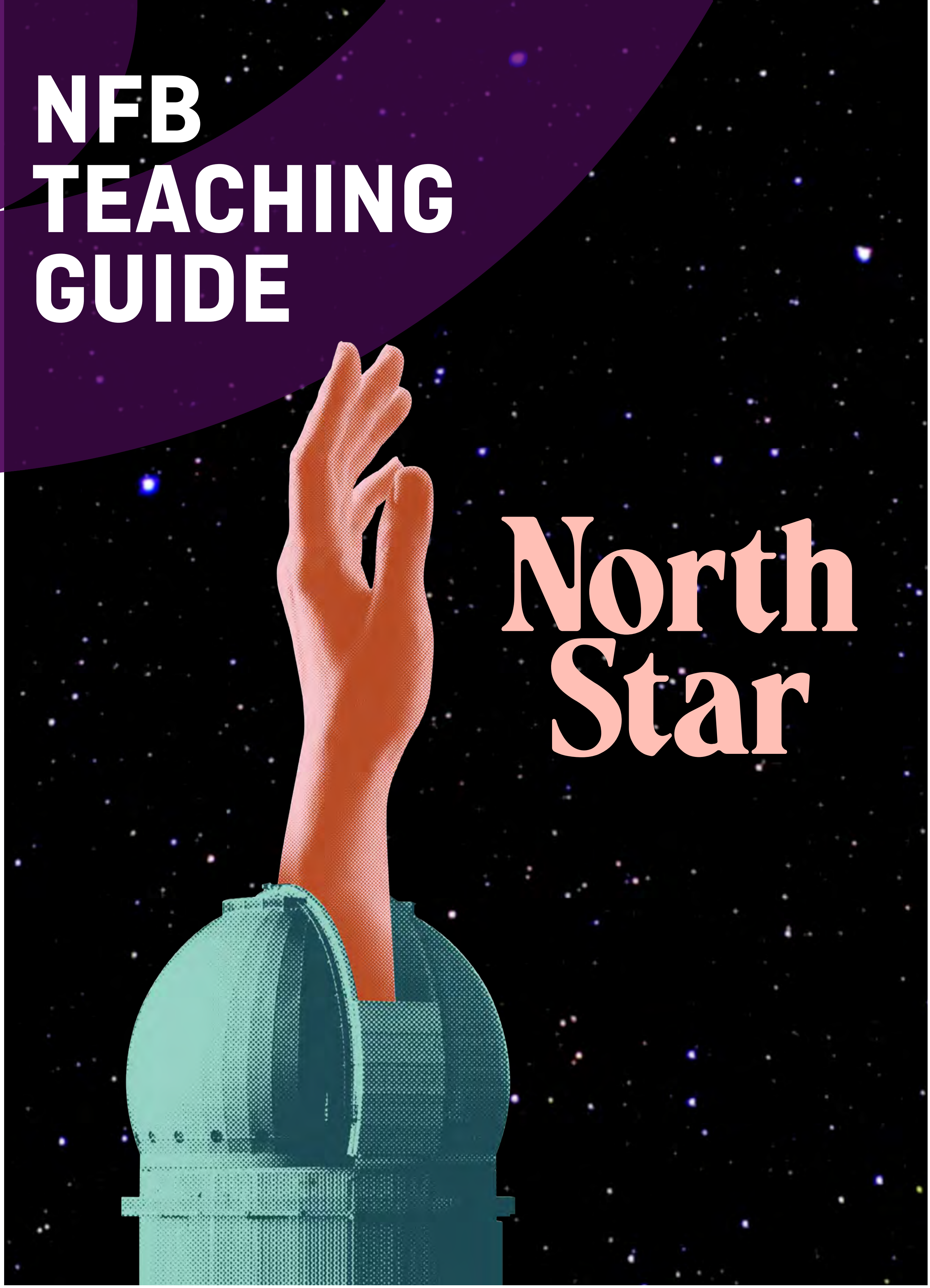
NFB TEACHING GUIDE



North Star

NFB ONF EDUCATION

CONTENTS

ABOUT THIS TEACHING GUIDE

The five-episode NFB series ***North Star*** is a fascinating look at the life of Laurie Rousseau-Nepton, a Canadian astronomer from the Innu Nation. Viewers learn about many concepts in astronomy while gaining awareness of the ways in which science and Indigenous cultures connect via oral tradition and observations made in nature. The protagonist's journey can also prompt young people to think about questions of identity from a personal and professional growth perspective.

Given that the series covers a wealth of topics, this guide presents activities for each episode that can be done in Science class, plus other activities for other subjects, and also offers ideas for cross-disciplinary assignments.

RECOMMENDED AGE RANGE

This guide is suitable for students between the ages of 12 and 17.

SCHOOL SUBJECTS

The content in this guide is relevant to the following subjects:

- Astronomy (and Science in general);
- Ethics;
- Indigenous Studies;
- History and Citizenship Education;
- Personal and Professional Development.

In addition, all of the content lends itself well to cross-disciplinary projects.

KEY WORDS, TOPICS AND THEMES

Astronomy, deep-space origins of elements in the human body, the history of the Universe, identity and career choices, Indigenous cultures and science, light and colours, oral tradition and science, skywatching, stars, women in astronomy.

MODULE 1: ACTIVITIES FOR SCIENCE CLASS

Remember to let your colleagues know that this guide also contains activities in other school subjects, corresponding to the various curricula in Canada. This will provide them with interesting opportunities to make use of in class.

1) EPISODE 1: *OBSERVATION*

Title of the activity: Observing the Sky

LEARNING OBJECTIVES

- Observing naked-eye celestial objects.
- Recognizing the cycles related to the movements of celestial bodies.
- Compiling one's observations, like an astronomer.

INTRODUCTION

In this episode, Laurie tells us why observation is important, whether it's on a forest expedition or as part of her research. Her observational skills and attention to detail help her in her work. For this activity, students are asked to observe the sky regularly for a month and note their observations in a logbook, the way astronomers do.

The activity will therefore take several weeks to complete (students don't have to finish it before you move on to Episode 2).

MATERIALS NEEDED

– Notebook or looseleaf sheets for the observation logbook.

