

Muse®

Among the Stars

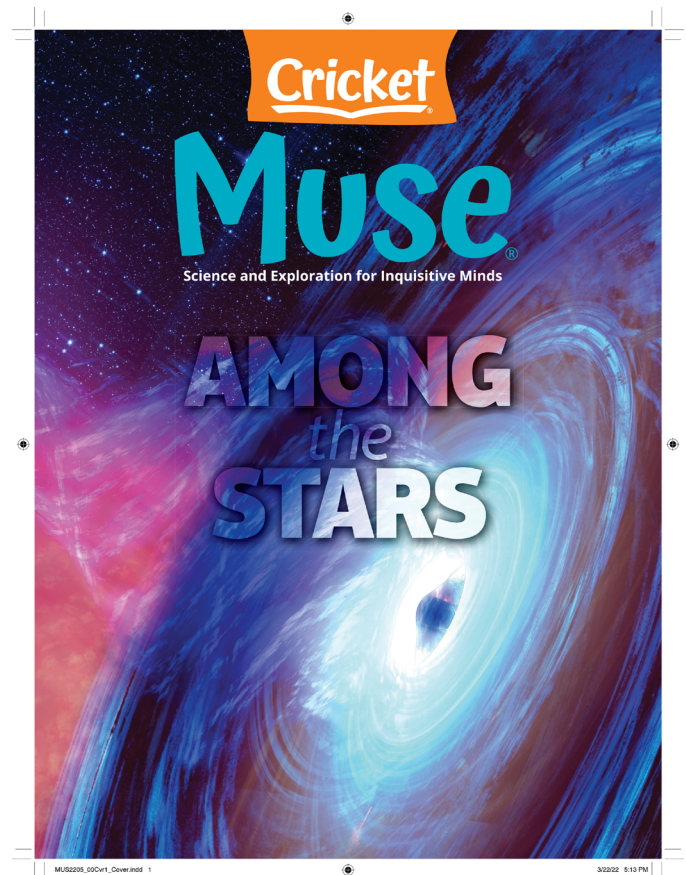
History shows us that humans are always striving “to boldly go where no man [or woman] has gone before,” as the fictional Captain Kirk once proclaimed. This month’s issue of MUSE magazines crosses the time-space continuum and explores how new technology is expanding our understanding of the universe.

CONVERSATION QUESTION

How are we learning more about the universe?

TEACHING OBJECTIVES

- Students will learn how scientists have collaborated to successfully photograph a black hole.
- Students will learn how a new generation of telescopes is giving scientists a fresh look at the universe.
- Students will learn how matter distorts space and bends light.
- Students will analyze the problem-and-solution relationships in an article.
- Students will collect evidence to support scientific claims.
- Students will obtain information from a scientific text.
- Students will write to develop imaginary experiences and events.
- Students will calculate mass using a mathematical formula.



In addition to supplemental materials focused on core STEM skills, this flexible teaching tool offers vocabulary-building activities, questions for discussion, and cross-curricular activities.

SELECTIONS

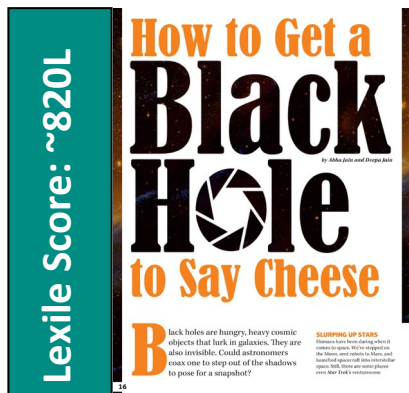
- **How to Get a Black Hole to Say Cheese**
Expository Nonfiction, ~820L
- **What Big Eyes You Have**
Expository Nonfiction, ~1150L
- **Rings, Arcs, Crosses, and Twins**
Expository Nonfiction, ~1030L

Muse® Teacher Guide: May/June 2022

How to Get a Black Hole to Say Cheese

pp. 16–19, Expository Nonfiction

Although humans have launched spacecraft, sent robots to Mars, and walked on the Moon, we are only just beginning to understand black holes. This article explores the complexities of studying and photographing these awesome objects.



RESOURCES

Problems and Solutions: Camera Shy

OBJECTIVES

- Students will learn how scientists have collaborated to successfully photograph a black hole.
- Students will analyze problem-and-solution relationships in the article.
- Students will write to develop imaginary experiences or events.

KEY VOCABULARY

- **coax** (p. 16) to manipulate with perseverance and considerable effort toward a desired state or activity
- **misnomer** (p. 17) a misapplied or inappropriate name or designation
- **theoretical** (p. 18) relating to the general principles or ideas of a subject rather than the practical uses of those ideas

ENGAGE

Conversation Question: How are we learning more about the universe?

