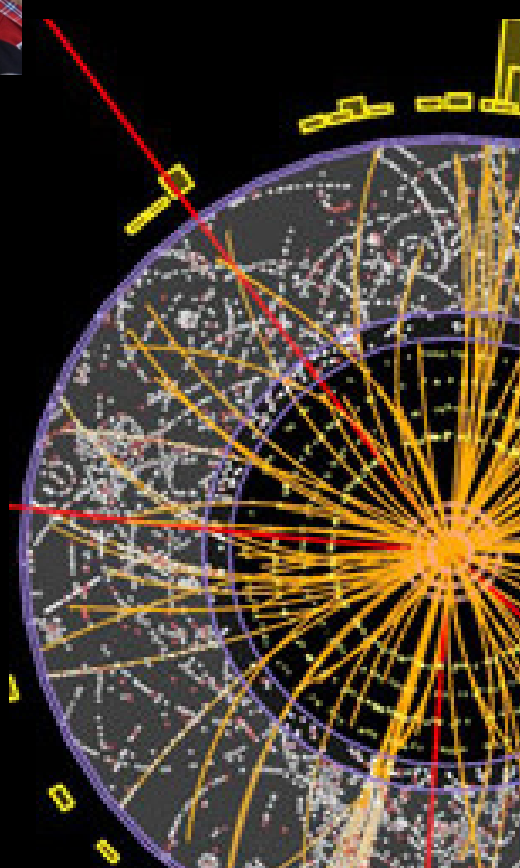
# NEWSLETTER

**ONTARIO ASSOCIATION OF PHYSICS TEACHERS**
An Affiliate of the A.A.P.T, and a charitable organization

April 2012

## Pimp Your Classroom, Inquiry-Style! (or, Equipping the Inquiry Classroom)

by Chris Meyer

## Dragon's Den for Space Exploration Programs

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## Art, Drama and Candy in Physics

By Lisa Lim-Cole

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## Demonstration Corner: Demonstration of a Phase Change Between Solid Phases of Iron

by Dr. Albert A. Bartlett

# Letter from the Newsletter Team

## Let's Get Excited! OAPT Conference planned to be outstanding! Be there!

As the OAPT Steering Committee finishes preparing for the conference, the Newsletter team would like to present this short newsletter to get you thinking about what is to come at this year's conference. Join us as we "Open Doors and Open Minds". Mingle with us. Let's talk Physics!

## Call for Articles

Have you or has a colleague of yours done something progressive or interesting with your physics teaching recently? Or perhaps you have the wisdom of many years of experience in teaching this difficult subject. Perhaps you teach Ontario's northland or in a rural area and have a different perspective or unique experiences to relate. SHARE your experiences! Write a brief (~400 word) article for the Newsletter and send it to newsletter_editor_8@oapt.ca.

# The Prez Sez

**Roberta Tevlin**
Danforth C.T.I.
Toronto, ON
roberta@tevlin.ca

## The OAPT Conference is all set to be a blast!

The Perimeter Institute is providing wonderful support and enthusiasm and our registrations are even greater than last year's fantastic conference. Over half of the workshops are already filled to capacity. But don`t worry – there is still space if you haven`t registered yet. Don`t forget that you can register for part of the conference or the whole thing.

There has been an exciting change to the program on Thursday. We still have lots of great food but rather than a panel discussion with some of the PI researchers we are introducing **Physics Speed Dating**. This is your chance to ask all those questions that have been keeping you up at night. How can the Big Bang make something (the universe) from nothing? Are those neutrinos going faster than c? Exactly what goes through the double slits? Why aren`t my socks entangled?

On Friday, **Dr. Neil Turok** is going to start us off with **Magic that Works** and **Dr. Cliff Burgess** will wrap it up with **Last Chance to be Wrong about the LHC**. In between we have some fabulous workshops about how physics can **Open Doors and Open Minds** from grades 6 and up.

