Exploring Your Night Sky

Dark Skies Journal
Rothney Astrophysical Observatory

Presented in partnership with the Ann & Sandy Cross Conservation Area

V. 2021.04.07
# Table of Contents

Be an Astronomer .............................................1
What is Light ..................................................2
Light and Astrophysics ......................................3
Dark Skies ......................................................4, 5, 6
Animals, Birds and Insects of the Night (coming soon) ..................................................7, 8
Lights and Human Connections (coming soon) ..................................................9
Traditional Knowledge of Dark Nights .........................10
History of Artificial Light ......................................11
Too Much Light ................................................12
Measuring Dark Skies .........................................13, 14
Near Earth Space Conservation ............................15
Big Ideas and Big Solutions ..................................16, 17, 18
Key Terms .......................................................19
Resources ....................................................20
Be an Astronomer

One of the first things to learn about astronomy is light, what light is and how it radiates energy. Understanding the properties of light is key to discovering the nature and motion of distance celestial objects such as stars, planets, and galaxies.

If you want to explore the night sky you can learn about light but also the importance of dark. Astronomer need dark skies to observe the light from distant celestial objects.

Explore your night sky in your neighbourhood. Observe the moon throughout the lunar month and you can take star magnitude measurements. Learn about how you can be an astronomer with the Dark Skies Journal, Dark Skies Workbook and Observing Guide.

Here is a list of your Be an Astronomer activities:

★ Learn the properties of light.
★ Discover how light moves through a telescope.
★ Learn skills and inquiring on how and when to observe stars in a constellation.
★ Carefully observing the sky and locating constellations and asterisms by use a star map.
★ Measuring star magnitude and thinking about what you are observing.
★ Recording your star magnitude data.
★ Sharing the information by completing the activities.
What is Light?

Light is created by stars. At the core of a star energy is created as hydrogen converts into helium. This fusion at the core is the process that creates the energy or the light.

Light acts like a wave but it is also a tiny bit of energy called a particle or a photon. The flow of photons acts like a wave. Astrophysicists demonstrate and categorize light properties and energy with the electromagnetic spectrum. The different wavelengths of light flow across the spectrum from very low energy frequency radiowaves to higher energy gamma ray light. You are see the orion nebula in different wave lengths or from different perspectives.
Light and Astrophysics

Light is the fastest thing in the universe. A star emits light, that light travels across space and Astronomers collect that light with their telescopes. You can bring that light into focus and study the light from the star. Below are two types of telescopes. A refracting telescope bends light and brings it to a focus. A reflecting telescope reflects light with a series of mirrors that direct the light to a focus.
Dark Skies and Astronomy

Light pollution has a direct impact on the ability of astronomers to observe objects in the sky. Astronomers use telescopes as tools that collect light. If there is too much artificial light around the telescope that light it blinds the telescope and its ability to collect the light from distant stars. Astronomers need dark skies to research the light from distant celestial objects.

Very dark skies allow astronomers see stars that are a low magnitude. Magnitude is the measurable amount of brightness of the star in the sky. The apparent magnitude scale below is a way to identify the luminosity of celestial objects as observed from earth. The magnitude scale is a logarithmic scale that provides a measurement of how bright a star appears from earth. This measurement of brightness of stars is compared along the scale compares one star to the next star. The brightest is the sun at -26.74 to faint light objects observed with the Hubble Space Telescope which are 31 magnitude.

Dr. Phillip Langill observing with the ARCT Telescope
Designed and built by UCalgary/PHAS 1982 – 1986
Primary mirror: 183 cm, f/2.7 parabolic optics.
Secondary mirror: 36.6 cm,
Dark Skies

The natural cycles we experience on earth are based upon the spin of the earth as it revolves around the sun. These motions create seasonal processes and each twenty four hours, we experience daytime and nighttime periods. The length of each night and day as well as how much sunlight we observe depends upon the time of day, time of month and type of year. Also, just as important is where you are located on the planet. All of these factors when you put them together will tell you when the sun will rise and set as well as where and when you will find the moon in the sky.

What is Natural Light?

What is Artificial Light?

http://www.crossconservation.org/

Dark Skies as a Natural Resource

You can take star magnitude measurements in your community. By measuring the magnitude of stars, you can determine how much light is in the night sky. The image below was taken by photographer Larry McNish. He captured the skyglow from Calgary that is created by too much artificial light.

