HIDDEN NO MORE

Facilitation Guide

Light and Time

MOREHEAD PLANETARIUM+ SCIENCE CENTER

Hidden No More
Facilitation Guide

Introduction

Grant Information

This exhibit is the third phase of a three-phase project connected to the NSF grant #1906686 Hidden No More: Shedding Light on Science Stories in the Shadows. More information about the grant can be found at https://moreheadplanetarium.org/program/special-initiatives-programs/hidden-no-more/

Light and Time

Phase 3 of the *Hidden No More* exhibit engages visitors in learning about physicist Gabriela González, who was part of the history-making LIGO team that accomplished the first detection of gravitational waves in 2015. Visitors also learn about scientific knowledge developed by the Blackfoot people long before "science" was a word—ways of knowing that helped them thrive across vast territories. These stories are connected by LIGO and by *Hidden No More*'s third theme: light and time.

We Need Your Feedback

One of the grant's goals is to learn from each phase. We do this with formal evaluation, but we would also like to hear any informal feedback from your institution's staff. Feedback can be sent to: Michele Kloda (mkloda@ad.unc.edu)

Exhibit Components

Hands-On Activities

Scientist Videos

Virtual Reality Experiences

LIGHT & TIME ACTIVITIES

The hands-on activities in this phase of Hidden No More aim to appeal to different interests and skills that participants may have—perhaps in experimenting, perhaps in making—and to help them make connections with science along those lines.

While "Laser Test" invites participants to experiment with scientific tools related to light (a laser, beam splitter, and mirrors), "Spacetime Timeline" involves participants in making models that represent the distance between objects in space as they are measured by the speed of light.

These tabletop activities can be set up in a variety of informal STEM learning settings. Assess table height to be sure all your visitors, including those who use wheelchairs, can participate.

Though developed with special attention to engaging middle-school students, the activities can be enjoyed by participants ranging from children of elementary-school age to adults.

RIGHT: A historical photo of people from the Blackfoot Nation.

Laser Test

How do scientists use light to detect gravitational waves?

The "Laser Test" activity invites participants to experiment with scientific tools related to light (a laser, beam splitter, and mirrors). The game pieces represent components of a LIGO (Light Interferometer Gravitational Wave Observatory) detector.

These tabletop activities can be set up in a variety of informal STEM learning settings. Assess table height to be sure all your visitors, including those who use wheelchairs, can participate.

Though developed with special attention to engaging middle-school students, the activities can be enjoyed by participants ranging from children of elementary-school age to adults.

MAIN IDEA

Participants in this activity learn that a laser is an intense beam of light that can be split and directed to a target and since it travels in a straight line, can be used to detect very small changes over long distances.

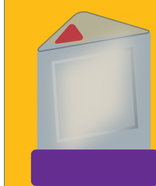
RIGHT: Illustrations for the Laser Test Activity.

HIDDEN NO MORE

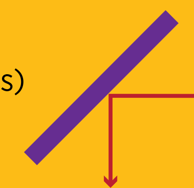
Laser Test

Can you bounce and bend a beam of light to reach a target?

Use mirrors and beam splitters to move a laser beam in different directions.



Mirror The light beam reflects (bounces) off this mirror at a 90° angle.



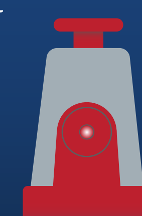
Beam splitter This beam splitter divides the light into two beams:

One beam continues in a straight line. The other beam bends at a 90° angle.

What is a laser?

A laser produces a very narrow, very bright beam of artificial light. A laser beam can travel long distances and concentrate a lot of energy on a small area.

The word "laser" stands for <u>L</u>ight <u>A</u>mplification by <u>S</u>timulated <u>E</u>mission of <u>R</u>adiation.



MATERIALS

TABLE SIGNS

- instruction sign (in sign holder)
- scientist connection sign (in sign holder)

ACTIVITY COMPONENTS

- "Laser Test" organizing mats
- "Laser Test" pieces: each set should include 1 grid, 1 laser, 2 beam splitters, and 5 mirror/target pieces.
- "Laser Test" cards (4 cards, each describing a task designed to help participants understand how the laser, beam splitter, and mirror/target pieces work).

OPTIONAL EXTENSIONS: Add extra materials from the *Laser Maze* game boxes provided in the *Hidden No More* kit:

- Offer one or more of these additional game components: double mirror, checkpoint, cell blocker.
- Offer a selection of Beginner, Advanced, Intermediate, and/or Expert challenge cards.

SAFETY NOTE

- Do not stare into the laser beam.

PREPARATION

FOR ENGAGING A GROUP OF PARTICIPANTS IN A FACILITATED MAKERSPACE, SCIENCE CAMP, ENRICHMENT CLASS DURING A FIELD TRIP, OR SIMILAR SETTING:

- Designate a table as a "Laser Test" activity station within the space you have organized for *Hidden No More*.
- Position the activity instruction and scientist connection signs on the activity table.
- Depending on the table size and number of participants, set out one or two "Laser Test" organizing mats. Place a grid, a laser, two beam splitters, and five mirror/target pieces in the color-coordinated spaces on the mat. Place one or two sets of "Laser Test" cards near the mat or mats.
    - » Alternatively, prepare up to five workstations around the room. Place a set of pieces (grid, laser, two beam splitters, and five mirror/target pieces) and the four "Laser Test" cards at each workstation.