The workshops continue on Saturday and include a special extra long workshop so you can really explore one of five great topics. Everyone and anyone interested in exploring being involved next year helping to run the conference, newsletter, contest, website and other plans is invited to adjourn afterwards for informal lunch/meeting at Heuther`s.

For full detail and to register go to **http://www.oapt.ca/conference/2012/index.html**

**See Attached Conference Schedule! Don't miss out!**

The Physics Education Research Column

# Pimp Your Classroom, Inquiry-Style!

## (or, Equipping the Inquiry Classroom)

**Chris Meyer**
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York Mills Collegiate Institute
Toronto

I'm really tired of bumping my head on the cabinets in my kitchen when I wash the dishes. The genius who designed it (not me!) obviously never anticipated humans who stood over five feet tall. I now blame these cabinets, wholly, for my dish washing aversion. Good design (or bad!) can really make the difference in matters domestic and, of course, educational. The environment in which our students work can have a great effect on their motivation and their approach to learning, so we should do whatever we can to help our physical classroom reflect our learning goals.

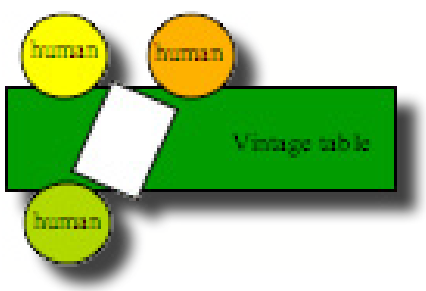
Two important goals in inquiry-based learning are collaboration within small groups and student or group independence. Both result from an overall shift to a student-centred approach to learning. There are a number of things we can do to any classroom to help our students realize these goals.

### You Are How You Seat

My classroom at York Mills is vintage 1950's. You might expect its inhabitants to jump up on the tables and break into songs from Grease. It has never been renovated and, especially after the recent provincial budget, I don't expect it to be renovated in my lifetime. It is surely the flagship model of teacher-centred design. The experts on student-centred design are the people from **SCALE-UP**, Student-Centered Active Learning Environment for Undergraduate Programs, who have redesigned over 150 university classroom sites around the world. My dream classroom would look something like this one at the **U of T**:

However, my actual classroom looks like this:

So the best I can do with long skinny tables bolted to the floor is to have the students move around and work with their groups in a triangle formation:



This idea seemed simple to enough me, but as it turned out, inertia was a major obstacle. I found myself constantly harassing students to move. It took me almost three years to figure out that if I permanently put one extra chair on the front side of the front table, no physical chairs needed to be moved when going into "group work mode". Now the harassing is down to an acceptable level.

To help out with the group organization, all the tables are **numbered** (and named!). And the room is "equipped" with a stack of **group self-evaluations** to help students assess the effectiveness of their groups. I find I remember to do this more often when the room has these amenities "built-in".


## Equipping the Masses

As part of the shift to student-centered learning, I want my students to have some latitude in deciding what equipment to use. The majority of the equipment I use is the low-tech, "standard" equipment – the typical flora and fauna of the vintage physics classroom – along with a set of large whiteboards. As much of this as possible is stored in convenient locations in the room and is carefully labeled.


After a brief introduction, students know where stuff is and if they decide they need to measure the mass of something, they head straight for the triple-beams. No one asks for permission and I don't spend time dragging the basic equipment out.

The careful layout of classroom equipment is not enough, however. It is a waste of time for students to walk across the room when they need a whiteboard marker or pair of scissors. Each table in the class is outfitted with a basket of goodies: whiteboard markers and an eraser, a ruler, a protractor, scissors, masking tape and three sets of multiple choice letters for concept questions.


Students' time in my class is precious (at least I think so) and I want them to be able to work as efficiently as possible. Replacing missing items is a very small price to pay (thank you, China). Hanging from the side of each table is a small whiteboard – this was a very happy addition. I now see students, usually during particularly heated discussions, reach over the side and grab the whiteboard for quick illustrations and calculations. I was at one point trying to decide if I could actually bolt the white boards to the table surface, but I think this will do. With this layout of equipment, my hope is that students feel

that they are in charge of what they are doing and also feel empowered to follow their ideas and test their hunches.