What is too Much Light?

Cities, towns and industrial areas are lit with artificial light. Light should be directed towards the ground, not up into the sky. After midnight lights could be turned off or dimmed to maintain dark skies. Artist Sarah Osmani depicts the effects of too much light in the downtown city center of Calgary. She shows us what we miss observing in the sky when there is too much light.
Traditional Knowledge

Up to 100 years ago, the Foothills region offered a window to the universe. Clear and dark skies allowed us to see the stars of our stellar neighbourhood, the planets in their orbital journeys and the mysterious Aurora Borealis. Humans, animals, plants, insects all living forms of life survived, thrived and found comfort in the regular patterns of the light of day and dark of night.

Old Man Napi by Bryce Singer

Indigenous ways of knowing are based upon connections to the land and sky. Elders share and teach spiritual and scientific traditional knowledge by using these connections to the natural world. Teaching the motion and meaning of stars, planets and the moon is sky is lost when the younger generation cannot see the stars? The glow of artificial light challenges and limits discovery teaching and our ability to find ourselves in the universe.
History of Artificial Light

Discoveries in light and the manufacture of artificial light developed in the nineteenth century. As experiments in forms of electrical charges from batteries to alternating currents were successful, new lighting mechanisms were created. The technology was used to develop new sources of light sources of artificial light.

1800
Great Britain's Humphrey Davies, was a chemist and in 1802 he is credited with developed the first electrical arc lamp.

1858
Developer of electromagnetic formula and the discovery of an electric motor. Michael Faraday build the first electric powered lamp in a lighthouse

1879
Paval Jablochkoff, a French engineer, improved the arc-lamp model that emitted light equivalent in brightness to several hundred candles.

1880
Thomas Edison patented the Edison bulb, then supervised the construction of the first commercial, central electric power station in New York City.
**Too Much Light**

As the light technologies developed, it was used to light up the night. In urban areas are where people live, lighting was installed along transport systems, roadways and buildings. Cities and towns became brighter and brighter. Over the past one hundred years, civil engineers have designed urban spaces with light. In areas where people walk and drive cars there is bright street lighting. New technologies are developing that provide needed light but in balance with the natural world and human, animal, bird, insects and plant biological needs.


The 24 hours society we live in require lit spaces for people to move and work. But today's cities, towns and even rural areas are lit up throughout the night. Too much light, light trespass and light shining up in the sky where it is not needed is all light pollution.
Measuring Dark Skies

The best way to understand the impacts of light pollution is to observe the sky at night, take star brightness measurements and recording the data. You can apply scientific process which involves locating stars that have a measurable amount of luminosity. Taking measurements of how much light is in the sky is a method of creating a starting place or a baseline. This baseline can be compared to other measurements and then you can determine if the amount of light is more or less. Recording and comparing numbers creates a measurable record, so any new changes can be identified.

Be a Citizen Scientist

- Learn how to collect light data
- Learn how to locate and observe stars
- Conclude develop new hypothesis
- Create Hypothesis
- Learn how to identify natural versus artificial light
- Contribute to a project to mitigate light pollution
- Experiment or Test
Tools to Measure the Amount of Light in the Sky

Increased development and industrialization has created a rise in the use of artificial light. Too much light in the night sky has challenged astronomers. Tools were tested and used to observe the amount of light in the night sky. The tools below are used by astronomers and engineers to collect data on how much and where too much light is observed. The data is used to identify opportunities to reduce or mitigate light pollution challenges.

Star magnitude provides a tool of measurement. How bright stars appear to your eyes is apparent star magnitude. Collecting data on star magnitude measurements creates a baseline of comparisons. This means that if more light pollution or less light pollution is emitting from an urban area, we have a way to measure where and by how much.

Bortle Scale helps amateur astronomers to quantify dark skies. Created by John Bortle is a measure of sky darkness. Along the scale 1 is very dark sky area up to 8.9 which is a sky lit up with too much light pollution.

Star Count
A advisable light measurement of recording how many stars are visible within a constellation or asterism.

