University of British Columbia

Volume 3 Issue 2 December 2010
British Columbia Version

PHYSICS & ASTRONOMY

Outreach Program News

In This Issue…

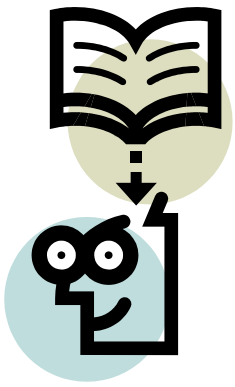
As we passed the winter solstice (we hope you caught the lunar eclipse this year!), we were reminded that the new year is near. We have many exciting 2011 events to tell you about! If you are interested in physics competitions and would like to receive training and preparation for free, be sure to read about the new Metro Vancouver Physics Circle run by our undergraduate students. The PITP lecture series has a new lineup of public lectures with topics on graphene (2010 Nobel Prize in Physics was awarded to the researchers who extracted graphene), and the possibility of other earths and life in the universe. For female students in Grades 11 & 12, don't miss the opportunity to learn more about the programs offered by our department at the WOW. We are also covering two major stories: the trapping of antihydrogen for the first time in history, as well as a recap of our Faraday Show on December 12. We hope that you enjoy the newsletter and have a wonderful holiday season!

Contact Us
Theresa Liao, Communications Coordinator
Department of Physics & Astronomy, University of British Columbia
6224 Agricultural Road, Vancouver, BC V6T 1Z1
Email outreach@phas.ubc.ca; Phone: 604-822-3675; Fax: 604-822-5324

Upcoming Outreach Events

Metro Vancouver Physics Circle - January 2011

A unique opportunity for high school students to receive training and preparation for physics competitions



The UBC Department of Physics & Astronomy is pleased to present the **Metro Vancouver Physics Circle.** This **free program** provides a unique opportunity for high school students to receive training and preparation for physics competitions and to become aware of the exhilarating world of physics.

The Circle will consist of **weekly two-hour sessions that run from January to March**. At the beginning of each meeting, students will be given a lecture pertaining to an interesting physics topic. During the rest of the event, students will work in groups and with UBC students to solve interesting and rewardingly challenging physics problems. This program is run by undergraduate physics students who were actively involved in physics competitions during their high school years - hence this is a great opportunity for high school students to make connections with and receive guidance from UBC physics students with similar interests.

As one of the purposes of the Circle is to encourage students to pursue an interest in physics competitions, numerous awards and prizes will be given out to students throughout the duration of the Circle. Pizza and refreshments will also be provided for all participants of the Circle.

Interested students can contact Ali Majd <aliali@live.com> for more information. We look forward to seeing you at the Metro Vancouver Physics Circle in the coming year!

Upcoming Outreach Events

Public Lectures - Pacific Institute of Theoretical Physics

Interested in the fundamental questions about the nature of the physical world? Want to learn about topics in theoretical physics from world renown researchers?

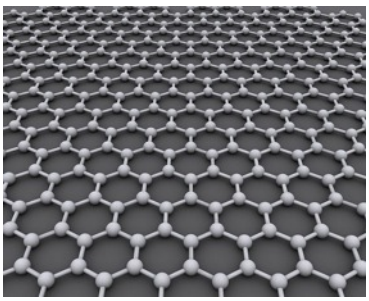
PITP public lectures are intended for a broad audience. Some of lectures are exciting topics suitable for senior high school students interested in the fundamental theories behind interesting everyday subjects!

LOCATION: St. John's college (2111 Lower Mall) at the University of British Columbia

DATE & TIME: Usually on the 2nd Wednesday of every month from October-April, at 7:30pm

January 12, 2011: Graphene: the Idea, the Material and the Future by Dr. Gordon Semenoff (University of British Columbia)

Graphene itself is a single sheet of Carbon atoms: but the collective behaviour is that of a relativistic quantum theory. Thus one can imagine testing fundamental principles in graphene, some of which are far beyond the reach of giant accelerators. Graphene's recent discovery in the lab (for which Andre Geim and Konstantin Novoselov shared the 2010 Nobel Prize in physics) showed it to be a promising candidate for future electronics technology: speculations abound that it may become 'the new silicon'. The graphene story is an object lesson in the extraordinary intellectual bridges that can exist in science between apparently utterly different phenomena, and in the predictive power of pure theory.