## Teachers Need Equipment Too

I finally have an effective setup for a computer and data projector that can remain in the room, ready to go at a moment's notice. I no longer

have the excuse that I have to drag the stuff out or that it gets in the way, so I use it much more regularly for quick simulations (Interactive Physics, applets) and also for **ConcepTests** (conceptually-based multiple choice questions often used with "clickers"). As a result, ConcepTests have become an important part of many of my lessons. Each group has in their basket a nicely laminated set of **multiple choice letters** ($1) that we use in the place of electronic clickers (>$1). I have never tried actual clickers and I don't plan to – my approach is cheaper, easier and I can decide to do a ConcepTest on a whim, as the situation demands.

Every semester since I started teaching inquiry-based physics, I find that my classes have run more smoothly than before and with fewer group or personality problems. I think this is due in part to the steady improvements in the classroom environment, along with improvements in my own teaching. While we can't renovate a classroom ourselves, with a bit of creativity, there are many changes we can make that will help our students to enjoy their time with physics and hopefully learn more than they thought possible.

## Learn More than You Thought Possible

Would you like to see an inquiry-class in action? The door to my room is always open. I am happy to have visitors and if you e-mail me today, there is usually no problem in arranging a visit for tomorrow when you fall ill.

Would you like to learn more about teaching physics through inquiry? I will be giving a presentation at the **OAPT conference**, April 26-28 at the Perimeter Institute for Theoretical Physics. There you will have a chance to experience what it is like to learn this way and to learn what it is like to teach this way. You can find a complete set of classroom resources on my website: **www.meyercreations.com/physics**

# Dragon's Den for Space Exploration Programs

**by Sean Clark**
**Sacred Heart High School**
**OCCDSB, Stittsville**

Old faithful: the research project! Using this time-honoured strategy you can expose students to a variety of applications from biotechnology to optical devices. Applying this strategy to the grade 9 Study of the Universe unit, in just two days of student presentations you can "cover" everything from Galileo's first telescope to the Hubble Space Telescope. The added bonus is that you doesn't necessarily have to be an expert on any one topic in order for the class as a whole to learn about it. But how can you be prepared to evaluate students on presentation day? You will need to be familiar with some of the intricacies of each research topic, but keeping up with even Nasa's space programs, let alone those of overseas nations, is a lot to accomplish on a prep period. Enter the "Investors".

Assigning a research topic is not nearly enough guidance for students embarking on a research project. The World Wide Web has made finding information easy enough that students no longer have to question and ponder in order to develop a flashy presentation. I look for ways to focus students on inquiry-based research rather than "stumble and find", placing more emphasis on the research process than on the presentation product. In this article I describe a hook to get kids thinking and wondering about their topics before they reach for Google.

I have students "sell" space technology programs that had already proven successful to an interested "investor", in order to complete just one more mission. The students have to be prepared to discuss not just the highlights of the program, but how challenges and setbacks were overcome and what side benefits or technological spinoffs resulted from that particular space program. Students, working in groups of three, immerse themselves in a space technology program, learning, for example, that the design of a lunar rover for the Apollo program resulted in the development of battery

operated tools and durable tires, and that these applications would translate to cash flow for those holding the patents on such designs. Students continue to question when they learn about the setbacks of a mission in order to show how solving a problem like the optical focus of the Hubble telescope might lead to the development of specialized lenses and computer enhancement software, perhaps setting their individual program off schedule, but ultimately advancing technology as a whole.

The key to making this work is a capable investor. This is a student I hand pick to research up to three different space programs (e.g., Mercury, Gemini, and Apollo) in order to identify some of the shortcomings, disasters or budget problems that those programs experienced. On presentation day that student is armed with questions designed to keep the presenters honest in their sales pitch. This creates incentive for the presenters, who have to be prepared to explain why people died, machines crashed or money was spent with nothing to show for it. The investors prepare a one-page analysis of each presentation, indicating how well their concerns were addressed, how good the return on their investment would be through spin off technologies, and what benefits they saw to the program as a whole. Each investor is given $1 billion to assign, and to date only

one has ever suggested playing the ponies as a safer investment than any of the space programs presented by her classmates!

