Open Universe: The Adventure of Teaching and Learning Physics Online

Svetlana Barkanova
Physics, School of Science and Environment
Grenfell, Memorial University of Newfoundland

Canadian Association of Physicists
SUPPORTING PHYSICS RESEARCH AND EDUCATION IN CANADA

Abstract:

Physics is the most fundamental of sciences, so learning it can be a challenge, especially online.

However, a fully-online asynchronous delivery mode can offer some advantages, especially for quickly-developing fields such as subatomic physics and astrophysics, whose active research communities often offer extensive educational resources online.

Asynchronous online delivery also allows for more diversity and accessibility engaging a wider group of students, and for more time on hands-on activities such as research projects and virtual labs.

The talk will outline the structure of three online courses, Astronomy, Astrophysics and Subatomic Physics, at Memorial University, and share tips and strategies on course design and delivery accumulated over a decade of online teaching

We acknowledge that the lands on which Memorial University's campuses are situated are in the traditional territories of diverse Indigenous groups, and we acknowledge with respect the diverse histories and cultures of the Beothuk, Mi'kmaq, Innu, and Inuit of this province.

Vast geography, dispersed low-density population

Total population: 525,000, 60% in rural areas

One university - Memorial University of Newfoundland, offering 475 online courses

St. John's population (Central Campus): 114,000

Corner Brook population (Grenfell Campus): 20,000

26% of Grenfell students are Indigenous

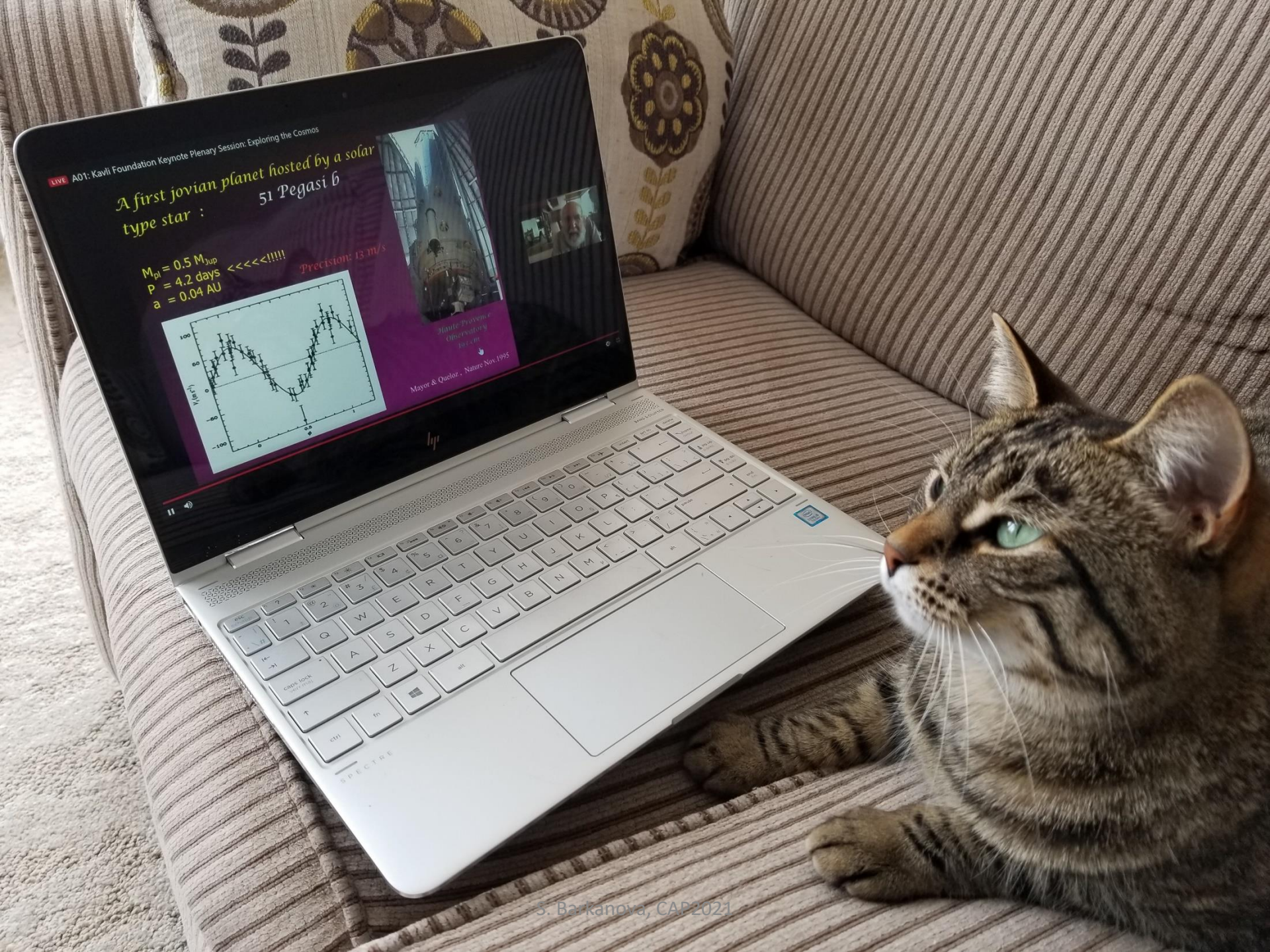
Pandemic teaching – synchronous remote (Zoom etc) or asynchronous fully online?

