Science & Literacy Activity

GRADES 6-8

OVERVIEW

This activity, which is aligned to the Common Core State Standards (CCSS) for English Language Arts, introduces students to scientific knowledge and language related to astronomy and the study of the universe. Students will read content-rich texts, view the *Dark Universe* space show, and use what they have learned to complete a CCSS-aligned writing task, creating an illustrated text about astronomy.

Materials in this activity include:

- Teacher instructions for:
  - o Pre-visit student reading
  - o Visit to *Dark Universe*
  - o Post-visit writing task
- Text for student reading: "Discovering the Universe"
- Student Writing Guidelines
- Teacher rubric for writing assessment

Common Core State Standards:
WST.6-8.2, WST.6-8.8, WST.6-8.9
RST.6-8.1, RST.6-8.2, RST.6-8.7, RST.6-8.10

New York State Science Core Curriculum:
PS 1.1b

Next Generation Science Standards:
PE MS-ESS1-2
DCI ESS1.A: The Universe and Its Stars
Patterns of the apparent motion of the Sun, the Moon, and stars in the sky can be observed, described, predicted, and explained with models. Earth and its solar system are part of the Milky Way Galaxy, which is one of many galaxies in the universe.

SUPPORTS FOR DIVERSE LEARNERS: An Overview

This resource has been designed to engage all learners with the principles of Universal Design for Learning in mind. It represents information in multiple ways and offers multiple ways for your students to engage with content as they read about, discuss, view, and write about scientific concepts. Different parts of the experience (e.g. reading texts, or locating information in the exhibit) may challenge individual students. However, the arc of learning is designed to offer varied opportunities to learn. We suggest that all learners experience each activity, even if challenging. We have provided ways to adapt each step of the activities for students with different skill-levels. If any students have an Individualized Education Program (IEP), consult it for additional accommodations or modifications.

1. BEFORE YOUR VISIT

This part of the activity engages students in reading a non-fiction text about astronomy. The reading will prepare students for their visit by introducing them to the topic and framing their investigation.

Student Reading

Have students read "Discovering the Universe." Have them write notes in the large right-hand margin. For example, they could underline key passages, paraphrase important information, or write down questions that they have. They may also use this space for drawings or diagrams that show how scientific understanding of the universe has changed over time.

Ask:

- What kinds of instruments do astronomers use to study the universe? *(A: Astronomers use telescopes to gather light, and collect the information contained within this light.)*
- Describe the discovery made by Edwin Hubble. Why was this discovery so revolutionary? *(A: Hubble discovered that objects once thought to be parts of our galaxy, are in fact distant galaxies. Not only this, but he also discovered that these galaxies are moving away from ours at great speed. This means that the universe is much larger than initially thought, and that it is expanding. This was revolutionary because scientists at the time, even famous scientists like Einstein, presumed that the universe was "static" which means not changing in size.)*

- How has our understanding of the universe changed as a result of the three discoveries covered in this reading? Include specific examples. *(A: Hubble discovered that the universe was much larger than scientists expected, and that it was expanding; growing larger all the time. This implies that the universe was once much smaller and hotter at some point in the past. Penzias and Wilson discovered the cosmic microwave background, the light from a much earlier time in the history of the universe when it was much smaller and hotter. This confirmed the expansion of the universe, and further supported the big bang theory as the most likely explanation for observations. The High-z Supernova Team discovered that rather than slowing down, the expansion rate of the universe was actually increasing, despite gravity that would naturally attempt to pull everything together. This represents the discovery of a totally new phenomenon: dark energy. We now know that the universe will accelerate forever, and expand forever becoming vastly larger than it is today.)*

They can work in pairs, small groups, or as a class. During discussion, remind students to use evidence from the text to explain their thinking, and to use specific examples, such as important discoveries made during the past century.

SUPPORTS FOR DIVERSE LEARNERS: Student Reading
- "Chunking" the reading can help keep them from becoming overwhelmed by the length of the text. Present them with only a few sentences or a single paragraph to read and discuss before moving on to the next "chunk."
- Provide "wait-time" for students after you ask a question. This will allow time for students to search for textual evidence or to more clearly formulate their thinking before they speak.