– Optional: a compass or an app to identify the four cardinal points.

SEQUENCE

Watch the episode with students.

Ask students what can be observed in the sky with the naked eye, and which objects they've seen themselves.

Ask them to observe the sky over the next month and record what they see in a logbook. Instead of long skywatching sessions, you can suggest that they simply look up as often as possible, both day and night.

- Is the sky clear or cloudy?
- Is the Moon visible? Many people don't realize that the Moon can be seen in the daytime!
- If the Moon is visible, which phase is it in?
- If it's nighttime, can you see any stars? Do you know whether any planets are visible when you look up?
- Do you recognize any constellations?

The students' logbooks need not be complicated. They can use any kind of notebook, but each observation should include a number of details, such as:

- the date and time;
- the observation site (where are they looking from?);
- the quality of the sky, or as astronomers say, whether "the seeing" is good or bad. Is the sky completely clear? Partly cloudy? Is there a lot of light pollution? Etc.;
- a simple sketch of their observation, including the direction in which they looked (N-S-E-W).

A good way to get used to the directions north, south, east and west is to remember that the sun sets in the west. When students face that direction, east is behind them, north is to their right and south is to their left.

Cool tools

There are many applications for mobile devices and web-based tools that simulate the positions of objects in the sky from any location and at any time. Stellarium Web is an especially useful tool because it's free to use and works directly in a browser. Make sure the tool "knows" your geographical location, because the visible portion of the sky depends on where you are in the world.

Further resources:

- The *Monthly Sky* from the Planétarium Rio Tinto Alcan website;
- Video tutorial for Stellarium Web.

WRAP-UP QUESTIONS

After several days of observations, the students will probably have questions about what they've seen. It's worth letting them skywatch for weeks or even months at a time, so that they start to notice the changes and cycles.

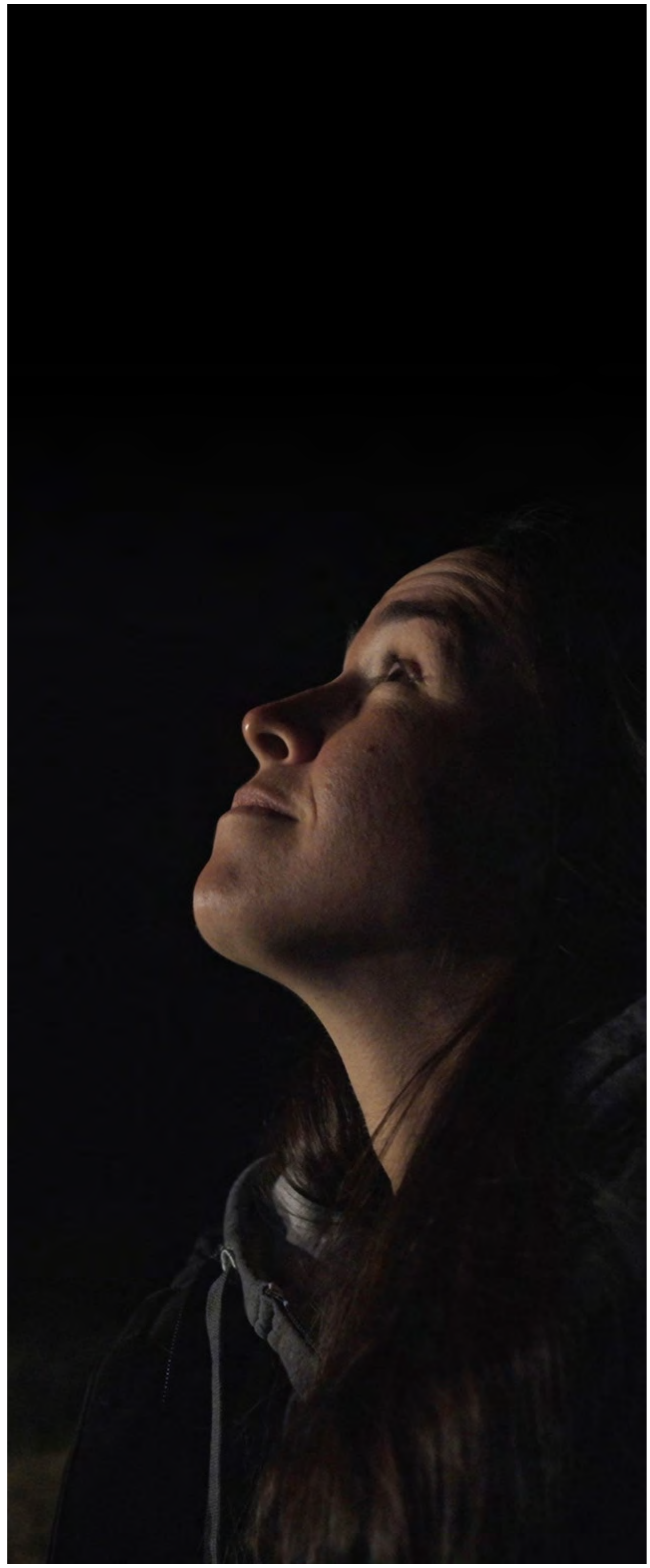
- What have you noticed?
- Did you appreciate the chance to connect with the sky?
- What are some connections between our calendar and the cycles of objects in the sky? (Think of the length of a day, a month and a year.)
- What concrete influence do the sky and the movements of the Earth have on the ways you organize your schedule and your life?

TAKING THINGS FURTHER

Get the students to think about the cultural aspect of our knowledge of celestial objects.

- In what ways are the constellations reflections of specific cultures?

Have them do some research to explore important things and characters (and the stories associated with them) represented in the constellations of various cultures.



2) EPISODE 2: *RESEARCH*

Title of the activity: Stars with Colours

LEARNING OBJECTIVES

- Formulate hypotheses the way scientists do.
- Learn the reason why stars are coloured.

INTRODUCTION

For this activity, students are invited to investigate the colour of stars and to formulate hypotheses, as a scientist would.

MATERIALS NEEDED

– Projector or smart board to show the suggested image.