The ideal crystalline structure of graphene is a hexagonal grid. Image by AlexanderAlUS, wikipedia

Mar 8, 2011, 2011: Other Earths and Other Life in the Universe by Dr. Geoff Marcy (Berkeley)

Science fiction taught us that our Milky Way Galaxy abounds with habitable planets populated by advanced civilizations engaged in interstellar commerce and conflict. Back in our real universe, Earth-like planets and alien life have proved elusive. Has science fiction led us astray? NASA recently launched a new space-borne telescope, Kepler, dedicated to discovering Earth-like worlds around other stars. The first results will arrive by March 2012 and will be described in this talk. Are any of these worlds suitable for life? What properties make a planet livable? How common is life in the universe, especially intelligent life? New telescopic and biological observations are providing the first answers to these questions.

February lecture: Feb 9, 2011 by Dr. John Norton (Pittsburg) - topic TBA
April lecture: Apr 6, 2011 by Dr. Klaus Schulten (Urbana): TBA

Remember to bookmark the PITP lecture website for updates regarding upcoming talks:
http://pitp.physics.ubc.ca/quant_lect/upcoming.html

To see what sort of lectures there have been in the past, visit the archives at:
http://pitp.physics.ubc.ca/quant_lect/archives.html

For further information contact pitpoffice@phas.ubc.ca, or phone the PITP office at (604) 822-1383

Upcoming Outreach Events

January 12, 2011 - Welcome Orientation for Women!

"As the world moves towards commercial applications of quantum information, quantum computing and practical applications of nano-technologies, 21st century business will be lead by physicists" (Haig Farris, Entrepreneur and Investor)

The annual Welcome Orientation for Women event is back! Did you know that degrees in Physics and Astronomy open doors to a wide variety of opportunities? From Medicine to Business, Education to Computing, our degrees will provide you with unique skills that are as applicable to business and industry as they are in research!

If you are a **female senior high-school student (Grades 11 and 12) or 1st year undergraduate student**, join us at this **FREE** event to learn more about our programs:

DATE & TIME: Wednesday January 12th, 2011, 10:00am - 4:30 pm
LOCATION: University of British Columbia (primarily Michael Smith Labs, see webpage for details)

The event includes:

- Hands-on activity (optional): build a small robot!
- Presentation of our programs
- Q&A session with faculty
- Meet and greet with students
- tours of some of our research labs and the opportunity to build a little robot!

We will provide a free gourmet lunch and afternoon snacks, as well as some prizes. If your parents are not convinced that physics, astronomy, biophysics or engineering physics is the right degree for you, you're welcome to bring them along!

For more details and to register go to http://www.phas.ubc.ca/wow/ or contact wow@phas.ubc.ca.

Other Outreach Opportunities

TRIUMF

Canada's National Laboratory for Particle and Nuclear Physics
Laboratoire national canadien pour la recherche en physique nucléaire et en physique des particules

Physics in Action video series

TRIUMF is creating a video series which will use the cutting-edge science at the world's largest cyclotron to teach basic concepts in secondary school physics.

Two of four planned videos have been released. Order your copy today !

http://www.triumf.ca/physicsinaction/

CAP Award for Excellence in Teaching High School/CEGEP physics

TRIUMF is honoured to be a national sponsor for these awards to a teacher in each of Canada's five regions who possess an exceptional ability to motivate their students to high academic achievement in physics.