FOR ENGAGING INDIVIDUALS OR PAIRS AT A FACILITATED TABLE IN AN EXHIBIT AREA, MAKERSPACE, SCIENCE EXPO, OR SIMILAR SETTING:

- Prepare a "Laser Test" activity table in the same way as you would set up a station for engaging a group of participants, with signage, one or two "Laser Test" mats, and one or two sets of pieces and "Laser Test" cards. (See above.)

TRY THE ACTIVITY

1. Follow the prompts on the "Laser Test" cards to learn how the components work.
   - Laser Test 1: Test a mirror.
   - Laser Test 2: Test two mirrors.
   - Laser Test 3: Test a beam splitter.
   - Laser Test 4: Test two beam splitters.
2. Now that you know how the components work, try some experiments:
   - Place the pieces in different positions on the grid.
   - Add and subtract pieces. Trying using *all* eight components. How many targets light up?
   - Try making a simple path from the laser to a target; then make a complicated path from the laser to a target.
3. If you are interested and there is time available to for an optional extension activity:
   - experiment with one or more additional components (double mirror, checkpoint, and/or cell blocker.
   - try one or more of the Beginner, Advanced, Intermediate, and/or Expert challenges on the cards included in the "Laser Maze" game box.

GUIDING QUESTIONS

- What is the difference between using a beam splitter and a mirror?
- Bump the table slightly with your hand, does the beam change? How small a "bump" can you detect with your laser?
- How might a really long laser beam be able to detect very small changes in gravity?

ABOUT THE SCIENCE

- LIGO's detectors use a beam splitter to divide a laser beam into two beams. The beams travel up and down tunnels 2.5 miles long. Mirrors reflect the beams to a photodetector. Tiny changes in the beams of light let scientists know that gravitational waves passing through the detector stretched and squeezed the tunnels.
- On September 14th 2015, scientists at LIGO detected gravitational waves directly for the first time. Despite being predicted by Albert Einstein, no direct evidence of gravitational waves existed until this discovery. Since this time LIGO has detected gravitational waves from events like the merger of two black holes taking place more than 2 billion light years away.

INNOVATE ON THE ACTIVITY

Include current LIGO findings or recent discoveries. For example, LIGO has recorded more than 300 black hole mergers to date.

LIGO publishes Science Summaries of major discoveries at https://ligo.org/science-summaries/. Besides finding evidence to support Einstein's theories, LIGO has made discoveries that may help to explain black hole formation and spin as well as shedding light on what happens when black holes merge.

LIGO has also attempted to find black holes lighter than our sun and although the results were mixed, the summary includes very good information on, and illustrations of, black hole formation. Learn more at https://ligo.org/science-summaries/O3bSSM/

ABOUT THE SCIENCE, continued

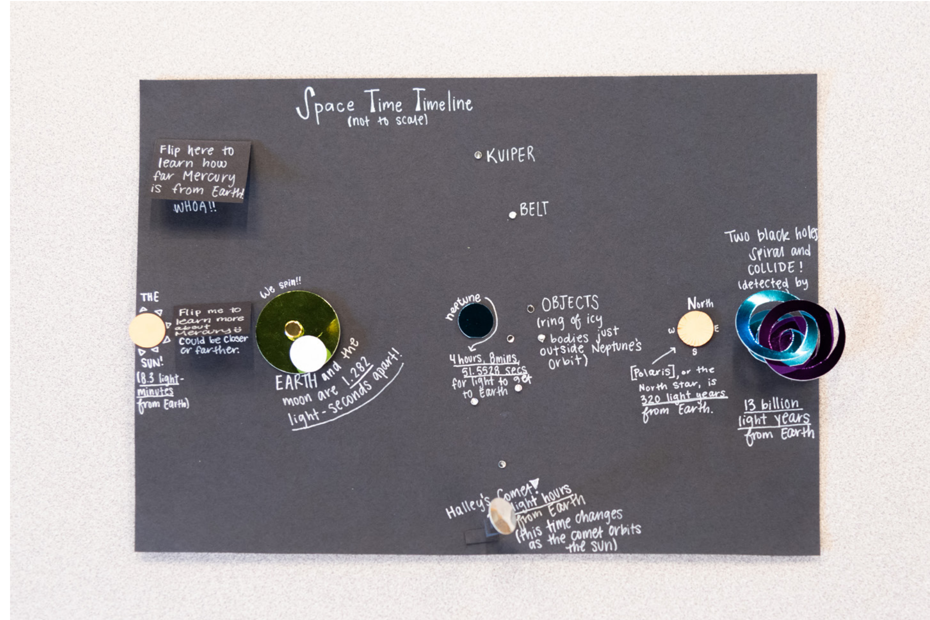
- LIGO has assisted with the detection of several hundred black hole mergers to date using gravitational waves. Most of these black holes are small, but when they merge, they can form medium-sized black holes which are larger than those formed by supernovae but smaller than the supermassive black holes found at the center of galaxies. This gives scientists an idea about how larger black holes may form.