SEQUENCE

Before watching the episode

Since students have been observing the sky as part of Activity 1, ask them whether they've noticed that some stars have specific colours. As the colours are only faintly visible to the naked eye, they may not have been able to make them out, especially if they've been looking in an area with a lot of light pollution.

Show the students an image of a region of the sky, like this one.

Ask the students to comment on what they see. They will surely notice that many different colours are visible.

Ask them the following questions:

- Are the stars really different colours?
- What do you think causes these differences?

Ask your students to apply the scientific method and formulate hypotheses about the reasons why stars have different colours.

After they've come up with their hypotheses, watch Episode 2 in class.

After watching the episode

Now that the students have heard Laurie's explanations, ask them to review their hypotheses. Are they surprised? Do they have questions? Do the explanations seem logical to them?

WRAP-UP QUESTIONS

After the students have discussed the reason why stars are coloured, you can wrap up the activity by showing them some coloured images of the night sky and asking questions about their knowledge of them.

Astrophotography images are often very beautiful and colourful. Careful, though: sometimes false colours are used in these images—not to cheat, but simply to emphasize certain details. Here is a series of images taken at the Canada-France-Hawaii Telescope showing different stages in the formation and evolution of stars, with explanations of the colours that are seen.

- What kinds of things do you notice in these images?
- How do you feel when you look at these photos?
- Do you think the Universe is capable of creating works of art?

INFO-CAPSULE

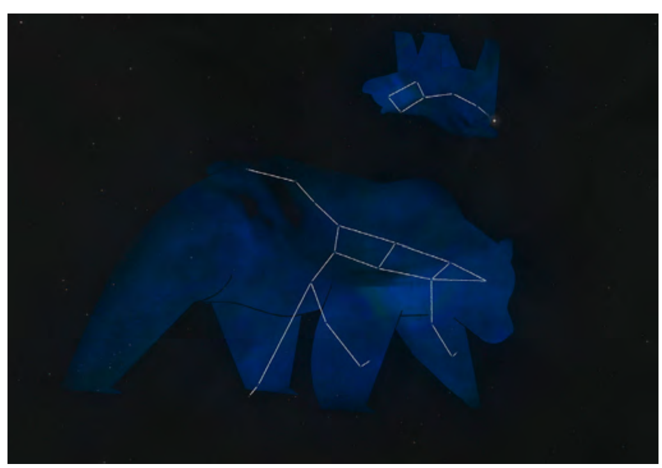
Laurie explains that it's the temperature of stars that determines their colour: a very hot star will look blue, while a cooler star will look red.

This explanation seems to run counter to what we see in our day-to-day experience: we tend to think of red as a warm colour and blue as a cool one. Why this difference?

In fact, every warm object gives off coloured light. The hotter it is, the more its colour will tend toward white and blue. For example, the hottest part of a flame is blue, and the expression "white hot" means something very hot, even hotter than "red hot." If we were able to reach temperatures that high here on Earth, we might use the expression "blue hot"! In order of temperature, the warmest stars are blue, followed by white, yellow, orange and red stars.

TAKING THINGS FURTHER

Ask students to reflect on the importance of technology in space studies. Without telescopes, for example, our understanding of the Universe would be very limited. Scientists and engineers create complex instruments and algorithms to gather as much information as possible from the light that reaches us from stars. How have science and technology worked together to help us expand our knowledge of the Universe?



3) EPISODE 3: *LIGHT*

Title of the activity: The Universe in Colour

LEARNING OBJECTIVES

- Describe how colour digital photographs are created.
- Learn why it's important to use various coloured filters in astronomy research.

INTRODUCTION

In this episode, Laurie explains how colour images are captured using the telescope and the cameras mounted to it. This activity allows students to explore this concept in more detail by experimenting with coloured filters.

MATERIALS NEEDED

– Coloured filters such as cellophane paper or coloured acetate sheets, red and blue filters in 3D glasses, coloured glass or wrapping paper.

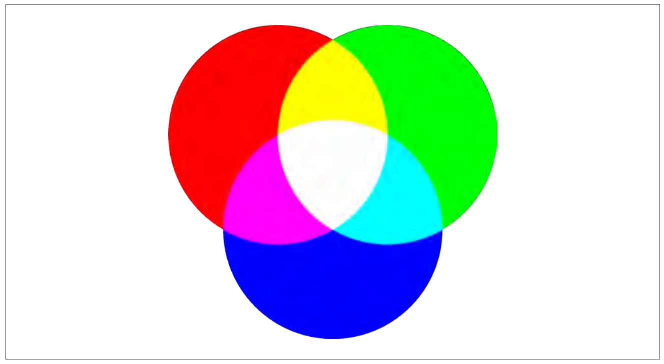
– Projector or smart board to show the suggested image.

SEQUENCE

Watch the episode with students.

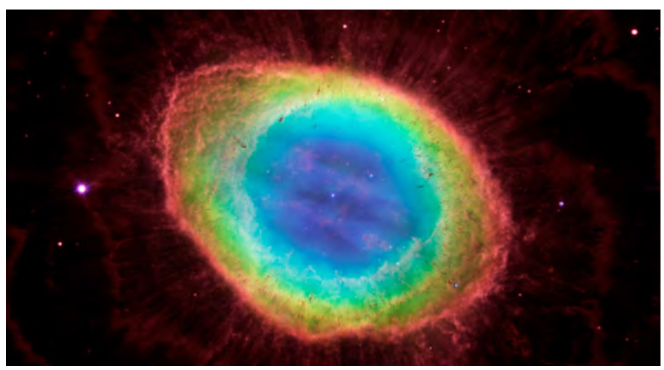
Explain to students that they'll be exploring how images from telescopes are created. Ask them: "What would things around you look like if you could see in only one colour?

For each of the following images, ask the students to imagine what they would see if their eyes could see in red or blue only. Which parts of the images would be light or dark? Which information would be lost, and which would be emphasized?



Source: commons.wikimedia.org/wiki/File:RGB_color_model.svg

Source: pexels.com/photo/landscape-nature-animal-cute-63853



Source: NASA/ESA
This is a photograph of the Ring Nebula. What we see is gas ejected by a dying star.

