The Fire *of* Stars

The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of

By Kirsten W. Larson, *Illustrated by* Katherine Roy

About the Book:

A biography that celebrates the astronomer Cecilia Payne, *The Fire of Stars* powerfully parallels the kindling of Payne's own curiosity and her scientific career with the process of a star's birth, from mere possibility in an expanse of space to an eventual, breathtaking explosion of light.

About the Author: Kirsten W. Larson

Kirsten used to work with rocket scientists at NASA. Now she writes books for curious kids. Kirsten is the author of the picture books: *Wood, Wire Wings: Emma Lilian Todd Invents an Airplane*, illustrated by Tracy Subisak (Calkins Creek, 2020), *A True Wonder: The Comic Book Hero Who Changed Everything*, illustrated by Katy Wu (Clarion, 2021), *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of*, illustrated by Katherine Roy (Chronicle, February 2023), and *This is How You Know*, illustrated by Cornelia Li (Little, Brown 2024). She also is the author of the middle grade, graphic nonfiction, *The Light of Resistance*, illustrated by Barbara McClintock, (Roaring Brook, 2023), along with 25 nonfiction books for the school and library market. *Find her at kirsten-w-larson.com or on Twitter/Instagram @KirstenWLarson.*

About the Illustrator: Katherine Roy

Katherine Roy is the award-winning and best-selling author and illustrator of science-based books for children, including the Robert F. Sibert Honor Book *Neighborhood Sharks: Hunting with the Great Whites of California's Farallon Islands, How to Be an Elephant: Growing Up in the African Wild*, and *Making More: How Life Begins*. She is also the illustrator of numerous other books, including *Otis and Will Discover the Deep*, by Barb Rosenstock, *Red Rover*, by Richard Ho, and *The Fire of Stars*, by Kirsten W. Larson. She lives with her husband and sons in western Oregon, where she is busy writing and drawing her next books.

About the Guide Creator: Marcie Colleen

This guide was created by Marcie Colleen, a former teacher with a BA in English Education from Oswego State and an MA in Educational Theater from NYU. In addition to creating curriculum guides for children's books, Marcie can often be found writing picture books of her own at home in San Diego, California. Visit her at www.thisismarciecolleen.com.

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How to Use This Guide

This classroom guide for *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of* is designed for students in first through fifth grade. It is assumed that teachers will adapt each activity to fit the needs and abilities of their own students.

It offers activities to help teachers integrate *The Fire of Stars* into English language arts (ELA), mathematics, science, and social studies curricula.

All activities were created in conjunction with relevant content standards in ELA, math, science, social studies, art, and drama.

Aligned for Grades 1-5 in both Common Core ELA and Math, and Next Generation Science Standards

1st grade:

CCSS: ELA.RL.1.1,2,3,5,7; RI.1.1,2,3,4,6,7,8,9; W.1.2,3; SL.1.1,2; L.1.1,2,4; MATH: 1.MD.1.4

NGSS: 1-ESS1-1.

2nd grade:

CCSS: ELA.RL.2.1,3,5,6,7; RI.2.1,2,3,4,6,8,9; W.2.1,2,3; SL.2.1,2,5; L.2.1,2,3,4; MATH: 2.MD.1-4, 9-10

NGSS: 2-LS4-1

3rd grade:

CCSS: ELA.RL.3.1,3,4,7; RI.3.1,2,3,4,6,7; W.3.1,2,3,4,7,8; SL.3.1,2,3,4,5; L.3.1,2,3,4; MATH: 3.MD.4

4th grade:

CCSS: ELA.RL.4.1,2,3,4,6; RI.4.1,2,3,4; W.4.1,2,3,4,7; SL.4.1,2,5; L.4.1,2,3,4; MATH: 4.MD.6

5th grade:

CCSS: ELA.RL.5.1,2,3,4,6; RI.5.1,2,3,4; W.5.1,2,3,4,7; SL.5.1,2,5; L.5.1,2,3,4

NGSS: 5-ESS1-1,2

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English Language Arts

Reading Comprehension

Before reading *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of*, ask students to look closely at the front cover ~

- Describe what you see.
- Who do you think the woman is?
- When do you think this story takes place? Today or a long time ago? What clues on the cover tell you this?
- Can you guess what the story might be about? What are some clues that help you make your prediction?

Now read or listen to the book.

