deviations would ensure our trust in effective field theories around black holes.

Thirty-Meter Telescope

UBC Professor Paul Hickson is the project scientist for the NFIRAOS facility adaptive optics system for the Thirty-Meter Telescope (or TMT). TMT will employ an actively controlled segmented primary mirror and laser adaptive optics to achieve a resolution ten times greater than that of the Hubble Space Telescope. Its combination of a 30 meter aperture and adaptive optics will make it 100 times more sensitive than the largest current telescopes, opening new scientific frontiers. The TMT is expected to detect and study the first luminous objects in the Universe, follow the history of galaxy evolution over all of cosmic time, probe the dense cores of star forming regions, and study planets orbiting nearby stars.

At UBC research for the TMT not only focuses on the far reaches of space but also on the far reaches of Earth's atmosphere. Graduate student Thomas Pfrommer under Professor Hickson's supervision has built a sodium lidar to study the sodium layer in the upper atmosphere 74 to 120 km above sea level at the edge of space, the most powerful system of its kind. Lidar probes the extent

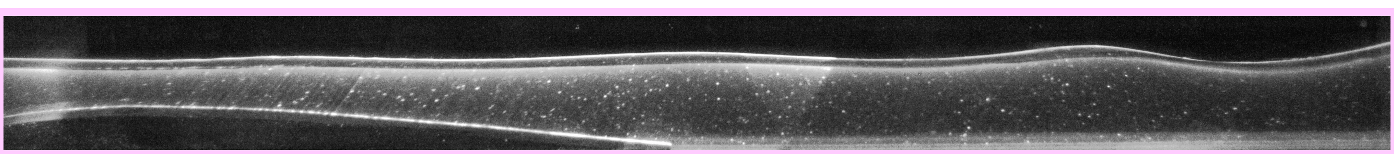


The development and dissipation of a turbulent eddy in the sodium layer (85-87km) over the course of five minutes.

of the sodium layer in the upper atmosphere by bouncing a powerful laser and measuring the time for the signal to return.

The properties of the sodium layer are so crucial for the TMT because most adaptive optics systems (including that planned for TMT) rely on an artificial star created by a laser that excites atoms in the sodium layer to correct for the effects of the Earth's turbulent atmosphere. By adjusting a deformable mirror in the telescope, the adaptive optics system tries to bring the artificial star to the tightest possible focus, but it needs to make a correction for the distance to the artificial star; hence, lidar is crucial to characterize the variability in the sodium layer and gain the best possible performance from the TMT.

An artist's impression of the Thirty Metre Telescope. Notice the truck and person at the base of the dome. Credit: Thirty Metre Telescope Project



Waves travel leftward along the surface of the water. The water flows toward the right. The critical region is the slight dimple in the surface above the top of the obstacle. The black-hole horizon lies at the left edge of the dimple (essentially at the left-edge of the image); the white-hole horizon lies at the right edge of the dimple.

Transitions

Derek Gagnier was promoted to Human Resources Manager.

Salena Li began her new role in the department as the Undergraduate Coordinator.

Theresa Liao joined the department as our new Communications Coordinator.

Steve Carey joined Physics and Astronomy in the position of Engineering Technician in our machine shop.

Pavel Trochtchanovitch took over as our new Electronics-Lab Manager.

Dave Muhlert started with us as as an Engineering Technician in the electronics lab.

Tyrone Strugnell started with the department in June as our new Storeperson.

Faculty and Staff Awards

Douglas Scott has been recognized by the APS has an Outstanding Referee.

Steven Plotkin and **Andrea Damascelli** were honoured as Killam Faculty Research Junior Fellows.

Congratulations to **Derek Gagnier**, who was awarded the 2008 Physics & Astronomy Staff Service Award at the department's Christmas party on December 16, 2008.

Congratulations to **Robert Raussendorf**, who has been awarded an Alfred P. Sloan Research Fellowship.

Shaun Woodruff was awarded a Faculty of Science Achievement Awards for his Herculean efforts in the Hebb Demo room.

Jeff Young was awarded a Faculty of Science Achievement Award for five years of tireless service as department head.

Quick News

WMAP papers get cited & cited ...

SPIRES publishes a list each year of the most highly cited articles in high energy physics and related fields. This year there are three papers by the WMAP team (which includes Mark Halpern, UBC) in the top ten and six WMAP papers in the top 50. This is the 5th year in a row with at least two WMAP papers in the top 10.

SPIRES is a searchable online database of particle physics literature run by the Stanford Linear Accelerator Center.