The added bonus of recruiting the best students to act as investors is that the rest of the research is spread more equitably among all the other students, rather than a few taking on the lion's share of the work. It's always impressive to see what students are capable of when their safety net is taken away, especially when the incentive is there for a little competition.

Researching space technologies and all of the ways that we have benefited from them is inspirational enough to keep students engaged. Crafting assignments that will hone students' inquiry and analytical skills does not have to mean teachers do all the researching themselves and design guided question sheets. Letting students' natural curiosity and their desire to prove themselves is often enough to direct their questions toward something meaningful. Of course, it helps to have a good investor in your corner!

# Clear Skies!

## Art, Drama, and Candy in Physics

**Lisa Lim-Cole**
**Uxbridge Secondary School - DDSB**
**Lisa_Cole@durham.edu.on.ca**

The OAPT Conference is coming up and I'm excited to share how I use art, drama and candy to bring physics alive in my classroom. Creativity, innovation and imagination are an integral part of science. Learning physics requires much more than just an understanding of the language of numbers and equations. As physics teachers it is easy for us to appreciate that mathematics is a linguistic tool used to communicate ideas in physics, just as the English language allows us to communicate ideas in words and sentences. However, many students have a difficult time understanding that the mathematics is simply a tool, not the physics itself. The concepts behind how nature operates are far more important than our students' ability to do algebra.

Using art and drama in my physics teaching has allowed me to explore these ideas with my students while "bracketing" the mathematics. When students are faced with preparing a skit or role play to simulate a physical process they need to discuss with their group what is really happening. When required to create a physics cartoon they will often bring to a conscious level their own buried preconceptions. In both cases they are forced to dissect the key ideas, confront their preconceptions and discuss these with their peers or their teacher. Join us as we explore science from an artistic and dramatic point of view – and with candy just for fun!

# Let's play!

# CERN People

## A new Films of Record collaboration involving Google+ and YouTube

**By: Nathan Wren**

Google+: http://goo.gl/MBLrs
YouTube: www.youtube.com/cernpeople
Email: cernpeople@gmail.com
Twitter: @CERNPeople
www.filmsofrecord.com

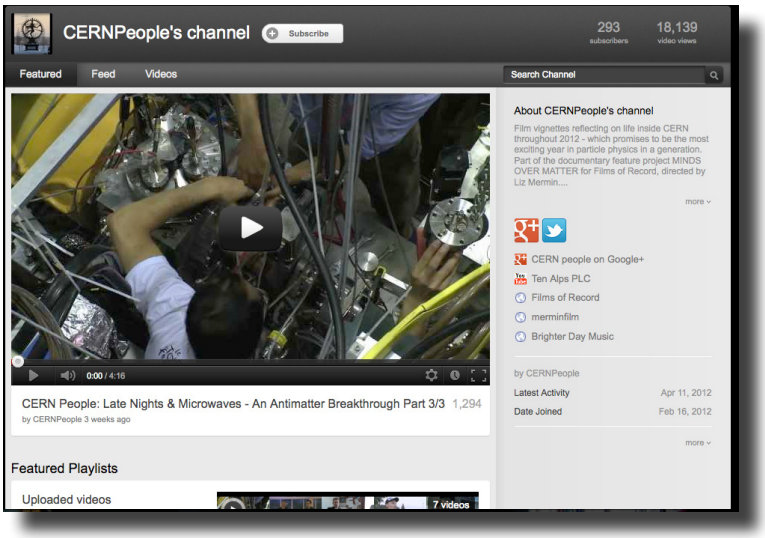
***CERN People*** is a Google+ page and YouTube channel at www.youtube.com/CERNPeople featuring short films about people inside the European Organisation for Nuclear Research at CERN – the biggest and most powerful scientific research institute in the world. These shorts will eventually be compiled into a feature documentary.

