SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Telescopes are Time Machines | **Grade 12 – Astronomy (Science of the Universe)**

Lesson Plan

Assessment	AFL, Scavenger Hunt
Cross-curricular	Physics

Big Ideas

- The development of more sophisticated technologies has enabled us to achieve a deeper, more thorough understanding of the origin and evolution of the universe.

Learning Goals

- I can describe some milestones in the development of telescope technology and how it has been improved over time.
- I know that telescopes use all wavelengths of electromagnetic radiation to observe celestial bodies and processes that occurred millions of light-years ago.

Specific Expectations:

B1. analyse the development of technologies that have contributed to our understanding of the universe, and evaluate the impact of milestones in astronomical theory or knowledge on the scientific community
B1.2 analyse why and how a particular technology related to astronomical research was developed and how it has been improved over time (e.g., the evolution from optical to radio telescopes and to the Hubble telescope)

Description:

In this lesson students will describe some milestones in the development of telescope technology and how it has been improved over time. They will know that telescopes use all wavelengths of electromagnetic radiation to observe celestial bodies. This lesson should take place after students have learned about the electromagnetic spectrum. **This lesson is intended for the university level.**

Materials	Safety Notes
The History of the Telescope Visuals Introduction to MicroObservatory (Teacher's Guide) How does my eye compare to a telescope? How Big and How Old is the Universe? Telescope Scavenger Hunt (Student) Telescope Scavenger Hunt (Teacher) Additional Resources	There are no safety notes for this lesson plan.

Introduction

Teacher presents a brief history of the telescope. Students view The History of the Telescope Visuals (See Link).

The PowerPoint is based on the following teacher notes:

(Slide 2) We have limited means by which to discover the universe outside our planet. The very first homo sapiens 600,000 years ago, of course saw the stars at night, and the first lunar calendar found was prehistoric, created around 8,000 B.C. Civilizations such as the Mayans, Babylonians, and Egyptians tracked the heavenly bodies to calculate solar years and keep track of crops and religious events and yet it seems that up until the early 17th Century observations of stars, planets and other celestial bodies were made using the naked eye.

(Slide 3) It was not until 1608, that an eyeglass maker, Hans Lippershey, applied for a patent for putting together two lenses to magnify distant objects. Galileo Galilei also experimented with these magnifying devices and pointed them to the sky. He proposed that the planets circled the sun much in the way the moons of Jupiter circled that planet, and while he was imprisoned for this suggestion (among others implying that the universe wasn't "perfect"), the shift to a heliocentric universe was inevitable and there was even greater interest in mapping the sky. Galileo was able to create a telescope with a magnification of only 20 times (http://amazingspace.org/resources/explorations/groundup/lesson/basics/g8a/)before Huygens, in 1655, discovered a new way of grinding powerful lenses.

(Slide 4) "Refracting" telescopes made with two lenses to focus light, were limited by their size, however, and within 80 years, Isaac Newton had invented a new type of "reflecting" telescope using a mirror. (http://amazingspace.org/resources/explorations/groundup/lesson/basics/g10areflector/. These early types of telescopes were optical in nature and collected and focused only visible light to make images.

(Slide 5) In the 1930's a telescope collecting radio waves was developed (http://amazingspace.org/resources/explorations/groundup/lesson/basics/g21btypical/), followed by an infrared telescope in the 1960's. All wavelengths of electromagnetic radiation are now used to create images and collect different types of data. Take a look at the Milky Way Galaxy through these different "lenses": http://www.chromoscope.net/

(Slide 6) Reflecting telescope mirrors have reached such huge diameters (8.2 m being the maximum for a single primary mirror) that they are now often segmented (or put together in parts) to create a larger effective primary mirror. Radio telescopes are even connected in arrays over 1 km^2 to make use of even larger reflecting surfaces (http://amazingspace.org/resources/explorations/groundup/lesson/basics/g21c/).
Since the early 1970's telescopes have been sent out into orbit to escape atmospheric effects, which limit the resolution and quality of images. The "granddaddy" of orbiting telescopes is the Hubble, which was launched in 1990 and has been followed by many others. While the Hubble can "see" 30 billion light years away, 700 million years after the Big Bang, Its true successor the James Webb telescope, which will launch in 2018, will make use of segmented reflectors to look further back – perhaps 100 million years after the Big Bang – to observe how planets and galaxies were first formed.

(Slide 7) We don't just use telescopes to see the surrounding sky as it is, but to observe the evolution of the universe. By observing electromagnetic radiation of different frequencies, we can learn about the beginning of the universe as well as its later stages because this radiation is coming to us from light years away in the universe and has taken a long time to get to the earth (or close to it).

Watch this video to learn more about the one of the Big Questions of astronomy -- how the universe was born -- and how we use telescopes to answer this question: Observing The Universe From The Bottom Of The Planet: Matt Dobbs at TEDxYouth@Montreal
https://www.youtube.com/watch?v=VXZaEUhwmtE

(Slide 8) The recent discovery of gravity waves adds another tool for data collection in the universe, which may allow scientists to develop new kinds of telescopes for waves that aren't electromagnetic, and allow the observation of rare phenomena like two black holes circling each other or even the initial gravitational waves produced from the Big Bang: What will we learn from the detection of gravitational waves?
https://www.youtube.com/watch?v=YMsbqONCvxQ

Action

Prior to introducing the activities the teacher should read**:** Introduction to MicroObservatory (Teacher's Guide) (see Link) and show students how to take an image using the microObservatory; a network of automated telescopes that is controlled over the Internet. Students can reserve telescope time, check weather, choose targets, select exposure times, color filters and other parameters.

**Please note that if you use the public access account, you should take the image at least 1-2 days before you wish to receive it and you need to download the image as soon as you receive it. The first activity does not require images and so can be done on day 1.

In the first activity, you will compare your vision to that of a telescope. In groups of 3, complete the activity How does my eye compare to a telescope? (See Link)

http://mo-www.cfa.harvard.edu/OWN/pdf/eyeScope.pdf

Second, you will measure images of galaxies to calculate how old the universe is. You can access the microObservatory through this site: http://www.microobservatory.org/

You can also download image-processing software at:
http://mo-www.harvard.edu/MicroObservatoryImage

How Big and How Old is the Universe (See Link):
https://www.cfa.harvard.edu/webscope/activities/pdfs/galaxies.pdf

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Consolidation/Extension

Students complete the Scavenger Hunt (Student and Teacher – See Link) with the following website: http://amazingspace.org/resources/explorations/groundup/.