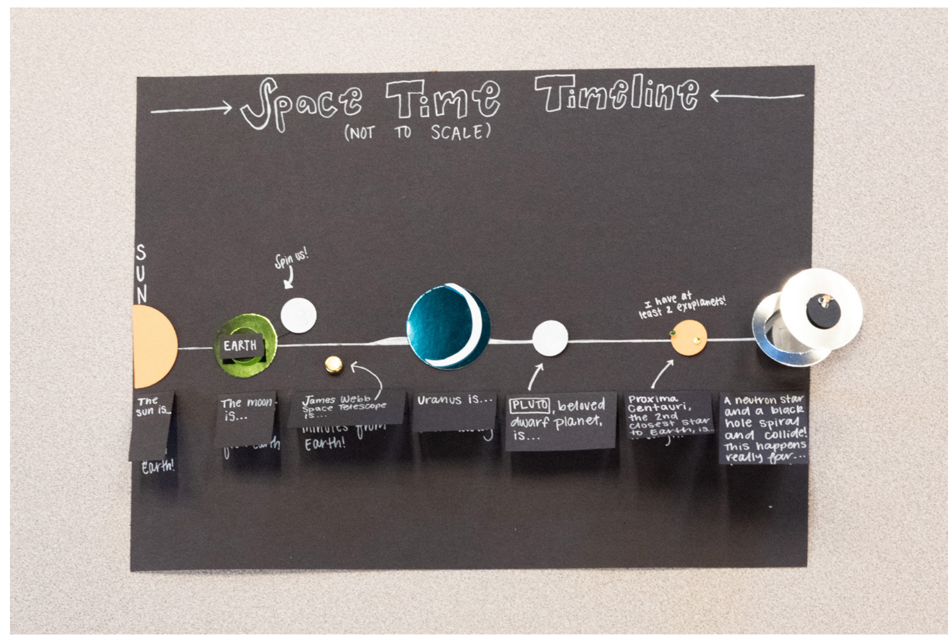
FACILITATION TIPS

- Review the "Safety Note" included on page 6.
- Before facilitating this activity, experiment with trying the challenge yourself. This will help prepare you to answer questions and offer tips.
- Be alert to participants who require assistance. At the same time, be careful not to "take over" the activity. Give additional information and offer help as needed, while allowing participants to do and discover as much as they can independently.

Spacetime Timeline

Can you use light to measure distances in space?





Spacetime Timeline helps participants get an idea of time and distance in space by making a model and placing objects along the timeline. This activity can be set up on a tabletop or along a wall in a variety of learning spaces including classrooms, exhibit floor or makerspaces. Assess table or display height to ensure all visitors can participate. Designed primarily for Middle School ages, this activity is still suitable for engaging students and visitors from elementary school age to adults.

MAIN IDEAS

Participants will gain an understanding that distances in space are enormous and are measured in light years. A light year is the distance light can travel in one earth year, roughly 6 trillion miles (9 trillion kilometers). By placing objects on the timeline, participants gain an understanding of the distances that light or gravitational waves need to travel to reach earth.

MATERIALS

TABLE SIGNS

- instruction sign (in sign holder)
- scientist connection sign (in sign holder)

ACTIVITY COMPONENTS

- circle punches (5/8-inch circle punch; also, 3-inch, 2.5-inch, 1-inch punches provided in the Phase 2 kit;
- glue dots (2-3 per participant)
- mini-brads/brass fasteners (1-3 per participant)
- purple, green, and blue metallic cardstock (suggested uses: comet tails, stars, neutron stars, or black holes)
- silver metallic cardstock (moons, asteroids, or comet nuclei)
- black permanent markers
- white gel pens
- paper-folding tools
- hole punches with 2"-reach to make an 1/8 inch hole
- black cardstock for backgrounds denoting outer space
- white cardstock: for labels, Moon, Earth, and other small objects that can be coloured with crayons or markers
- orange cardstock: for Suns (cut freehand or with circle cutters)

PREPARATION

FOR ENGAGING A GROUP OF PARTICIPANTS IN A FACILITATED MAKERSPACE, SCIENCE CAMP, ENRICHMENT CLASS DURING A FIELD TRIP, OR SIMILAR SETTING:

- Designate a table as a “Spacetime Timeline” activity station within the space you have organized for *Hidden No More*.
- Position the activity instruction and scientist connection signs on the activity table.
- Depending on the model or models you have determined that participants will be making, use the circle cutters to pre-cut circles for the Sun, moons, planets, and so on.
- Place information on distance from Earth of the selected objects that can be used on the table.

FOR ENGAGING INDIVIDUALS OR PAIRS AT A FACILITATED TABLE IN AN EXHIBIT AREA, MAKERSPACE, SCIENCE EXPO, OR SIMILAR SETTING:

- Prepare a “Spacetime Timeline” activity table in the same way as you would set up a station for engaging a group of participants (described above).
- Guide participants in choosing supplies that they may take from the central supply station to their workspace in the room, or provide a set of the needed supplies at each workspace (e.g., scissors, a sheet of glue dots, one or two brads, and so on) before the model-making begins.

TRY THE ACTIVITY

1. Select the Earth and several more objects to place on the timeline. Place the Earth at one end of the prepared table.
2. Determine what other objects/events you wish to place on the timeline or let participants choose. Gather appropriate materials to construct the timeline based on the choices (see table on page 13).
3. Place objects on the timeline in order by distance. Include one LIGO detected event.

GUIDING QUESTIONS

- How long will it take gravitational waves moving at the speed of light to reach Earth from a selected LIGO detected event?
- Proxima Centauri is the closest star to Earth besides the Sun. It is four light years away. Can you remember what you were doing four years ago? That’s when the light that we see now left Proxima Centauri.
- Why is looking at the night sky like looking into the past?

