- Using subtitles, which seems to be a new function

Agenda

- Introduction
- Information review
- Key focus areas
- Key science and resources
- Best practices for working with Subject Matter Experts (SMEs)
- Breakout session
- Questions
- Wrap-up

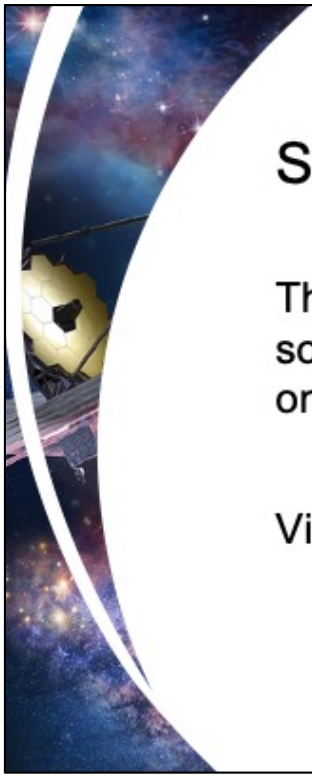
Questions

To ask questions or vote up other questions go to
https://gsfc.cnf.io/sessions/wa5d/#!/dashboard

Training Evaluation

https://grginc.co1.qualtrics.com/jfe/form/SV_07IZTFymtDU0Ydw

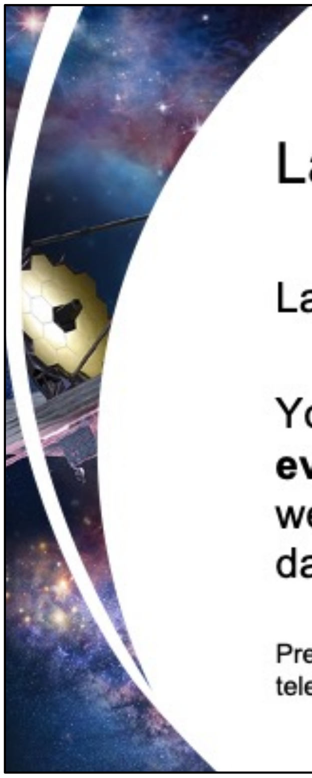
Information Review



Safety First

The COVID situation in the country is rapidly evolving, so please be sure to follow local and federal guidance on holding events.

Virtual events are fine!

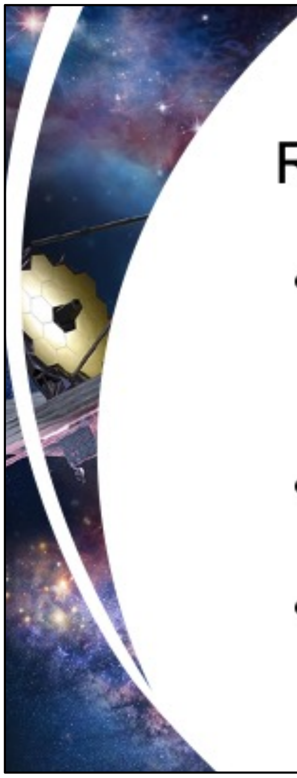


Launch Date

Launch is scheduled for December 18!

You are **NOT required to move the date of your event(s)**. If you chose to move it, however, you are welcome to. Just let us know if you change your event date.

Press release: https://www.nasa.gov/press-release/nasa-readies-james-webb-space-telescope-for-december-launch



Reminders

- Community Events Map: https://outerspace.stsci.edu/x/plBtBg
  - To be replaced by a map with more features soon!
  - If you would like to connect to the other Community Event hosts near you, please let your point of contact know.
- Event date/time/description was due Aug. 20 (only for public events)
- Expert speaker request - https://www.universe-of-learning.org/sme-request?rq=SME
  - Requests are being filled chronologically

Points of Contact

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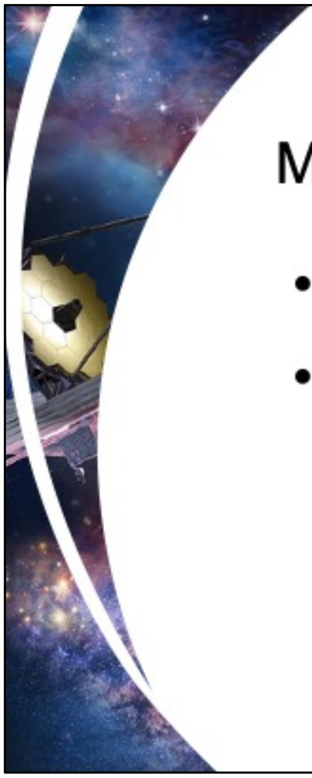
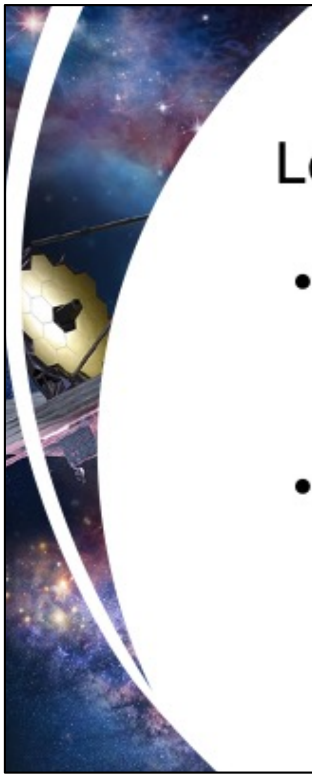
Utah, Texas	Cathi Duncan, cduncanf@arizona.edu



Materials

- Requests to have materials shipped were due Aug. 27
- Materials being mailed in September and October



Logo Guidance

- Community Events may not use the NASA logo (commonly referred to as “the meatball”) for personal identification or to advertise events unless the materials (print or digital) are provided by NASA.

- Community Events may use the Webb Space Telescope identifier (https://nasa-external-ocomm.app.box.com/s/2kjxp6zfzyucbxzqoqot2fsqtppfnd3k)

Resources (part 1)

- Everything: https://outerspace.stsci.edu/x/KoPMBQ
- FAQs: https://outerspace.stsci.edu/download/attachments/97289002/FAQS.docx.pdf?version=1&modificationDate=1630430811320&api=v2
- Activity guides: https://outerspace.stsci.edu/download/attachments/97289002/Activity%20Guides.docx?version=4&modificationDate=1630345799044&api=v2
- Webb videos: https://webb.nasa.gov/content/multimedia/videos.html
- Webb resources in Spanish: https://webbtelescope.org/resource-gallery/recursos-en-espanol
- Webb STEM Toolkit: https://www.nasa.gov/stem/nextgenstem/webb-toolkit.html

Resources (part 2)

- Photo Release Forms (optional):
    - Adult: https://outerspace.stsci.edu/download/attachments/97289002/NASA_Adult_Media_Release_Form.pdf?version=1&modificationDate=1630428536906&api=v2
    - Minors: https://outerspace.stsci.edu/download/attachments/97289002/Media%20Release%20for%20Parent%20and%20Minor%20%28English%20and%20Spanish%29.pdf?version=1&modificationDate=1630428566038&api=v2

- Training
    - NISENET training on engaging audiences for Webb: https://www.nisenet.org/events/online-workshop/online-workshop-engaging-audiences-launch-james-webb-space-telescope-part-2
    - Night Sky Network training on Webb: https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=687

Optional Media Release Template

Template for Community Events is coming!

For Immediate Release
[MONTH DATE, YEAR]

[LIBRARY NAME] JOINS NASA AND OTHER ORGANIZATIONS IN CELEBRATING THE CELESTIAL EVENT OF THE CENTURY

WHAT **[LIBRARY NAME]** is pleased to announce that it is joining more than 1,000 libraries across the country to participate in the celestial event of the century, the ***August 21, 2017 Solar Eclipse***. During this national event, the shadow of the moon will sweep across the United States from the Pacific Ocean to the Atlantic Ocean in a spectacle that hasn't occurred in decades. The rest of the U.S. and North America will see a *partial eclipse,* with the Moon covering up only part of the Sun. It is aptly named the *Great American Eclipse*.

WHEN The solar eclipse event takes place August 21, 2017. The **[LIB[illegible]]** will offer public events to bring STEM (science, [illegible]ring and math) programming to children, teens and ad[illegible]unity. For a calendar of related programs, visit **[WEBSITE[illegible]** [illegible] **[LIBRARY NAME]** is open **[LIBRARY HOURS]**.

WHERE **[LIBRARY NAME [illegible]DRESS]**

WHY [illegible]ting [illegible]ple [illegible]rested in science can be a challenge, but this event will be a gr[illegible]at oppo[illegible]unity for our community to celebrate science with fun, hands-on and m[illegible]ltimedia activities culminating in the eclipse event on August 21, 2017.

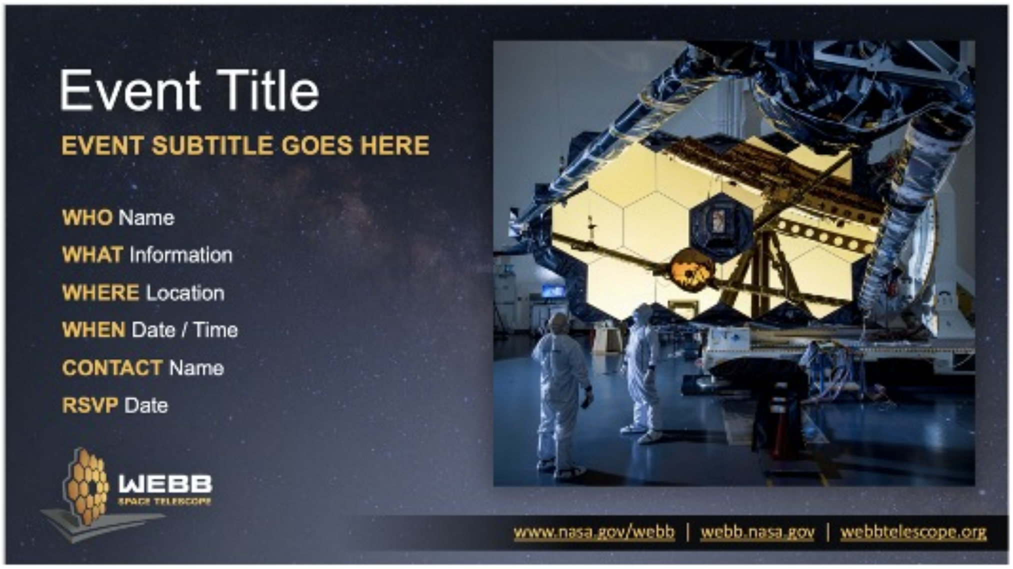
[illegible]O **[LIBRARY NAME]** has joined the *STAR Library Education Network* (*STAR_Net*) and its *NASA@ My Library* project. Partners include NASA, the American Library Association, the Girl Scouts, SETI Institute, and many other organizations. This project was made possible through support from the NASA Science Mission Directorate and the National Science Foundation.

CONTACT **[LIBRARY CONTACT, PHONE, EMAIL]**

2017 Eclipse Example

Flyer Template #1

Flyer Template #2



Post-Event Evaluation Form

Webb Events Host Survey

or https://grginc.co1.qualtrics.com/jfe/form/SV_8q9vjE13sMK4YwC

Please provide the following information about the Webb Space Telescope launch event(s) you hosted:

# of in-person events	
# of virtual events	
# of hybrid events (both in-person and virtual)	
# attendees across all events (your best estimate)	

Which of the following were primary target audiences for your event(s)? Select all that apply.

Children and Families

Tweens and Teens

Classrooms/School Groups

Adults

Other; please describe in the text box below:

Launch event materials were available in English, Spanish, and American Sign Language. For future events, which other languages or formats would help you engage a wider audience? Select all that apply.

- Languages other than English, Spanish, and ASL; please specify in the text box:
- Formats for Deaf or otherwise hearing impaired audiences; we're interested in any specific suggestions:
- Formats for blind or visually impaired audiences; we're interested in any specific suggestions:
- Other language or format; please describe in the text box below:
- No need for materials in any other languages or formats

Did you have an expert speaker (subject matter expert) participate in your event(s)?

Yes

No

Answer “Yes” even if you found your own expert speaker.

How much value did the subject matter expert(s) add to your launch event(s) in terms of engaging your audiences in science?

Not very much

Some

A great deal

We welcome any additional comments about your speaker(s)/experts(s):

In your opinion, how effective were your Webb launch events overall in accomplishing each of the following objectives?

	Not very effective	Somewhat effective	Very effective	Not applicable (event not designed to accomplish objective)
Inspiring participants' interest in STEM	○	○	○	○
Help participants understand how science works	○	○	○	○
Increasing participants' familiarity with the James Webb Space Telescope	○	○	○	○
Reaching populations or communities that are traditionally underrepresented or underserved in STEM	○	○	○	○
Your organization's objective(s): please describe in the box below:	○	○	○	○

Would you want to host any future Webb Community Events, especially for when the telescope sends back its first images in summer 2022?

- Yes
- Maybe
- Depends on the COVID situation in our area
- No

What was your biggest takeaway or lesson learned that will be helpful to NASA in planning future Webb Community Events?

The Goodman Research Group will remind you about the survey at the end of the month that you are having your event(s).

Please complete it no later than 2 weeks after the reminder.

Webb Events Host Survey

or https://grginc.co1.qualtrics.com/jfe/form/SV_8q9vjE13sMK4YwC

Key Focus Areas

(About 5 min)

These key focus areas will be used as the main points of information we want our audience (communities who are attending your events) to hear, understand, and remember.

The theme for our key focus areas around launch is the Power of People, the Power of Webb.

These focus areas are broken down into three sections: The audience, the people behind webb, and the mission itself.

So when participating in these launch events please keep this language in mind for the following:

Audience: NASA’s next era of space exploration is just beginning, and we want you to be a part of it.

- We want community buy in here. Webb just like the night sky is for everyone, and the community should feel empowered that this telescope is for them and can create more pathways for all audiences to engage in science and astronomy.

The People: Across the US and the world, thousands of people have come together to create this remarkable telescope.

- We want our audiences to know that Webb is an international mission that thousands of people of working on and collaborating successfully to create this amazing feat in space exploration. Audiences are not always aware of the people behind these types of missions and it is important to stress and humanize this mission to encourage younger audiences to get excited and think that this is something they can do too.

The Mission: Aspirational science requires ambitious engineering and breaking technological barriers.

- This telescope is no small feat. We want our audiences to know how incredible the engineering behind this telescope really is. Alot of times when I am explaining Webb to younger audiences or the general public, the first question I usually get is how will this telescope survive in space? This is our opportunity to tell them.

For more on specific goals, objectives and outcomes see below:

Goals: Briefly highlight a few of these within multi-generational units of audiences

●Goal 1: *Webb will spark interest in science.*

●**Objective**: Webb mission will focus on key science themes to better understand our universe and will locate and uncover hidden mysteries.

●**Outcome**: As a result of Webb launch and community events, the public will be more excited and interested in STEM fields by seeing never before seen images of the universe.

○Suggested measurement themes: Attitude, Interest

●Goal 2: *Webb will provide science and results the public will value*

●**Objective**: Webb mission will open up possibilities for new science to be analyzed and will create fields of interest in the STEM community.