Next, hand out red and blue coloured filters so that the students can validate their hypotheses by looking at the three previous images through the filters.

WRAP-UP QUESTIONS

Once the students have finished observing the three images with filters, show them how the images from the Hubble Space Telescope are created. This page provides explanations, with some great visual examples. Get students to think about what information is conveyed by each different colour (i.e., wavelength of light).

- How would our knowledge of celestial objects be different if telescopes captured only one colour?
- Why do astronomers use telescopes that "see" only in infrared (a single wavelength), or in another wavelength that is invisible to human eyes?

You can also reuse the images from Activity 2; ask students to talk about what they see and what the colours represent.

INFO-CAPSULE

The sensors in a camera, whether on a professional astronomer's telescope or in a mobile phone, don't actually measure colours; they measure light intensity in shades of grey, from black to white.

The colour information is obtained by placing a coloured filter—blue, red or green—in front of the sensor and measuring the intensity of the light passing through it.

In a phone camera, each pixel on the sensor has its own tiny filter. This means that on a 20-megapixel sensor, there are 20 million tiny blue, red or green filters in front of each pixel. Each pixel measures the intensity of light associated with only one colour. The camera then combines all that information to generate a colour image.

In a telescope, three large filters are placed in turn in front of all of the sensor's pixels. Each pixel measures the intensity of each colour, but in three "passes." The result is three black-and-white images, representing the levels of blue, red and green light, respectively, from the celestial object. These three black-and-white image files must then be coloured and combined to obtain the colour image.

The colour of light is determined by its *wavelength*. There are wavelengths that are invisible to the human eye, such as infrared and ultraviolet.

TAKING THINGS FURTHER

Get students to think about the importance of light in astronomy research. Is light our only "cosmic messenger," i.e., our only source of information about celestial bodies? For a long time, it was. But more recently, new advances have made it possible to use gravitational waves and particles in our studies of the Universe. Canadian astrophysicist Maria Drout is an expert in this new research field, which is known as *multi-messenger astronomy*.

4) EPISODE 4: *COLLABORATION*

Title of the activity: Stardust

LEARNING OBJECTIVES

- Consider the idea that we are all made of stardust.
- Explain the connection between us and the stars.
- Explore the connections between biology (our bodies), chemistry (the elements) and astronomy.

INTRODUCTION

At the end of this episode, Laurie talks about what connects us as humans to the stars, and the idea that each of us is made of stardust. What does this mean, exactly? In this activity, the students will study the elements that make up our bodies and discover their cosmic origins.

MATERIALS NEEDED

– A computer or mobile device with an Internet connection for each student or team of students.

SEQUENCE

Watch the episode with your students.

Get the discussion going by asking students: What are our bodies made of?

The students should be able to name organs and perhaps cells. Can they refer to even smaller objects? What are cells made of? Get them to mention atoms.

Divide the class into teams and assign each team an element that is present in the human body.

The body is made up of the following elements (in order of mass):

– 65% oxygen;
– 19% carbon;
– 10% hydrogen;
– 3% nitrogen;
– < 3% calcium, phosphorus and sulphur, plus trace amounts of other elements.

Ask students to do research so that they can:

- describe the origin of their assigned element. How is it created? To guide their research, this NASA periodic table is useful;
- understand the importance of this element to the human body and to life in general.

WRAP-UP QUESTIONS

At the end of the activity, bring the whole group back together and have each team briefly present their findings. Then lead a discussion:

- What are other life forms, such as plants and animals, made of? Do they have the same constituent elements as we do?
- How did these elements wind up in our bodies?
- Go back to the images from Activity 2 and talk about the processes involved in the formation of stars and planetary systems. How did our solar system and the planet Earth come to be?
- How does it feel to know that your body is made of the dust of stars?

Even more amazingly, the hydrogen atoms in our bodies have been around since the Big Bang!

INFO-CAPSULE

Besides hydrogen, which came directly from the Big Bang, all of the other primary elements in the human body were made by stars. Some were formed by nuclear fusion inside stars and were dispersed into space when those stars died. The precise way a star "dies" and ejects part of its material into space depends most of all on its mass. That's why the version of the periodic table created by NASA and mentioned above shows two different sources of elements: *dying low-mass stars* and *dying high-mass stars*. Other elements, such as gold, were formed by stars colliding and merging.

These elements flung out into space were eventually involved in the formation of our solar system. Later, they became part of Earth's chemical, physical and biological cycles and eventually entered our bodies. In the *oxygen cycle*, for example, this element is exchanged between the atmosphere, the biosphere and the lithosphere. Chances are that an oxygen atom in your body was once inside a rock and was later breathed in by another animal before ending up in you!

TAKING THINGS FURTHER

Get the students to think about what studying the Universe can tell us about ourselves. Why is it important to understand the composition of stars? Our studies of the Universe, and more specifically the evolution of stars, have made us realize just how connected we all are to each other and to the cosmos.

5) EPISODE 5: *ORIGINS*

Title of the activity: Timeline of the Universe

LEARNING OBJECTIVES

- Identify important events in the history of the Universe from a human perspective.
- Calculate the timeline of the Universe.

INTRODUCTION

In this episode, Laurie takes us through some of the important steps in the evolution of the Universe, from the Big Bang to the present. This period of time is so long that it can be difficult to grasp its scale. In this activity, students create a timeline of the Universe, to scale, in their classroom.

MATERIALS NEEDED

- Tape measure or 1-metre ruler.
- Calculators.
- Paper or cardboard to identify the events in the classroom.
- Adhesive tape or pushpins to stick the events to the wall.

SEQUENCE

Watch the episode with your students.

Have the students measure the length of the classroom. Now ask them to imagine that this length represents a timeline extending from the Big Bang to today—i.e., 13.8 billion years—and label one end of a wall of the classroom "Big Bang" and the other "Now."

Next, have the students perform the necessary calculations to place the following events on the timeline. Make sure at least two people do the calculation for each event so that they can check their answers.