The filmmakers are following a handful of physicists throughout 2012, a year promising to be the most important one for physics in at least a generation. The Google+ page and hang-outs will offer a chance for users to comment on and interact with CERN researchers. The intended audience includes anyone curious for a behind-the-scenes peek at the workings of "the science of everything".

***CERN People*** and the feature documentary that will emerge from it in 2013 explore the motivations, aspirations, fears, and desires that keep this extraordinary research facility going, deepening our knowledge about the most fundamental questions of existence.

CERN brings together some of the most brilliant and ambitious minds in science from over 100 nations – people who could be earning millions in the private sector – to pursue pure knowledge about the ghost-like subatomic particles that make up everything we know.

***CERN People*** has the potential to be a unique scientific record of history in the making. The daily interest shown in all media, with or without new developments around popular topics like the Higgs boson, suggests that the Google+ page will draw substantial and diverse visitors. These followers will then be anticipating the feature length documentary.




## Become one of them!

**Ernie McFarland**
**Column Editor**
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Submissions describing demonstrations will be gladly received by the column editor.

# Demonstration of a Phase Change Between Solid Phases of Iron

**Albert A. Bartlett**
**Professor Emeritus of Physics**
**University of Colorado at Boulder**
**Albert.Bartlett@Colorado.edu**

## Introduction

Solids can exist in different crystalline phases. When you add heat at a constant rate to a sample of a solid the temperature rises until the sample reaches the transition temperature from the low temperature solid phase to the high temperature solid phase. The sample then absorbs the latent heat of the transition without changing its temperature. When the transition to the higher temperature solid phase is complete, the temperature resumes its rise as heat continues to be added to the sample. The behaviour is reversed when you remove the source of heat.

The experiment below is designed to give a qualitative and spectacular demonstration of a phase transition between solid phases in a sample of ordinary iron wire.

## Properties of Iron

At room temperature iron is in the **alpha phase** in the form of a body-centred cubic (BCC) crystal (ferrite). At 910°C the transition takes place to the **gamma phase**, a face-centred cubic (FCC) crystal, (austenite). The melting temperature is reached at 1528°C.

## The Experiment

The sample is a piece of ordinary iron wire, no. 22 gauge, about 2 m long. The wire is an all-purpose bare iron wire that comes on small wooden spools that are sold in hardware stores. The wire is strung horizontally from two alligator clips each of which is fastened to a piece of wooden dowel rod. The wood provides electrical insulation and the wooden rods can be attached to lab stands with ordinary lab clamps. String the wire without too much sag about 70 cm above the lecture table. Connect the ends of the wire are to a variable output power supply that will give about 15 amperes at around 50 volts, either AC or DC.

When the wire is heated it will expand and sag. To make this more visible I have a partially straightened paper clip to which a ping-pong ball has been glued to the lower end. The upper end of this clip is hooked over the iron wire near its midpoint. A light source, directed away from the class, sends a horizontal beam of light to illuminate the ball so that the ball casts a shadow on the front chalkboard. On the chalkboard I make a few horizontal

chalk marks perhaps 10 cm apart vertically to constitute a crude scale on which the shadow of the ball will be seen to move up and down as the amount of sag in the wire increases or decreases as the iron wire expands or contracts.

Bring up the current gradually in the wire. The wire expands and sags dramatically and it starts to glow. Continue slowly increasing the current until the wire is glowing hotter than red. The wire sags a great deal and the glow is impressive. It gets “Oooohs” and “Aaaahs” from the students. Ask the students to watch the vertical movement of the shadow of the ping pong ball on the chalkboard.

At the count of three turn off the current. As the wire cools and contracts the ball rises for a couple of seconds, pauses, drops slightly, and then continues its rise until the wire is at room temperature. The pause indicates that the iron of the wire is going through the transition from the high temperature solid phase to the low temperature solid phase. During the pause it is losing the latent heat associated with the transition. The increase in the sag of the cooling wire just after it passes through the phase transition suggests that the low temperature phase has a lower density than the high temperature phase.