●**Outcome**: As a result of Webb launch and community events, the mission will create avenues of new research. This will allow Webb to establish more pathways for underserved populations to foster their curiosity in new and meaningful ways in STEM fields.

○Suggested measurement themes: Knowledge, Skills, Behavior

●Goal 3: *Webb will generate excitement towards STEM fields/careers* with a focus on underserved & underrepresented communities.

●**Objective**: Webb mission seeks to implement programming with community sites all over the world to celebrate this new era of science and create lasting relationships with a wide range of communities particularly those not currently represented in STEM.

●**Outcome**: The public will have stronger connections to the telescope and familiarity at the level of Hubble. This will be accomplished by Webb mission working in tandem with multiple community sites ahead of launch, especially sites with bigger reach in underrepresented audiences. Webb will be able to be a part of new and different levels of programming that will generate excitement within multiple communities to celebrate this new era of science with the public.

○Suggested measurement themes: Interest, Attitude, Behavior

●Goal 4: *Webb will create new and personal relationships with the public*

●**Objective**: Webb mission will work to gather and access new and exciting data that has never been captured before to have a better understanding of science concepts.

●**Outcome**: The public will have a deeper understanding of the universe around us. Webb mission will have experts in the field studying and measuring this new data and will work on project teams to create products and programs to make these science concepts more accessible.

○Suggested measurement themes: Interest, Knowledge

●Goal 5: *Webb will deepen understanding of science concepts*

●**Objective**: Webb mission will seek Interpretation of scientific results broken down into simple language for the public

●**Outcomes**: The public will have a deeper understanding of the universe around us. Webb mission will have experts in the field studying and measuring this new data and will work on project teams to create products and programs to make these science concepts more accessible.

○Suggested measurement themes: Interest, knowledge

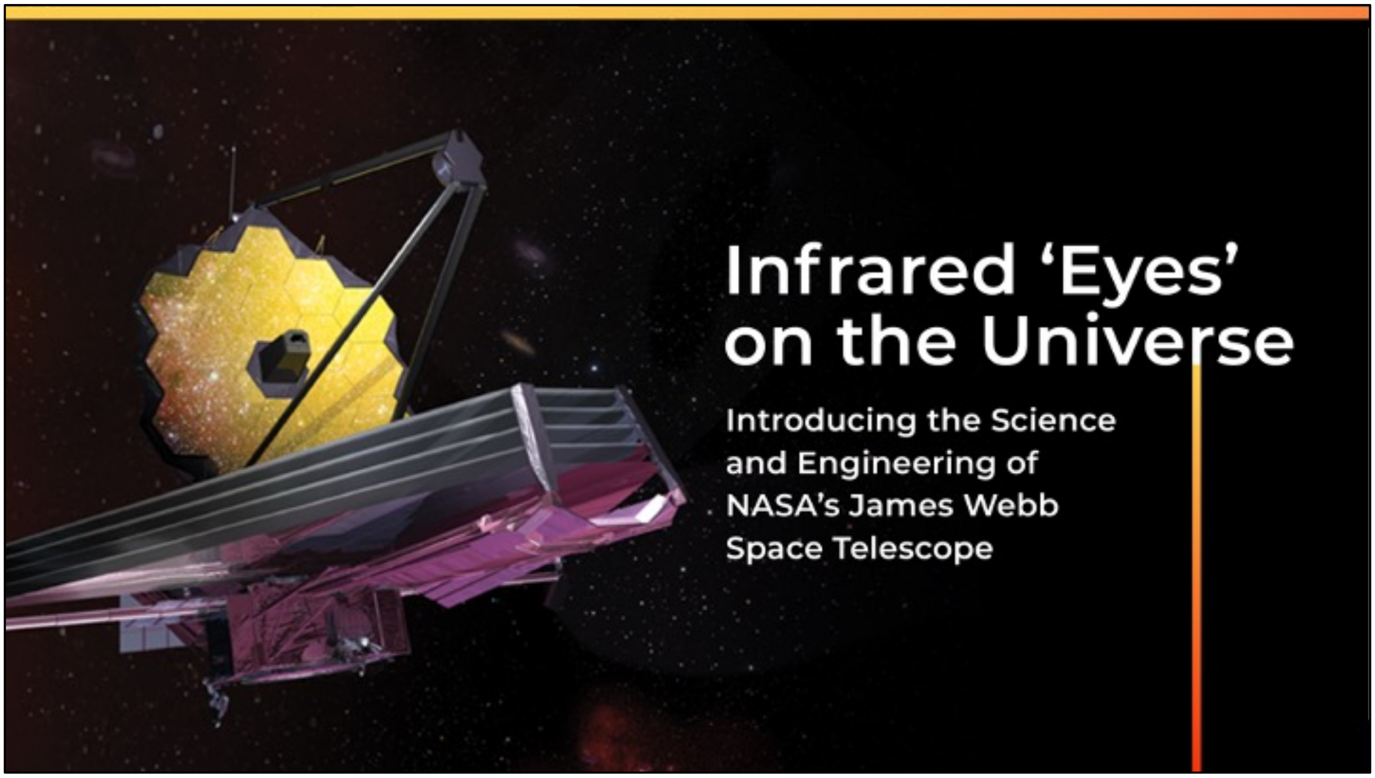
(About 2 mins)

The James Webb Space Telescope's revolutionary technology will study every phase of cosmic history—from the first galaxies that formed after the big bang to newly discovered comets and moons in our solar system, and everything in space and time in between. This rich cosmic history is now within our reach with Webb!

So what are some key goals are that the audience should know that webb will do?

- Search for and discover some of the first galaxies in the Universe, expanding our understanding of the Early Universe.
- Study galaxies near and far, young and old, to understand how galaxies assemble and change over time.
- Uncover the details of how stars and planets are born, by using infrared wavelengths to see through the massive clouds of dust that enshroud them.
- Reveal new details of planets, within our own Solar System and beyond, to determine their formation and evolution and do comparative studies.

Key Science and Resources



- Please display this slide onscreen before your presentation begins and during your introduction.
-
- In this notes pane area, you will find supporting information for each slide and links to additional resources.
-
- You may customize this presentation. We recommend adding slides to this document (not importing slides from this template into your file). Using this as your primary file will preserve the fonts and styling.
-
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-
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-
- The templates are accessible with existing content, but make sure that your final presentation still meets accessibility standards once you add your own content and images. For general PowerPoint Accessibility Guidelines: https://webaim.org/techniques/powerpoint/
- ______________________________

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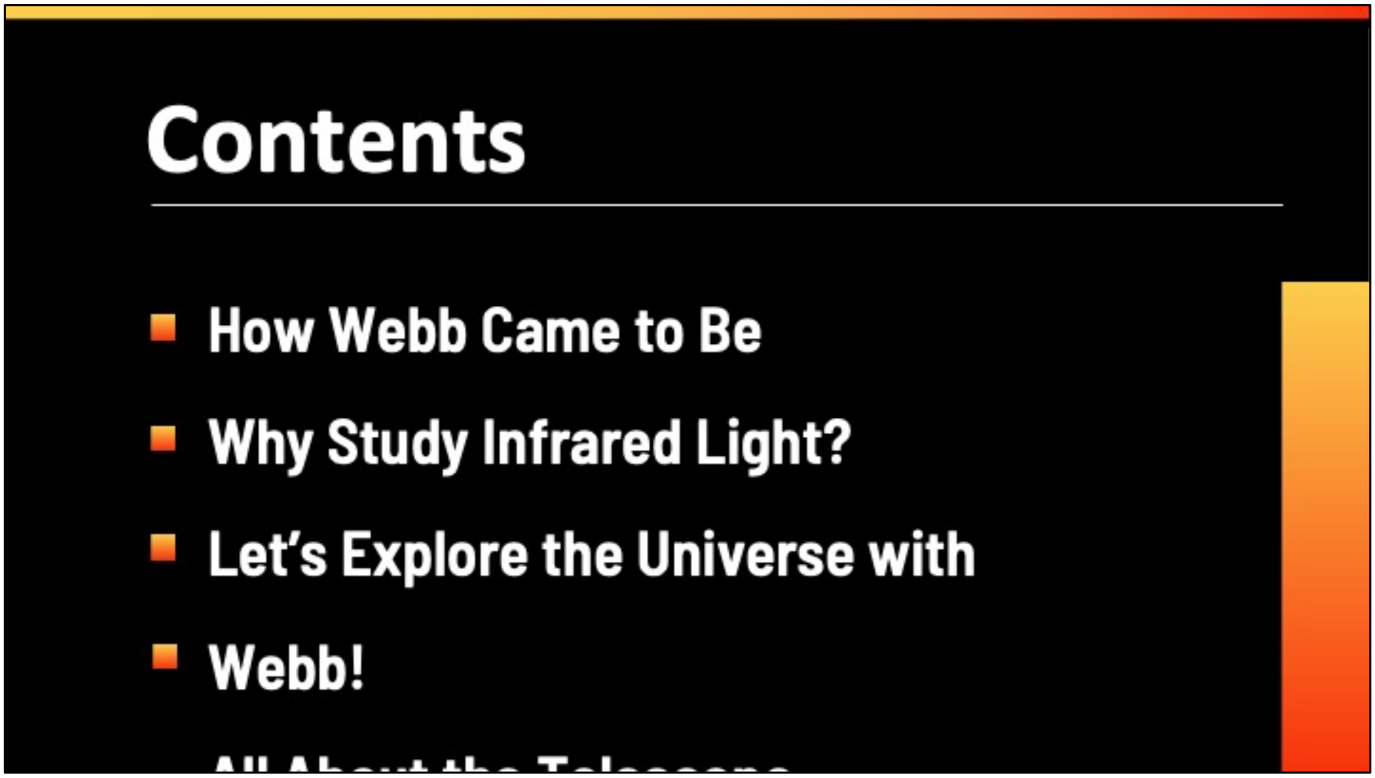
- NASA, ESA, Northrop Grumman
- https://webbtelescope.org/contents/media/images/2017/28/4051-Image



[Note to presenter: This slide is optional.]

- NASA's James Webb Space Telescope will solve mysteries in our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it.
-
- Why does it need to be in space? And why is it specializing in gathering infrared light?
-
- Let's briefly explore its history and goals.
- ______________________________
-
- Image Credit: NASA, ESA and G. Bacon (STScI)
- https://hubblesite.org/contents/media/images/2006/06/1857-Image.html

- Earth's atmosphere filters out some of the light that reaches Earth and blurs the light that does reach the ground. To capture more of the light in the universe, we must send telescopes to space that have specialized instruments.
-
- Starting in the 1990s, NASA launched a series of space-based observatories to study different wavelength of light:
-
- The Spitzer Space Telescope, which operated from 2003 to 2020
- The Hubble Space Telescope, which launched in 1990 and still operates today
- And the Chandra X-ray Observatory, which launched in 1999 and still operates today
-
- What have they shown us?
- ___________________________
-
- Image Credit: NASA, ESA, and J. Kang (STScI)

- With each additional space telescope, we continue to learn an incredible amount about the universe. Telescopes observe different types of light, offering unique perspectives of objects in space.
-
- When observers around the world first reported seeing the Crab Nebula, at top left, in 1054 A.D., they described it as a new star. Chandra gave us a new view into the heart of the nebula that was left behind a supernova explosion, revealing new details about the area around the central pulsar. Chandra's observations in X-rays have allowed us to trace their movements of the particles in its bright ring for more than 20 years.
-
- One object Spitzer studied is Zeta Ophiuchi, a bright star obscured by dust in most observations. Infrared light allowed us to see through that dust to learn that the star is sending out powerful winds that are making ripples in the dust, creating a bow shock, like a boat does when it travels through water.
-
- Hubble has revealed the finer details of the Ring Nebula—the gaseous layers cast off by a dying star. Thousands of comet-like filaments likely formed when hot stellar winds and radiation plowed into colder shells of

gas and dust.

-
- Multiple telescopes showed us the Antennae galaxies—and all that is happening as two galaxies collide. In this image alone, we can trace the lifecycle of massive stars, from formation in gas clouds to afterlife as compact X-ray sources. (Chandra data are blue, Hubble data are gold and brown, and Spitzer data are red.)
- ___________________________
-
- Resources:
-
- Multi-wavelength look at the Crab Nebula in a ViewSpace interactive: https://viewspace.org/interactives/unveiling_invisible_universe/star_death/crab_nebula
-
- Multi-wavelength look at the Helix Nebula in a ViewSpace interactive: https://viewspace.org/interactives/unveiling_invisible_universe/star_death/helix_nebula
-
- Multi-wavelength look at the Antennae galaxies in a ViewSpace interactive:
- https://viewspace.org/interactives/unveiling_invisible_universe/interacting_galaxies/the_antennae
-
- Image Credits:
-
- Chandra's X-ray view of the Crab Nebula: NASA/CXC/SAO
- https://chandra.harvard.edu/photo/2018/crab/
-
- Spitzer's infrared light view of Zeta Ophiuchi: NASA/JPL-Caltech
- https://www.spitzer.caltech.edu/image/sig12-014-massive-star-makes-waves
-
- Hubble's visible light view of the Ring Nebula: NASA, ESA, and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration
- https://hubblesite.org/contents/media/images/2013/13/3170-Image.html
-
- Multiwavelength view of the Antennae galaxies: NASA, ESA, SAO, CXC, JPL-Caltech, and STScI; J. DePasquale (Harvard-Smithsonian CfA), and B. Whitmore (STScI)
- https://hubblesite.org/contents/media/images/2010/25/2755-Image.html

- We’ve shown you a few of the objects that are closer to Earth, but what about those that are very far away? What do the earliest galaxies in the universe look like?
-
- One view stands out among the rest: the Hubble Deep Field, which was produced in 1995 and has led to a series of deep fields by Hubble and other observatories, including Chandra, in the decades since.
-
- On screen, we have the Hubble Ultra Deep Field, taken in 2014.
-
- This image contains approximately 10,000 galaxies that extend back in time to within a few hundred million years of the big bang.
-
- In 1995, the first Hubble Deep Field was captured when researchers pointed the telescope at a single, nearly empty patch of the sky for more than 10 days.
-
- This image combines data from many observations of that same patch of sky, equivalent to to 25 days (or 600 hours) of observing time.
-
- <u>When we look out at space, we are looking back in time. The light</u>