Events to be placed along the timeline of the Universe:

Time in the past	Event
13.8 billion years	Big Bang
13.6 billion years	First stars
13.2 billion years	First galaxies
4.57 billion years	Formation of our Sun
4.56 billion years	Formation of Earth and the other planets
3.5 billion years	First life forms on Earth
600 million years	First multicellular organisms
200,000 years	First humans (*Homo sapiens*)
0 years	Now

Example of calculation

If the classroom is 9.3 metres long and we want to find where to place the formation of our Sun on the timeline, we can use the following proportions:

$$\frac{13{,}800{,}000{,}000 \textit{ years}}{9.3\ m} = \frac{4{,}570{,}000{,}000 \textit{ years}}{d}$$

$$\text{Thus distance } d = \frac{9.3 \times 4{,}570{,}000{,}000}{13{,}800{,}000{,}000} = 3.08 \text{ m}$$

The formation of the Sun should therefore be placed 3.08 metres from the end of the classroom that represents the present day.

These calculations are easily done with a spreadsheet application like Excel if your students know how to use it.

This activity could be turned into a great permanent exhibition of drawings or printed pages, on a wall of the classroom, on the ceiling or even in a hallway in the school.

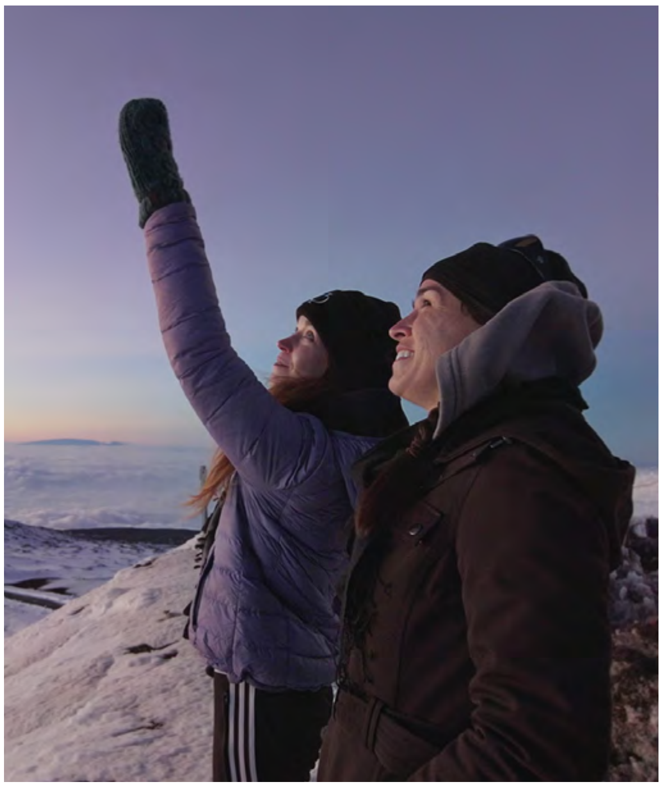
TAKING THINGS FURTHER

Get students to think about how it's possible to study the history of the Universe. What are some of the main discoveries that allowed scientists to determine the age of the Universe? The idea of an *expanding universe* that in the distant past was much denser and hotter is related to the discovery that galaxies are moving away from each other. That discovery, by astronomer Edwin Hubble, was so momentous that the Hubble Space Telescope was named after him.

WRAP-UP QUESTIONS

When students realize at what point on the cosmic timescale humans appeared, and even when the Solar System was formed, they will probably be quite surprised. It can be easy to feel very small, both in space and in time, but it's fascinating to realize that our brains have evolved to the point where we can now study and understand our vast Universe without even leaving our tiny planet. Humans may be small in size, but we are giants of creativity and ingenuity!

- How do you feel now that you have a better understanding of the scale of the history of the Universe?
- What is the importance of human beings on that scale?
- How might this timescale be different for a hypothetical extraterrestrial civilization on some distant planet?



MODULE 2: ACTIVITY ON INDIGENOUS PEOPLES AND ASTRONOMY

INTRODUCTION

In the ***North Star*** episodes, we learn that Laurie is of Innu ancestry. She's interested in how Indigenous Peoples, throughout history, have observed nature and the sky to better understand the workings of the world and the Universe—to help them travel and plan activities depending on the season, among other things. Not only is she fascinated by the knowledge that has been transmitted over millennia by members of her own First Nation, but she also values the importance of learning from other communities and nations, and is eager to learn more from the Indigenous Peoples of Hawaii, the site of the telescope she uses to conduct her research into star formation.

ACTIVITY: AN INDIGENOUS NARRATIVE THAT'S RICH IN SCIENCE

LEARNING OBJECTIVES

- Connect the elements of a narrative to its scientific content.
- Evaluate the usual criteria used in the historical method.

SEQUENCE

In Episode 1, Laurie talks about the constellation known as the Big Dipper or Ursa Major, which the Innu named after the spirit of Utshek (the "fisher," a weasel-like mammal whose scientific name is *Pekania pennanti*). What Innu history tells us about this constellation is impressive: through observation of the sky and oral tradition, a great deal of knowledge—about the history of the continent across thousands of years and about how the stars move in the sky—has reached us.

Laurie talks about this wealth of learnings from this knowledge in [this video clip](#).

Questions to ask students BEFORE you watch the video:

- How many years into the past do you think oral tradition (e.g., tales, narratives) allows us to travel?
- In what ways do you think ancestral narratives can provide us with factual information about the world we live in (e.g., features of the land, the seasons, the movements of stars in the sky)?

Questions to ask AFTER watching the video:

- The story of the constellation Utshek dates from a period when there had no longer been any summers for quite some time. What does this tell us about how old the narrative is? In other words, what period in the history of the North American continent does it refer to?
- Observing the sky over very long periods allows us to learn about the movements of stars within a much broader perspective. What were people of the Innu Nation able to observe over a very long period? (Clue: this moving celestial object is found in non-Indigenous historical records. What is it?)

CONVERSATION STARTER

- Now that you've seen all the connections between skywatching, oral tradition and the history of the continent, how would you answer someone who tells you that written records are the only way to know about history?

SUMMARY

The constellations we see in the sky today are quite similar to how they appeared 15,000 or 30,000 years ago (although much longer ago, e.g., millions of years, they would be unrecognizable). So our ancestors saw constellations with much the same shapes as those we see today. Between 10,000 and 15,000 years ago, however, Canada was in the midst of a very long glacial period: it was covered by an enormous ice sheet. There were no seasons, and therefore there were no migratory birds.