Nominations are now open until February 14, 2011. Visit the CAP website for details.

http://www.cap.ca

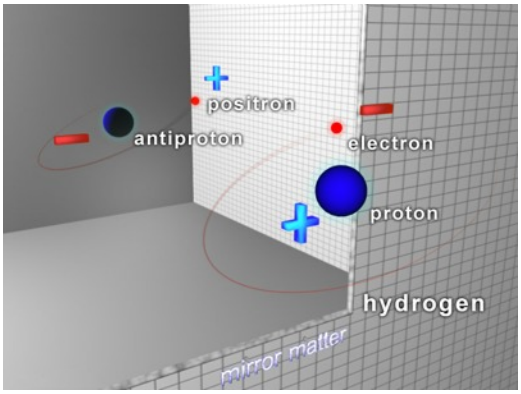
This Just In!

Mind Over Matter…or Antimatter?

If you are a fan of the TV series Star Trek, enjoyed Dan Brown's novel "Angels & Demons" (or its movie version starred by Tom Hanks), or if you simply have a curious mind for particle physics, then you must have heard of the term "antimatter". What exactly is antimatter? And does it really have the power as portrayed in movies and novels? How much is fact, and how much is fiction?

To answer these questions, let's first ask the question - what is ***matter***? Based on the Merriam-Webster dictionary, matter is

> "Material substance that occupies space, has mass, and is composed predominantly of atoms consisting of protons, neutrons, and electrons, that constitutes the observable universe, and that is interconvertible with energy"

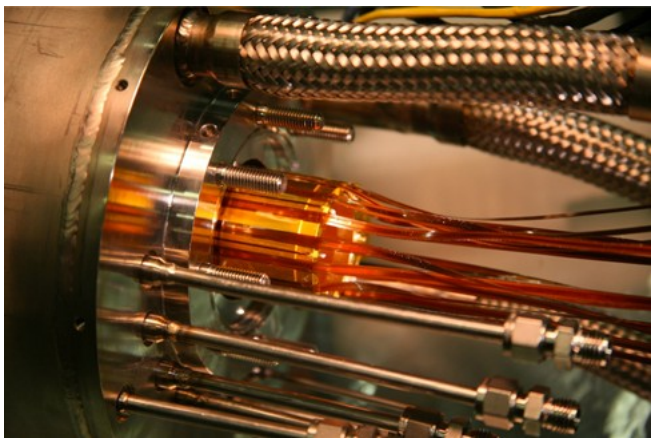


3D rendition of hydrogen and antihydrogen[1]
(image by US National Science Foundation)

The basic building block of matter is an atom. Let's take hydrogen, the simplest atom we can find. A hydrogen atom has a negatively charged electron (e-), and a positively charge proton (p+). Since its discovery by Henry Cavendish in the 1700's , this simple atom has been studied so well (both because of its simplicity and its abundance in the world… it's in every single water molecule!) that scientists love to use it as a standard atom to study. Now here is a crazy idea - Instead of having an e- and a p+ in a hydrogen atom, how about changing the charges so that this special "hydrogen" has a positively charged electron, and a negatively charged proton?

But is that really so crazy? Not as much as you think! In fact, the first ever antihydrogen was synthetically generated in 1995 at CERN - the European Organization for Nuclear Research (yes, this was mentioned in the novel Angels & Demons…this place does exist). Nowadays scientists start with making the negatively charge protons (called antiprotons) by smashing regular protons into a piece of iridium . Then positively charge electrons (called positrons) are generated by the decay of radioactive sodium-22. Finally the two are mixed together and voilà, we now have a special hydrogen atom…this is now called an ***antihydrogen atom***!

So in principle, hydrogen and antihydrogen are supposed to be the same except the charges are flipped - ***matter consist of atoms with positive protons and negative electrons, while antimatter have atoms with negative protons and positive electrons***. While the making of antihydrogen atoms sounds like it is straight out of science fiction, this is real and it is actually a lot of work - definitely not like mixing egg and flour into a batter. The hardest part of all is that the antihydrogen atoms generated are so high energy (they travel almost at the speed of light) that it is nearly impossible to keep them still. Just about immediately they bounce into the walls of the container. And since the container is made of "matter" - guess what happens? Antihydrogen atoms are annihilated and you get nothing but a shower of particles that decay into pure energy.