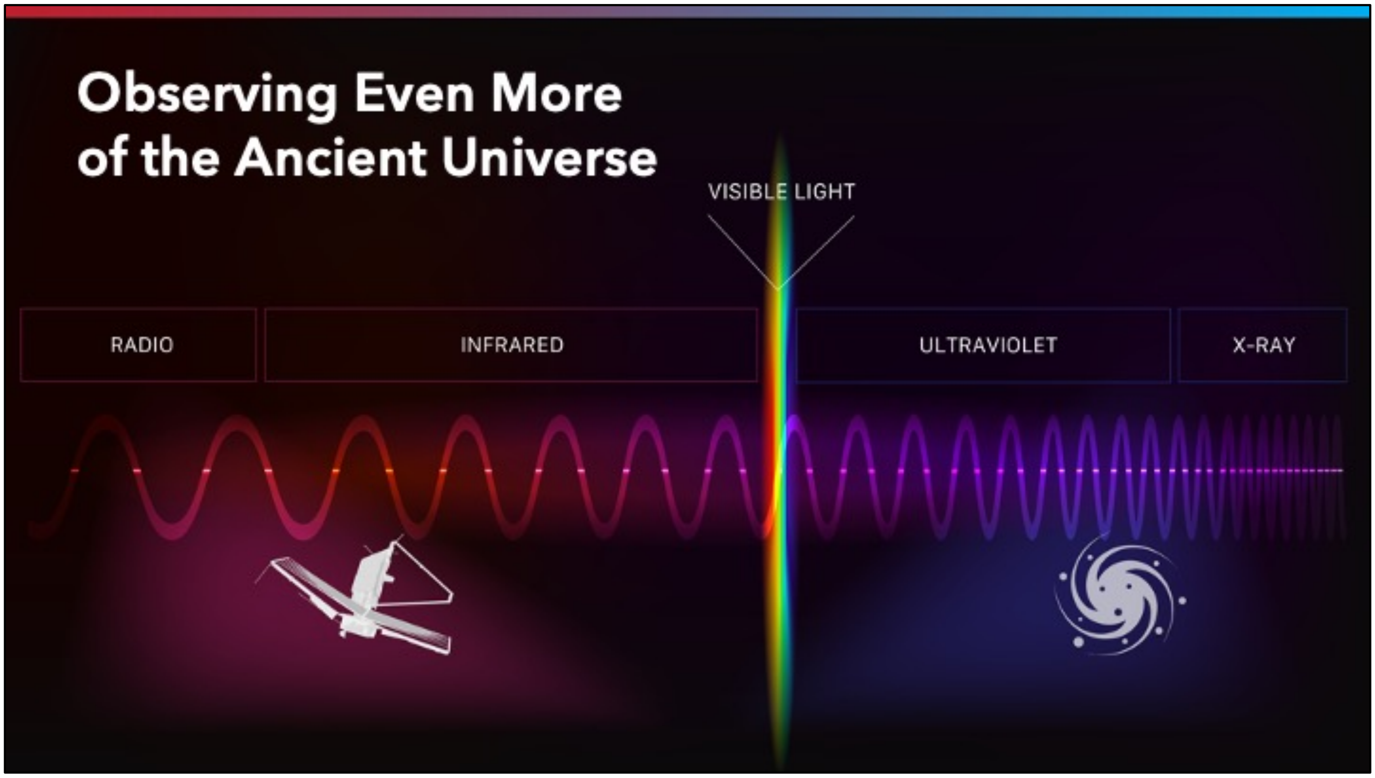
arriving at Earth from the farthest objects in the universe is light that left those objects billions of years ago. We see those objects not as they are today, but as they appeared long ago.

- We want to see even more of that light—to see the first galaxies. But that requires we switch back to gathering infrared light—and a new, great observatory: NASA's James Webb Space Telescope.
- ______________________________
- Resources:
- Article, "Hubble Deep Fields": https://hubblesite.org/contents/articles/hubble-deep-fields
- Hubble Ultra Deep Field explainer video, "Looking out into Space, Looking Back into Time":
- https://hubblesite.org/contents/media/videos/1310-Video
- Hubble Ultra Deep Field 2014 news release: https://hubblesite.org/contents/media/images/2014/27/3380-Image.html?news=true
- Chandra Deep Field-South 2017 news release: https://chandra.harvard.edu/photo/2017/cdfs/
- Hubble Extreme Deep Field "fly through" video without narration: https://hubblesite.org/contents/media/videos/22-Video
- Video: "Galaxies Through Time": https://webbtelescope.org/contents/media/videos/2020/49/1290-Video
- Image Credit: NASA, ESA, H. Teplitz and M. Rafelski (IPAC/Caltech), A. Koekemoer (STScI), R. Windhorst (Arizona State University), and Z. Levay (STScI)
- https://hubblesite.org/contents/media/images/2014/27/4449-Image.html

- As NASA's most ambitious and complex astronomical space observatory ever, the James Webb Space Telescope will deliver amazing science, complementing the spectacular scientific discoveries made by other space science missions.
-
- Webb will match the incredible image quality offered by Hubble, but with infrared light instead of visible light. (We'll go into depth about infrared light in a moment.)
-
- Webb, Hubble, and many other observatories will work together: They will target some of the same regions of the sky to provide simultaneous or follow-up observations in infrared light.
-
- Using infrared imaging at unparalleled sensitivity and resolution to detect the faint infrared light, Webb's discoveries will revolutionize and enrich our understanding of the universe.
- ______________________________
-
- Resources:
-
- Reference for all things Webb: https://webbtelescope.org/news/webb-

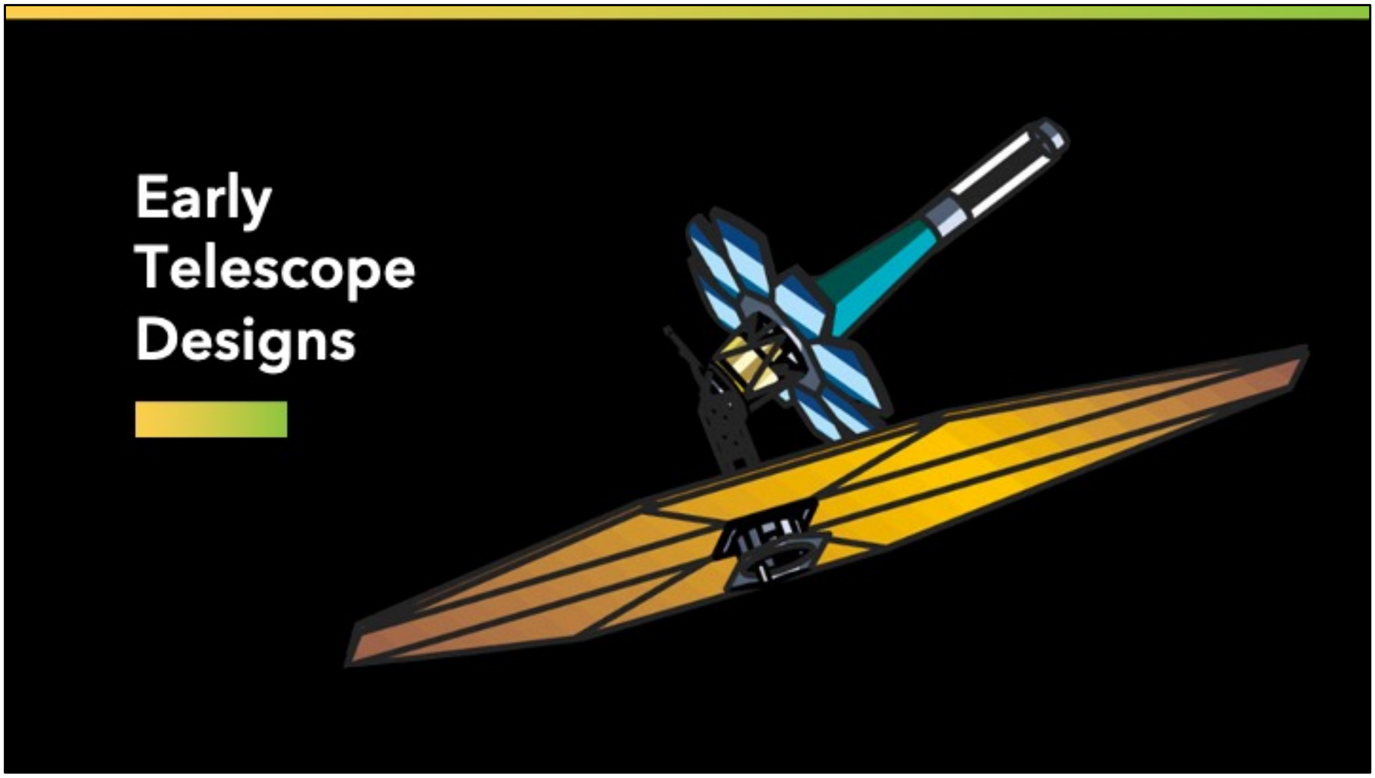
science-writers-guide

-
- Learn how Webb and Hubble will complement one another:
- https://webbtelescope.org/contents/media/videos/1279-Video
-
- Illustration Credit: NASA



- To capture light that's traveled more than 13 billion years to reach us—from when the universe was only hundreds of millions of years old—we need a telescope that focuses on gathering light that has stretched, or redshifted, over time into infrared light.
-
- Webb's sensitivity to infrared light allows us to see the ancient light of the first galaxies, which has been redshifted as it travels toward Earth over billions of years.
-
- When Webb takes its first deep fields, we will see some of the first galaxies that formed in the universe.
-
- There is so much more we will learn. Let's explore all of the amazing science Webb will contribute.
-
- And remember these moments—in five or ten years, what we expected to learn will have profoundly changed for the better.
- ______________________________
-
- Resources:
-

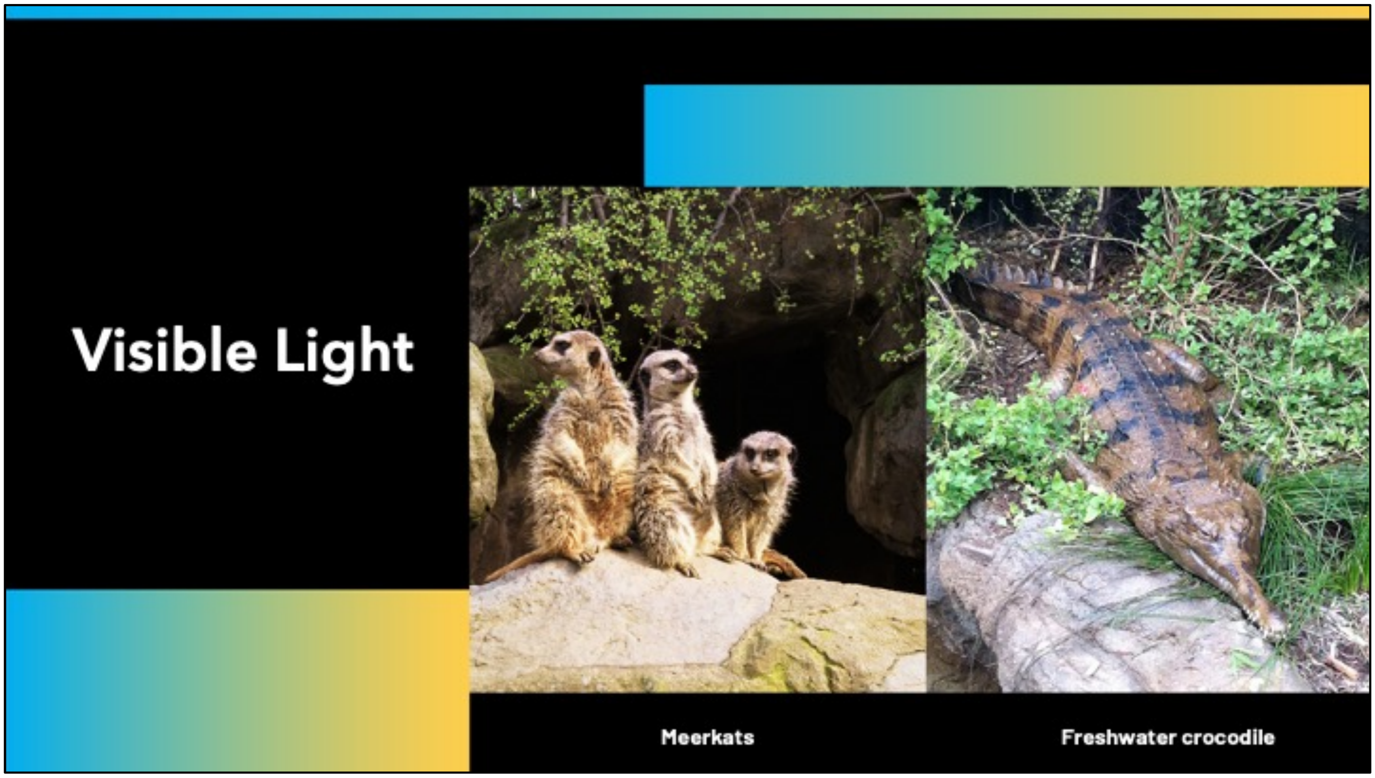
- Complete infographic: https://webbtelescope.org/contents/media/images/2019/20/4378-Image
-
- Image Credit: NASA, ESA, and L. Hustak (STScI)
- https://webbtelescope.org/contents/media/images/2019/20/4378-Image



- Scientists and engineers had a lot of information to build on when designing Webb since other telescopes were designed and launched before it.
-
- Planning for Webb began in 1989. For context, Hubble was launched in 1990. New concepts and designs for Webb, like the one shown here, were developed in the 1990s.
-
- The Next Generation Space Telescope, as it was originally known, was renamed the James Webb Space Telescope in 2002.
-
- Construction began on its instruments in 2002. Since new technologies were required—along with a battery of tests at every stage of development. Scientists and engineers took time to ensure each instrument operates as planned.
-
- As I mentioned earlier, Webb is also designed to capture infrared light. What is it? Let’s look at it in detail.
- ______________________________
-
- Resources:

-
- Interactive timeline, including the 1989 workshop with a link to the report: https://www.stsci.edu/who-we-are/our-history/stsci-timeline#h4-c2850d9a-8588-4e65-b039-4a1b6e28fa53
-
- Webb mission timeline: https://webbtelescope.org/webb-science/the-observatory/mission-timeline
-
- Illustration Credit: NASA
- https://webbtelescope.org/contents/media/images/01F51ANETW751XVDXGEK5KSV3G

- The rainbow of light that the human eye can see is a small portion of the total range of light, known in science as the electromagnetic spectrum.
- Telescopes can be engineered to detect light outside the visible range to show us otherwise hidden regions of space.
- Webb detects near-infrared and mid-infrared wavelengths, the light beyond the red end of the visible spectrum.
- Resources:
- Infrared astronomy overview: https://webbtelescope.org/webb-science/the-observatory/infrared-astronomy