2. DURING YOUR VISIT

This part of the activity engages students in viewing the space show.

Museum Visit
Explain to students that they will be viewing a space show in the Hayden Planetarium called *Dark Universe*. Back in the classroom they will use this experience to help complete the writing assignment. As soon as possible after the show, have students discuss and take notes on the important discoveries that they learned about. Tell them that back in the classroom they will refer to these notes when completing the writing assignment.

SUPPORTS FOR DIVERSE LEARNERS: Museum Visit
- Review the assignment with students, clarifying what information they should collect during the visit.
- Have students discuss the show in pairs, with each student taking their own notes.

3. BACK IN THE CLASSROOM

This part of the activity engages students in an informational writing task that draws on the pre-visit reading and on observations made at the Museum.

Writing Task
Distribute the Student Writing Guidelines handout, which includes the following prompt for the writing task:

> Based on your reading, your viewing of the *Dark Universe* space show, and your discussions, write an essay in which you describe how astronomers have used powerful telescopes to make important discoveries in astronomy, and how these discoveries have changed our understanding of the universe.
>
> Be sure to include:
> - at least two important discoveries
> - an explanation of how these discoveries have changed our understanding of the universe
> - examples of the instruments, such as telescopes, used to make these discoveries
>
> Support your discussion with evidence from the reading and *Dark Universe*.

Go over the handout with students. Tell them that they will use it while writing, and afterwards, to evaluate and revise their essays.

Before they begin to write, have students use the prompt and guidelines to frame a discussion around the information that they gathered from *Dark Universe*, and compare their findings. They can work in pairs, small groups, or as a class. Referring to the writing prompt, have students underline or highlight all relevant passages and information from the reading that can be used in their response to the prompt. Instruct each student to take notes on useful information that their peers gathered as they compare findings. Students should write their essays individually.

SUPPORTS FOR DIVERSE LEARNERS: Writing Task

- Re-read the "Before Your Visit" assignment with students. Ask what they saw in the show that helps them understand astronomy.
- Allow time for students to read their essay drafts to a peer and receive feedback based on the Student Writing Guidelines.

Student Reading
Discovering the Universe

When you look up at the night sky, the farthest stars you can see without a telescope are thousands of light-years away. But compared to the size of the universe, that distance is tiny — like looking at a nearby sand grain on a giant beach. In fact, scientists estimate the farthest galaxies are billion of light-years away — and moving farther away all the time. Scientists have also determined that the universe was born in a fiery instant nearly 14 billion years ago.

How do scientists learn about the size and age of the universe? They begin by asking questions about things they observe (and many things they can't). Then they use scientific tools to collect data. Telescopes allow astronomers to observe objects far past our own galaxy — even some that don't give off visible light. With the data they collect using these tools, scientists develop or revise theories about the universe. Sometimes they raise new questions based on the evidence.

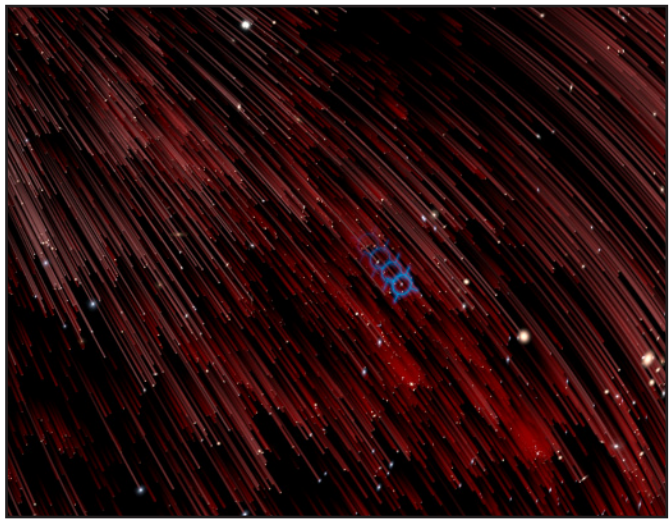
Let's take a look at three of the most important discoveries of the past century and see how each one changed our understanding of the universe.

Almost all our information about the universe comes from light emitted, absorbed, or reflected by the objects in it. Light from distant galaxies has taken hundreds of millions or even billions of years to reach us.