**I generally repeat the experiment two or three times** so that students can have a better opportunity to see the effect.

**Safety Precautions**

1. The electrical connections to the ends of the wire should be insulated so the conductors can’t touch the lab stands that support the wire.
2. The experimenter should wear protective goggles in case the wire melts and globs of molten iron are scattered about.
3. Students watching the demonstration should be at least 3 metres from the hot wire.
4. Aluminum foil or some other metal should be on the table top in order to keep the table top from being burned in case the wire melts and breaks.

**Acknowledgements**

This demonstration is not original with me. I first saw it done in 1951 by Professor W.B. Pietenpol who was head of our Department of Physics for many years. Long after his death I published a description of his demonstration. (*American Journal of Physics*, Vol 13, December 1975, pgs. 545-547).

My thanks to Mike Thomasson who has maintained our physics demonstration equipment for many years.

**Special Thanks**

Let me offer my thanks to Ernie McFarland and to the OAPT for your kindness in hosting me and my daughter Carol at your meeting at McMaster University last spring. I appreciate the wonderful experience and thank all who were so very kind to me. I am very proud to be an honorary member of the OAPT.

# Up Coming Conference


## Opening Doors – Opening Minds

Ontario Association of Physics Teachers (OAPT)
34th Annual Conference 2012

### When and where?

***Opening Doors – Opening Minds*** will be held in **April 26 to 28, 2012** at Perimeter Institute for Theoretical Physics in Waterloo, Ontario, Canada.

### Keynote Address

Neil Turok, Director, Perimeter Institute for Theoretical Physics

### Opening Doors

- Why Study Physics? with Carolyn Burgess
  The Physics of the Nervous System with Dr. Deda Gillespie and Dr. Dan Goldreich
- Tour of the Institute for Quantum Computing with Martin Laforest
- Workshops for grades 6-10 science with John Atherton, Mike Newnham and Dr. Jason Harlow

### Opening Minds

- Understanding the quantum world, the latest from the LHC and the earliest moments of the Big Bang with Perimeter Researchers Cliff Burgess, Lucien Hardy, Louis Leblond, and Michele Mosca
- Workshops exploring Physics Education Research with Chris Meyers, Glenn Wagner and Dave Doucette
- Unusual and fun connections with music, dance and drama with James Ball, Lisa Lim-Cole, Rolly Meisel

**Thursday Night Barbeque, Wine & Cheese**
**Reduced rates for year 1-2 and pre-service teachers**

Early Registration: $19.99 per night at University of Waterloo Residence

**Residence Accommodation Sponsor**

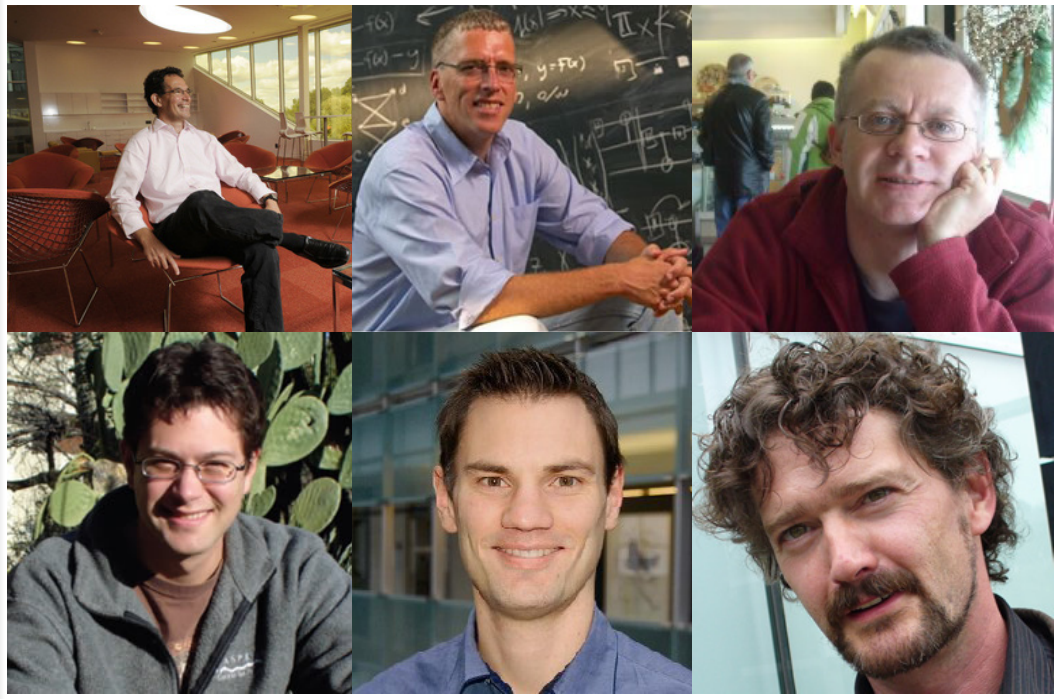
UNIVERSITY OF TORONTO The Edward S. Rogers Sr. Department of Electrical and Computer Engineering at the University of Toronto