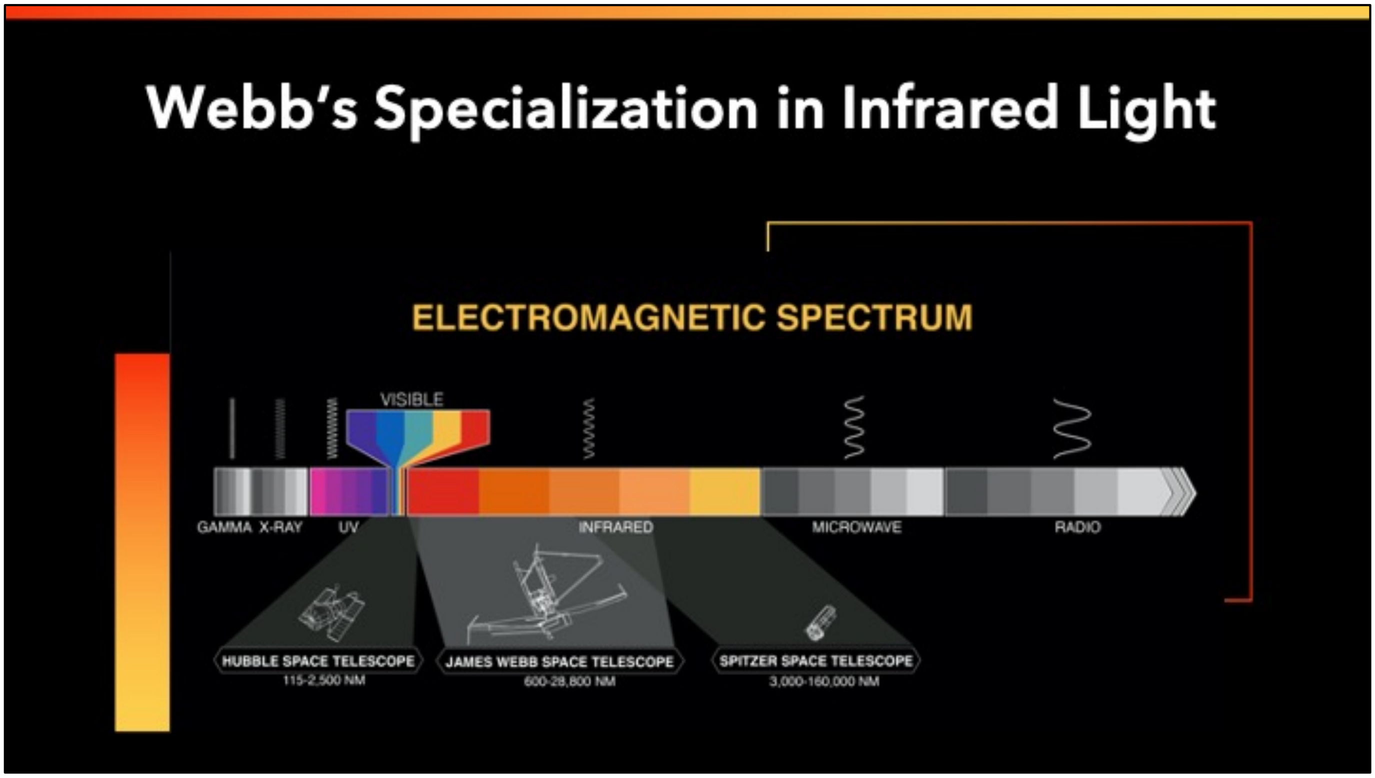


- Let’s look at this concept with more familiar objects.
-
- Visible light provides us with detailed information about our environment, including colors and textures, as seen with these meerkats and freshwater crocodile (a Tomistoma).
- ______________________________
-
- Resources:
-
- Clickable ViewSpace interactive: https://viewspace.org/interactives/unveiling_invisible_universe/forms_of_light/infrared_animals
-
- Cool Cosmos visible and infrared light images of animals:
- https://coolcosmos.ipac.caltech.edu/infrared_gallery/1
-
- Image Credit: NASA, IPAC, Los Angeles Zoo https://coolcosmos.ipac.caltech.edu/infrared_gallery/1

- In infrared light, we see different details. The meerkats glow dramatically. Their high metabolisms cause them to glow brightly in the infrared, through insulating layers of fur.
- The freshwater crocodile is faintly brighter than the cool ground, which tells us it had recently been lounging in the pool of warm water (at lower left), which is the warmest thing in the picture. It's been out of the water long enough to start to cool down.
- Infrared is a type of light our eyes can't see. It's redder than red light.
- Everything is glowing, even if we can't see it with our eyes. Many things, like computers, humans, and animals, glow in infrared light.
- [Accuracy Note: Because of our everyday experiences with hot things glowing with infrared light, it may be tempting to refer to infrared as heat or heat energy. While the two concepts are related, they are not the same thing. Technically speaking, "heat" is the transfer of energy from something that is hotter to something that is cooler. The greater the difference in temperature, the faster the energy is transferred. Energy transfer can happen through several different methods, including

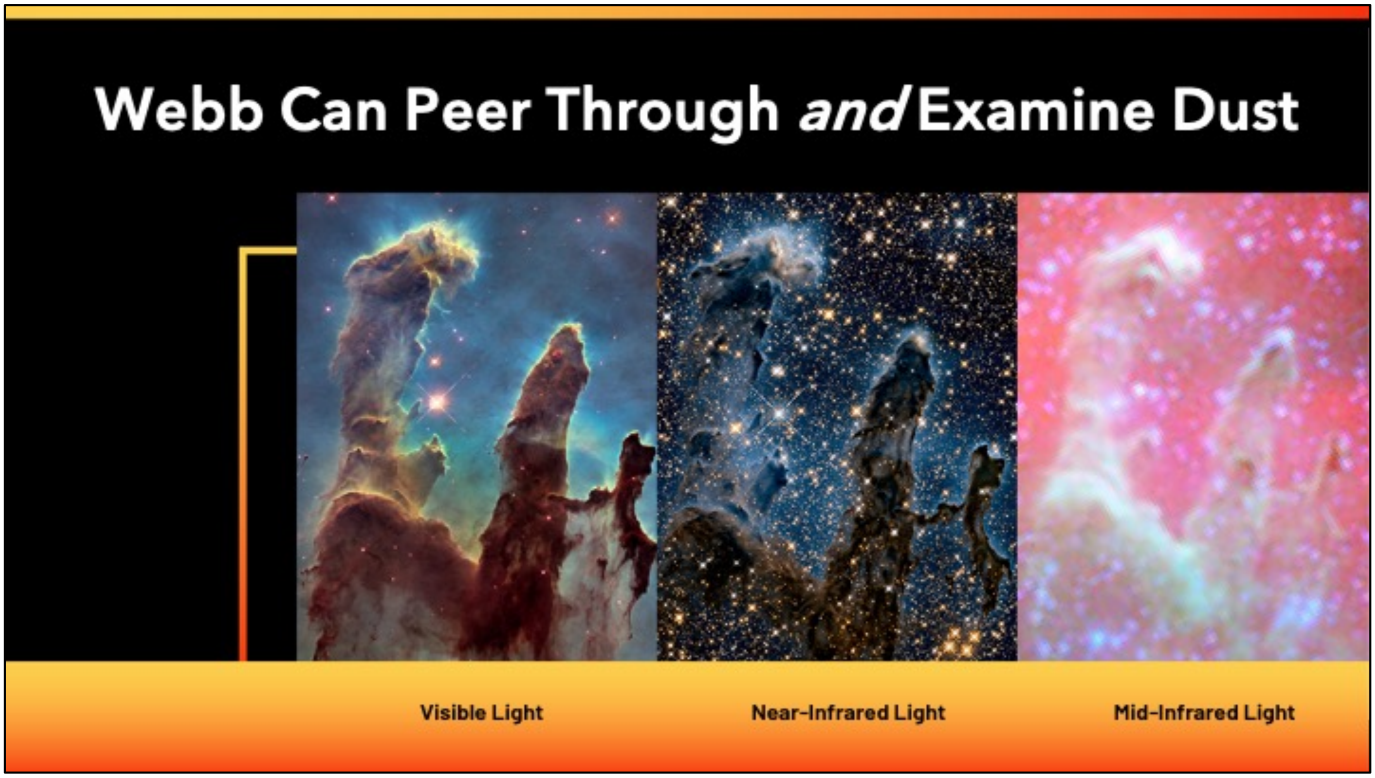
conduction, convection, and radiation. So, while energy can be transferred from one place to another via infrared radiation (light), infrared is not itself heat or thermal energy.]

- ______________________________
-
- Resources:
-
- Clickable ViewSpace interactive: https://viewspace.org/interactives/unveiling_invisible_universe/forms_of_light/infrared_animals
-
- Cool Cosmos visible and infrared light images of animals:
- https://coolcosmos.ipac.caltech.edu/infrared_gallery/1
-
- Image Credit: NASA, IPAC, Los Angeles Zoo https://coolcosmos.ipac.caltech.edu/infrared_gallery/1



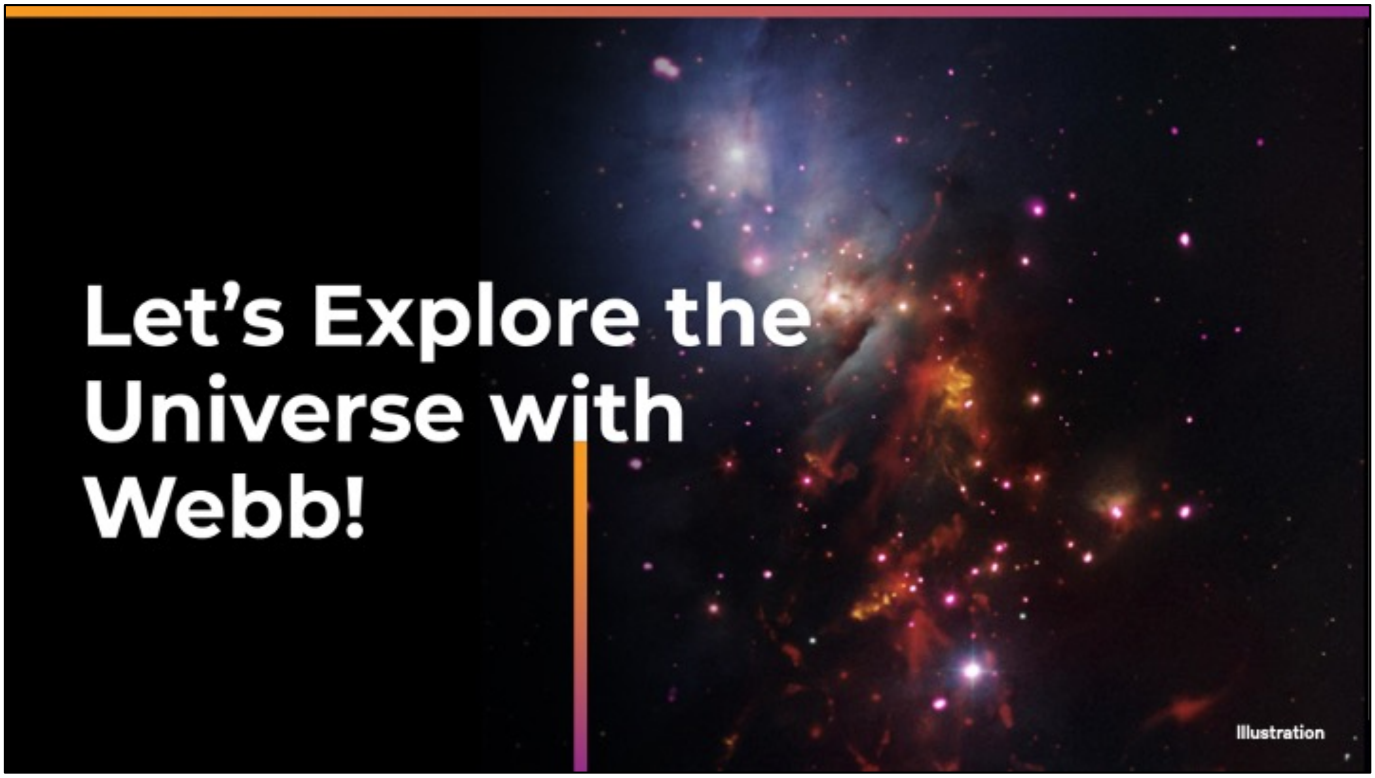
- Let's go back to the electromagnetic spectrum—and look at it in detail.
-
- The portion of the spectrum of light labeled "visible," with the colors of the rainbow, is what humans detect as visible light.
-
- Beyond the red end of the visible spectrum, the wavelengths are longer than the human eye can detect. The portion of the spectrum immediately beyond red is called infrared.
-
- Longer wavelengths, including infrared light, are able to pass through areas of dense gas clouds and other matter in the universe.
-
- Shorter wavelengths get trapped, which means telescopes that specialize in visible light can't capture them.
-
- By detecting longer infrared wavelengths of light with Webb, we will be able to see cool stars and warm planets clearly for the first time.
- ______________________________
-
- Resources:
-

- Article, “Infrared Astronomy”: https://webbtelescope.org/webb-science/the-observatory/infrared-astronomy
-
- Image Credit: NASA and A. James (STScI)



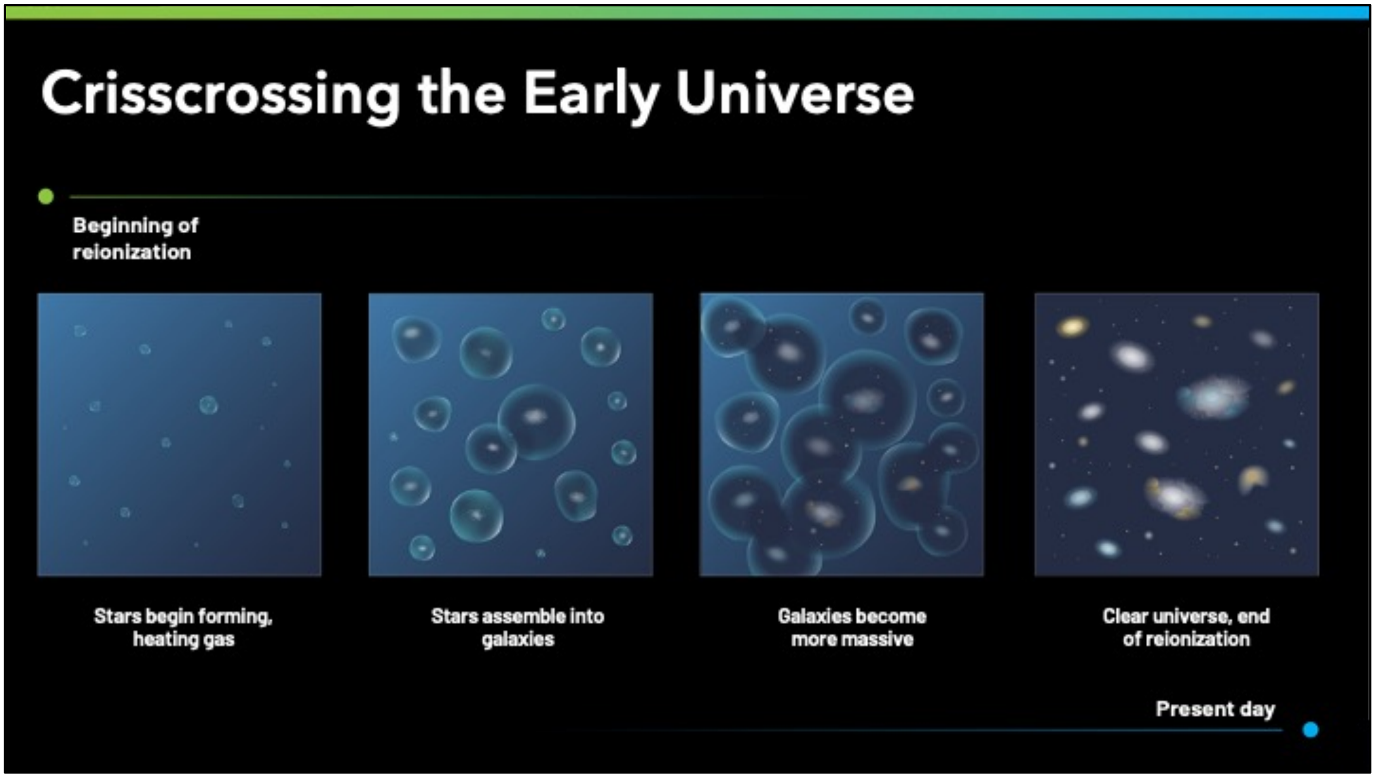
- By specializing in infrared light, Webb will be able to see what's behind the dust we see everywhere in the universe!
-
- The Eagle Nebula's Pillars of Creation were captured by the Hubble Space Telescope in visible light (left) near-infrared light (middle), and the Spitzer Space Telescope in the mid-infrared light (right).
-
- Like Spitzer, Webb will be able to see through the dust in regions like this—but at high resolution, like Hubble.
-
- What does each type of light show?
-
- In visible light, forming stars are inside dense cocoons of gas and dust, which block their visible light from reaching the telescope.
-
- Near-infrared light shines through all but the densest dust, revealing many stars inside and around the pillars.
-
- Mid-infrared light shows the eroded pillars of gas and dust glow with heat from bright young stars.
-