Hubble and the Expanding Universe

In the 1920s, many scientists, including Albert Einstein, believed the size of the universe was constant — neither collapsing nor expanding. Then in 1929, astronomer Edwin Hubble made an amazing discovery that would change everything. Hubble's instrument was the Hooker telescope, the largest optical telescope in the world at the time.

With its 100-inch mirror, the reflecting telescope could collect more light than smaller telescopes. After all, the purpose of a telescope mirror is to gather as much light as possible. The larger a telescope's mirror, the more light it collects, and the more information it gathers from objects in space. The Hooker telescope gave scientists a clearer view into the universe, letting them study distant objects in detail that were once too faint to see.



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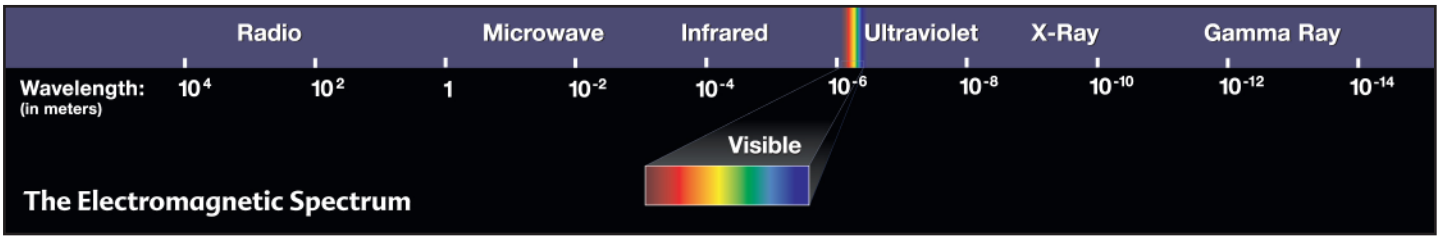
Because our universe is expanding, distant galaxies appear to be moving away from Earth. The farther away an astronomical object is, the faster that motion is. This motion elongates the wavelengths of light — called "red shifting" — making distant galaxies appear redder than they should be.

Using this new instrument, Hubble identified galaxies beyond the Milky Way. His discovery revealed that ours was just one of many galaxies in the universe. He also observed that other galaxies — in all directions — were moving away from us. He figured this out by studying the light from distant galaxies. Hubble observed that the light coming from these galaxies were redder than expected. This unexpected "redshift," an increase in wavelength, led him to conclude that the galaxy must be moving away. Every other galaxy he observed in every direction also exhibited redshift, and thus was also moving away. This new evidence showed the universe was expanding. And scientists concluded that if the universe was expanding, it must have once been much smaller than it is today.

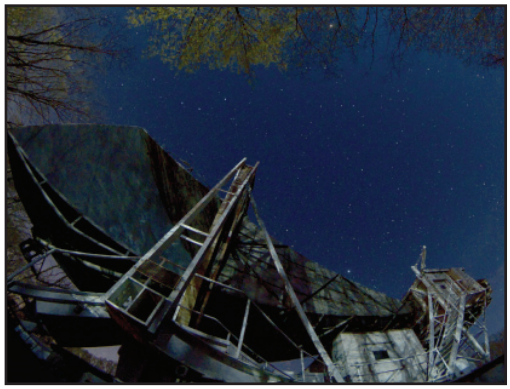
Penzias and Wilson and the Cosmic Microwave Background

After Hubble's discovery, scientists proposed different theories for the expansion of the universe. One idea was that the universe started in a fiery explosion or "big bang." The early universe would have been small, dense, and extremely hot. So hot, it would give off light the way a star does. Some thought we might be able to detect light from the early universe. We wouldn't be able to see this light because — like the light of a receding galaxy — the light waves that reach us would be stretched out (redshifted) beyond the visible spectrum. Only a radio telescope could pick up these longer wavelengths.