WMAP, the Wilkinson Microwave Anisotropy Probe, is a NASA Explorer mission. WMAP produced the first full-sky map of the microwave sky with a resolution of under a degree, about the angular size of the moon. The patterns in the map result from well-understood physical processes that happened when the universe was young. By matching the patterns in the map to the physics we know, WMAP has produced a convincing consensus on the contents of the universe, erasing lingering doubts about the existence of dark energy, and severely limiting the density of hot dark matter.

Paving stone makes it as a "Cover Stone"

A representation of a Feynman diagram carved into stone is featured on the cover of the latest issue of Electronic Journal of Theoretical Physics. This stone is one of the specially carved pavers that grace the front entrance of the Hennings Building. Each of the six pavers depict some important aspect of Physics & Astronomy.

Lorne Whitehead's "bright" idea gets funding

A University of British Columbia invention that brings natural sunlight into multi-floor office buildings will receive up to $2.1 million in funding from Sustainable Development Technology Canada (SDTC).

Lorne Whitehead and colleagues in the Structured Surface Physics Laboratory developed the patented Solar Canopy Illumination System. The system consists of exterior facades with specially designed arrays of mirrors to track and collect the sunlight; and customizable light guides to bring the light into the building replacing traditional light fixtures. Dimmable flourescent lights within these guides provide the illumination when there is no sun.

A UBC spin-off company, SunCentral Inc., has recently been established to carry out six demonstration projects in Canada, including a prototype system that has already been installed in a building on the British Columbia Institute of Technology campus.

CFI funds Superconducting Electron Accelerator

CFI has funded the new "Superconducting Electron Accelerator at TRIUMF" with an award of $17,761,281 (99.7% of requested funds!) to build the new $52M high intensity electron accelerator at TRIUMF. The development of this accelerator plays a central role in TRIUMF's next five year plan released in July 2008.

The superconducting RF accelerator technology at the heart of this accelerator is key to many research programs, from the radioactive beam expansion program at ISAC, to the International Linear Collider, as well as research in medical imaging, particle astrophysics and materials science. Many research programs will be centered upon this new accelerator technology being developed by our researchers here on the UBC campus.

In the Physics and Astronomy Department, Rob Kiefl, Jens Dilling, Chris Hearty, Andrew MacFarlane, Tom Mattison, Janis McKenna, and Lia Merminga are among the 19 co-applicants on this new CFI project.

NWAPS

In May the Department of Physics and Astronomy hosted nearly three hundred physicists from throughout the Pacific Northwest at the Eleventh Annual Meeting of the American Physical Society's Northwest Section. Janis McKenna spearheaded the local effort with lots of help from PHAS and TRIUMF faculty, staff and students. The program covered everything from distant galaxies to the potential discoveries at the LHC and lots in between.

New technique improves extraction of DNA from highly contaminated samples

The research team led by Dr. Andre Marziali recently developed a method, co-invented with Lorne Whitehead, to purify DNA from highly contaminated samples while minimizing the risk of unnecessary loss. This technique utilizes the physical characteristics of DNA (electric charge, length and flexibility) to extract DNA from samples that normally would not withstand conventional extraction methods to yield clean DNA for analysis. This method is now being commercialized and expected to have a great impact on various fields including forensic analysis, disease/pathogen identification, fossil testing, and so on. Original research article was published in the November 3rd issue of the Proceedings of the National Academy of Sciences (PNAS).

Quick News continues on page 7.

Back Page: *Erich Vogt's Last Class*

by Jess Brewer

On Friday 4 December 2009, Erich Vogt gave his last lecture to his last class of Physics 107 students. The lecture was also attended by many generations of previous recipients of the famous Vogt didactic magic in first-year Honours Physics at UBC, as well as many of his colleagues, including most of those who taught beside him in the forty-five years he served as the launching pad for innumerable Physics careers. To learn more about Erich please consult the feature article in last year's newsletter (http://www.phas.ubc.ca/∼heyl/newsletterJan09.pdf)

We would like to encourage you to visit http://musr.physics.ubc.ca/∼jess/Vogt/ to learn more.

A plaque was presented to Erich by the Department of Physics & Astronomy as a token of appreciation for forty-five years of teaching First Year Physics at UBC.

Erich's colleagues (David Measday and Jess Brewer) congratulate him.

Erich Vogt is surrounded by the beloved students that he has served for nearly half a century.

Department of Physics and Astronomy
University of British Columbia
6224 Agricultural Road
Vancouver BC V6T 1Z1 Canada