Since the narrative of the "spirit of Utshek" constellation dates to a time when there were no summers and birds did not migrate north every year, that means it is as old as the end of that glacial period, i.e., at least 10,000 years old. It tells of how there was a great change when the seasons—in particular summer—returned, and migratory birds came back as well. Another clue to how old this narrative is that some of its elements were shared across a very large territory, and that takes time to happen.

This story also tells us that generations of Innu observed the night sky over a very long period, because it recounts the movement of one star that "quickly" passed through the constellation—quickly if we represent it in a video that is sped up, but that movement actually happened over thousands of years. It was added to the narrative in the form of the arrow lodged in Utshek's tail.

Lastly, the movement of the canoe from north to south, observable every night, recalls the story of the animals who travelled south to find the summer birds, and its position directly overhead recalls the moment when Utshek climbed to the top of the tree, was hit by the arrow, and was flung into the sky.

MODULE 3: ACTIVITY FOR PERSONAL AND PROFESSIONAL GROWTH

In the ***North Star*** episodes, Laurie tells us how she developed her enthusiasm for science and astronomy from a very young age. Among other things, she talks about how we perceive ourselves when we are young, and the various components of our identity that influence our journey through life. These perceptions can make it easier, or harder, to imagine ourselves studying in a particular field, or having a particular job, later on. In Laurie's case, among all the facets of her identity, the fact of being a woman and Innu—but also having spent a lot of time in the forest with her father and enjoying observing nature and the sky—played a key role in her personal and professional development.

ACTIVITY: CHARTING YOUR OWN COURSE

LEARNING OBJECTIVES

- Determine the elements of an identity that play a role in one's personal and professional journey.
- Imagine your own journey based on the components of your distinct identity.

SEQUENCE

Once the students have been reminded of the broad outlines of Laurie's life story, have them imagine, in writing, their own journeys—as if, after becoming adults, they too were depicted as the main character in a documentary series, where we see them in their dream careers. What were some distinctive aspects of their personality when they were young? What parts of their identity played a role in their life journey—their studies, choice of career, obstacles they overcame, successes?

CONVERSATION STARTERS AND WRAP-UP TO THE ACTIVITY

Collect the texts that the students have written. If possible, give them individual feedback that:

– gives them support in addressing the challenges they identified;

– helps boost their confidence in their ability to achieve their dreams.

With the whole class, provide general feedback (but be careful not to reveal to the larger group any private aspects that the students wrote about).

MODULE 4: CONNECTIONS BETWEEN SCHOOL SUBJECTS AND CROSS-DISCIPLINARY LEARNING

A large part of this guide concerns science teaching, but it can also help with developing skills in other subjects. There are two main routes available to teams and schools for using the suggested activities in subjects other than science.

1) Partnership between teachers

How?

Science teachers can let colleagues know they will be showing ***North Star*** to students that they have in common, looking at questions of identity and personal and professional growth as well as the links between Indigenous Peoples and astronomy. The screenings of the five episodes could be shared across different subjects if possible, depending on the configuration of the groups.

2) Grade- or cycle-level cross-disciplinary project

How?

A grade- or cycle-specific teaching team can organize a cross-disciplinary project aimed at all students. The suggested activities should seek to develop skills across several subjects by having them interact with each other. Research can be done in science, social studies and ethics, for example, while content development can be done in a language course, and the results can be communicated in arts and multimedia as well as in mother-tongue instruction.

Sample cross-disciplinary project: **Exploring the Life and Career of a Woman Astronomer.**

Learning objectives

- Identify challenges specific to women in science/STEM.
- Identify the main elements of a woman scientist's career journey.
- Analyze the work, discoveries and achievements of a woman scientist.
- Incorporate geography and history elements into the analysis.
- Identify ethical issues at stake.
- Illustrate scientific discoveries and achievements as part of an art project.
- Communicate one's learnings in a structured way.

Step	Subjects	Key questions
1) Present the main topic of the cross-disciplinary project: A look at the history of women in astronomy[1]	All within grade or cycle	What challenges have women astronomers faced over the centuries?
2) Assign, or have students choose, one woman astronomer per team: write a backgrounder listing the main points about her	One of the subjects concerned OR in a de-streaming situation	What is her name, birthplace and workplace? In what period was she born? What did she study in school? What are the main topics of her research? What are her most significant discoveries or achievements?
3) A) Research: Work, discoveries and achievements of the chosen astronomer	Science	What are the aspects of her work? What are her discoveries and achievements? Explain them in text and illustrations.
3) B) Research: Geographical and historical aspects of the life and work of the chosen astronomer	Social studies	How did the place and time in which this astronomer worked influence her journey?
3) C) Research: Ethical questions raised in the story of the chosen astronomer	Ethics	What ethical questions or problems were/are posed by the challenges this astronomer met? They could be challenges related to freedom, justice, society, etc. How do her discoveries and achievements raise ethical issues?
4) Develop and structure the research content	Mother-tongue instruction	Write a text using the suggested structure for your language course (e.g., descriptive, informative, explanatory).
5) Produce a tool that communicates the research content	Arts and multimedia	Create an artistic representation of the outcome of your work in a format recommended by your teacher, or whichever one you prefer (justify your choice).
6) Presentation	All within grade or cycle	Take part in the information-sharing activity (e.g., Science Fair, women in astronomy/STEM festival).

[1]In French: fr.wikipedia.org/wiki/Place_des_femmes_en_astronomie; in English: bbvaopenmind.com/en/science/leading-figures/women-astronomers-history-timeline

ADDITIONAL RESOURCES

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APPENDIX: IMAGES PROVIDED BY THE CANADA-FRANCE-HAWAII TELESCOPE

TRIFID NEBULA

This nebula is a star-forming region, or "nursery." It contains many young and very hot stars.

The blue glow is from light emitted by these young stars reflecting on the dust of the nebula. The pink regions, meanwhile, are light emitted directly by hydrogen gas.