- Webb’s images help us see past dust clouds—and figure out what’s going on in these dense regions in great detail for the first time.
-
- Now that we know why infrared light is so valuable, let’s look at what Webb study.
- ______________________________
-
- Resources:
-
- Clickable ViewSpace interactive:
- https://viewspace.org/interactives/unveiling_invisible_universe/star_formation/eagle_nebula
-
- Image Credits: Hubble visible light image: NASA, ESA, and the Hubble Heritage Team (STScI/AURA) https://hubblesite.org/contents/media/images/2015/01/3470-Image.html
- Hubble near-infrared light image: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)
- https://hubblesite.org/contents/media/images/2015/01/3475-Image.html
- Spitzer mid-infrared image: NASA/JPL-Caltech/N. Flagey (IAS/SSC & A. Noriega-Crespo (SSC/Caltech)
- http://www.spitzer.caltech.edu/images/1710-ssc2007-01a1-The-Infrared-Eagle-Nebula



- What was the universe like after the big bang?
-
- What are the characteristics of galaxies as the universe aged over billions of years?
-
- What more will we learn about how stars form, live, and die?
-
- Since Webb can see through dust—what will it reveal about forming planets and other distant worlds?
-
- These are only a few of the questions Webb will help answer. Webb will contribute to all areas of astronomy—and its most exciting discoveries may be the ones that we didn't anticipate!
-
- The science that will be done using the Webb telescope will bring us closer to NASA's overarching science goals of discovering secrets of the universe and searching for life beyond Earth.
- ________________________________
-
- Resources:
-

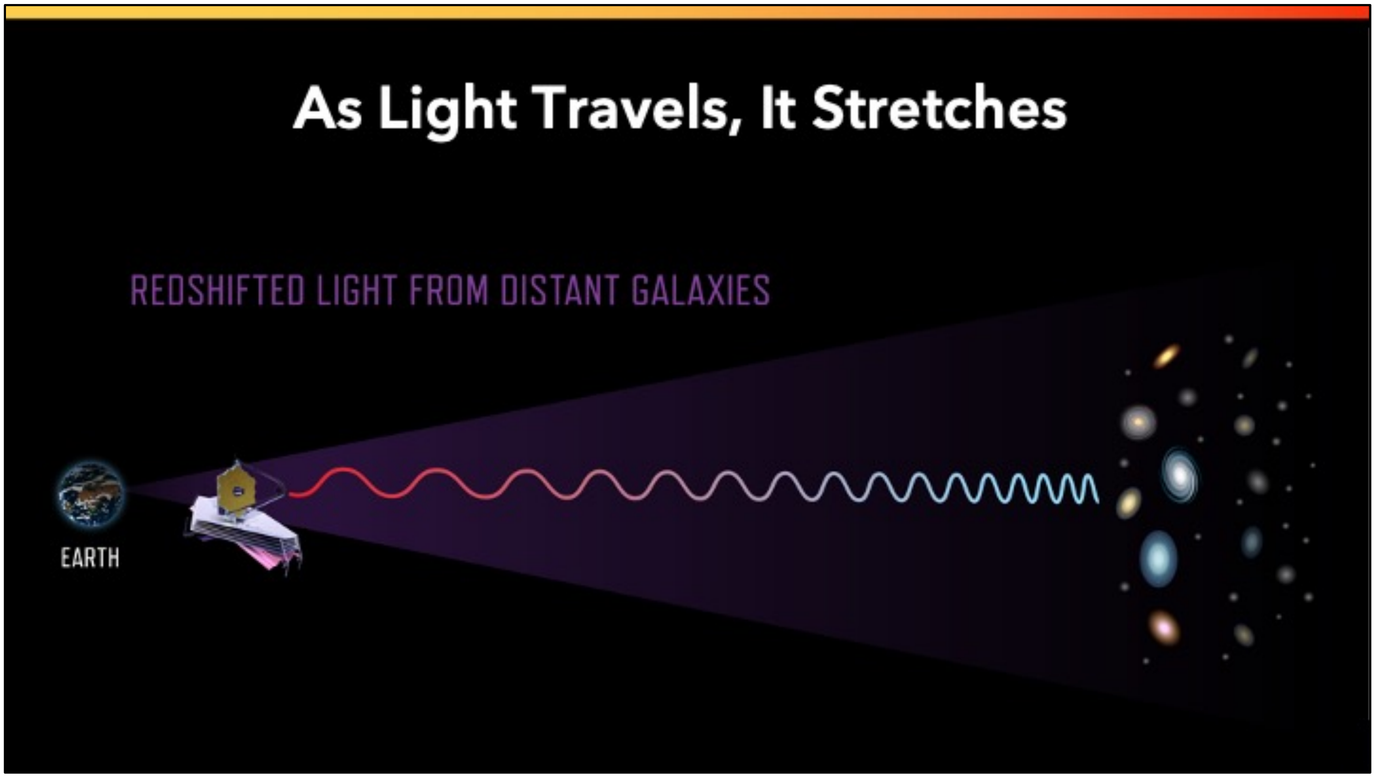
- Webb’s science: https://webbtelescope.org/webb-science



- Let's start with the early universe.
-
- Webb can peer deep into space—capturing some of the first galaxies that formed as the universe cooled down after the big bang over 13.5 billion years ago.
-
- During this period, known as the Era of Reionization, the universe was a very different place. The gas between galaxies was largely opaque to energetic light (shown in the top left image), which makes it difficult to observe young galaxies.
-
- What allowed the universe to become completely ionized, or transparent, eventually leading to the "clear" conditions detected in much of the universe today? (Seen in bottom right image.) When did it begin and how long did this process take?
-
- Webb's infrared observations will help us create the first detailed snapshot of galaxies in the early universe and provide much more information than ever possible before. These new data will allow researchers to analyze individual objects to understand how the surrounding gas changed from neutral to ionized, creating the

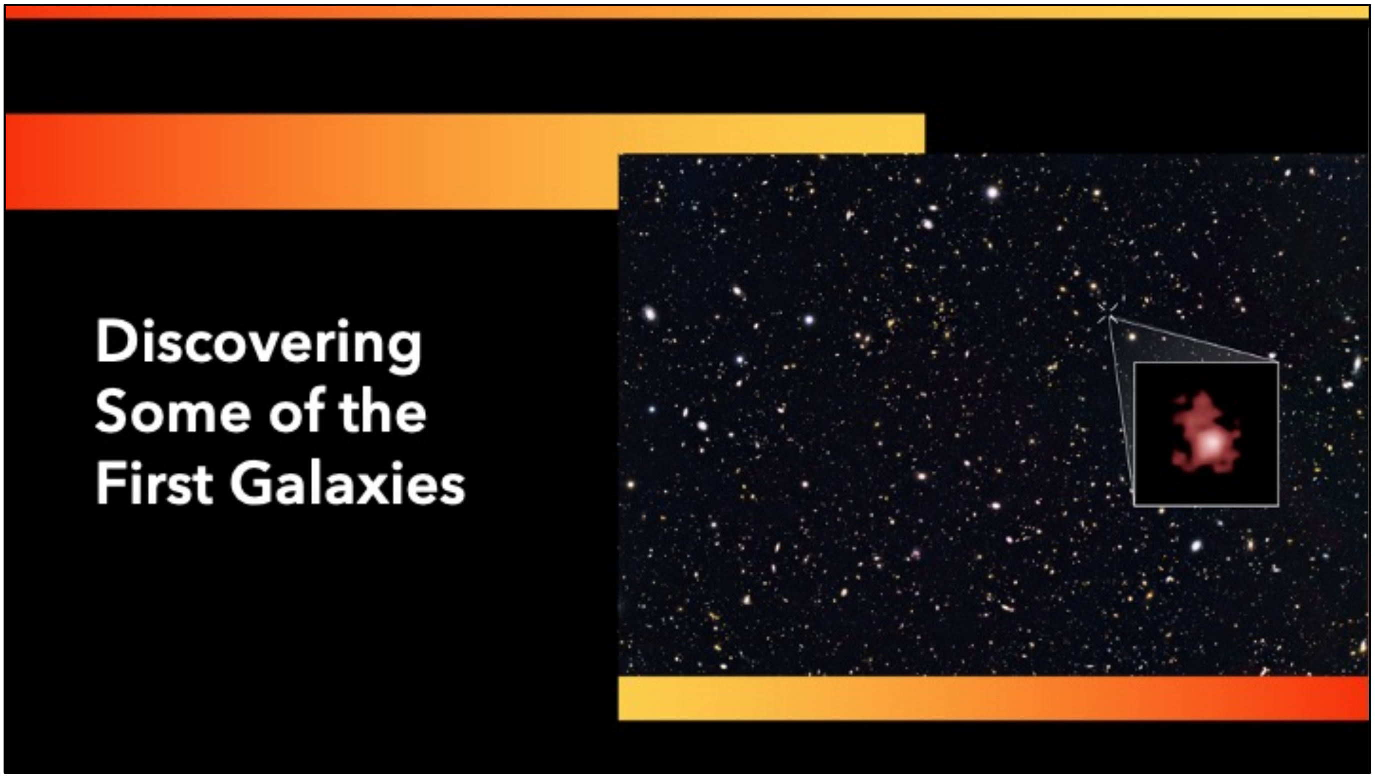
transparent universe we see today.

-
- How can Webb capture light from the early universe?
- ____________________________
-
- Resources:
-
- Infographic (click files under “Download Options” at left for the complete infographic): https://webbtelescope.org/contents/media/images/2020/37/4697-Image
-
- Article, “How Can Webb Study the Early Universe?”:
- https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-can-webb-study-the-early-universe
-
- Image Credit: NASA, ESA, and J. Kang (STScI)
- https://webbtelescope.org/contents/media/images/2020/37/4697-Image

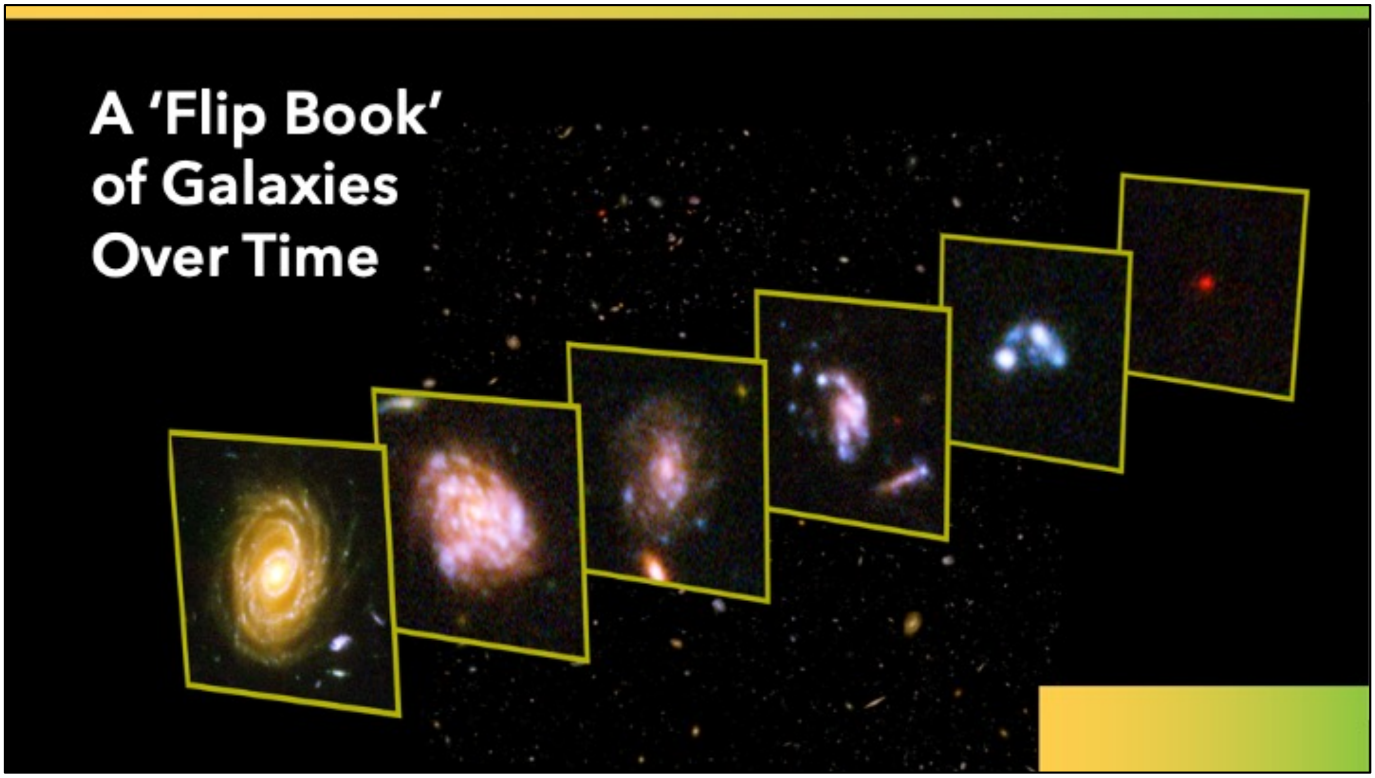


- As light travels through the expanding universe, light is stretched into longer wavelengths, which is called cosmological redshift.
-
- Light from stars that is emitted as ultraviolet light and visible light is stretched to the longer wavelengths of infrared light.
-
- This is the light Webb will capture—and how it can observe extremely distant galaxies.
- ______________________________
-
- Resources:
-
- https://webbtelescope.org/webb-science/the-observatory/infrared-astronomy
-
- Example about the first stars in the universe to further explain this concept: https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/what-were-the-first-stars-like
-
- Image Credit: NASA and J. Kang (STScI)
- -