© NASA/Space Telescope Science Institute

The theory had many skeptics. Then, in 1965, two astronomers, Arno Penzias and Robert Wilson, encountered something unexpected. Arno Penzias and Robert Wilson detected unusual background "static" as they were mapping radio signals from the Milky Way. The static turned out to be microwave radiation coming from all directions. At first, the mysterious radiation was a nuisance. After ruling out different possibilities, even bird droppings inside the horn-shaped radio telescope, they realized what it was: the afterglow of the young universe. This light — the oldest light ever seen — became known as the "cosmic microwave background." It was evidence that the early universe was very hot — hot enough to glow brightly the way a star does. It was also evidence that confirmed the big bang theory.



Astronomers testing a radio antenna at New Jersey's Bell Labs accidentally recorded low-level light coming from all directions: the cosmic microwave background.

High-z Supernova Search Team and Dark Energy

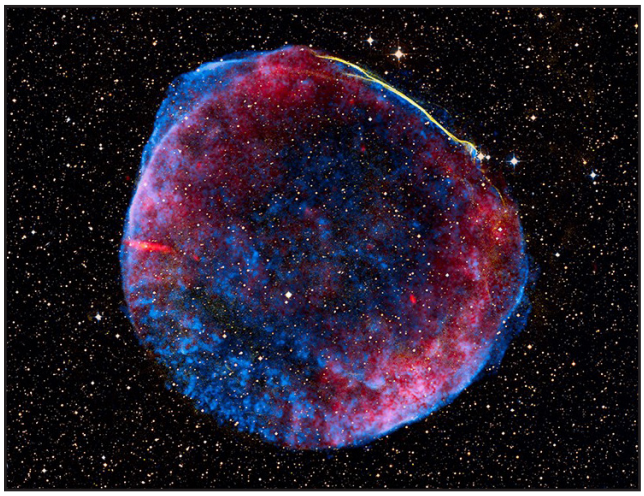
By the 1990s, evidence from Hubble, Penzias, Wilson and other astronomers supported two important ideas: First, the universe is not infinite in age; it was formed about 14 billion years ago. Second, the universe was expanding. Many scientists predicted that gravity — the same force that holds together stars, solar systems, and galaxies — would slow down this expansion. After all, gravity is the force that attracts matter to other matter — so wouldn't gravity attract all the matter in the universe? Some thought the force of gravity might act as a break to some day stop, or even reverse the expansion of the universe. Think of what happens when you push a skateboard against the force of gravity, for example up a shallow hill. You'd expect the skateboard to slow down, eventually stop, and maybe even roll back down. But what if, instead of slowing down, the skateboard actually started rolling faster uphill? That would be surprising, right? Your response might describe how an international team of astronomers felt in 1998.

The High-z Supernova Search Team was studying the expansion of the universe — specifically, how fast it has expanded at different times in its history. To measure expansion very early in the history of the universe they needed to look at objects as far away as possible. To do this, they used a series of telescopes, including two enormous optical telescopes with mirrors 10 meters (almost 33 feet) across. By collecting huge amounts of light, these telescopes let astronomers observe objects at extremely remote distances.

With these powerful telescopes, the team searched for distant supernovae — bright, exploding stars. By focusing on one type of supernova, they could determine each one's distance by its brightness, like car headlights on a highway. They also measured the supernova's redshift to determine how fast it was moving away from us. By analyzing the data from many supernovae, they could begin to see how the universe's rate of expansion has changed over time.

They were not surprised to find that the expansion slowed down during the first eight billion years. But after that the rate increased — it started expanding faster. And it's expanding faster all the time.

What was propelling this acceleration? On the cosmic scale of the universe, an invisible pressure seems to be working in opposition to gravity — pushing matter apart. Scientists called this mysterious pressure "dark energy." They still don't know what dark energy is, but they know it exists. Scientists estimate that dark energy makes up about 70% of the total mass-energy of the universe.



By investigating exploding stars, called supernovas (pictured), scientists have found that space itself, once thought to be mere nothingness, holds more energy than all the stars. They call this mysterious pressure "dark energy."

New Tools, New Discoveries

Less than a century ago, Edwin Hubble peered through the world's largest telescope and changed what we knew about the universe. His discovery revealed the universe was expanding. Decades later, Penzias and Wilson used a large radio telescope to pick up the remnant light from the early universe, evidence that the universe began with a sudden explosion. By the 1990s, telescopes four times larger than Hubble's gave scientists their deepest view into the universe and led to the discovery of dark energy. What discoveries lie ahead to explain dark energy? What else is out there yet to be discovered?