This nebula is about 4,000 light-years from Earth.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum

HORSEHEAD NEBULA

This nebula is part of the Orion Molecular Cloud Complex, a gigantic star-forming region.

The pink glow is from glowing hydrogen gas. The horse's head shape is actually a cloud of opaque dust blocking the light behind it. At the lower left is a star whose light is reflected on the surrounding dust, giving it a blue cast.

This nebula is about 1,400 light-years away.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum

THE PLEIADES

The Pleiades are a group of young, very bright, high-mass stars. This means they are very hot and glow with a blue colour.

The light from these stars is also reflected on the dust surrounding them, resulting in a nebula with a blueish glow.

The Pleiades are about 450 light-years away from us.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum

YOUNG AND OLD CLUSTERS

The star cluster seen in the lower left part of this picture is made of young, massive, very hot stars. They glow with a blue light.

The cluster at upper right is older and no longer contains blue stars. Only cooler, low-mass stars remain, and they glow with yellowish light.

The lower cluster is located some 2,800 light-years from us, while the upper one is more than 11,000 light-years away.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum

MESSIER 56 GLOBULAR CLUSTER

Globular clusters are formed by old yellow and red stars (that is, stars that are cooler than blue stars). They are some of the oldest stars in our galaxy, formed more than 10 billion years ago. This star cluster is around 33,000 light-years away from us.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum

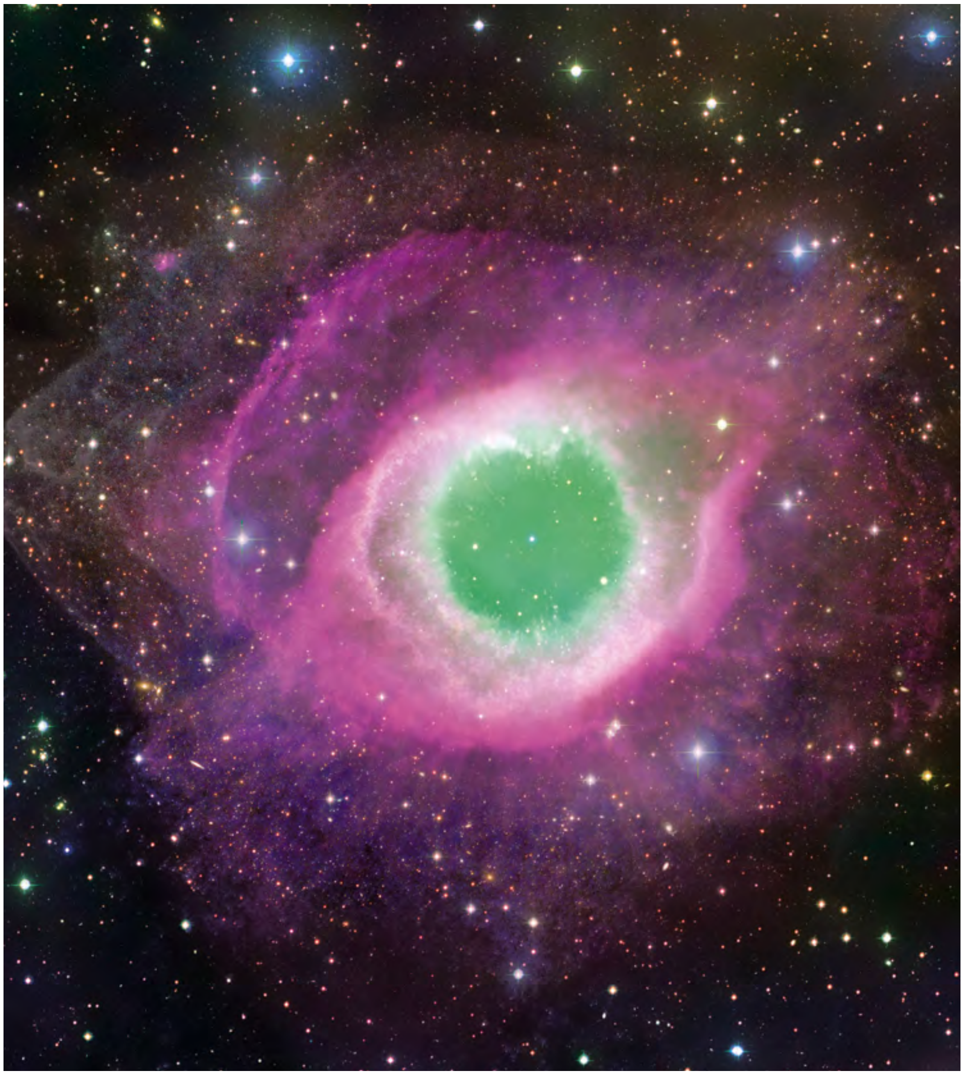
DOLPHIN NEBULA (SH2-188)

The Dolphin Nebula is what's known as a planetary nebula, a giant bubble of gas formed when a star much like our Sun ejects its outer layers of gas at the end of its life.

The red colour is produced by glowing hydrogen gas.

This nebula is approximately 850 light-years from Earth.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum



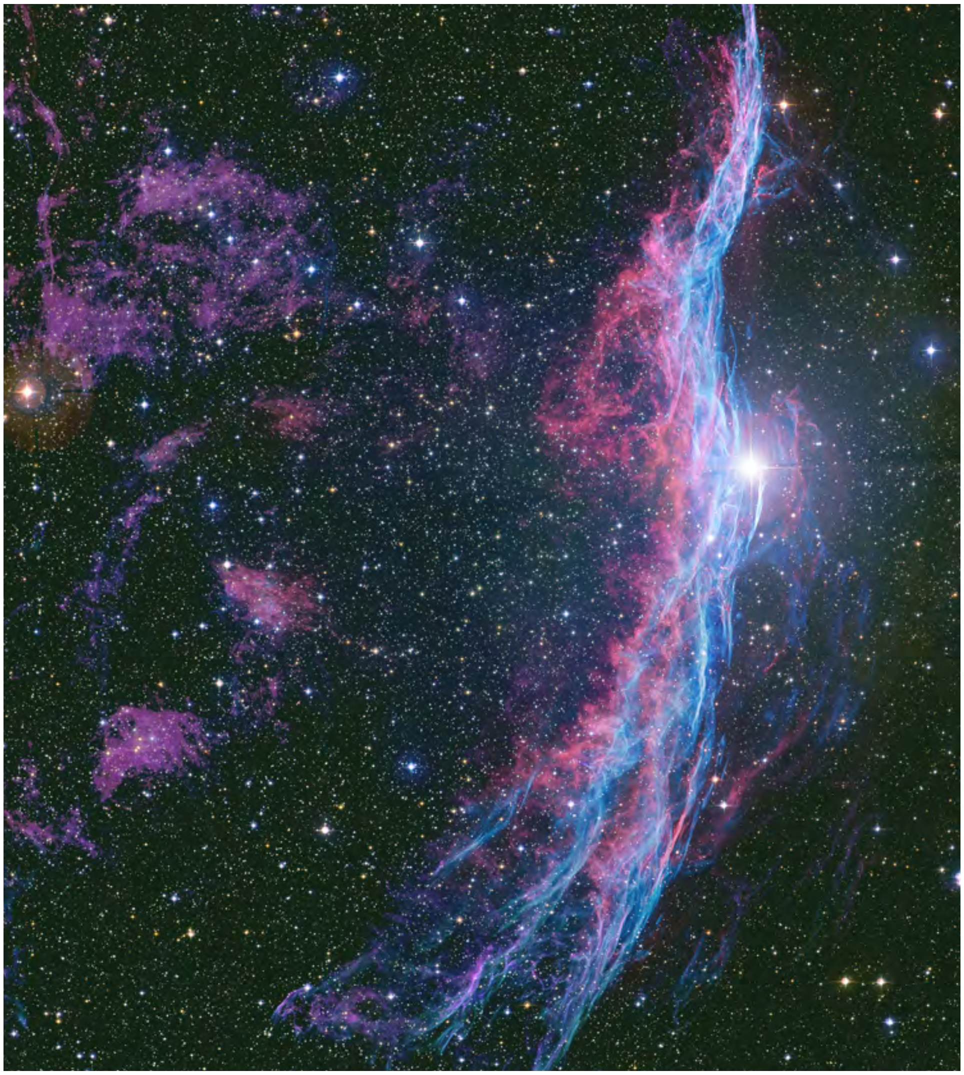
HELIX NEBULA

The Helix Nebula is a planetary nebula, a giant bubble of gas formed after the death of a star like our Sun. The visible gas was ejected by the star in the final stages of its existence.

In this photograph, red/purple represents hydrogen gas, while green indicates the presence of oxygen.

The Helix Nebula is around 650 light-years away from us.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum



VEIL NEBULA

The Veil Nebula is the remnants of a supernova: an event that occurs when a very massive star reaches the end of its life and explodes, suddenly appearing very bright in our sky.

Tens of thousands of years later, we can see the gas projected into space by that exploding star in the form of this nebula.

The colours are caused by different glowing gases: the pink is hydrogen and the blue is oxygen.

The Veil Nebula is about 2,400 light-years from Earth.

Image credit: Canada-France-Hawaii Telescope / Edizione Scientifiche Coelum

APPENDIX: LIST OF WOMEN IN ASTRONOMY

CANADIAN

CONTEMPORARY ASTRONOMERS

Carmelle Robert: She is a professor at Université Laval and was Laurie Rousseau-Nepton's thesis advisor.

Christine Wilson: A McMaster University professor, she is the recipient of several awards.

Julie Hlavacek-Larrondo: A professor at Université de Montréal, she is an expert on black holes.

Louise Edwards: She is a professor at California Polytechnic State University and was one of the first Black Canadians to receive a PhD in astronomy.

Sarah Gallagher: She is a past Science Advisor to the Canadian Space Agency.

Sara Seager: Originally from Toronto, she now lives and works in the U.S. and is world-renowned for her expertise in the field of exoplanets; she has published widely and has won several awards.

Victoria Kaspi: A professor at McGill University, she is known around the world as an expert on pulsars, and is the recipient of several awards.

Wendy Freedman: She is the director of the Carnegie Observatories in California and Chile and has won many awards.

HISTORICAL FIGURES

Allie Vibert Douglas (1894-1988) was the first woman to be awarded a PhD in astrophysics from a Canadian university.

Helen Sawyer Hogg (1905-1993) made huge contributions to astronomy in Canada and to popularizing it.

Mercedes Richards (1955-2016), originally from Jamaica, earned her PhD in Astronomy and Astrophysics at the University of Toronto.

FOREIGN

CONTEMPORARY ASTRONOMERS

Andrea Ghez: She shared the Nobel Prize in Physics in 2020 for her work on black holes.

Annette S. Lee: This astrophysicist and artist identifies as mixed-race (Lakota, Irish and Chinese) and is a pioneer among Indigenous astronomers in North America.

Carolyn Porco: She is an expert on planets in the outer Solar System, including Saturn.

Jill Tarter: She was the inspiration for the character played by Jodie Foster in the film *Contact* (1997).

Jocelyn Bell Burnell: She made discoveries that were recognized by the Nobel Prize in Physics in 1974, but the prize was awarded to her supervisor.

Wanda Diaz-Merced: She is a blind astronomer.

HISTORICAL FIGURES

Annie Jump Cannon (1863-1941) was the leader of a group of women astronomers at the Harvard College Observatory early in the 20th century. Her work led to the system that scientists use to classify stars.

Caroline Herschel (1750-1848), the first woman to earn a salary as a scientist, discovered many comets, including one that now bears her name, 35P/Herschel-Rigollet.

Cecilia Payne Gaposchkin (1900-1979) worked with Annie Jump Cannon. Her PhD thesis was described as "the most brilliant [...] ever written in astronomy."

Nancy Grace Roman (1925-2018) was the first woman executive at NASA, and is known as the "Mother of the Hubble Space Telescope" because she played a key role in its planning. She now has her own space telescope named after her.

Vera Rubin (1928-2016) did work that helped prove the existence of dark matter in the Universe. Many people think she deserved the Nobel Prize, but she never won it.