- Similar graphic: https://webbtelescope.org/contents/media/images/4195-Image

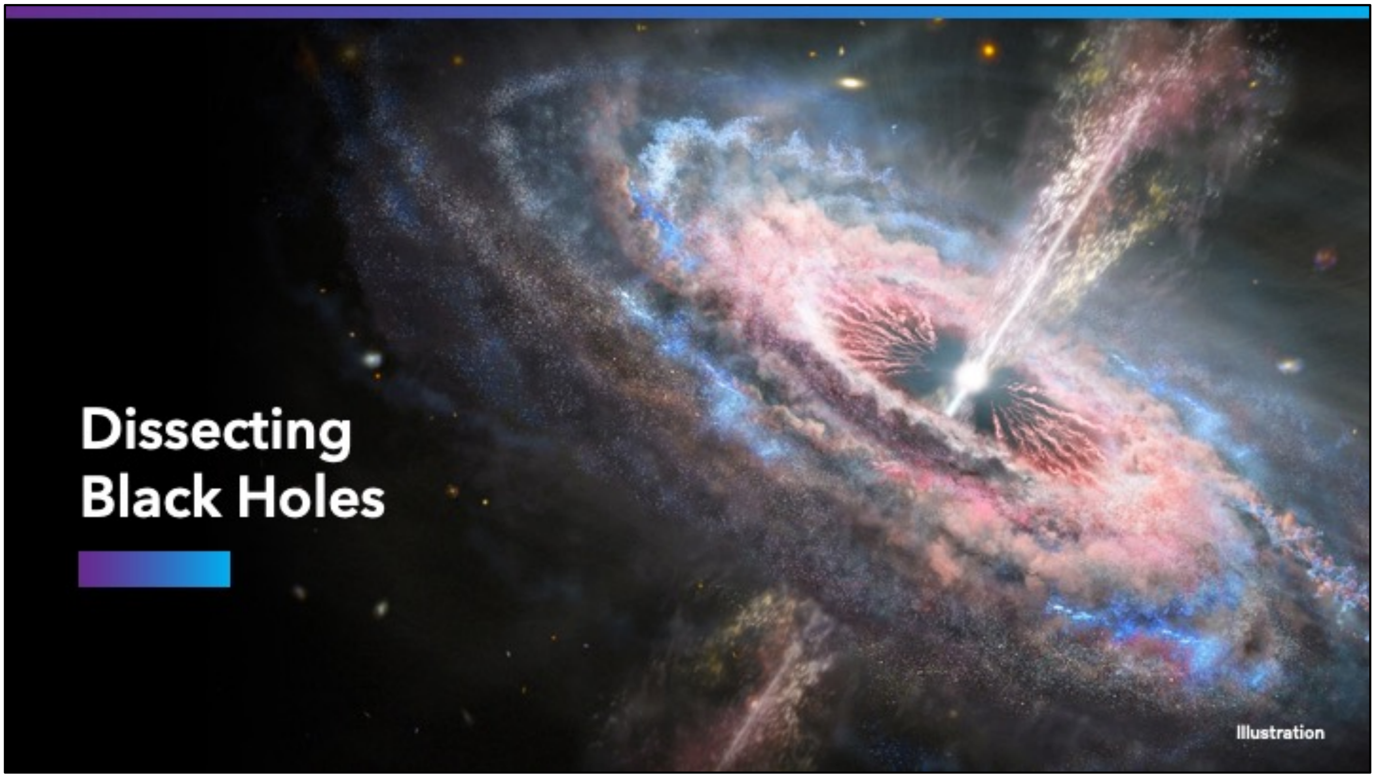


- The galaxy shown in the inset was observed as it was 13.4 billion years in the past. That's just 400 million years after the big bang.
-
- Webb will show us even more galaxies that existed in the early universe.
-
- How will Webb do this?
-
- (Inset galaxy is GN-z11.)
- ______________________________
-
- Resources:
-
- Article: "How Can Webb Study the Early Universe?":
- https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-can-webb-study-the-early-universe
-
- Image Credit: NASA, ESA, P. Oesch (Yale University), G. Brammer (STScI), P. van Dokkum (Yale University), and G. Illingworth (University of California, Santa Cruz)
- https://hubblesite.org/contents/media/images/2016/07/3706-Image.html



- Researchers will examine individual galaxies in Webb's images and data. They will pinpoint how old each one is—leading to Webb's next science specialty: studying galaxies over time.
-
- By viewing the universe at different distances and eras, we have evidence that galaxies change over time—they grow, collide, and merge with each other.
-
- The most distant, earliest galaxies we have seen tend to be smaller and less structured than those in the nearby universe. However, the earliest galaxies in the universe are still undetected.
-
- This is because the universe is expanding, and as space itself stretches, so does the wavelength of the light from the first galaxies—into infrared light.
-
- Webb will examine these early galaxies and eras that followed in new detail, providing essential insight and helping us learn more about how galaxies evolve. What's great about this is that Webb's observations will be added to Hubble's—so we'll learn even more about dust, stars, and galaxies over cosmic time.

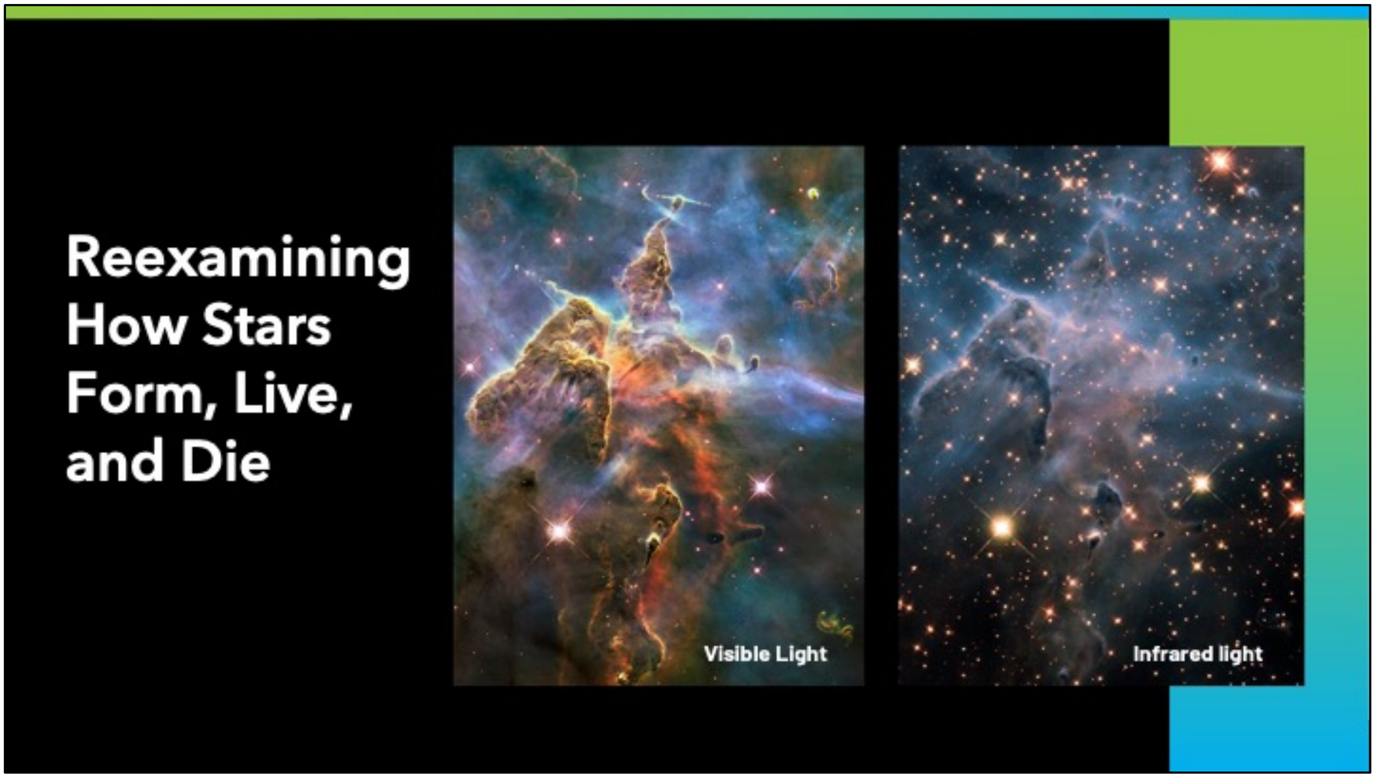
-
- Webb will also help us learn more about the history of the mergers and growth of galaxies, black holes, and the history of star formation.
- ___________________________
-
- Resources:
-
- “Galaxies Through Time” video: https://webbtelescope.org/contents/media/videos/2020/49/1290-Video
-
- Article, “Galaxies Over Time”: https://webbtelescope.org/webb-science/galaxies-over-time
-
- Video Still Credit: Frank Summers (STScI), Alyssa Pagan (STScI), Leah Hustak (STScI), Greg T. Bacon (STScI), Zolt G. Levay (STScI), Lisa Frattare (STScI)
- Image pulled from 4:50 mark: https://hubblesite.org/contents/media/videos/1310-Video



- Webb will study black holes, both near and far.
-
- In our own Milky Way, Webb will peer through obscuring dust to study the center of the galaxy, specifically at our resident supermassive black hole Sagittarius A* (A-star), and the stars that orbit it.
-
- In nearby galaxies, Webb will take high-resolution spectra to learn about the temperatures, speeds, and compositions of the material at their centers. Researchers will use this data to measure the mass of the black holes at the center of the galaxies by mapping speeds of the central gas and stars. Webb will also study the feedback loop between central black holes, their powerful jets, and the formation of new stars in those galaxies.
-
- Quasars are another type of very distant, but very bright active supermassive black hole. They are among the brightest objects in the distant universe. These supermassive black holes, typically located at the centers of galaxies, are millions to billions of times the mass of the Sun. They feed on infalling matter and unleash fantastic torrents of radiation, outshining all the stars in their host galaxy combined. Their jets and winds shape their host galaxy.

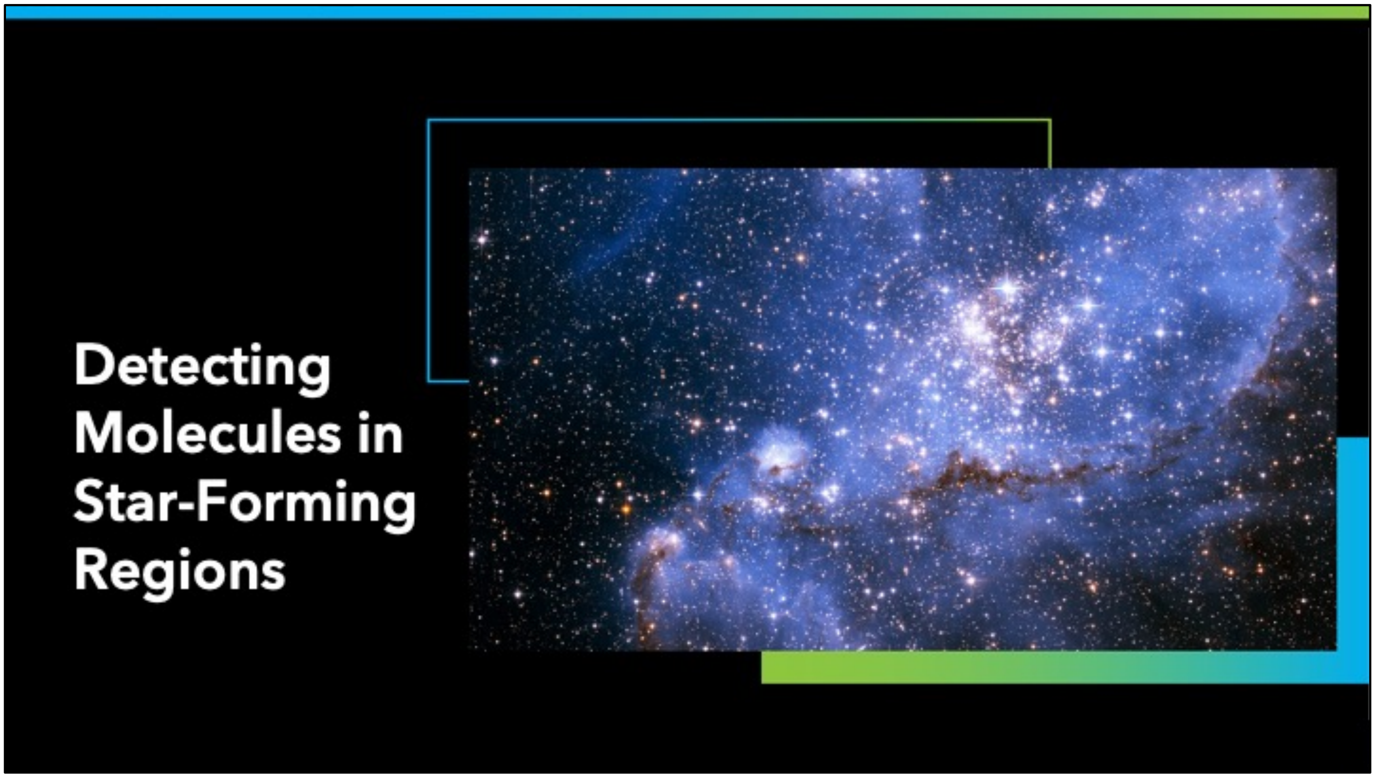
-
- Webb will study the properties of quasars and their galaxies, and how their black holes influence the first stages of galaxy development in the very early universe.
-
- Webb also could help address broader questions of how galaxies form, including the longstanding problem of which came first: the galaxy or the black hole?
- ________________________________
-
- Illustration Credit: NASA, ESA, Joseph Olmsted (STScI)
- https://webbtelescope.org/contents/media/images/2021/026/01F8QS893NVRJ6EYF0S46237KP
-
- Resources:
-
- Infographic, “Dissecting Supermassive Black Holes”:
- https://webbtelescope.org/contents/media/images/2021/015/01EZ5F0BYEP19BGPCZ7BMMCDGT
-
- Clickable ViewSpace interactive about Sagittarius A*
- https://viewspace.org/interactives/unveiling_invisible_universe/black_holes/sagittarius_a
-
- Clickable ViewSpace interactiveabout Centaurus A
- https://viewspace.org/interactives/unveiling_invisible_universe/black_holes/centaurus_a
-
- Video, “Reading the Rainbow: Speed”:
- https://webbtelescope.org/contents/media/videos/01F9KWVZCV229ATG0NQCGA6TE0
-
  Video, “Dissecting Supermassive Black Holes: The Feedback Loop”:
- https://webbtelescope.org/contents/media/videos/2021/015/01F09AQGN1JD1H8BJJZDR4RPWS
-
- Video, “Dissecting Supermassive Black Holes: Pinpointing the Flows”:
- https://webbtelescope.org/contents/media/videos/01F099WFKMGVB0B549DDBA4BAF
-
- Article, “What Are Active Galactic Nuclei?”:
  https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-

articles/what-are-active-galactic-nuclei



- Next up for Webb: stars.
-
- These are two views of the same object. It’s an area of star formation in the Carina Nebula, nicknamed Mystic Mountain.
-
- Visible light shows how scorching radiation and fast winds from super-hot new stars are shaping and compressing the pillar, causing new stars to form. But more forming stars remain unseen in its dusty, towering peaks.
-
- Near-infrared light reveals the stars behind the gaseous, dusty veil of the nebula. The foreground pillar becomes semi-transparent because infrared light from background stars penetrates through much of the dust. A few stars inside the pillar also become visible.
-
- Webb’s view will show us even more details of star-forming regions. Its images and data will help us learn about the physical and chemical properties of stellar and planetary systems. It will also give us insight into their formation.
-
-

- Resources:
-
- Article, “The Star Lifecycle”: https://webbtelescope.org/webb-science/the-star-lifecycle
-
- Hubble Image Credit: NASA, ESA, and M. Livio and the Hubble 20th Anniversary Team (STScI)
- https://hubblesite.org/contents/media/images/2010/13/2715-Image.html