The electrodes (gold) for the ALPHA Penning trap being inserted into the vacuum chamber and cryostat assembly. This is the trap used to combine or "mix" positrons and antiprotons to make anti-hydrogen. (Credit: Niels Madsen, ALPHA/Swansea.)

Not to worry - where there is a problem, there is a solution! Just recently, and we are talking about very recently, like in November 2010, a group of physicists (the ALPHA team) at CERN were able to trap antihydrogen atoms by "cooling" the positrons and antiprotons (reducing its energy level) all the way down so that the slightly more stable antihydrogen atoms could be generated when antiprotons and positrons were combined. And because the antihydrogen atoms were "cooler," physicists were able to trap the atoms in a special magnetic chamber - suspending the atoms so that they wouldn't touch the walls of the container.

This Just In! (con't)

This is a huge scientific development. The first time ever in history that we are able to trap antihydrogen! But why is this so interesting to physicists? Well, this doesn't have as much to do with making explosives or looking for a new energy source (like described in Angels & Demons or in Star Trek). Overall only 38 antihydrogen atoms were generated after mixing 10 million antiprotons and 700 million positrons. If we do some simple calculations here:

1 mole of hydrogen = 6.02×10^{23} atoms

1 mole of hydrogen weighs 1 gram

Each hydrogen atom = $1 / 6.02 \times 10^{23} = 1.66 \times 10^{-24}$ grams

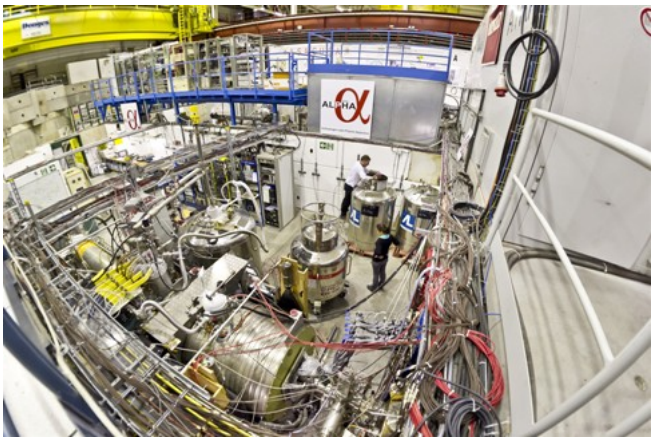
Assuming 38 antihydrogen atoms will weigh the same as 38 hydrogen atoms, then in total we have:

$1.66 \times 10^{-24} \times 38 = 6.31 \times 10^{-23}$ grams of antihydrogen

(To be honest, I doubt we will even be able to feel a tingle if this amount of antihydrogen comes in contact with matter, not to mention an explosion…)

Also, the amount of energy put into the production and cooling of the positrons, antiprotons, and antihydrogens is enormous (a lot of electricity is needed to run the machines!). Because of this, antimatter cannot really serve as a source of energy. So why go through all the trouble? The main reason why physicists are interested in making antihydrogen is to actually study this really cool question: ***why does the universe consist entirely of matter, instead of antimatter?*** The currently accepted laws of physics predict symmetry - when the universe began with the Big Bang, supposedly an equal amount of antimatter and matter were generated. But if that was the case then I wouldn't be sitting here writing this and you wouldn't be here reading this - antimatter and matter would have come into contact with each other and everything is then annihilated! So something must have happened, and that is what physicists are interested in finding out. Another question is whether antimatter and matter are exactly the same, other than the sign of their charges. Technically they should be - they should have the same weight, for example, as predicted by the standard model of particle physics (a model used by physicists to predict the behaviours of subatomic particles). By generating the antihydrogen atoms, we can also test whether gravity acts on both hydrogen and antihydrogen the same way, as one of the key steps to evaluate similarities and differences.