The text of *The Fire of Stars* is two parallel stories: one of the creation of a star and the other the story of Cecilia Payne's life's journey. While reading through the book, see what parallels can be drawn between the two stories on each spread.

Help students summarize in their own words what the book was about.

- When is the first time Cecilia Payne learns that things aren't always as they seem? Describe the moment in your own words.
- How does the illustrator use panels to show two different stories happening at once?
- How did Cecilia like to pass the time when she lived in the country?
- "The change is crushing" for Cecilia when her family moves to London. How so? Explain in your own words.
- How and where does Cecilia study science in secret?
- Using examples from the art, how do you think it feels to study something new?
- Why do you think the author describes science as a "kindling light" to Cecilia?
- Describe the relationship between Miss Dalglish and Cecilia in your own words.
  - » How do you think Cecilia would describe Miss Dalglish?
- Even after Miss Dalglish has to leave school, how does she continue to inspire Cecilia?
- What does Cecilia study at the University of Cambridge?
- Using examples from the text, give examples of moments of discovery in Cecilia's life.
- Using examples from the art, what does it feel like to make a discovery?
- What does Cecilia hear Arthur Eddington talk about?
  - » What is it about astrophysics that excites Cecilia?
- How does Cecilia end up at Harvard?
  - » What is Cecilia's work at Harvard?
- What do most scientists believe stars to be made of?
  - » What does Cecilia discover stars are made of?

- What do you think is meant by the "best of all … other questions are rising?" Why is that something positive in science?
- How does the illustrator use marks and colors in the art to set the mood of the of the story?

Let's talk about the people who created The Fire of Stars.

- Who is the author?
- Who is the illustrator?
- What kind of work did each person do to make the book?

Reading Nonfiction

Before reading *The Fire of Stars* aloud, invite students to consider the information presented in the illustrations alone, without the help of words. Have the students take notes in two columns. Once students have recorded all of the information they can from the illustrations, return to the text. While reading *The Fire of Stars* aloud to the class, have students take notes in two columns:

- *Things We Learned*
- *Questions We Have*

Pause before each page turn to add notes to the columns. These columns can either be worked on individually or put on the smartboard and worked on as a class.

Things We Learned (Facts)	Questions We Have	Answers We Found

- Once the story is read, discuss the *Questions We Have* column.
  - » Were any of these questions answered as the story went along?
  - » If so, ask students to find the answer within the text or illustration.
  - » Record the answer next to the question in a third column labeled *Answers We Found*.
- For all remaining questions in the *Questions We Have* column, that have yet to be answered, students will need to take the steps to find answers, either through Internet or book research.
  - » Discuss how to find answers to questions through research.
  - » Assign students to specific questions to help them focus.
  - » Record all answers in the *Answers We Found* column.
- After the answers have been shared with the class, engage in a discussion on research practices.
  - » What was the most difficult part about finding answers?
  - » Was it easier to find answers on the Internet or in a book?
  - » Which source is more reliable, the Internet or a printed book? Why?

  - » How can you determine whether to trust a source?
  - » What tips would you give someone who is about to do research?

- Read Cecilia Payne: Science Superstar and A Star is Born at the back of the book, in addition to the timeline.
  - » Create an additional chart to document what information in the back matter was included in the story and what information was not included.
  - » Why do you think Kirsten Larson chose to include certain information in the main text and leave other information to the backmatter?
  - » Choose three facts from the backmatter and explain why you think each was not included in the story.
  - » How do Katherine Roy's illustrations of a star's birth help you understand each stage of the process?
  - » How do the text and illustrations work together to give information in a way that they cannot do alone?

Extension: Design and illustrate posters representing each Fact, Question, and researched Answer based on *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of* and display them within the classroom.

Writing Activities

Letters of Inspiration

When Cecilia starts to feel lonely at school, Miss Dalglish reaches out to encourage her. Imagine that you are Miss Dalglish and write a letter to Cecilia Payne in which you boost her confidence and tell her to stick to her path.

Then, imagine you are Cecilia Payne and write a response to Miss Dalglish in which you update her on what you are doing and tell her what her letters mean to you.

BONUS: Think of someone in your own life who might be feeling lonely or discouraged and write them a letter of encouragement, too.

Speaking and Listening Activities

Picture books are written to be read aloud. Here are some other ways to bring *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of* to life in your classroom and have fun with speaking and listening skills!

