Virtual School Visits

U of T Department of Physics

Atmospheric Physics

Talk I: Up, Up and Away! Doing Scientific Experiments from a Really Big Balloon (30-minute talk + 15-minute Q & A)
Facilitated By: Professor Kaley Walker and her research group

Come along for the ride as we discuss how high-altitude balloons can be used to study Earth's atmosphere from "near-space".

Learn how instruments are designed and tested to handle the harsh conditions of the lower stratosphere, about three times higher in altitude than passenger planes fly. Here temperatures go down to -60°C and pressure is only 5 mbar, 1/200th of the pressure where we live on the surface of Earth.

We will take you through how we prepare for a balloon flight with a helium-filled balloon capable of carrying 500-1000 kg of experimental equipment up to altitudes of 30-40 km. Hint, the balloon is 25 stories tall!

Talk II: A Visit to the Polar Environment Atmospheric Research Lab (PEARL) (30-minute talk + 15-minute Q & A)
Facilitated By: Professor Kaley Walker and her research group

• Get a glimpse into what it's like to work at a remote polar research laboratory in Eureka, Nunavut. The Polar Environment Atmospheric Research Laboratory (PEARL) is situated on Ellesmere Island at 80°N, 1,100 km from the North Pole and over 4,000 km north of Toronto.

• Learn about how we make observations of the atmosphere during the brief Arctic spring where the outside temperatures can be as low as -50°C. That's before the wind chill!

• Discover the unique environment of the high Arctic including local weather and wildlife.

Workshop I: A hands-on experiment on spectroscopy: Building your own spectroscopes (45 minutes)
Facilitated By: Professor Kaley Walker and her research group

• In this hands-on workshop, the electromagnetic spectrum and the basic concepts of spectroscopy will be introduced

• Build your own spectroscope to study different light sources.

• Learn how spectroscopy can be used to study Earth's atmosphere and how this is applied in our work studying the atmosphere over the Canadian Arctic.

Requirements:

• Cardstock (to print provided spectroscope template)
• DVDs
• Scissors
• Utility knife or craft knife (with adult supervision)
• Different light bulbs: incandescent, compact fluorescent, LED, Halogen, etc.
• Optional: ruler

Workshop II: A hands-on experiment on aerosols: Making a cloud in a jar 45 minutes (15-minute introductory talk + 30-minute practical)
Facilitated By: Professor Kaley Walker and her research group

• In this hands-on workshop, aerosols, their role in global warming and the basic concepts of cloud formation will be introduced.

• Learn how aerosols are detected and how we measure them in the Canadian Arctic.

• Create your own clouds in a jar based on the knowledge you gained in the first part of the workshop.

Requirements:

• 1-2L wide-mouth jars (wide enough to easily fit your hand in the opening)
• Rubber gloves (non-latex)
• Matches
• Water

Computational Physics

Workshop I: The Motion of Oscillators and Pendulums using Computers (Workshop, 1 hour)
Facilitated by: Garett Brown (PhD Candidate)

Description: Starting from Newton's 2nd Law, we will numerically solve the motion of the simple harmonic oscillator (mass on a spring) as well as the simple pendulum. We will then move on to experimenting with the double pendulum before closing on a discussion of chaos (as seen with the double pendulum).

Requirements: A computer and browser with internet access for each participant. Little to no programming experience required (Python and JavaScript). Tablets/iPads can work, but the experience is best with a desktop browser.

Workshop II: Gravity and the Three Body Problem (Workshop, 1.5-2 hours)
Facilitated by: Garett Brown (PhD Candidate)

Description: Starting from Newton's 2nd Law, we will numerically solve the motion of the simple pendulum. We then go through a similar process for the two-body problem before reviewing vectors and going through the process one more time for the three body problem. We finish with a brief discussion of chaos (as seen with a double pendulum). Includes a brief review of vector addition.

Requirements: A computer and browser with internet access for each participant. Some programming experience would be helpful, but not required (Python. Tablets/iPads can work, but the experience is best with a desktop browse

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Condensed Matter Physics

Talk: The Challenge of Superconductivity (30 minutes plus Q and A)
Facilitated by: Nazim Boudjada (PhD Candidate)

In this presentation, we will discuss the fascinating and intriguing phenomenon of superconductivity. Superconductors were discovered more than a century ago and they continue to baffle scientists to this day... Why? Because superconductors can do much more than what their name suggests (to conduct electricity with no resistance, or energy loss) and have many technological applications: better energy efficiency, magnetically levitated trains, particle accelerators, medical imaging, and even quantum computing! But before we get there, we need to understand what makes a material superconducting and what destroys superconductivity. We will go through the historical milestones in the field and explain the modern challenges that prevent us from having superconductors all around us. We will also discuss the different types of superconductors that exist and how they are related to each other.

Experimentally Probing the Dark Universe

Three Workshops (1 hour total)

Workshop I: Weighing the Dark Universe With a Balloon-borne Telescope
Facilitated by: Mohamed Shaaban (PhD Candidate)

Not only is the Universe expanding, but it's also accelerating! This revelation implies either our understanding of gravity is flawed or that a mysterious negative pressure known as Dark Energy is driving the expansion. It turns out that the contents of the universe can be divided into three groups: dark energy, dark matter and the matter that is everything we can see and interact with, which only accounts for 5% of the universe!

One way to understand the relationship between these three groups is to find out how heavy they are! Unfortunately, there are no universe-sized scales so instead we have to build an experiment to weigh the universe for us!

Requirements: Access to camera phone, two way virtual live interaction

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Workshop II: Virtual Tour of SNOLAB
Facilitated By: Professor Miriam Diamond available for Q&A

SNOLAB is a world-class science facility located deep underground in an operational nickel mine, near Sudbury, Ontario in Canada. The combination of great depth and cleanliness that SNOLAB affords allows extremely rare interactions and weak processes to be studied. The science program at SNOLAB is currently focused on sub-atomic physics, largely neutrino and dark matter. At 2km, SNOLAB is the deepest clean room facility in the world.

Requirements: A computer and browser with internet access - https://www.youtube.com/watch?v=22QOZjCdUKo

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Workshop III: Virtual Tour of CERN available for Q&A
Facilitated By: Professor Miriam Diamond

Discover CERN in Virtual Reality with 2 short clips. From the LHC to the CMS detector and the challenge of analyzing petabytes of data with more than half a million processor cores, go to places few persons are allowed.

Requirements: A computer and browser with internet access - https://visit.cern/tours/virtual-visits

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Oceans in Motion

Talk: Oceans in Motion (30 minutes, plus Q and A)

Speakers: Jesse Velay-Vitow (PhD Candidate) and Prof. Nicolas Grisouard

Description: The oceans have inspired many throughout history, and the tools developed to understand them have led to numerous advances in timekeeping, navigation, and mathematics. This presentation first provides an overview of the science of tides from ancient times all the way up to the modern satellite era. We then explain how physicists shape the contemporary study of the oceans and of the climate system.

Optional short workshop: The Amplitude of Sloshing Water (30 minutes)

Description: Explaining the high tides in the Bay of Fundy from watching water slosh back and forth in a container.

Required Equipment: Rectangular plastic tubs, water, paper towels; empty 2L pop bottles with caps (optional), a stick to balance the containers on.

Ask Me About Physics at U of T – Q and A with a U of T Physics Undergraduate students.