"Higher Ed needs to go on a Zoom diet: Three reasons why swapping out face-to-face class meetings for online Zoom class sessions is a spectacularly bad idea", by Joshua Kim, CAUT Bulletin Commentary, December 2020

- Zoom Sucks Energy
- Zoom Is Bad for Lecturing
- ZoomU May Be Good for the Course, but ZoomU Is Bad for the Learner

"Zoom is presenting higher ed with something like a tragedy of the commons. Individual instructors benefit from running lots of Zoom classes, but if all (or even most) instructors follow this strategy, then all the students lose out."

Commentary / Higher Ed needs to go on a Zoom diet | CAUT


LIVE A01: Kavli Foundation Keynote Plenary Session: Exploring the Cosmos
A first jovian planet hosted by a solar type star :
51 Pegasi b
M_{pl} = 0.5 M_{Jup}
P = 4.2 days <<<<<!!!!!
a = 0.04 AU
Precision: 13 m/s
Haute Provence Observatory 1.93 cm
Mayor & Queloz , Nature Nov.1995
S. Barkanova, CAP2021

Best courses for asynchronous, fully-online delivery:

- No labs

In-person, hands-on labs are irreplaceable. Labs can be remote for emergency teaching but only short-term. On the other hand, if real labs are not available (astrophysics, nuclear physics), they can be partially simulated online.

- External resources

Multimedia from publishers, research centres etc.

- Wide audience

Physics majors and minors, education students, medical students, non-degree students, part-time students, adult students, students in remote communities, international students, etc.

[MUN is affordable: $85 per credit hour, $255 per course.]

Fully-online, asynchronous [physics courses] at MUN:

https://www.grenfell.mun.ca/academics-and-research/Pages/school-of-science-and-t...

Fully Online	**PHYS 2150** **The Foundation of Astronomy**	course emphasizes the scientific method, basic physics, night sky and objects in our solar system. Topics include space science, telescopes, spectroscopy, atomic structure, the formation and evolution of planetary systems, and the detection and properties of exoplanets.	PR: no pre-requisites.
Fully Online	**PHYS 2151** **Stellar Astronomy and Astrophysics**	Stellar Astronomy and Astrophysics is atomic structure and spectra. The sun: radiation, energetics, magnetic field. Stars: distance, velocity, size, atmospheres, interiors. Variable stars, multiple stars, clusters and stellar associations. Stellar evolution, interstellar matter, structure of the Milky Way Galaxy. Exterior galaxies, quasi-stellar objects, pulsars. Cosmology.	PR: 6 credit hours in Mathematics at the first year level
In Progress	**PHYS 2400** **Subatomic Physics**	Subatomic Physics is an introduction to nuclear and particle physics. Topics include nuclear properties and models; radioactive dating; fission; nuclear reactors; accelerators; the detection, classification, and properties of subatomic particles. Applications in areas such as ecology, dosimetry, medical physics and nuclear astrophysics are discussed.	PR: Level III Advanced Mathematics or Mathematics 1090 or 109B. It is recommended that students have completed at least one of Level II and Level III high school physics courses

https://subatomicphysics.ca/
See the joint CINP-IPP session June 11, 2021.