Choral Reading

- Turn *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of* into a script. Read the script out loud together. Emphasize memorization of the students' parts as well as good vocal expression.

Mime

- Divide the class in half. While the teacher reads the book aloud, half of the students can act out the events in the book that tell Cecilia Payne's story. The other half of the class can create physical interpretation of the text describing the formation of a star. Emphasize body motion and facial expressions, as well as listening skills.

Drama

- Create a Flipgrid or PowerPoint presentation to encourage people to read *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of*.

Language Activities

Astro-Wordplay

Wordplay is figurative language that uses words that have two or more meanings to create an alternate, sometimes lyrical or poetic, interpretation.

Kirsten W. Larson uses lots of nature and astronomy-related wordplay throughout The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of.

How many nature and astronomical words can you find in the text of The Fire of Stars?

Examples:

Cecilia *buzzes* too—her body *humming* with the *lightning bolt* of discovery.
Cecilia's *sphere* feels smaller and smaller still when she realizes her new school is a *black hole*...

Spot the Alliteration

Kirsten W. Larson uses lots of alliteration in her lyrical text. Alliteration is using the same letter or sound at the beginning of closely connected words.

For example:

Cecilia **k**icks and **c**ries,
Until her mother
sets her down
so **C**ecilia can feel with her own **t**iny **t**oes
the **c**old and **c**rackly snow,
which isn't soft and warm like she expected.

Alliteration can add to the read-aloud quality of a book. Look closely at the text for *The Fire of Stars* and spot the alliteration. How many examples of alliteration can you find?

Then, describe a moment from your own day or childhood using alliteration.

New Vocabulary: Discovery

What is discovery?

Look up 'discovery' in the dictionary. (Depending on the level of your students, a student volunteer can do this or the teacher can.)

- Read the definition.
- Explain that discovery is the act of finding something new or answers to something that had been unknown.

Kirsten W. Larson describes discovery as a lightning bolt in *The Fire of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of*. Do you think this is a good description? Why or why not?

- The first step to discovery is finding out what interests you. Are there things that you are interested in but don't know much about?
  - » What interests did Cecilia Payne have?
- What do you wonder about? What are you curious about?
  - » What did Cecilia Payne wonder about?

Discovery needs freedom to explore ideas through many means and tools. What tools and opportunities did Cecilia Payne use in her quest for discovery? Use specific examples from the text to support your answer.

After better understanding discovery, discuss:

- The value of discovery.
- Why discovery is so important to scientists and creators.
- How discovery leads to more questions and curiosity.

Describe what you think Cecilia Payne meant in the following quote in your own words:
"The reward of the young scientist is the emotional thrill of being the first person in the history of the world to see something or to understanding something."

Math

Make an Astrolabe

Astronomers and scientists describe the position of a star by measuring its position relative to the horizon. An astrolabe measures how high above the horizon a star is in degrees.

To make your own astrolabe, you'll need:

String
Plastic protractor
Weight (washer, rock, or fishing weight)
Pen and paper

1. Tie a 12-inch piece of string to the hole in the middle of the crossbar on the protractor. Tie a weight to the other end.
2. Hold the protractor so that the curved part is down and the zero-degree mark is closest to you.
3. Sit on the ground and look along the flat edge of the protractor with your eye at the zero mark. Point the flat edge at the star whose position you want to measure.
4. Once you have the star at the end of your sight, hold the string against the side of the protractor.
5. Note which degree mark the string crosses. Write this down in your notebook. This number tells you how many degrees above the horizon your star is.
6. Take the measurements of several stars.
7. Return every 30 minutes and take new measurements. Notice the pattern in which the stars seem to move across the sky as the earth turns.

Science

What is a Scientist?

- What does it mean to think like a scientist?
- How do scientists like Cecilia go about their work?
- What does it mean to see like a scientist?
- What tools do scientists like Cecilia use, and how do they help them see the natural world in new ways?
- What does it mean to stick with it like a scientist?
- How do you stick with it when you face challenges and want to give up?
- How are the following important to scientists:
  - » Curiosity
  - » Passion
  - » Hard work
  - » Belief in oneself
  - » Observation
  - » Gathering
  - » Analyzing evidence
  - » Drawing conclusions
- How were the following evident in the work of Cecilia Payne:
  - » Curiosity
  - » Passion
  - » Hard work
  - » Belief in oneself
  - » Observation
  - » Gathering
  - » Analyzing evidence
  - » Drawing conclusions

Observing Nature

When Cecilia was a child, before moving to the city, she spent time enjoying the natural world. In this activity students will learn to be observant, like Cecilia, to even the littlest pieces of the outdoors.