SPACETIME TIMELINE, OBJECTS AND EVENTS TABLE

OBJECT OR EVENT	DISTANCE FROM EARTH
Moon	1.282 light seconds
James Webb Space Telescope	5.38 light seconds
Sun	8.3 light minutes
Mercury	5.1 - 11.5 light minutes
Venus	2.2 - 14.4 light minutes
Mars	4.7 - 21.3 light minutes
Jupiter	35 - 51 light minutes
Saturn	70 - 86 light minutes
Uranus	152 - 168 light minutes
Neptune	3.86 - 4.14 light hours
Pluto	about 4.8 light hours
Voyager 1	23.4 light hours
Alpheratz (bright star in Andromeda)	97 light years
Spica (bright star in Virgo)	249 light years
Polaris (the North Star)	320 light years
Pleiades (star cluster within Taurus)	444 light years
Betelgeuse (red supergiant star in Orion)	498 light years
Antares (red supergiant star in Scorpius)	553 light years
Neutron star and black hole collision (detected by LIGO in 2019)	370 - 640 million light years
Two black holes spiral and collide (detected by LIGO in 2015)	1.3 billion light years

The distances from Earth to the other planets change depending on where they are around the Sun!

ABOUT THE SCIENCE

- Since most objects we see in the night sky are quite distant, we are actually looking back in time! The further away the object is, the "older" the light is when it reaches us. Light and gravitational waves travel very fast but distances in space are immense, so it takes a long time to reach us.
- The stars we see in the night sky are within our galaxy (the Milky Way) but there are many other galaxies with their own stars. In a very dark sky with a telescope, we can see the Andromeda Galaxy which is 2.5 million light years away. We are actually looking at this galaxy as it was 2.5 million years ago.
- The space-based telescopes Hubble and James Webb are finding very distant and objects. This means that the light we are seeing comes from a much earlier time. By looking "into the past" in this way, scientists can learn about the properties of the early Universe.

FACILITATION TIPS

- Practice applying glue dots. Participants who have not used glue dots before may need your advice. Offer this suggestion: Press the dot firmly onto the cardstock or brad fastener, then rip the backing off quickly (a bit like a bandaid!).

INNOVATE ON THE ACTIVITY

- **Look for recent LIGO discoveries to add to your timeline. Click to visit an activity resource at Space.com**
- **Allow participants to research their own objects to add. Can they find a "birthday star" which is a star that the number of light years distant matches their current age? Remind them that they won't have the same birthday star next year since the distance doesn't change but they will be a year older. Light year is a measure of distance. Click to visit an activity resource at NCSciFest.org**
- **Provide extra materials to create a scale model using the objects in our solar system. This can be done in several ways by using the timeline and measuring to create a relative scale or using beads on string. This reinforces to participants that the objects in the inner solar system are closer together than those in the outer solar system.**