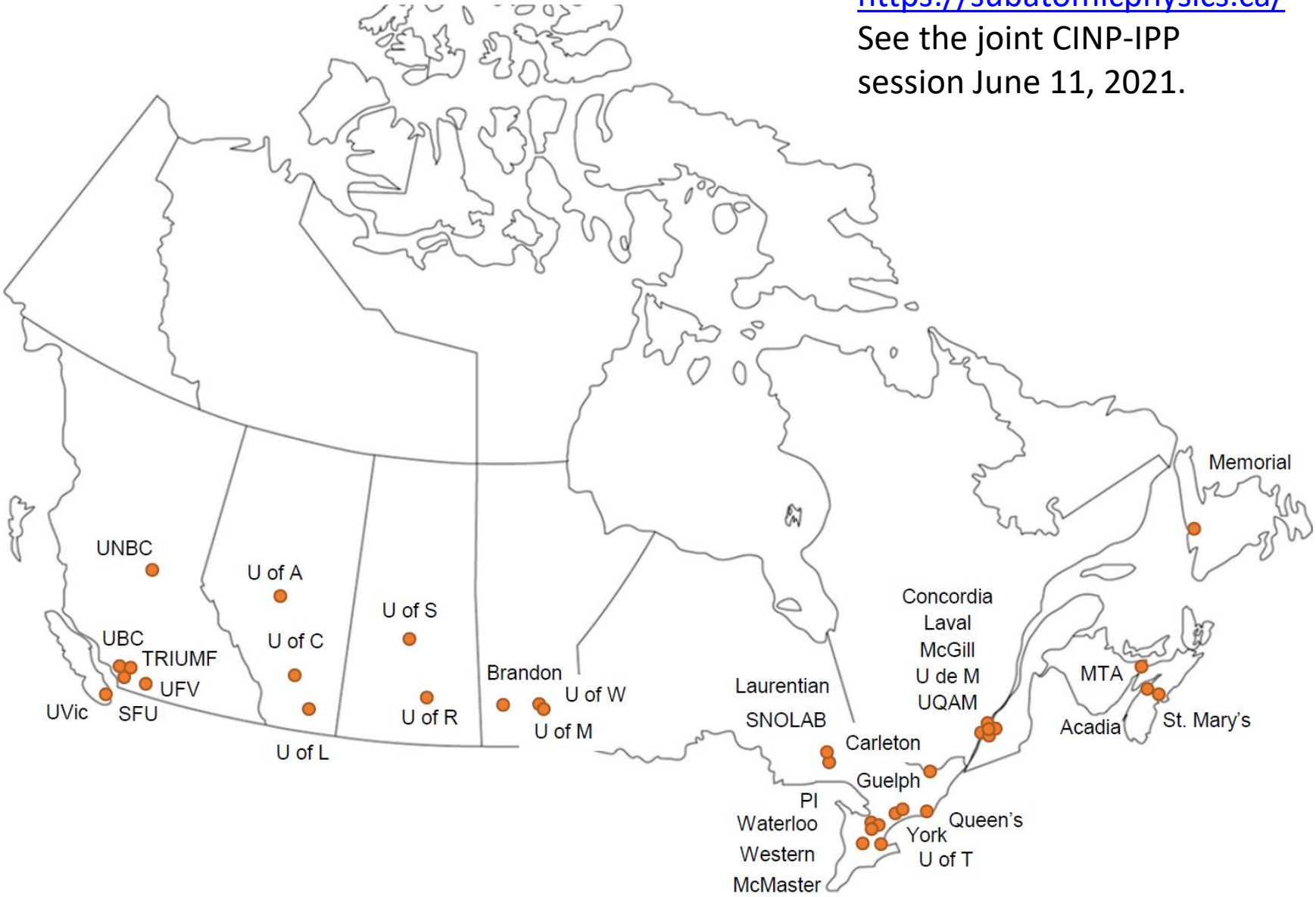


Fig. 1, “Community Profile”, Canadian Subatomic Physics Long Range Plan 2017-2021

http://skymaps.com/downloads.html

The Evening Sky Map

FREE* EACH MONTH FOR YOU TO EXPLORE, LEARN & ENJOY THE NIGHT SKY

NORTHERN HEMISPHERE
JUNE 2021

Sky Calendar – June 2021

Get Sky Calendar on Twitter
http://twitter.com/skymaps

1 **Moon near Jupiter** (morning sky) at 13h UT. Mag. −2.4.

2 **Last Quarter Moon** at 7:25 UT.

8 **Moon at apogee** (farthest from Earth) at 2h UT (distance 406,228 km; angular size 29.4').

8 **Moon near the Pleiades** (18° from Sun, morning sky) at 21h UT.

10 **New Moon** at 10:53 UT. Start of lunation 1218.

10 **Annular Solar Eclipse** from 9:50 to 11:34 UT. Greatest eclipse at 10:43 UT. The path of annularity extends across northern Canada, Greenland, and Russia. Partial eclipse in N. America, Europe and Asia.

11 **Mercury at inferior conjunction** with the Sun at 1h UT. Mercury passes into the morning sky.

12 **Venus 1.5° SSW of Moon** (20° from Sun, evening sky) at 8h UT. Mag. −3.9.

13 **Moon near Mars** (38° from Sun, evening sky) at 22h UT. Mag. 1.8.

14 **Moon near Beehive cluster M44** (evening sky) at 9h UT. The Beehive is a lovely sight in binoculars.

16 **Moon near Regulus** at 4h UT (evening sky).

18 **First Quarter Moon** at 3:54 UT.

20 **Moon near Spica** at 4h UT (evening sky).

21 **June solstice** at 3:32 UT. The time when the Sun reaches the point farthest north of the celestial equator marking the start of summer in the Northern Hemisphere and winter in the Southern Hemisphere.

23 **Moon near Antares** at 7h UT (evening sky).

23 **Moon at perigee** (closest to Earth) at 9:52 UT (distance 359,956 km; angular size 33.2').

23 **Mars 0.03° SE of Beehive cluster M44** (evening sky) at 23h UT. Mag. 1.8. Mars will present a beautiful sight as it traverses M44.