Create a Nature Journal:

- Gather together 6-8 pieces of paper (some can be lined for writing, others blank for drawing).
- Add on top a piece of blank paper for the cover.
- Punch three holes through the pieces of paper and the cover sheet.
- Cut a piece of cardboard just a bit larger than your paper.
- Punch three corresponding holes in the cardboard.
- Place the papers on top of the cardboard and top everything with the cover sheet.
- Line up the paper and cardboard holes. Then tie together with yarn or string.
- You are now ready to head outside and observe nature.

Observing nature.

- Find a spot to sit outside where you can be quiet and observe. Be sure to have your Nature Journal and something to write with. You may use colored pencils, crayons or markers if you prefer.
- Sit for at least fifteen minutes. You may set an alarm.
- Look all around you. What do you see? What do you hear? What do you smell? What do you feel?"
- Find something you want to write about or draw and record it in your Nature Observation notebook.
- Continue to observe nature in the same spot, fifteen minutes at a time, for a whole week. Every day, take care to notice something different to write about or draw.

Share your notebook with the class.

- What did you find when you paid attention?
- What did you feel? What did you smell? What did you hear? What did you see?
- Did the weather ever change? How was it different? How did the weather (wind, rain, snow, etc.) affect nature?
- What astonished you?
- If you were to continue observing nature, what spot would you choose? Why?

The Beauty of Nature

Go on a nature walk around the school or ask students to take a nature walk in their neighborhoods and gather pieces of natural art that they find: acorns, leaves, flowers, petals, rocks, etc. *Be sure to point to not pick or harm any growing/living thing to gather items.*

Activity #1 – A Bees-eyed View of Flowers

Once items have been gathered, take time to look at each item closely.

What are the shapes that make up this piece of nature?

What are the different colors?
Are there small details that you didn't notice before?

Show the class examples of Georgia O'Keeffe's flower paintings. As the children look closely, tell them about her life and her work.

Two great books on O'Keeffe are *Through Georgia's Eyes* by Rachel Victoria Rodriguez and Julie Paschkis (Holt 2006) and *My Name is Georgia: A Portrait of Jeanette Winter* by Jeanette Winter (HMH 2003).

Explain that making something larger than life catches our attention and causes us to look more closely.

- Each student should choose one item to paint.
- Using pencils, have the children draw the basic outline, or outer edge, of their item on paper. Encourage them to draw the outline so big that it touches or even goes off the edge of the paper.
- Have students paint their item, closely observing the variety of colors, textures and details.
- When the paintings are completed, the students should paint the backgrounds.

Display the paintings in a classroom gallery.

Activity #2 – Preserving and Pressing Flowers

Drying and pressing leaves and flowers can be done by placing the items under a large heavy book, or you can get scientific about it and use a fun chemical reaction to create 3-dimensional artwork.

Materials needed:

Sand
Household Laundry Borax
Medium-sized cardboard box with cover removed

Directions:

1. Make a mixture of 3 parts borax and 1 parts sand.
2. Dump this mixture into the cardboard box and spread evenly.
3. Place each flower or leave face down into the mixture, making sure that it is fully covered. Stems can be left uncovered and upright.
4. Store in a dark, dry place for 2-3 weeks.

The dried flowers and leaves can then be used to create a piece of art. Apply the flowers or leaves to a piece of paper, canvas, or poster board with simple white glue.

What is it about the sand and borax that dries out the flower and leaf? Research the reason in the library or online!

Make Your Own Stellar Scene

The James Webb Space Telescope was launched in 2021 and is the largest optical telescope in space. It is capable of producing high-resolution photographs of ancient, remote galaxies like no telescope before it. Show images that the James Webb Space Telescope has taken to the class.

1. What are the different colors and shapes in these photographs?
2. How do the photographs make them feel?
3. How big or small do you think these scenes are?
4. What marks or textures could be used to represent these scenes in a drawing?