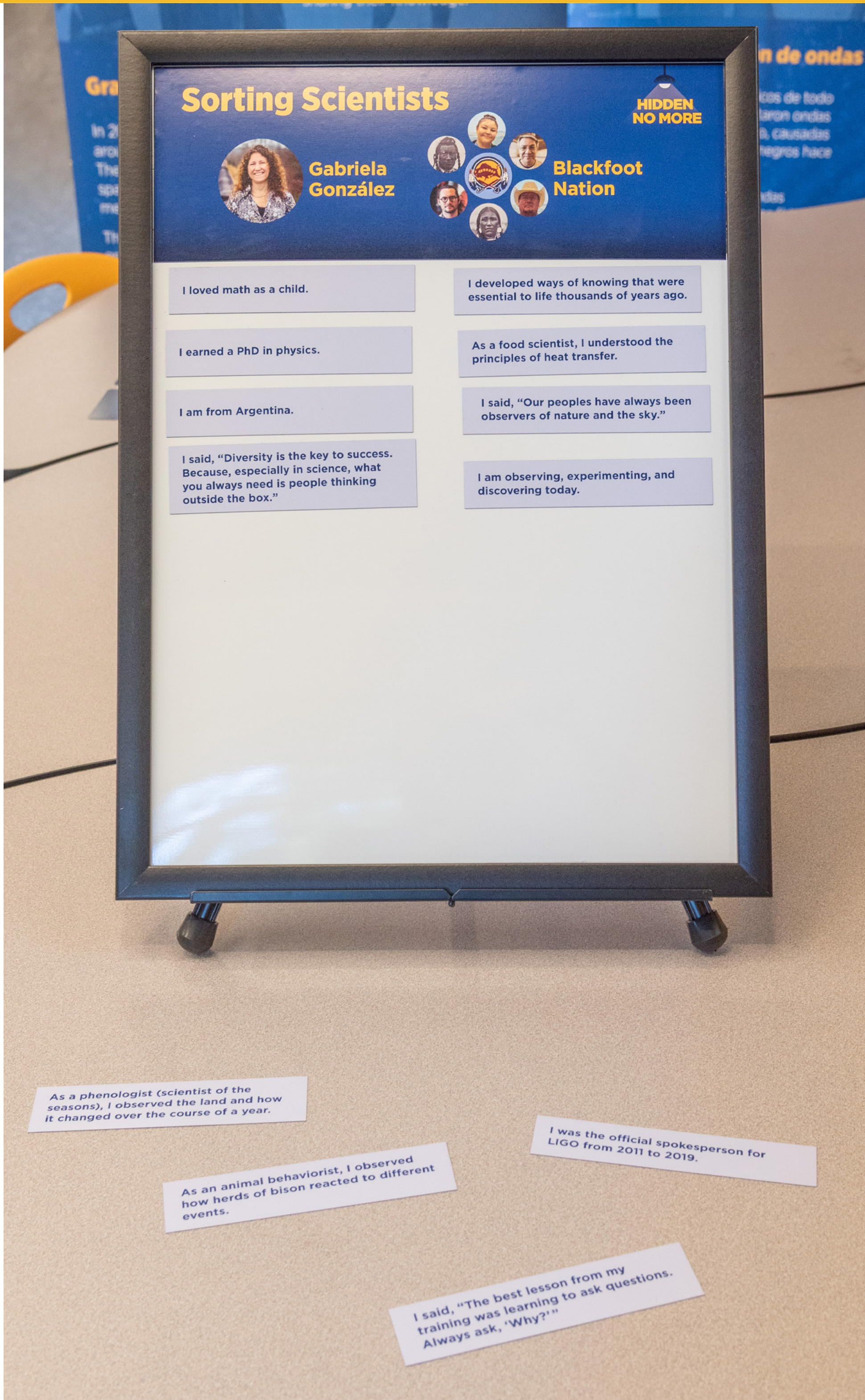
Sorting Scientists

Facilitate a game to help visitors learn about Gabriela González and the Blackfoot Nation

The "Sorting Scientists" game helps visitors learn about Gabriela González and the Blackfoot Nation—where they are from, what their research is about, and more. As they match each fact with Dr. González or Blackfoot Nation, visitors make connections to learning experiences included in the *Hidden No More* exhibit.

This game reinforces the exhibit's message that many kinds of people, often unknown to us, have helped us—and are helping us—understand gravity and explain the world around us. Because of their careful observations, we can gain an understanding of the patterns of life on Earth as well as gain knowledge about events happening at huge distances from our planet. Both help us understand our world and its place in the universe.

RIGHT: The "Sorting Scientists" cards and magnetic board are set up, ready for play.



MAIN IDEA

Visitors play a matching game with cards or magnets that display facts about Gabriela González and Blackfoot Nation.

EXHIBIT COMPONENTS

- Two options for setting up this activity are provided:

  [Option 1] Set of face cards (1 card for Gabriela González and 1 card for the Blackfoot Nation) and fact cards (6 facts for Dr. González and 6 facts for the Blackfoot Nation)

  [Option 2] Magnetic "Sorting Scientists" board and magnetic fact pieces (6 facts for Dr. González and 6 facts for Blackfoot Nation)

- Table large enough for the game to be spread out on it—and with space around it for the facilitator and up to four visitors.

Note: Assess the table height to be sure that all your visitors—including those who use wheelchairs—can reach it and see the cards.

TRY THE ACTIVITY

[Option 1] Card game. To begin, the facilitator places a picture card for the Blackfoot Nation and a picture card for Gabriela González face up on the table. The fact cards are placed facedown. This allows visitors to discover each fact one at a time, consider it, and place it next to the picture of the scientist to whom it connects.

1. As you turn each card over, try to match the fact with one of the scientists.
2. There are six fact cards for Dr. González and six fact cards for the Blackfoot Nation. How many can you match?
3. This is not a test—you can discuss the facts and ask for answers (or just for hints and clues before you make your choices)!

[Option 2] Magnetic game. Same as Option 1, but the facilitator can place the fact pieces on the table and invite visitors to place each fact in the matching scientist's column on the magnetic board.

GUIDING QUESTIONS

- What clues helped you match the facts to Dr. González and six fact cards for the Blackfoot Nation scientists?
- Did you already know about these scientists before you came here today? (Guide the visitor to a related video, panel, or other resource in the exhibit that will help them learn more about a topic raised during this activity that has particularly sparked their interest.)

FACILITATION TIPS

This facilitated activity can be played by one or more visitors at a time. A family or a small group of friends, for example, can have fun playing together—reading each card aloud and discussing it before making a choice.

If there is room to do so, set up the game near the monitor showing the documentary videos about Gabriela González and the achievements of Blackfoot science. This can help participants recall and make connections.

While the game can be played at any time during a visit, students who tested “Sorting Scientists” indicated they felt it was best played after visitors had experienced other parts of the exhibit first.

MAKE CONNECTIONS

Help visitors notice connections between Gabriela González and the science of the Blackfoot Nation. Science may be done in different ways and answer different questions but both use similar skills such as:

- **Both rely on the power of observation. Observation is an essential tool of science whether using instruments to observe gravitational waves or human senses to observe the world.**
- **They both seek a better understanding of the world and universe. Often, they may make predictions and see if the evidence fits the prediction.**
- **Both have made significant discoveries that add to human knowledge.**

ANSWER KEY

Gabriela González

I earned a PhD in physics.

I am from Argentina.

I loved math as a child.

I was the official spokesperson for LIGO from 2011 to 2019.

I said, "The best lesson from my training was learning to ask questions. Always ask, 'Why?'"

I said, "Diversity is the key to success. Because, especially in science, what you always need is people thinking outside the box."

Blackfoot Nation

I developed ways of knowing that were essential to life thousands of years ago.

As a food scientist, I understood the principles of heat transfer.