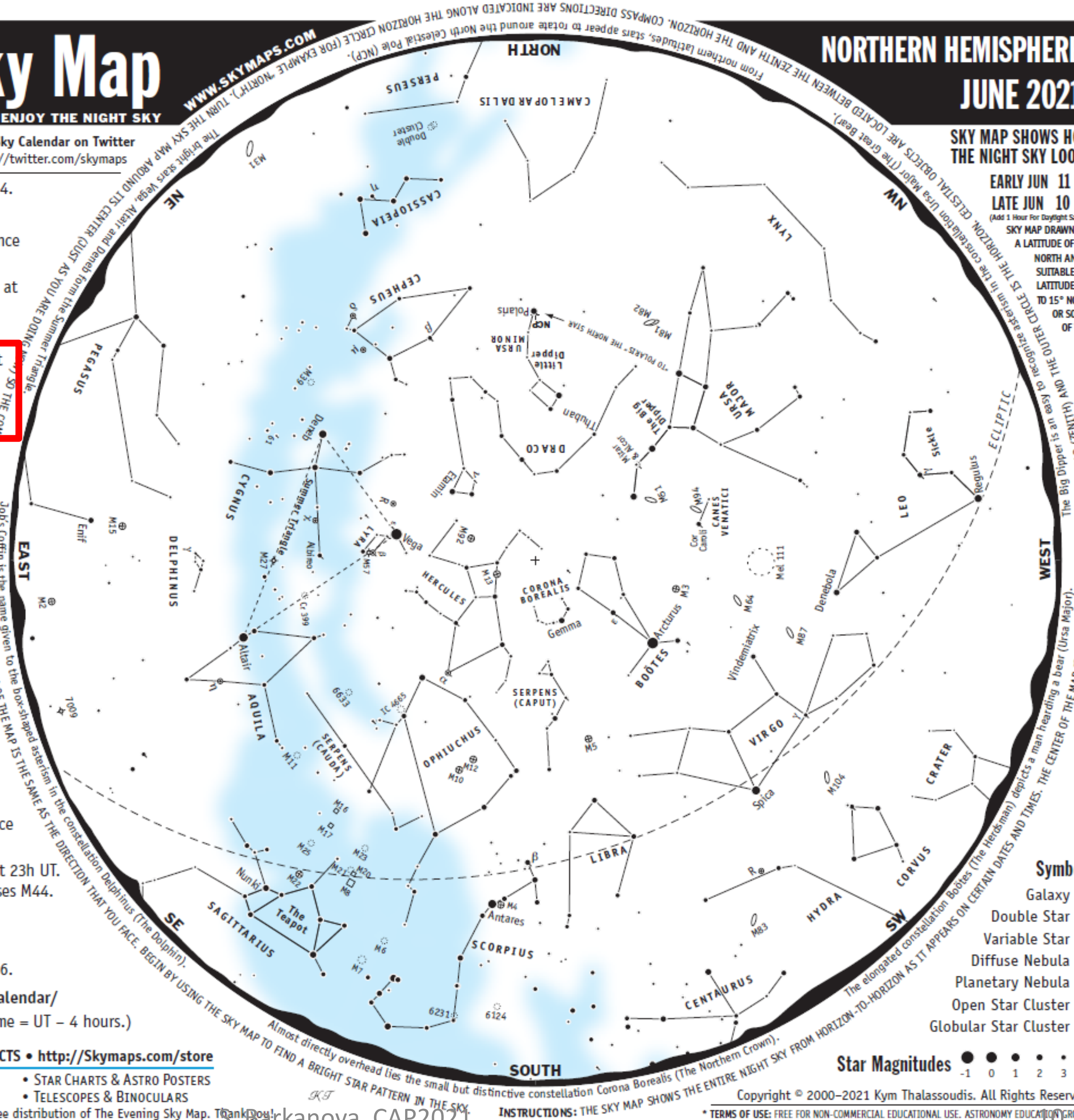
24 **Full Moon** at 18:39 UT.

27 **Moon near Saturn** (morning sky) at 12h UT. Mag. 0.4.

28 **Moon near Jupiter** (morning sky) at 22h UT. Mag. −2.6.

More sky events and links at http://Skymaps.com/skycalendar/

All times in Universal Time (UT). (USA Eastern Daylight Time = UT – 4 hours.)



SKY MAP SHOWS HOW THE NIGHT SKY LOOKS

EARLY JUN 11 PM
LATE JUN 10 PM
(Add 1 Hour For Daylight Saving)

SKY MAP DRAWN FOR A LATITUDE OF 40° NORTH AND IS SUITABLE FOR LATITUDES UP TO 15° NORTH OR SOUTH OF THIS

Symbols

Galaxy
Double Star
Variable Star
Diffuse Nebula
Planetary Nebula
Open Star Cluster
Globular Star Cluster

Star Magnitudes -1 0 1 2 3 4

Skymaps.com

SAVE ON RECOMMENDED PRODUCTS • http://Skymaps.com/store

- Star Atlases & Planispheres
- Books for Sky Watchers
- Star Charts & Astro Posters
- Telescopes & Binoculars

All sales support the production and free distribution of The Evening Sky Map. Thank you!

MEMORIAL UNIVERSITY

CENTRE FOR INNOVATION IN TEACHING AND LEARNING

	Remote	Fully Online
Design	By instructor with some support; learning experience varies depending upon the instructor's level of expertise with learning technologies.	Instructor as content author supported by instructional designer and media support; various technologies considered to facilitate a self-directed learning experience.
Development time frame	Often developed week by week, with consideration of the overall course plan.	Fully developed at the start of the course. May go through multiple iterations before development is considered complete.
Delivery of instruction	Asynchronous (i.e. recorded lectures) OR Synchronous (i.e. real-time classes in web conferencing applications)	Primarily asynchronous; some synchronous components.

Instructional Continuity | Centre for Innovation in Teaching and Learning | Memorial University of Newfoundland (mun.ca)

	Remote	Fully Online
Student preparedness	Students may be less technologically prepared, with access to a mobile device only and limited connectivity in their homes; instructional planning should reflect this limitations.	Students know from the onset that all instruction will happen online, so likely have access to the technology that enables them to actively engage in the learning experience.
Learning Management Sysem Use	General use of system to communicate with students, relay course content, and administer assessments and grades.	Advanced use of tools and components to facilitate social interaction of class and learning activities.
Instructor presence	Mirrors expectations of face-to-face instruction	Students are expected to be self-directed with regular check-ins by Instructors to monitor progress and provide feedback.
Interaction with classmates	Periodic; often instructor initiated.	Interactivity is built into learning activities; addition of defined spaces within the learning environment for social interaction.