One thing to mention is that the making of antihydrogens is no simple task and requires the collaboration of many physicists - the ALPHA team has a group of 43 researchers, of which 15 are from Canada (yay!), and more than half of them came from the Vancouver area - among them, Dr. Walter Hardy is a professor at the UBC Department of Physics & Astronomy; Dr. Fujiwara of University of Calgary (also the spokesperson for the ALPHA-Canada team) and Dr. Michael Hayden of Simon Fraser University are both alumni of the department. ***With the successful generation and trapping of the antihydrogen atoms, the ALPHA team will continue to work together to find answers to big questions asked about the universe and our world.***



View from the top of the ALPHA experiment (Photograph: Maximilien Brice, CERN)

From left to right: Dr Makoto Fujiwara, Research Scientist, TRIUMF and Adjunct Assistant Professor, University of Calgary; Andrea Gutierrez, PhD student, University of British Columbia; Dr Walter Hardy, Professor, University of British Columbia; Tim Frieser, PhD student, University of Calgary; Dr Michael Hayden, Professor, Simon Fraser University; Mohammad Dehghani Ashkezari, PhD student, Simon Fraser University. (Credit: Niels Madsen, ALPHA/Swansea.)

This Just In! (con't)

Acknowledgement

We would like to thank Dr. Walter Hardy for reviewing this article.

References

1. Wikipedia, The Free Encyclopedia. (November 25, 2010). *3D image of Antihydrogen.jpg*. Retrieved December 14, 2010 from http://en.wikipedia.org/wiki/File:3D_image_of_Antihydrogen.jpg

Want to learn more? Check out the following

- Original Research Article: http://www.nature.com/nature/journal/v468/n7324/full/nature09610.html (might require subscription)
- The ALPHA Collaboration: http://alpha.web.cern.ch/alpha/
- Angels & Demons: The Science Revealed by Dr. Joel Fajans (also a member of the ALPHA team): http://www.youtube.com/watch?v=_sqYh8puZ-I
- *Antimatter: Gotcha!* from the Economist: http://www.economist.com/node/17519521
- *Antimatter trapped for the first time* from Gizmodo, the Gadget Guide: http://gizmodo.com/5692614/antimatter-trapped-for-the-first-time
- *Upping the Anti: CERN Physicists Trap Antimatter Atoms for the First Time* from Scientific American: http://www.scientificamerican.com/article.cfm?id=antimatter-confined

December 12, 2010 - UBC 7th Annual Faraday Show

"Physics of Light and Colour!"

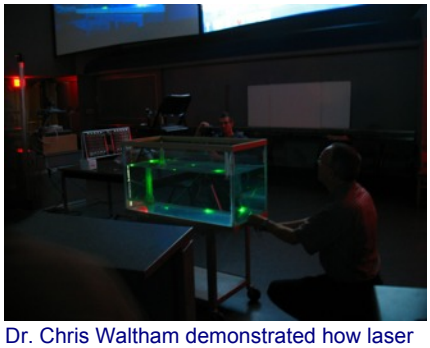
In 1826, physicist Michael Faraday founded the Children's Christmas Lectures at London's Royal Institution. His goal was to communicate to children the excitement of scientific discovery. In keeping with the spirit of those lectures, every year students and faculty at the Department of Physics and Astronomy present the Faraday Show - this year our topic was the "Physics of Light and Colour." 320 parents and children joined us to learn how optical illusions work and how we can create lights of different colours. We also found out which type of Christmas light decorations consumes the least amount of energy, and how we can use light to generate electricity. Interesting student and faculty projects were presented, and the show ended with a demonstration of the reflection and refraction of laser in water.

This year we collected donation of non-perishable food items for the Greater Vancouver Food Bank

Did you miss it this year? The Faraday Show is an annual event - remember to check our web site in December and mark it down on your calendar next time!

Dr. Georg Rieger discussed the wave properties of light

"What did you see through the telescope?"



Dr. Chris Waltham demonstrated how laser passes through water with reflection and refraction