Explain that illustrator Katherine Roy used an old toothbrush dipped in ink and watercolor to represent the star storyline in *The Fire Of Stars: The Life and Brilliance of the Woman Who Discovered What Stars Are Made Of*. To make their own stellar scenes, students will need:

Paper
Old Toothbrushes Or Paint Brushes
Watercolor, Paint, Or Ink
Water
Salt

1. Make a swirling circle in the middle of your paper.
2. Get a little more paint or ink on your brush and make bigger swirls. These are the gases orbiting your newly formed star.
3. Try making some thick marks. Now try making some thin marks. What feels right to you?
4. Try adding spatter marks and salt to represent dust and particles.

When the paintings are completed, display the paintings in a classroom gallery for their own view of the cosmos.

Be a Starry Night Observer

Star gazing is an easy way to teach yourself how to recognize the stars and constellations.

On a clear night, go outdoors and see if you can find the constellations in the sky. A star chart found online or in a book at the library can be helpful. The stars move throughout the year, so you'll see different constellations at different times of the year.

In the northern hemisphere, locate the North Star, also called Polaris, first. It's the only star that does not move. It's also the last star on the handle of the Little Dipper.

To use your star chart outside, cover a flashlight with red cellophane. That way you can still see the stars when you look back up at the sky.

All stars may look the same, but if you become a starry night observer, you'll see that they vary in color and brightness. Stars have dozens of distinctive qualities and characteristics based on age, distance, and light pollution.

- Take time to study the night sky and write down notes of the different colors and levels of brightness you see.
- Try to find some stars that are bigger, brighter, or more colorful than others.
- Consult a star chart to find out if all the lights in the sky are actually stars at all. Some may be planets.

Make a simple star brightness detector to measure and categorize the brightness of stars.

Materials needed:

Scissors
Cardboard
Ruler
Colored cellophane
Tape

1. Cut four 1-3/4 inch rectangles next to each other on a piece of cardboard, like windows.
2. Tape one piece of cellophane over all four rectangles.
3. Tape an overlapping sheet of cellophane over the last three rectangles.
4. Tape more cellophane over the last two rectangles, and finally a last overlapping sheet of cellophane on the last rectangle only. Each window will have a different number of cellophane layers.
5. View the night sky with your brightness detector. Notice you will see more stars through fewer cellophane layers. Only the light from the brightest stars is able to penetrate all four sheets.

Record your observations in the following chart:

# of cellophane sheets	# of stars seen	Any additional description

Social Studies

Famous Female Astronomers

Assign a famous female astronomer for students to research in the library and on the Internet. A list of 11 are below, but do not feel limited to those on the list.

- Hypatia
- Émilie du Châtelet
- Mary Somerville
- Caroline Herschel
- Henrietta Leavitt
- Sara Seager
- Andrea Ghez
- Maria Mitchell
- Heidi Hammel
- Jane Luu
- Annie Jump Cannon

Possible sources for information:

- Nonfiction books
- Encyclopedias
- The Internet

Take notes and gather as much information as possible on the following five topics about your inventor:

- Early Life/Childhood/Family
- Life as an astronomer
- Famous work
- Legacy
- Other fun facts

Once the information is gathered, work to create either an illustrated poster or booklet of the findings.

Gender Bias in Science

We hope students today realize that girls can do and be anything boys can. But bias still exists in the science, technology, engineering, and mathematics fields.

While we rarely recognize biases within our own thinking, this activity, adapted from www.smarttutor.com, will raise consciousness and spark discussion.

1. Ask children to draw a picture of an inventor or scientist. They may not ask any questions of you or any of their peers. They must simply draw the first inventor or scientist that comes to their minds, with no talking or sharing.

2. Then, students should create a brief written description of who their person is and their person does.
3. Ask them to share their drawings and descriptions with the class.
4. While students are sharing, chart the number of male and female inventors and scientists that students create on a graph. Do not reveal what you are doing to avoid skewing the results.

Discuss the results. Often children draw mostly male scientists or inventors in lab coats with chemicals or something of the sort. Share the graph with the students. Do the results show an internalized gender bias? Challenge the class to discuss where they feel this bias comes from and why it is harmful to society.

Use Cecilia Payne's experience in *The Fire of Stars* as an example.

- How have the STEM fields changed for females since Cecilia's time?
- How have they stayed the same?
- How can we take steps to end gender bias in the sciences?