As scientists keep asking questions about the universe, they'll rely on larger and more powerful instruments to look for evidence. Today, there are plans for optical telescopes with mirrors up to thirty meters across, and radio telescopes hundreds of meters across. These tools will let scientists observe new and more distant parts of the universe. They will likely lead to fascinating discoveries, new theories, and a better understanding of our cosmos.

Student Writing Guidelines

Based on your reading, your viewing of the *Dark Universe* space show, and your discussions, write an essay in which you describe how astronomers have used powerful telescopes to make important discoveries in astronomy, and how these discoveries have changed our understanding of the universe.

Be sure to include:
- at least two important discoveries
- an explanation of how these discoveries have changed our understanding of the universe
- examples of the instruments, such as telescopes, used to make these discoveries

Support your discussion with evidence from the reading and *Dark Universe*.

Use this checklist to ensure that you have included all of the required elements in your essay.

- ☐ I introduced at least two important discoveries made by astronomers and explained how these discoveries changed our understanding of the universe.
- ☐ I clearly named telescopes and described how these telescopes help astronomers study the universe.
- ☐ I only included relevant information about discoveries in astronomy have changed our understanding of the universe.
- ☐ I used information from "Discovering the Universe" to explain at least two major discoveries in astronomy in detail.
- ☐ I used information from the *Dark Universe* space show to explain at least two major discoveries in astronomy in detail.
- ☐ I used academic, non-conversational tone and language.
- ☐ I included a conclusion at the end.
- ☐ I proofread my essay for grammar and spelling errors.

Assessment Rubric

	Scoring Elements	1 Below Expectations	2 Approaches Expectations	3 Meets Expectations	4 Exceeds Expectations
RESEARCH	**Reading**	Attempts to present information in response to the prompt, but lacks connections to the texts or relevance to the purpose of the prompt.	Presents information from the text relevant to the purpose of the prompt with minor lapses in accuracy or completeness.	Presents information from the text relevant to the prompt with accuracy and sufficient detail.	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the text.
	AMNH Exhibit	Attempts to present information in response to the prompt, but lacks connections to the Museum exhibit content or relevance to the purpose of the prompt.	Presents information from the Museum exhibit relevant to the purpose of the prompt with minor lapses in accuracy or completeness.	Presents information from the Museum exhibit relevant to the prompt with accuracy and sufficient detail.	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the Museum exhibit.
WRITING	**Focus**	Attempts to address the prompt, but lacks focus or is off-task.	Addresses the prompt appropriately, but with a weak or uneven focus.	Addresses the prompt appropriately and maintains a clear, steady focus.	Addresses all aspects of the prompt appropriately and maintains a strongly developed focus.
	Development	Attempts to provide details in response to the prompt, including retelling, but lacks sufficient development or relevancy.	Presents appropriate details to support the focus and controlling idea.	Presents appropriate and sufficient details to support the focus and controlling idea.	Presents thorough and detailed information to strongly support the focus and controlling idea.
	Conventions	Attempts to demonstrate standard English conventions, but lacks cohesion and control of grammar, usage, and mechanics.	Demonstrates an uneven command of standard English conventions and cohesion. Uses language and tone with some inaccurate, inappropriate, or uneven features.	Demonstrates a command of standard English conventions and cohesion, with few errors. Response includes language and tone appropriate to the purpose and specific requirements of the prompt.	Demonstrates and maintains a well-developed command of standard English conventions and cohesion, with few errors. Response includes language and tone consistently appropriate to the purpose and specific requirements of the prompt.
SCIENCE	**Content Understanding**	Attempts to include science content in explanations, but understanding of the topic is weak; content is irrelevant, inappropriate, or inaccurate.	Briefly notes science content relevant to the prompt; shows basic or uneven understanding of the topic; minor errors in explanation.	Accurately presents science content relevant to the prompt with sufficient explanations that demonstrate understanding of the topic.	Integrates relevant and accurate science content with thorough explanations that demonstrate in-depth understanding of the topic.