- Webb can also detect the molecules in star-forming regions, including the Small Magellanic Cloud shown here.
- While Webb will also capture spectacular infrared images of space, its real power is in spectroscopy, which is a scientific method of studying objects and materials based on detailed patterns of colors (wavelengths).
- Astronomers will use spectra captured by Webb to study:
- Mature stars of different size, mass, age, color, temperature, evolutionary stage, and formation environment,
- Newly forming stars cocooned in dense dark clouds of gas and dust,
- Cold molecular clouds that collapse to form stars,
- Gas and dust ejected from dying stars, and
- Molecules between stars.
- Resources:
- First article in a series about spectroscopy:

https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/spectroscopy-101--introduction

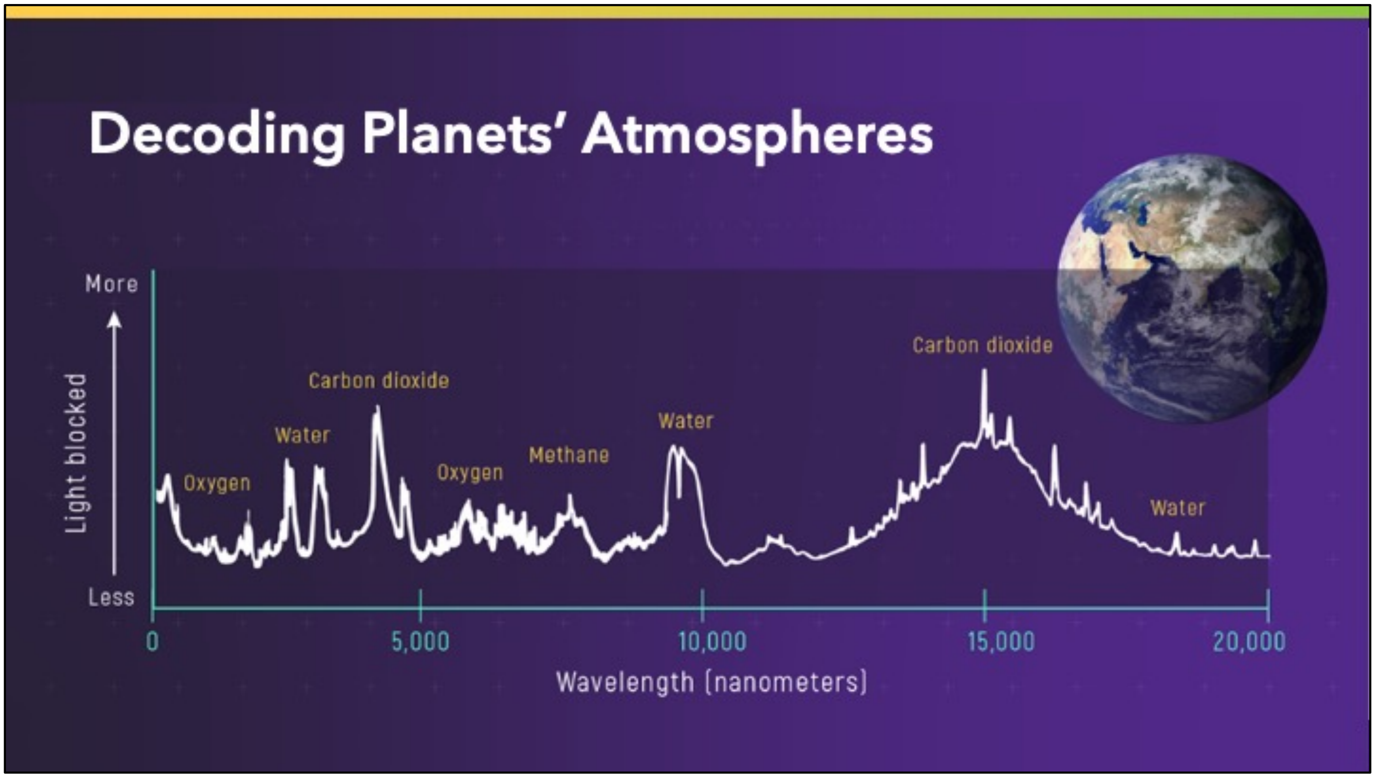
-
- Sixth article in a series about spectroscopy: https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/spectroscopy-101--invisible-spectroscopy
-
- Article about the star lifecycle: https://webbtelescope.org/webb-science/the-star-lifecycle
-
- Clickable ViewSpace interactive: Analyzing Light: Spectrum of the Star Altair
- https://viewspace.org/interactives/unveiling_invisible_universe/analyzing_light/spectrum_of_the_star_altair
-
- Video, “Reading the Rainbow: Temperature”:
- https://webbtelescope.org/contents/media/videos/01F9KWXB37VDZXVJVWEBMEQQW9
-
- Image Credit: NASA, ESA, and A. Nota (STScI/ESA)
- https://hubblesite.org/contents/media/images/2005/04/1646-Image.html

- Webb will explore planets in our own solar system—and worlds that are light-years away.
-
- It can gather data about Mars, Jupiter, which is shown above in near-infrared light, Saturn, Uranus, Neptune, and more distant Kuiper Belt objects to help us build a broader picture of the objects in our solar system.
-
- Webb will help us better understand Mars' atmosphere; map the cloud structures on Jupiter, Saturn, Uranus, and Neptune; study the seasonal weather and climate on the giant gas planets and their moons; and study the composition of asteroids and Kuiper belt objects.
-
- But we know from other missions that there are many more planets out there.
-
- Webb will also study other planets in our Milky Way galaxy, extending the scientific discoveries of other NASA missions.
-
- If you're interested in planets inside and outside our solar system, follow Webb closely. We're going to learn a lot.

- ___________________________
-
- Resources:
-
- Article, “How Will Webb Study our Solar System?”: https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-will-webb-study-our-solar-system
-
- Article, “How Will Webb Study Exoplanets?”: https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-will-webb-study-exoplanets
-
- Article, “Other Worlds”: https://webbtelescope.org/webb-science/other-worlds
-
- Video, “Reading the Rainbow: Planets” https://webbtelescope.org/contents/media/videos/01F9KWWJVJC8PZBNGGED35HSQT
-
- Image Credit: International Gemini Observatory/NOIRLab/NSF/AURA, M.H. Wong (UC Berkeley) et al.; M. Zamani
- https://noirlab.edu/public/images/noirlab2116a/

- Many observatories already study distant planets. What will Webb do differently?
- Warm planets glow brightly in infrared light, while their host stars usually don't shine as brightly in those wavelengths. Their innate contrast means infrared light is the ideal wavelength range to observe planets.
- From its position in space—and with its huge mirrors—Webb will be able to capture longer infrared wavelengths of light in high resolution for the first time. Webb's unique abilities to take very sharp and very fast images also allow it to spot smaller planets than other telescopes.
- The image shown above are direct observations of a distant solar system known as HR 8799.
- Most of the light of the star at the center is blocked by an instrument known as a coronagraph, making it possible to detect four planets. (A white pinpoint notes where the star is.)
- With multiple observations, it is clear that this is a solar system viewed from above.

- (The ground-based Keck telescope in Hawaii detected heat radiated from the planets in the form of infrared light. The brightness of planets in infrared light provides clues about their mass.)
- With its position in space, Webb can add to what we know about systems like this by providing considerably more detail with the same technique.
- ______________________________
- Resources:
- Article, “How Will Webb Study Exoplanets?”: https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-will-webb-study-exoplanets
- ViewSpace interactive, “Detecting Other Worlds**:** Direct Imaging”: https://viewspace.org/interactives/unveiling_invisible_universe/detecting_other_worlds/direct_imaging
- Eclipse/coronagraph animation: https://webbtelescope.org/contents/media/videos/2019/29/1210-Video
- Image Credit: Jason Wang (Caltech)/Christian Marois (NRC Herzberg).
- Image details: Motion interpolation of seven images of the HR 8799 system taken from the W. M. Keck Observatory over seven years, featuring four exoplanets.
- Source: https://jasonwang.space/orbits.html



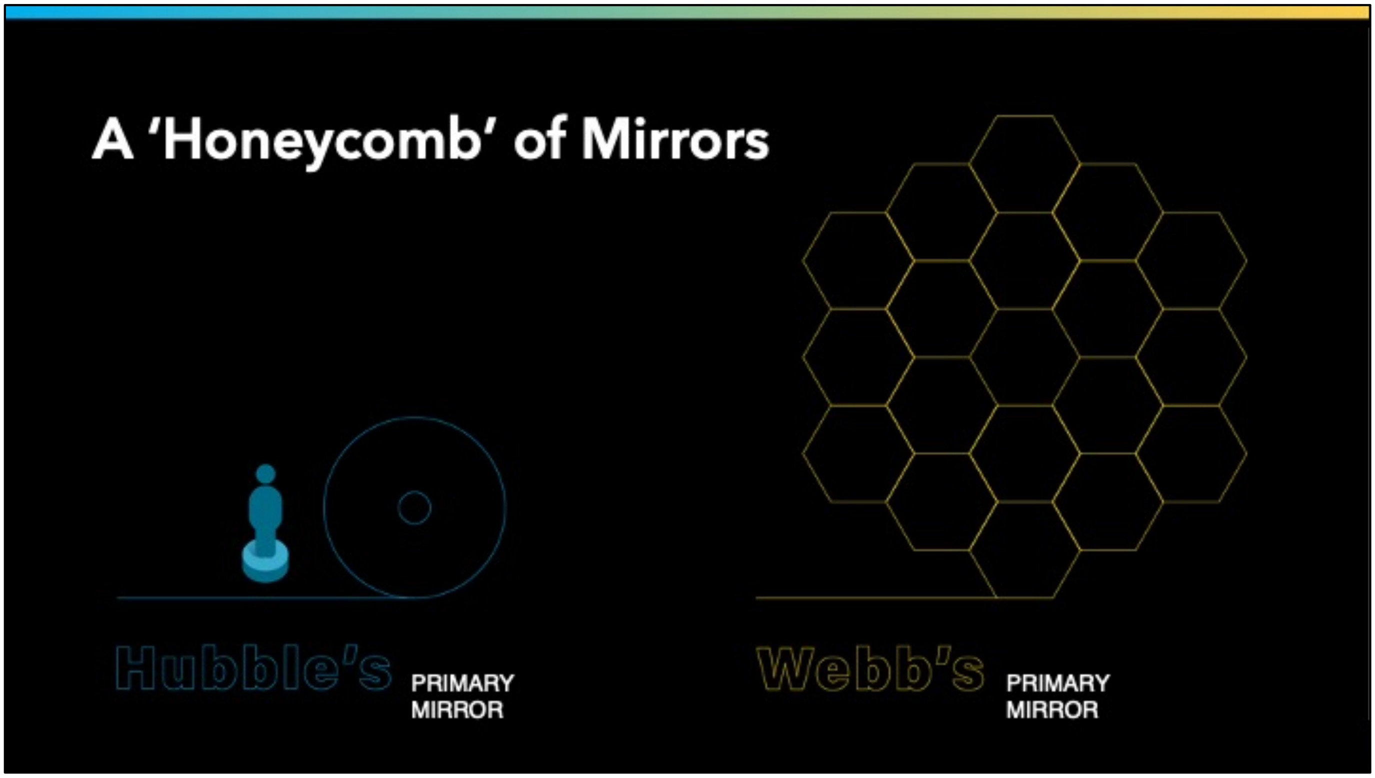
- This is a transmission spectrum of Earth's atmosphere. Before I go too far—I want to state that Webb will not observe the Earth. This is an example to show the data—known as spectra—Webb will produce when studying distant planets.
-
- This transmission spectrum shows wavelengths of sunlight that molecules like oxygen, water, carbon dioxide, and methane absorb.
-
- Measuring a planet's atmosphere from hundreds or thousands of light-years away is not as daunting as it may sound, though it certainly requires specialized instruments and rigorous techniques. One method Webb will use is known as transmission spectroscopy.
-
- Webb will observe the star's spectrum and then the exoplanet as it passes in front of the star. Scientists will subtract the star's light in the spectrum to see which molecules the planet's atmosphere absorbed—which appear as dips in the spectrum.
-
- Webb's data will also be transformed into models or "maps" of exoplanets to provide more information about exoplanets at each stage of their orbit.

-
- By using both imaging and spectroscopy, Webb will return incredible detail about planets we haven't been able to detect with other telescopes.
-
- Spectroscopy helps researchers identify the colors, temperatures, motions, and masses of celestial objects—helping us learn a lot more about these distant worlds.
- ___________________________
-
- Resources:
-
- Article, "How Will Webb Study Exoplanets?": https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-will-webb-study-exoplanets
-
- Video, "How Do We Learn About a Planet's Atmosphere?":
- https://webbtelescope.org/contents/media/videos/2018/30/1158-Video
-
- Video, "Reading the Rainbow: Planets":
- https://webbtelescope.org/contents/media/videos/01F9KWWJVJC8PZBNGGED35HSQT
-
- Viewspace interactive about atmospheres: https://viewspace.org/interactives/unveiling_invisible_universe/exoplanet_diversity/atmospheres
-
- Image Credit: NASA, ESA, Leah Hustak (STScI); model transmission spectrum data courtesy of Tyler Robinson
- https://webbtelescope.org/contents/media/images/01F8GF9XGA29AD3QWNPNKMPD1W

- Where will Webb orbit? Why does it have a hot and a cold side? Why is it an ambitious piece of engineering?
-
- Let's explore these questions—and more—including what we'll learn from Webb's images and data.
-
- Illustration Credit: NASA, ESA, Northrop Grumman
- https://webbtelescope.org/contents/media/images/2017/28/4051-Image