**Host Venue Sponsor** PERIMETER INSTITUTE FOR THEORETICAL PHYSICS

**Opening Doors – Opening Minds** www.oapt.ca/conference/2012/

# Don't Miss Out! It's Not Too Late! REGISTER TODAY!

# Opening Doors - Opening Minds!



Neil Turok, Cliff Burgess, Lucien Hardy, Louis Leblond, Damian Pope and Richard Epp

# OAPT Conference Schedule!

## Thursday 26 April 2012

| | |
|---|---|
| 5:30 – 7:30 pm | Registration/BBQ at Bistro |
| 7:30 - 7:40 pm | Welcome - Greg Dick and Roberta Tevlin |
| 7:45 – 8:45 pm | Physics Speed Dating with PI Researchers |
| 8:45 – 10:00 pm | Social |

## Friday 27 April 2012

| | |
|---|---|
| 8:45 – 8:55 am | Welcome - Roberta Tevlin, Greg Dick |
| 8:55 – 10:15 am | **Keynote Address: Dr. Neil Turok** |
| 10:15 - 10:45 am | Coffee break/vendors |
| 10:45 - 12:00 pm | Session A Workshops |
| 12:00 - 1:30 pm | Lunch |
| 1:30 - 2:45 pm | Session B Workshops |
| 2:45 - 3:00 pm | Coffee break/vendors |
| 3:00 – 4:15 pm | Session C Workshops |
| 4:15 – 4:30 pm | The Annual Great Giveaway (door prizes) |
| 4:30 – 5:15 pm | **Special Address: Dr. Cliff Burgess** |

## Saturday 28 April 2012

| | |
|---|---|
| 9:00 - 10:15 am | Session D Workshops |
| 10:15 - 10:30 am | Coffee break/vendors |
| 10:30 - 12:15 am | Session E Extended Workshops |
| 12:15 - 12:30 pm | Closing remarks in Theatre - Roberta Tevlin |
| 12:30 – 1:30 | Steering Committee Lunch: Heuthers |