My Design Strategy:

- Introductory videos
- Digital tools to engage learners
- Consistent weekly structure
- Strict deadlines
- Immediate or rapid feedback
- Frequent tests (note time zones)
- Local knowledge, if relevant
- Emails with subject-relevant news
- Links to optional webinars
- Groups projects, if feasible
- Chat rooms

Example – course structure:

Fall 2020
Schedule for PHYS 2150 (Astronomy)

Date	Class	Homework
Week 1 Sept. 8-12	Introduction. Register for Mastering Astronomy. Install planetarium software (such as Stellarium). Form your group for Course Project.	HA#0 (practice, no credit)
Week 2 Sept. 13-19	Chapter 1: Charting the Heavens	HA#1
Week 3 Sept. 20-26	Chapter 2: The Copernican Revolution	HA#2
Week 4 Sept. 27 – Oct. 3	Chapter 3: Radiation Chapter 4: Spectroscopy	HA#3
Week 5 Oct. 4 - 10	Chapter 5: Telescopes	HA#4
Week 6 Oct. 11-17	Reading Week	Course Project
Week 7 Oct. 18 - 24	Chapter 6: The Solar System	HA#5
Week 8 Oct. 25 - 31	Chapter 7: Earth Chapter 8: The Moon and Mercury	HA#6
Week 9 Nov. 1 - 7	Chapter 9: Venus Chapter 10: Mars	HA#7
Week 10 Nov. 8 - 14	Chapter 11: Jupiter Chapter 12: Saturn	HA#8
Week 11 Nov. 15 - 21	Chapter 13: Uranus, Neptune, and Pluto Chapter 14: Solar System Debris	HA#9
Week 12 Nov. 22 - 28	Chapter 15: The Formation of Planetary System	HA#10

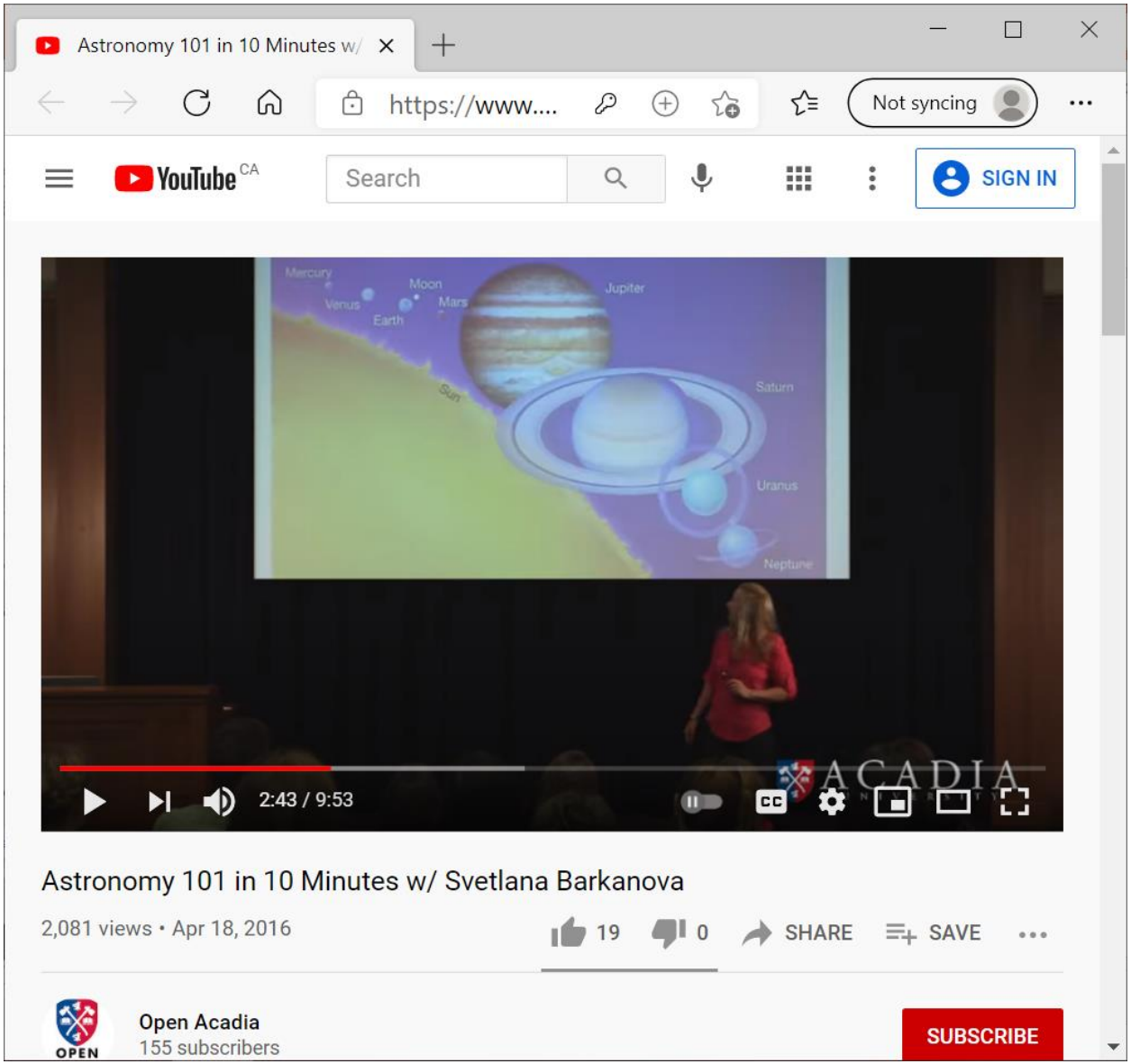
If possible – record an introduction or a short video on the subject:

[Astronomy 101 in 10 Minutes w/ Svetlana Barkanova – YouTube]

[Nuclear Physics 101 in 10 Minutes w/ Svetlana Barkanova – YouTube]

[Particle Physics in 10 Minutes w/ Svetlana Barkanova – YouTube]

(From my Acadia time)



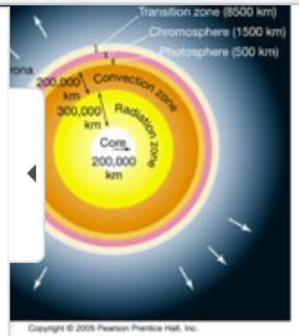
Topic 1: Physical Proper

https://online.mun.ca/d2l/le/content/284838/viewContent/2652550/View

Table of Contents

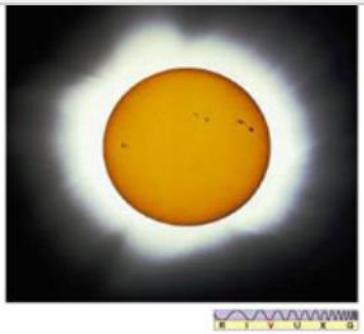
Module 1: The Sun

- Overview — Web Page
- Topic 1: Physical Properties of the Sun — Web Page
- Topic 2: The Solar Interior — Web Page
- Topic 3: The Solar



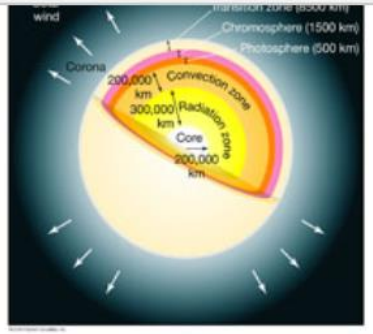
ior structure of the Sun.

5. Pearson Prentice Hall, Inc.



Solar structure above photosphere.

©2005. Pearson Prentice Hall, Inc.



Solar Structure.

©2018. Pearson Education, Inc.

ENGAGE!

Locate each of the following regions on the Solar Structure images above:

Photosphere
Chromosphere
Transition zone
Corona
Convection zone
Radiation zone
Core

Photosphere

The Particle Adventure

The Particle Adventure | What ho

https://particleadventure.org/inter_summ...

Microsoft Search (Alt+Q)

Just start typing here to bring features to your fingertips and get help.

Tell me more

THE PARTICLE ADVENTURE

THE FUNDAMENTALS OF MATTER AND FORCE

SEARCH

GLOSSARY HOME

THE STANDARD MODEL

What is fundamental?

What is the world made of?

What holds it together?

- The four interactions
- How does matter interact?
- The unseen effect
- Electromagnetism
- Residual EM force
- What about the nucleus?
- Strong
- Color charge
- Quark confinement
- Quarks emit gluons
- Residual strong force
- Weak
- Electroweak
- Gravity
- Interaction summary
- Quantum mechanics
- The Pauli Exclusion Principle
- Fermions and bosons
- A lot to remember
- End of section

ACCELERATORS AND PARTICLE DETECTORS

The Standard Model > What holds it together? > Interaction summary

Interaction summary

This is a summary of the different interactions, their force carrier particles, and what particles they act on:

	Gravity	Weak (Electroweak)	Electromagnetic	Strong
Carried By	Graviton (not yet observed)	W^+ W^- Z^0	Photon	Gluon
Acts on	All	Quarks and Leptons	Quarks and Charged Leptons and W^+ W^-	Quarks and Gluons

Which fundamental interaction is responsible for:

Friction?

Answer

Nuclear bonding?

Answer

YouTube Channels:

Physics Girl - YouTube

Kurzgesagt – In a Nutshell - YouTube

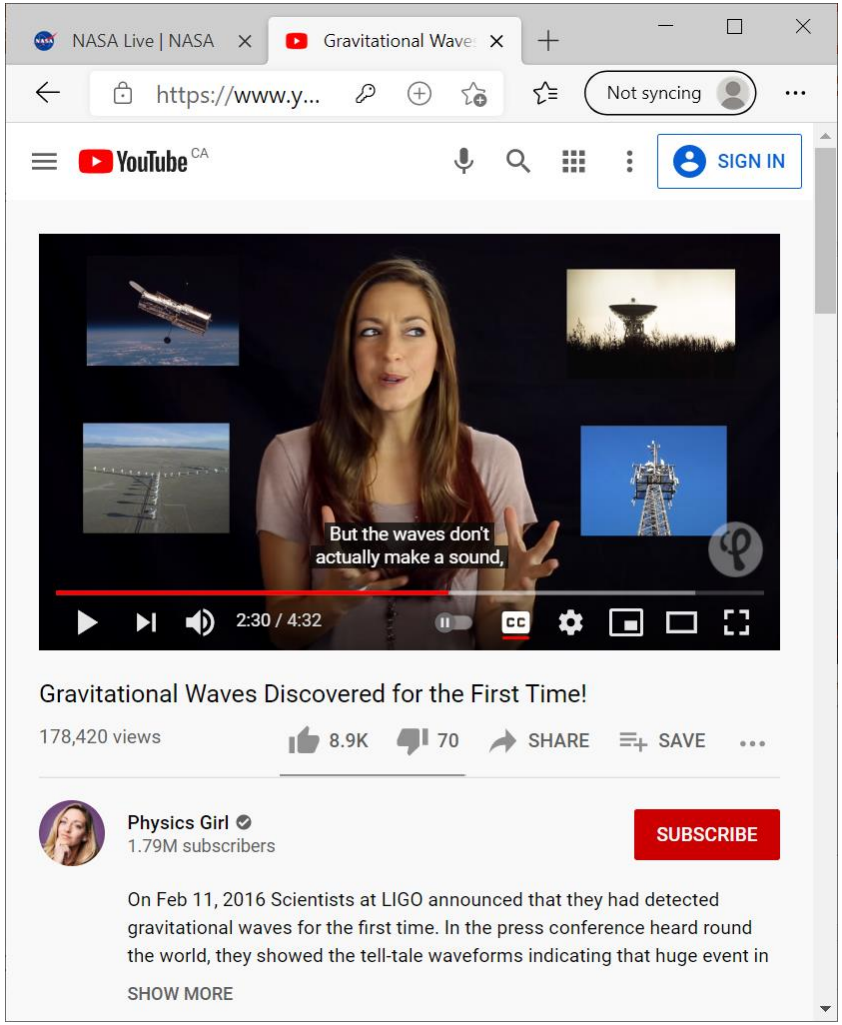
TED-Ed - YouTube

FuseSchool - Global Education - YouTube

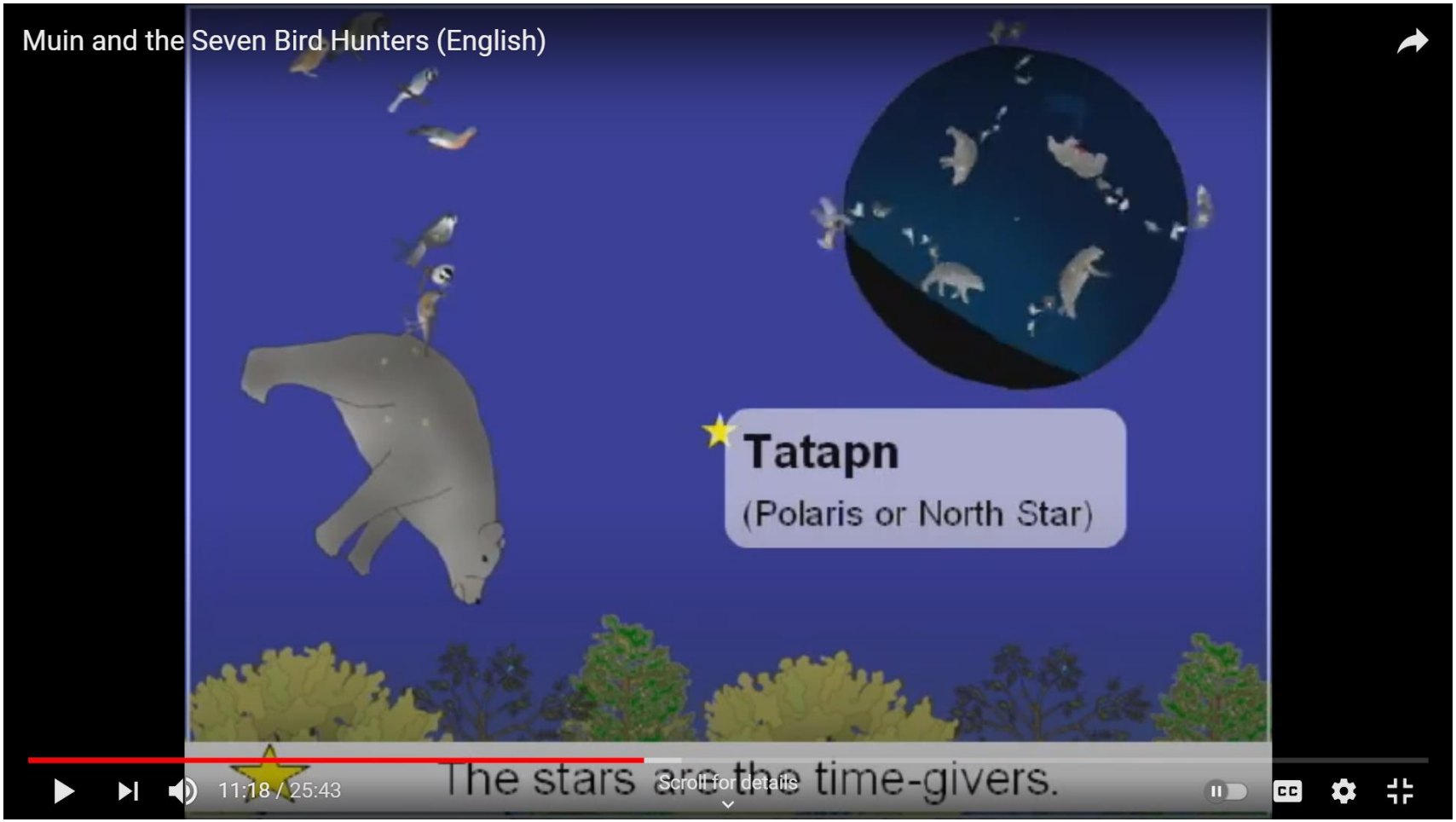
CrashCourse - YouTube

Professor Dave Explains - YouTube

Elearnin - YouTube



Activity example: Read or watch “Muin and the Seven Bird Hunters” (Muin aqq L’uiknek Te’sijik Ntuksuinu’k) story and match the birds with the stars on the sky:



[Muin and the Seven Bird Hunters (English) - YouTube]

[Stellarium Astronomy Software](#) – Inuit Starlore

PHYS 2400 Homework Submission Example:

I asked the opinions of a Tech engineer at Canadian Nuclear Laboratories in Ontario, who recommended anywhere from a 5-300MW of electrical generation, for a smaller, less dense, population. He also said there is a push in Canada for the use of SMR (Small Modular Reactors) in remote places. These would be a good choice because they would not require constant supplies to the island, because the reactor's core has a ~30 year life-time.