As an animal behaviorist, I observed how herds of bison reacted to different events.

As a phenologist (scientist of the seasons), I observed the land and how it changed over the course of a year.

I am observing, experimenting, and discovering today.

I said, "Our peoples have always been observers of nature and the sky."

MORE TO LEARN

KAYIHTSIPIMIOHKITOP (KENT AYOUNGMAN)

Kent Ayoungman, a ceremonial knowledge keeper, has provided significant guidance during the development of this phase of the *Hidden No More* project.

You will hear Mr. Ayoungman in the Blackfoot Nation VR experience, as he is the narrator.

This photograph of the Water Chief family was taken at the Winnipeg Stampede, Winnipeg, Manitoba, in 1913. William and Mary Water Chief are the great-grandparents of Kent Ayoungman.

Documentary Video

Blackfoot Nation

MAIN IDEA

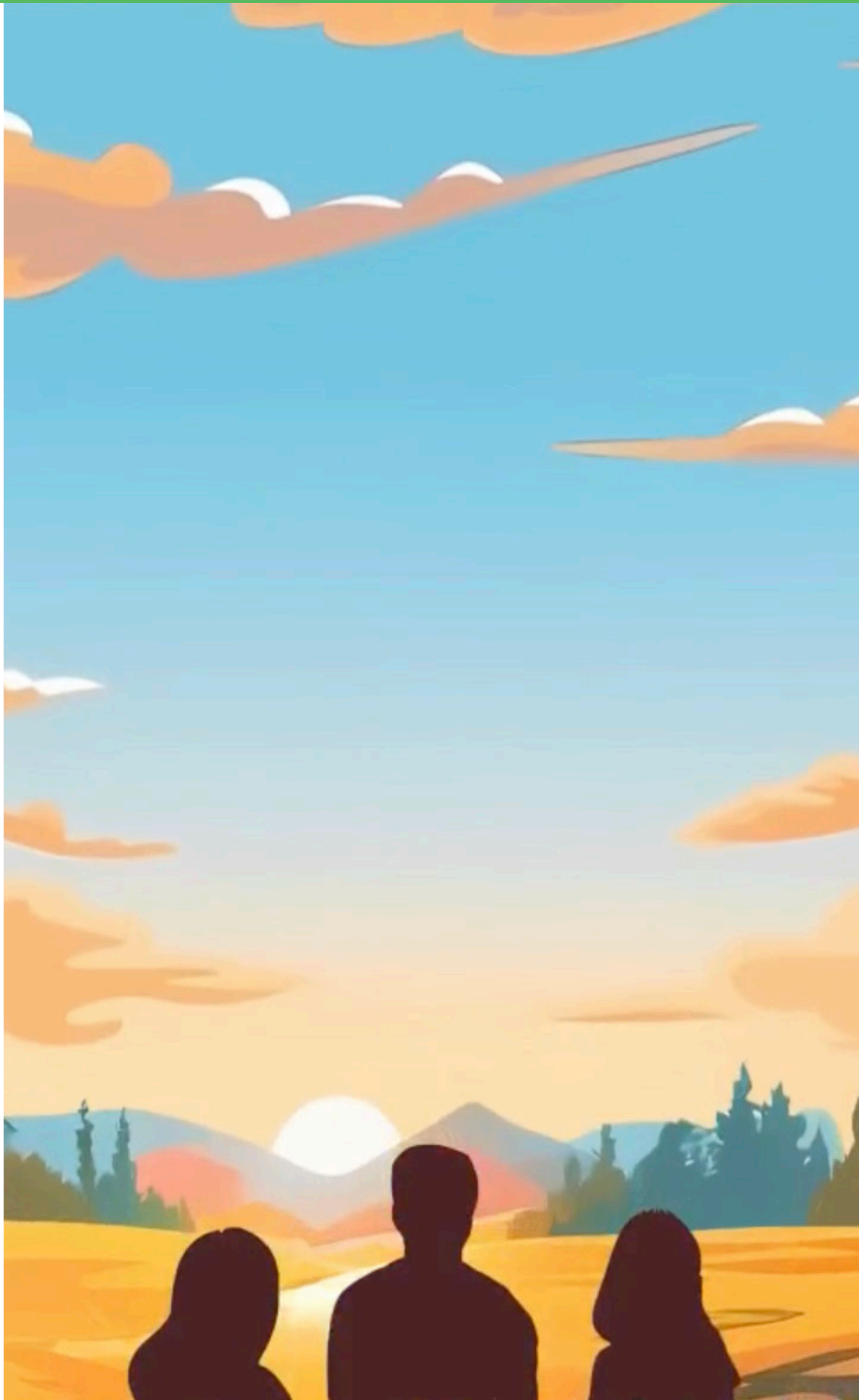
Visitors engage with a short video to learn about ways of knowing that Blackfoot ancestors developed thousands of years ago. Animated and live-action sequences highlight discoveries in three scientific areas: food science, animal behavior, and phenology (science of the seasons).

EXHIBIT COMPONENTS

- ELO touchscreen video monitor and Brightsign media player
- Information sign (with sign holder)

GUIDING QUESTIONS

- What did you find most interesting about this video?
- If you could go back in time, which scientific information would be most useful to you: food science to help cook, weather observations to prepare for the seasons, or astronomical observation to understand when to plant crops and harvest food?
- Did you recognize Corey Gray, who spoke at the end of the video? He Is a member of Blackfoot Nation who works at LIGO experience, too.