A sky quality meter is a tool that measures the brightness of light in the sky.
Near Earth Space Conservation

Near Earth Space is the zone or area that surrounds the biosphere of the earth. This includes all of the ecosystems of the earth all together. Shooting straight up from the surface of the earth to the beginning of space and the edge of earth’s atmosphere is called the Karman Line and is 100 kilometers up from sea level. Near earth space is the area around the earth from the edge of earth’s atmosphere to the orbit path of the moon. In 1957, the first satellite was launched and Sputnik brought the world into the space age. Since that time, near earth space is now home to thousands of satellites. The following are the challenges created by the human manufactured objects that are orbiting the earth. These satellites and spacecraft have their impacts on the ecology of near earth space:

- **Light Pollution**
  Satellites with reflective surfaces create too much reflected light

- **Chemical Pollution**
  Rockets expend fuel into the atmosphere

- **Electromagnetic & Radioactive Debris**
  Technologies and materials that create pollution

- **Satellites**
  Over 6,000 currently orbit the earth
Big Ideas

Be an Astronomer and track and monitor the amount of light in the sky. Careful observations and recording of data allows us to understand how much light is in the sky. Where the light is and if there are any changes such as new infrastructure or development. Once we know the challenge of how much light is in the sky, we can work towards smarter and more efficient lighting.

The skies over the Rothney Astrophysical Observatory. This map is an area of 468 km from east-to-west, by 556Km north-to-south. The colours on the map show how much light pollution is shining on the RAO.

Light Pollution Atlas 2016 by David Lorenz.


On the roof of the Rothney Astrophysical Observatory is a fish eye lens camera. You can observe sky quality conditions, how much cloud cover and level of humidity. You can also observe the amount of light pollution in the night sky.

https://science.ucalgary.ca/rothney-observatory/about/skywatch-and-multimedia
You can be an ecologist and help to protect natural areas where there is dark skies. National parks, conservation areas and nature preserves are designated areas that protect wildlife and the natural environment. We can help these areas to become dark sky preserves and support them to ensure they can continue to protect wildlife, plants, birds, insects, and people. These special natural darks areas allow us to go out into the night and see stars, planets, and the Milky Way.

We can also work towards creating spaces within urban areas that provide darkness. Cities parks, residential communities and even retail developments can keep lights turned down with smart lighting design after midnight to ensure all people and animals and birds can benefit from dark skies.
Big Solutions and You

You can be a Citizen Scientist and observe the artificial light in your community. Think like a Civil Engineer. All artificial lights are manufactured and placed by people. There are great opportunities for smart design and to mitigate the amount of light shining in the sky. New LED lighting technologies enable us to change the amount of light and colour of the light emitted by a lighting fixture. Bright ideas such reducing blue light or the amount of light of an outdoor lighting installation after midnight would help to create balance in urban areas.

Below are actions suggested by the International Dark Skies Association:

- Assess the lighting around your residence.
- Use dark sky friendly lighting at your home and business.
- Talk to your friends, family, and neighbors. Spread the word online!
- Become a citizen scientist.
- Set up an outreach table at a local event.
- Advocate for a lighting ordinance in your town.

In the Netherlands, engineers are experimenting with phosphorous paint in the road instead of light posts.


The Rothney Astrophysical Observatory works with our partners on light pollution mitigation:

https://calgary.rasc.ca/lp/index.html

https://www.darksky.org/
Key Terms

Artificial Light - light that is created by human made technology

Circadian Rhythm - internal cycles within human body that respond to night and day

Conservation - object or natural area that are cared for and protected

Constellation - a group of stars that are identified within a set border in the sky as viewed from earth

Light Pollution - any artificial light that shines where it is not wanted or creates harm by its brightness, colour or direction

Luminosity - a unit of measurement of the degree of brightness

Magnitude - a unit of measurement of the degree of brightness of objects in the sky

Mitigation - solutions and positive action towards solving challenges

Natural Light - Light created by the sun or another star

Satellite - natural objects that orbit, like a moon or human made technology that orbits the earth

Star - A hot ball of gas that creates its own energy in its core and emits electromagnetic energy

Stewardship - Action and care of the natural environment
Resources

Astronomical Society of the Pacific

International Dark Sky Society
https://www.darksky.org/

Globe at Night
https://www.globeatnight.org/

Royal Astronomical Society of Canada
https://www.rasc.ca/lpa

Dark Skies - Wales
https://www.visitwales.com/inspire-me/days-out/dark-sky-destinations-go-stargazing-wales-winter

The new world atlas of artificial night sky brightness
https://advances.sciencemag.org/content/2/6/e1600377

Jet Propulsion Laboratory - NASA
https://cneos.jpl.nasa.gov/

United Nation Office for Outer Space Affairs