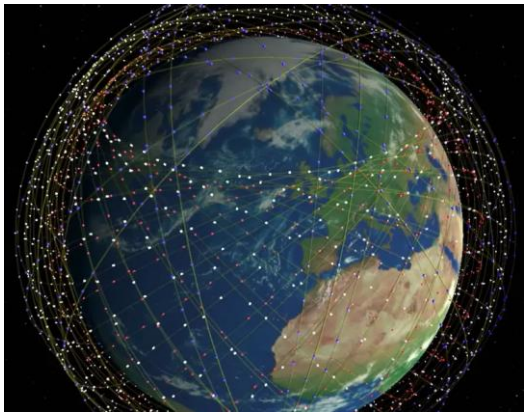
A SMR could also easily replace the energy produced by the Holyrood Thermal Generating Station, in Conception Bay, which has been set to be decommissioned this year. This plant generates 15 to 25% of Newfoundland's electricity.

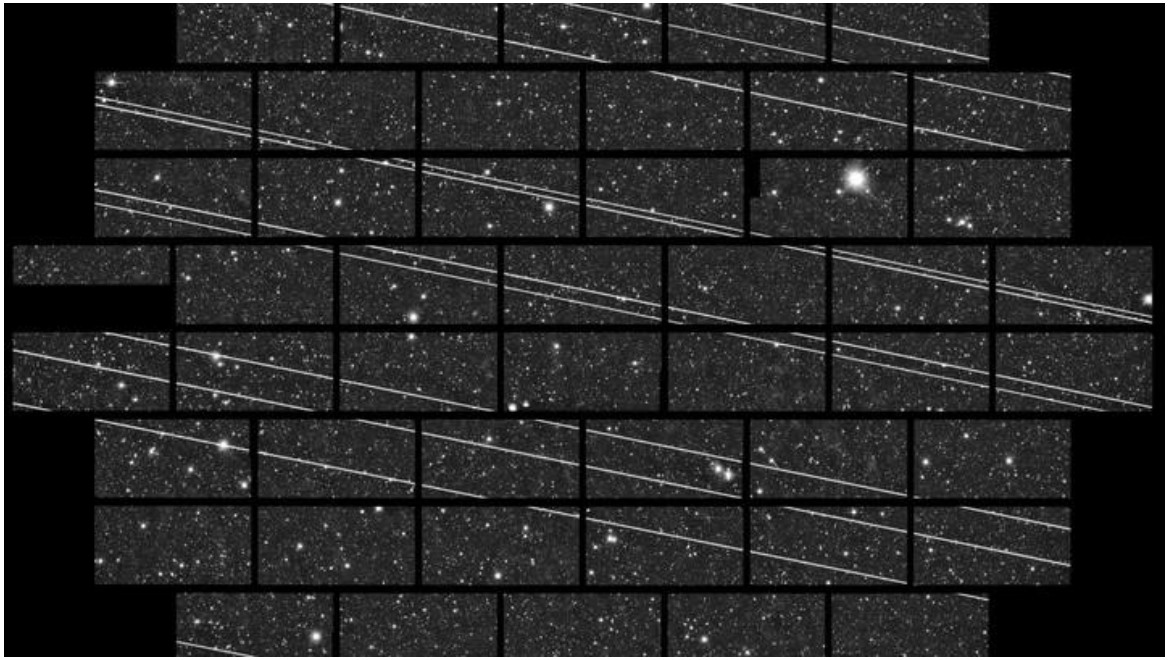
Not only would an SMR be a good idea for the low-supply, it would also provide heat to the Island during its long winters.

Share News - Example:

"SpaceX launches 60 new Starlink internet satellites into orbit, misses rocket landing", Feb. 16, 2021, space.com

"The Night Sky Will Never Be the Same: Elon Musk's plan for worldwide internet has sent bright artificial, lights streaking through the dark", Feb. 6, 2021, theatlantic.com





Starlink satellites streak through images captured by a telescope in Chile.NSF'S NATIONAL OPTICAL-INFRARED ASTRONOMY RESEARCH LABORATORY / CTIO / AURA / DELVE)

Summary and Conclusions:

Fully-online asynchronous courses can be a great option for part-time students, adult students, parents, students in remote communities, international students, etc.

We make the technology requirements clear from the start, and try to accommodate students with intermittent internet access.

Not all physics courses work well online. We have three, Astronomy, Astrophysics, and Subatomic Physics, all very popular.

It is essential to include engaging activities, consistent weekly structure, frequents assessment, strict deadlines, and rapid feedback.

Fully-online asynchronous courses take considerable time to design. Time spend on teaching is about the same as for a regular course.

THANK YOU!

Svetlana Barkanova
Physics, School of Science and Environment
Grenfell, Memorial University of Newfoundland
sbarkanova@grenfell.mun.ca

Canadian Association of Physicists
SUPPORTING PHYSICS RESEARCH AND EDUCATION IN CANADA