MORE TO LEARN ABOUT COREY GRAY

Corey Gray is a senior operations specialist for LIGO and a member of the Blackfoot nation. He was part of the team when the first gravitational waves were recorded in September of 2015. He states that he had gotten home after midnight and had just gone to bed when the gravitational wave was detected. The waves were likely produced by two black holes merging some 1.3 billion light years away. Such a merger had never been previously observed.

Growing up Mr. Gray did not speak the Blackfoot language although he did grow up hearing it. As a scientist and educator, he felt that a discovery like this should be translated into the Blackfoot language, so he asked his mother for help in translating the gravitational wave discovery. To accomplish this, his mother, Sharon Yellowfly, had to invent some new terms in the language. For example, bisaatsinsiimaan is the word for Einstein's general theory of relativity and translates to "beautiful plantings".

Mr. Gray was honored in June 2024 with a Blackfoot headdress for his science outreach work to inspire Native youth and as one of the first Blackfoot physicists.

Mr. Gray has been featured on several podcasts and has a TED talk which can be viewed at the following link: The Night My Heart Was Hijacked by Black Holes and Gravitational Waves.

Documentary Video

Gabriela González (born in 1967)

MAIN IDEA

Visitors engage with a short documentary video to learn about contemporary scientist Gabriela González. They learn how her curiosity and her youthful belief that physics "could explain everything" led her to become a physicist and a leader on the history-making LIGO team that first detected gravitational waves.

EXHIBIT COMPONENTS

- ELO touchscreen video monitor and Brightsign media player
- Information sign (with sign holder)

GUIDING QUESTIONS

- What did you find most interesting about Dr. González's story?
- What obstacles did Dr. González face because she wanted to study physics and become a physicist?
- If you could have lunch with Dr. González, what questions would you ask her?

MORE TO LEARN ABOUT GABRIELA GONZÁLEZ

Gabriela González is an astrophysicist, professor and member of the LIGO Scientific Collaboration. She was born in Cordoba, Argentina in 1965 and attended the University of Cordoba to pursue a bachelor's degree and "Licenciatura" which is similar to a Master of Science degree. Graduating in 1988, she moved to the United States in 1989 to pursue a Ph.D and graduated in 1995.

Dr. Gonzalez then went to MIT where she pursued a postdoctoral position and worked as a researcher. She was hired as a professor at Pennsylvania State University and moved to Louisana State University in 2001. In 2008, she became the first woman to achieve a full professorship in the Department of Physics and Astronomy at LSU.

In February 2016, Dr. Gonzalez was one of the five LIGO scientists present for the announcement that the first direct detection of gravitational waves had been made by LIGO in September 2015.

Dr. Gonzalez continues to research the characterization of "noise" in LIGO detectors, the calibration of the detectors, and data analysis. She searches for waves produced by binary systems of compact stars in the last orbits of their cosmic dance, before coalescing into a single black hole.

Virtual Reality Experience

The Blackfoot People
The Cycle of the World

MAIN IDEA

Visit the home of the Blackfoot people, on land we now call Western Canada. Tonight is the last night of the Flower Blossom Moon, the fifth moon of this year, and your visit comes at a time when the Blackfoot people are preparing for their annual journey to the Bow River for the Sundance.

Long before the common calendar we use today was established, the Blackfoot people learned the cycles of the world and established a calendar of a year on Earth. You are warmly invited to enter a dwelling and learn how the Blackfoot people have used their observations of the world around them and the sky above to track the passing of time and plan for the coming months.

Participants can sit or stand to interact with this VR experience.

EXHIBIT COMPONENTS

- Oculus Quest 2 headset with case
- Round floor mat with diagrams of foot positions (for standing use, or for use with a chair in the center)
- Charging cord
- Sanitizing wipes

Note: Make a chair available for visitors who will need to sit down to take part in this activity. For example, some visitors may rely on a cane or walker to steady themselves when they are standing. Being provided a chair will allow them to use both of their hands to engage with the VR experience.

GUIDING QUESTIONS

- Tell me how you learned about Blackfoot Science. What did you discover?
- What did observing the Saskatoon tree tell you?
- What was the coolest part of the experience, in your opinion?
- Is there anything you could apply from the video if you were out camping or hiking?

MAKE CONNECTIONS

TO OTHER EXHIBIT RESOURCES

This can be an additional guiding question: "What are some similarities you see between the science of the Blackfoot Nation and the work of Dr. Gabriela Gonzalez at LIGO? What do they use to observe the world and do science? How could you observe your own world and learn about it?"