The opening sentence of this article states, “Black holes are hungry, heavy cosmic objects that lurk in galaxies.” Study descriptive language by having students complete the following sentence frame: _____ **are hungry, heavy** _____ **that lurk in** _____. Ask students to share their completed sentences and guide them to notice how the meaning changes as the subject, object, and setting are substituted. Reread the first sentence aloud and introduce the article’s topic.

INTRODUCE VOCABULARY

Display the following statements and underline the key vocabulary terms. Review how to infer the meanings of new words by using context clues and background knowledge. Then have partners work together to determine the meaning of each word. Reveal definitions.

1. Anita tried to coax her younger sisters to stop fighting.
2. The term “koala bear” is a misnomer since koalas are not bears.
3. You can gain theoretical knowledge of farming from reading books.

READ & DISCUSS

Post the questions prior to reading. Read the article aloud, pausing when answers are revealed and encourage students to elaborate.

1. What is a black hole?
2. How can black holes vary from each other?
3. Explain the structure and function of the Event Horizon Telescope.
4. Why did all the stations need to mail their physical hard drives to the researchers?
5. What other discoveries is the EHT team responsible for?

SKILL FOCUS: Problem and Solution

INSTRUCT: Inform students that they will be rereading the article with a partner and highlighting passages that depict how the problems of photographing a black hole were solved by scientists. Distribute copies of the *Problems and Solutions: Camera Shy* graphic organizer. Tell students they will be responsible for explaining how scientists overcame each problem listed and ultimately produced a successful photograph.

ASSESS: Have students discuss other objects that are difficult to photograph and brainstorm possible solutions.

EXTEND

Writing Show students examples of poems written about black holes (available on the internet). Be sure to read them first to ensure they are appropriate for your classroom. Then have students write their own poems about black holes. Encourage students to think about writing from an unusual perspective, such as that of a black hole, a scientist, or a distant star. Explain that they should incorporate factual information about black holes in their poems, but they can express these facts as creatively as they like.

Camera Shy

Problems and Solutions Review the article and locate passages that describe how the problems shown in the chart below were solved. Explain how solving each problem contributed to capturing a successful photo of a black hole.

Problem	Solution
Black holes are invisible.	
Black holes don't reflect light.	
Building the gigantic telescope needed to photograph a black hole is currently impossible.	
Different weather systems scramble radio waves emitted by the telescopes.	

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What Big Eyes You Have

pp. 30–31, Expository Nonfiction

Is bigger better? When it comes to telescopes, scientists say “YES!” This article teaches readers how a new generation of telescopes is giving scientists a fresh look at the universe.



RESOURCES

Collecting Evidence: Eye to the Sky

OBJECTIVES

- Students will learn how a new generation of telescopes is giving scientists a fresh look at the universe.
- Students will collect evidence to support scientific claims.
- Students will write to develop imaginary experiences and events.

KEY VOCABULARY

- astrophysicist (p. 30)** a scientist who studies the physical and chemical properties and structures of stars, planets, and other objects in outer space
- galaxies (p. 31)** very large groups of stars, along with dust and gas, held together by gravity

ENGAGE

Conversation Question: How are we learning more about the universe?

Post the article's title: “What Big Eyes You Have.” Ask students why these words are familiar (*Little Red Riding Hood*). Then ask students what animals and insects have big eyes. Next, have students name inanimate objects with eyes (needle, storm, etc.). If no one has referenced telescopes/cameras, give them clues one at a time in order to predict the content of the article. (Ex: it has mirrors/it has lenses/it makes things appear larger/closer/Hubble)

INTRODUCE VOCABULARY

Post the key terms and discuss the definitions. Then display the following questions and have students supply the correct answers.

- Which would NOT be studied by an **astrophysicist**?
a) stars b) comets c) Mars d) organs
- Which is NOT part of a **galaxy**?
a) dust b) lava c) gas d) stars

READ & DISCUSS

Reinforce comprehension of the concepts in the article by using the following prompts to direct discussion.

- How are powerful new telescopes expanding our understanding of space?
- What is the most noticeable feature of new telescopes? Why is it relevant?
- Why are there limitations on telescopes launched into space?
- Explain how distance in space is measured.
- What is the significance of the new telescope being completed in Chile at the Vera C. Rubin Observatory?

SKILL FOCUS: Collect Evidence

INSTRUCT: This article presents readers with detailed information about the new generation of telescopes. Instruct students to review the article and highlight sentences that provide evidence to support each of the claims listed on the *Collecting Evidence: Eye to the Sky* worksheet.

ASSESS: Evaluate students' evidence to ensure it supports the claims.

EXTEND

Creative Writing The article states that scientists often compare telescopes to time machines. Have students imagine they have built a functional time machine. Instruct them to write a creative essay explaining what time period they would travel back/ahead to and why. Also have them describe what things they would do and see in this period. Remind the class to use descriptive language and proper form. Encourage students to read their final copies aloud.