# OAPT 2011 Conference Workshops and Speakers

## Friday 27 April 2012

| | | | | | | |
|---|---|---|---|---|---|---|
| 8:55– 10:15 | **Keynote Address: Dr. Neil Turok**<br>***"Magic that works"*** | | | | | |
| **Session A**<br>10:45-12:00 pm | **Dr. Lucien Hardy**<br>*The Conceptual Challenges of Quantum Theory*<br>**Bob Room** | **Martin Laforest**<br>*Tour of the Institute of Quantum Computing*<br>**Go to bus at 10:30 !!!** | **Dave Doucette**<br>*Getting the H.O.T.S. for Brain Based Physics*<br>**Sky Room** | **Lisa Lim-Cole**<br>*Art, Drama and Candy in Physics*<br>**Reflecting Lounge** | **Jason Harlow**<br>*Grade 10: Optics*<br>**Time Room** | **Chris Howes**<br>*Differentiated Scientific Inquiry*<br>**Elementary (gr 6 -8)**<br>**Space Room** |
| **Session B**<br>1:30 - 2:45 pm | **Dr. Michele Mosca**<br>*Quantum Computing*<br>**Bob Room** | **Caroline Burgess**<br>*Why Take Physics?*<br>**Space Room** | **Dr. Richard Epp**<br>*Revolutions in Science: Making Models in Science*<br>**Sky Room** | **Dr. Micah Stickel**<br>*Engineering With Electricity and Magnetism*<br>**Time Room** | **Margaret Greenberg**<br>*Grade 10: Biophysics Activities*<br>**Reflecting Lounge** | **Marilyn Orszulik**<br>*Creativity and Hands-On Learning*<br>**Elementary (gr 6 -8)**<br>**Alice Room** |
| **Session C**<br>3:00 – 4:15 pm | **Dr. Louis Leblond**<br>*The Big Bang and the Biggest Things*<br>**Bob Room** | **Dr. Deda Gillespie / Dr. Dan Goldreich**<br>*The Physics of the Nervous System*<br>**Time Room** | **Shawn Bullock**<br>*Using the History of Physic to Teach … Physics*<br>**Sky Room** | **Nadia Camara**<br>*Minute To Win It*<br>**Space Room** | **Greg Macdonald**<br>*Grade 9: Beyond the Atom*<br>**Reflecting Lounge** | **Mike Newnham**<br>*Inquiry Learning with Smarter Science*<br>**Elementary (gr 6 -8)**<br>**Alice Room** |
| 4:30-5:15 | **Special Address: Dr. Cliff Burgess**<br>*"Last Chance to be Wrong About the LHC"* | | | | | |

## Saturday 28 April 2012

| | | | | | | |
|---|---|---|---|---|---|---|
| **Session D**<br>9:00-10:15 am | | **Glenn Wagner**<br>*Physics Review: Teams, Games and Tournaments*<br>**Sky Room** | **Rolly Meisel**<br>*Music, Math and Physics*<br>**Time Room** | **James Ball**<br>*YouTube Physics*<br>**Bob Room** | **Richard Taylor**<br>*Can We Offer 12C Physics?*<br>**Space Room** | **Graham Whisen**<br>**Gotta Get Gizmo!**<br>**Elementary (gr 6 -8)**<br>**Alice Room** |
| **Session E**<br>10:30-12:15 pm | | **Damian Pope, Dave Fish**<br>**Particle Physics**<br>**Sky Room** | **Jim Hunt**<br>**The Kitchener Anamorph: Creating Public Art with Math**<br>**Bob Room** | **Ernie McFarland and Friends**<br>*Best of Demo Corner*<br>**Time Room** | **Chris Meyer**<br>*Cooperative Group Physics – Experience the Difference!*<br>**Alice Room** | **John Caranci**<br>*The Frilly Bits*<br>**Elementary (gr 6 -8)**<br>**Space Room** |
| **12:15–12:30** | Closing Remarks: Roberta Tevlin **Theatre** | | | | | |

# Grade 11 Physics Contest 2012

OAPT PHYSICS CONTEST

## Tuesday May 15, 2012
## ABSOLUTELY FREE!!!

## REGISTER TODAY!!!

This year's contest will feature:

- An UPDATED online contest system.
- No registration fee - the contest will be offered free-of-charge.
- Great prizes including DEEP scholarships.

**CONTEST COORDINATORS / TEACHERS:** Please follow the link, http://oapt.ece.utoronto.ca/, to register yourself and your school. If you already registered last year, you will not need to register again.

Your interested students will need to register on the website prior to the contest.

## Prizes &Scholarships

ROGERS DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING UNIVERSITY of TORONTO

PERIMETER INSTITUTE FOR THEORETICAL PHYSICS