Virtual Reality Experience

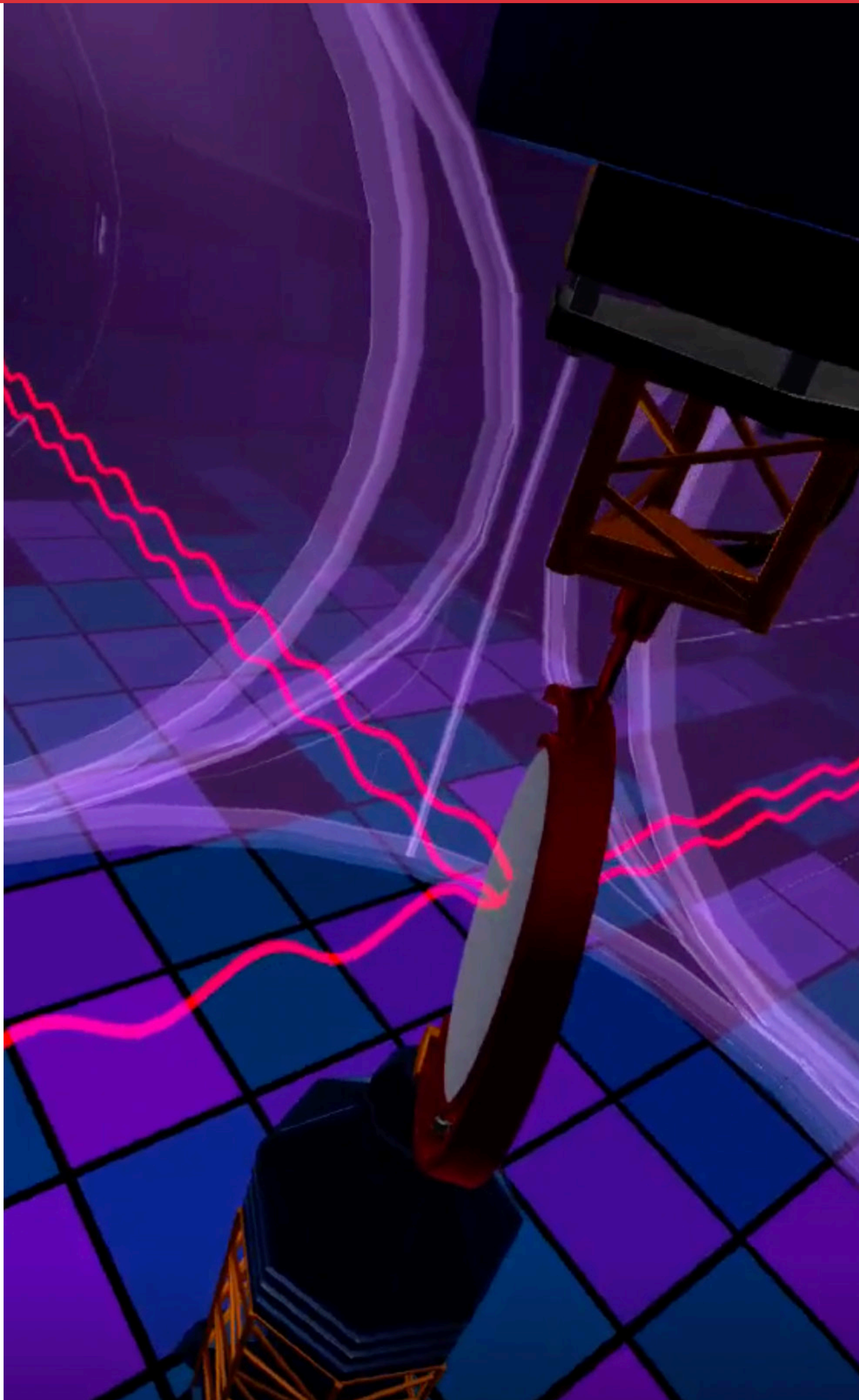
Gabriela González
Ripples in Space-Time

MAIN IDEA

Events like the merging of black holes cause ripples across the space-time continuum. In this VR experience, you will go to a training facility at the Laser Interferometer Gravitational-wave Observatory (LIGO) site in Livingston, Louisiana, and find out how to use a beam of light to detect these invisible gravitational waves.

You will learn about black holes—and even drop planets into a black hole! Then, Dr. Gabriela González and her colleague Mr. Corey Gray will train you to use a LIGO laser to search for gravitational waves caused when two black holes merged.

Participants can sit or stand to interact with this VR experience.



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GUIDING QUESTIONS

- Tell me what you worked on when you were at the LIGO facility. What were you working on with Gabriela González and Corey Gray?
- What was the most interesting (or coolest) part of the experience for you?
- Gabriela González and Corey Gray are part of a team that worked together to find something (gravitational waves) that people like Albert Einstein thought were present but had never detected before. Would it be fun to discover something that has never been discovered before?

MAKE CONNECTIONS

TO OTHER EXHIBIT RESOURCES

Encourage visitors to try the "Laser Test" activity. This hands-on activity enables participants to learn more about LIGO and experiment with simple versions of some its key components: a laser, mirrors, and beam splitters.

A short documentary video included in the exhibit will help visitors learn how Gabriela González's determination, from an early age, to pursue a life in physics led to her playing a key role in the groundbreaking achievements of the LIGO team.

Selected Sources

ABOUT LASERMAZE

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ABOUT INDIGENOUS KNOWLEDGE

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ABOUT GABRIELA GONZÁLEZ

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ABOUT LIGO

LIGO Caltech (2016, February 11). ***Gravitational Waves Detected 100 Years After Einstein's Prediction*** [Press Release]. https://www.ligo.caltech.edu/news/ligo20160211

ABOUT COREY GRAY

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Calgary Public Library. (2019, June 26). ***Three Questions with Corey Gray*** [Video]. Youtube. Retrieved July 31, 2025 from https://www.youtube.com/watch?v=s_6dPXqxPIA

ABOUT THE SPACETIME TIMELINE ACTIVITY

Activity: Mapping in Time. (n.d.). Princeton University. https://www.astro.princeton.edu/~dns/teachersguide/MapTimeAct.html