Eye to the Sky

Collecting Evidence Gather evidence from the text to support each claim. Include details and cite your findings by using page numbers.

Claim: An incredible new generation of telescopes will sharpen our focus on outer space.

Supporting evidence (p.____)

Claim: Telescopes can be compared to time machines.

Supporting evidence (p.____)

Claim: Infrared light is an essential tool for understanding the earliest galaxies.

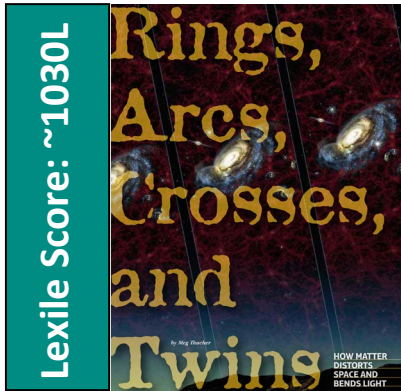
Supporting evidence (p.____)

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Rings, Arcs, Crosses, and Twins

pp. 32–35, Expository Nonfiction

Albert Einstein was the first to realize that light and space would curve around massive objects. This article explains how gravitational lensing affects how we view the universe.



RESOURCES

Obtain Information: A MATTER of Fact

OBJECTIVES

- Students will learn how matter distorts space and bends light.
- Students will obtain information from a scientific text.
- Students will calculate mass using a mathematical formula.

KEY VOCABULARY

- **mass** (p. 32) the measure of the amount of matter in something
- **distortion** (p. 34) a change, twist, or exaggeration that makes something appear different from the way it really is
- **quasar** (p. 34) a very bright object in space that is similar to a star, is very far away from the Earth, and gives off powerful radio waves

ENGAGE

Conversation Question: How are we learning more about the universe?

To motivate students to learn about bending light (lensing), complete the experiment in the text box on page 35 with the class. Using paper, a marker, and a wineglass, students will be able to see the effects of gravitational lensing. Discuss how this phenomenon distorts our view of the universe.

INTRODUCE VOCABULARY

Post the key terms and discuss the definitions. Instruct students that they will be creating a word-search puzzle using the three vocabulary words, in addition to another 17 theme-related words. Have them highlight topical words as they read for use in the word search. Provide grid paper to make the puzzles. Share the puzzles with another class for use as a pre-reading exercise for this article.

READ & DISCUSS

Read the article aloud with the class. Have students reread the article in small groups to answer the questions below. Share responses.

1. What is gravitational lensing?
2. How does general relativity give us a new way of looking at gravity?
3. What are the brightest objects in the galaxy?
4. How do astronomers find dark matter?
5. Explain the following sentence from page 35: *Everything you see in the sky is in the wrong place.*
6. Why do astronomers map how previous maps of the universe have changed over time?

SKILL FOCUS: Obtain Information

INSTRUCT: Guide students to obtain information from the text, captions, and photos in the article. Remind them that the article was written to teach readers how matter distorts space and bends light. Introduce the *Obtain Information: A MATTER of Fact* worksheet and instruct students to complete the sentences by circling the correct answer choices.

ASSESS: Review answers. Have students make corrections if necessary. To extend the activity, have students cite the pages where the information was found.

EXTEND

Mathematics This article teaches readers how the mass of a star, a planet, or a galaxy actually warps the space around it. Scientists use a variety of formulas to determine how great the distortion is. Have students solve the word problem below using the following formula:

$$\text{Mass} = \text{Volume} \times \text{Density}$$

A puddle of water has a volume of 3 gallons. The density of water is 8.34 pounds per gallon. What is the mass of the puddle? Show your work.

(Answer: 25.02 pounds)

A MATTER of Fact

Obtain Information Circle the correct answer to complete each statement below. Review information in “Rings, Arcs, Crosses, and Twins” to help you identify the correct answers.

1. The brightest objects in the universe are quasars and **(stars/comets/galaxies)**.
2. Light travels **(168,000/186,000/681,000)** miles per second.
3. The **(light/density/mass)** of a star actually warps the space around it.
4. The more massive an object, the more it bends **(light/sound/color)**.
5. The more **(dense/large/distant)** a galaxy is, the farther back in time we’re looking.
6. The theory of General Relativity was created by **(Einstein/Musk/Tyson)**.
7. Galaxy **(moons/clusters/clouds)** have enormous mass.
8. Gravitational lensing helps us to see **(fractured/large/distant)** objects that would be too faint for our telescopes to see otherwise.
9. The matter that makes up stars, planets, and us is only about **(45%/5%/25%)** of the mass of the universe.
10. Astronomers can’t see **(dark matter/clusters/the sun)**, but they can use gravitational lenses to find it.