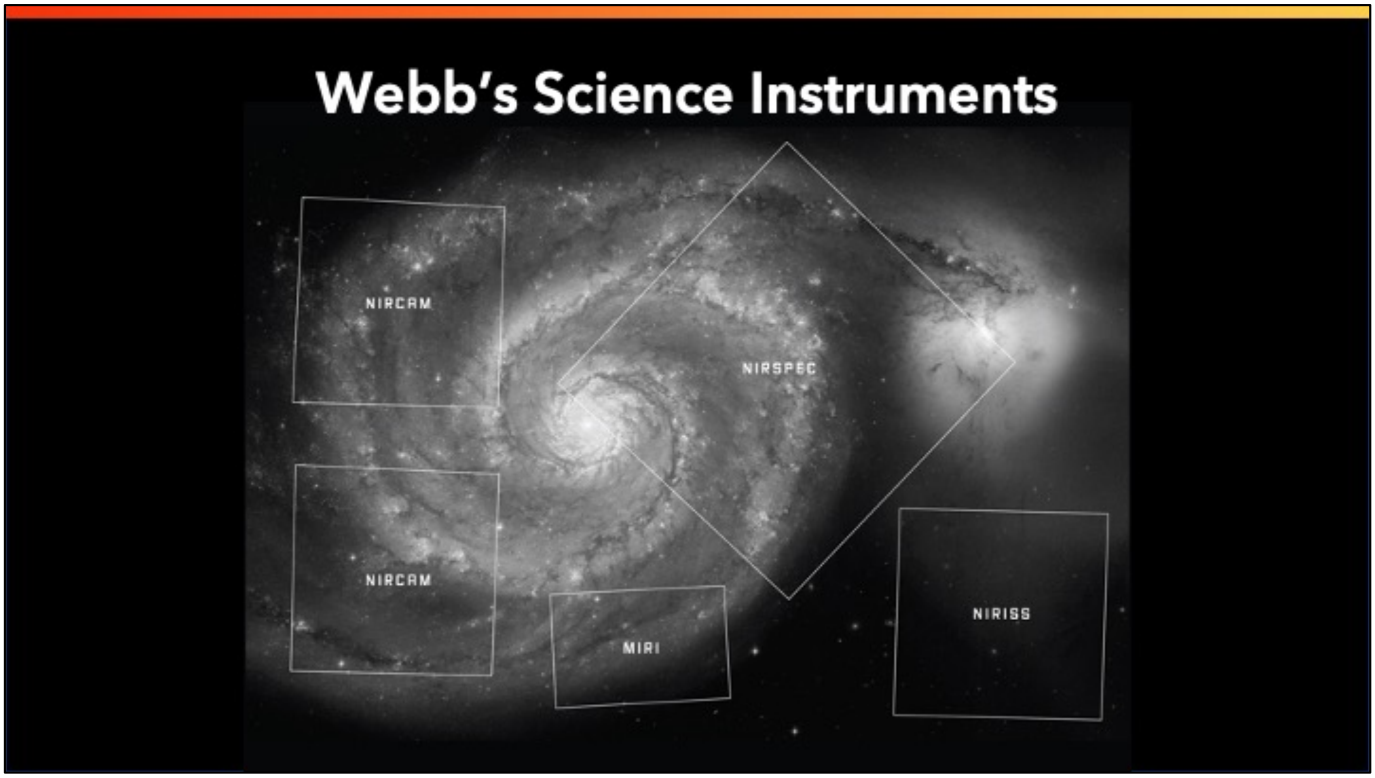
- Several innovative and powerful new technologies make Webb's ambitious science goals possible. Examples include specialized optics to align the mirrors, detectors that can capture and separate light from hundreds of sources at once, and thermal control systems. These technologies make Webb the most sophisticated and complex space science telescope ever created.
-
- Webb is a collection of movable parts that have been designed to fold into a compact formation that is considerably smaller than when the observatory is when fully deployed. This allows it to just barely fit in a 5-meter (16-foot) rocket payload fairing.
-
- Since Webb's mirror needs to fold to fit, engineers ensured its 18 mirror segments can also be adjusted to form a single, perfect focus. Each mirror segment has an actuator, or tiny mechanical motor attached to the back, allowing operators to move each.
-
- <u>Webb's tennis-court-sized sunshield is deployed by 139 tiny mechanical motors called actuators, eight motors, and thousands of other components, which unfold and stretch the five membranes of the sunshield into its final taut shape.</u>

-
- Let’s look closer at its mirrors.
-
- Image Credits: Image credit: NASA/Chris Gunn
-
- Resources:
-
- Animation: –“Folding the Webb Telescope to Fit Inside Ariane 5 Rocket Fairing”: https://svs.gsfc.nasa.gov/13551
-
- Video showing the final folding of the telescope before launch: https://svs.gsfc.nasa.gov/13923
-
- Article about Webb innovations: https://www.jwst.nasa.gov/content/about/innovations/index.html
-
- Webb Science Writer’s Guide Instrument Overview: https://webbtelescope.org/news/webb-science-writers-guide/telescope-overview
-



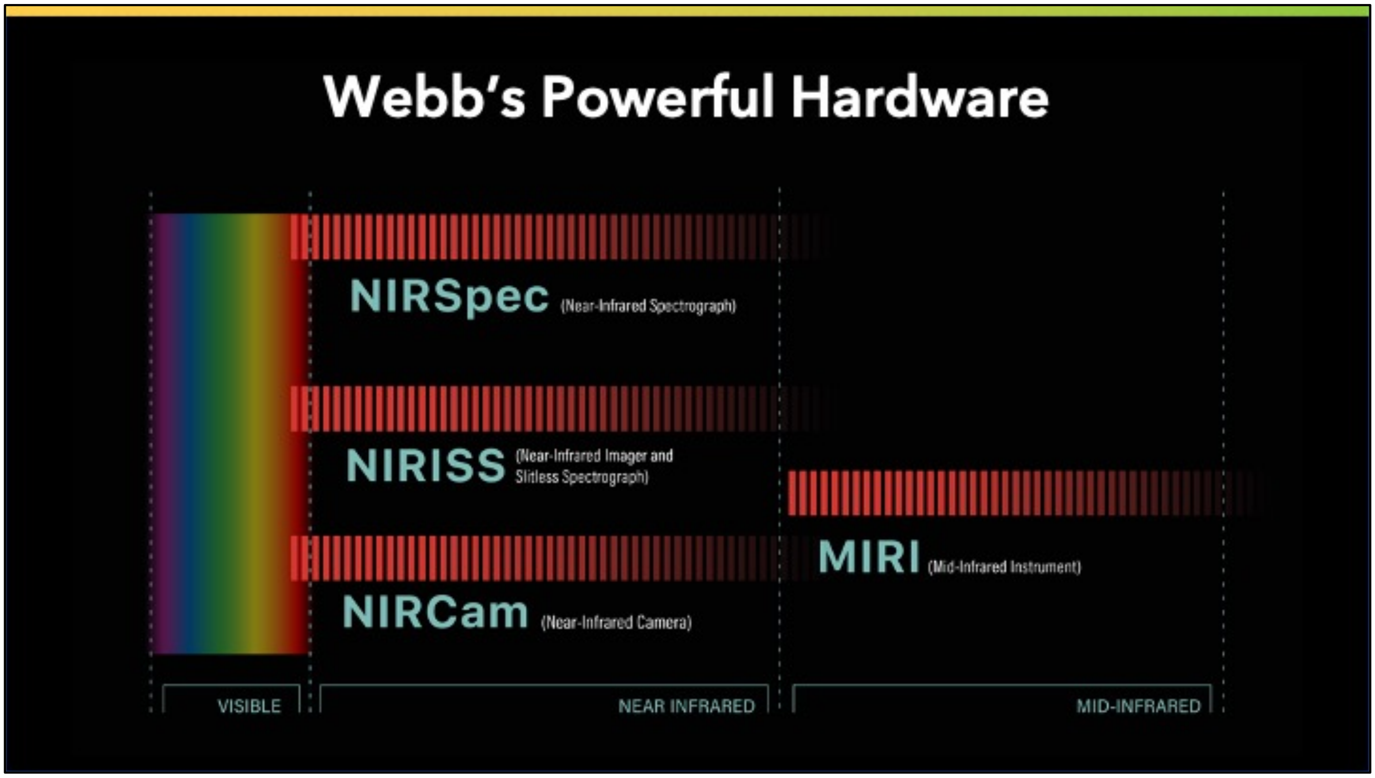
- Webb has a 6.6-meter (21.7 foot-) diameter primary mirror. It's quite large—and that's for several reasons.
-
- For context, Hubble's mirror is much smaller, at 2.4 meters (7.8 feet) in diameter.
-
- Webb has to have a bigger mirror to capture high-resolution, Hubble-like details in infrared light.
-
- Its mirror also needs to be stable at very cold temperatures—40 K (roughly -390°F, -235°C), which is why it is made of Beryllium, which is six times stronger than steel and two thirds the density of aluminum.
-
- There are 18 hexagonal segments. They are hexagons so the mirrors can be adjusted to align without gaps and form a circular shape.
-
- Each segment is coated in a very thin layer of gold—about 1,000 atoms thick! Gold was selected because it is the best reflector of infrared light.
- ______________________________
-
- Resources:

-
- Webb’s mirrors: https://webbtelescope.org/news/webb-science-writers-guide/telescope-overview
-
- Hubble’s mirrors: https://hubblesite.org/mission-and-telescope/the-telescope
-
- Additional graphic of Webb’s mirror size and material: https://webbtelescope.org/contents/media/images/4199-Image
-
- Article about aligning Webb’s mirrors: https://www.nasa.gov/feature/goddard/2017/aligning-the-primary-mirror-segments-of-nasa-s-james-webb-space-telescope-with-light
-
- Video comparing Webb and Hubble’s mirrors: https://svs.gsfc.nasa.gov/13521
-
- Video of the alignment of Webb’s primary mirror segments: https://svs.gsfc.nasa.gov/12895
-
- Similar illustration: https://webbtelescope.org/contents/media/images/4181-Image
-
- Illustration Credit: NASA, ESA, and J. Kang (STScI)



- How will Webb conduct its science operations?
-
- Let's start with a bit of context: The Whirlpool Galaxy, seen here in the background, is about 87,000 light-years across and 31 million light-years away. You can think about it another way: It is about a third of the size of the Moon as you see it from Earth.
-
- Each of Webb's four instruments is like a Swiss army knife of more specialized components, with multiple ways of observing.
-
- Although some instruments are more suitable than others for observing specific types of targets, all four can be used for investigations of the wide variety of objects that make up the universe, including planets, stars, nebulas, and galaxies.
- ______________________________
-
- Resources:
-
- Overview of instruments: https://webbtelescope.org/news/webb-science-writers-guide/webbs-scientific-instruments
-

- Individual instrument infographics:
- NIRCam: https://webbtelescope.org/contents/media/images/01FA0SZSEW1TZ51BHG0EGW2EZP
- NIRSpec: https://webbtelescope.org/contents/media/images/01FA0T08S2V810Y7ENZMGWTVDA
- NIRISS: https://webbtelescope.org/contents/media/images/01FA0T0WM3X65FFXM0JBR4C5ZB
- MIRI: https://webbtelescope.org/contents/media/images/01FA0SZA5HPXKRKH8Y6PKB10V1
-
- Microshutter infographic
- https://webbtelescope.org/contents/media/images/4673-Image
-
- Image Credit: NASA, ESA, Andi James (STScI)



- Webb's four science instruments are sensitive to a range infrared light.
-
- The Near-Infrared Spectrograph, or NIRSpec, is one of Webb's versatile tools for near-infrared spectroscopy, which spreads out light into its component wavelengths like a rainbow. This instrument has the first multi-object spectrograph in space, known as a microshutter array. It can capture individual spectra of dozens of objects at once, making it ideal for efficiently studding many distant, faint galaxies.
-
- Next up is the Near-Infrared Imager and Slitless Spectrograph (NIRISS). It will also gather spectra—and photograph the universe at near-infrared wavelengths. It can study the composition of exoplanets' atmospheres, observe distant galaxies, and examine bright objects that are very close together.
-
- The Near-Infrared Camera, or NIRCam, is Webb's primary imager or camera. It delivers high-resolution imaging and spectroscopy for a wide variety of investigations. It will detect light from the earliest stars and galaxies in the process of formation, stars in nearby galaxies, young stars in the Milky Way, and objects from a distant region of our solar system called the Kuiper Belt. It also can track the motion of exoplanets

as they orbit their star.

-
- The Mid-Infrared Instrument, or MIRI, is another powerhouse. It can take images and gather spectra—and it covers longer and redder infrared wavelengths of light. As the only mid-infrared instrument, astronomers rely on MIRI to study cooler objects like debris disks around stars, which emit most of their light in the mid-infrared, and extremely distant galaxies whose light has been shifted into the mid-infrared over time.
- ___________________________
-
- Resources:
-
- Webb's scientific instruments overview: https://webbtelescope.org/news/webb-science-writers-guide/webbs-scientific-instruments
-
- Eclipse/coronagraph animation: https://webbtelescope.org/contents/media/videos/2019/29/1210-Video
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- Illustration Credit: NASA, ESA, and J. Kang (STScI)
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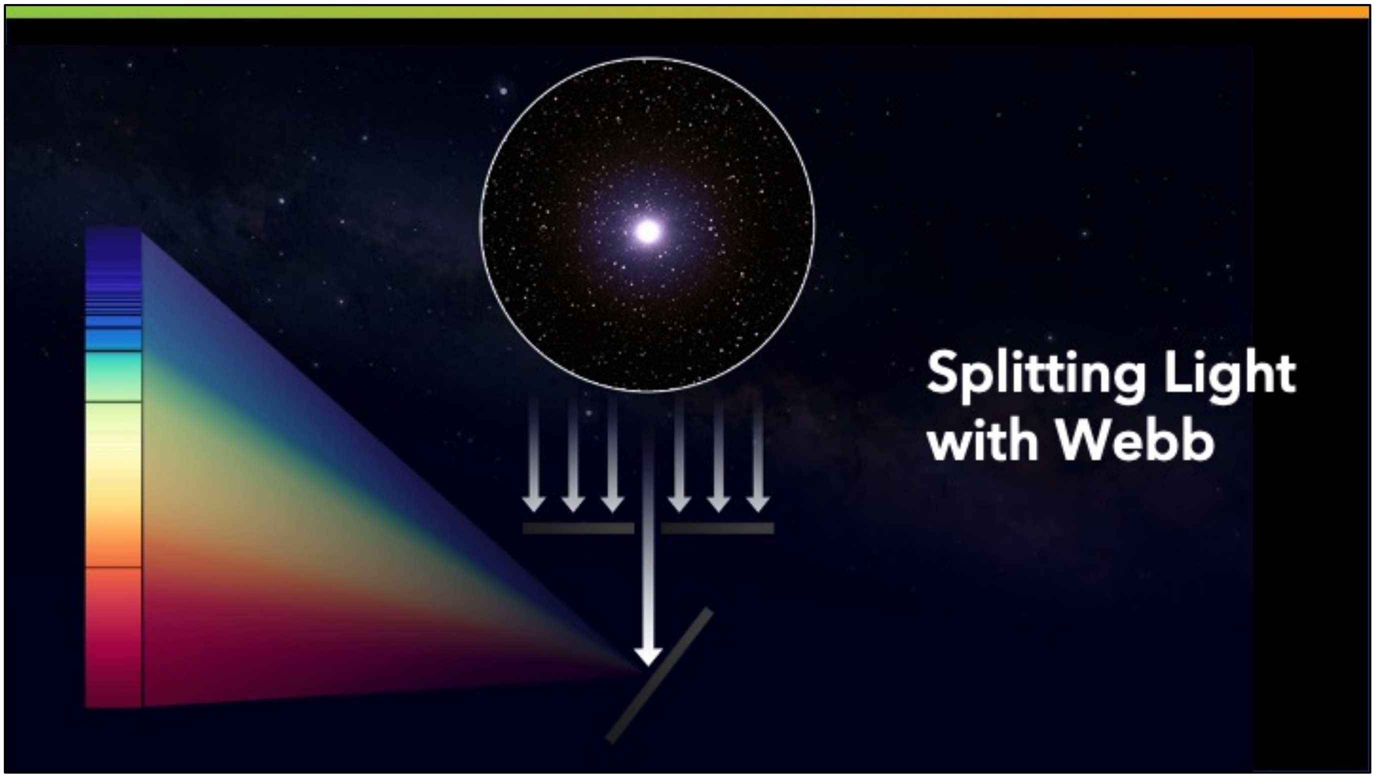
- Similar image: https://webbtelescope.org/contents/media/images/4207-Image



- <u>I've mentioned spectrographs and spectra several times. If you are not already familiar with them, it is probably because spectra typically appear as graphs and aren't quite as flashy as a telescope's images.</u>
-
- But spectra are in fact humbly hanging out behind the scenes of some of the most intriguing headlines in astronomy and they provide an incredible amount of information.
-
- Spectrographs are instruments that spread light out so that the brightness of individual wavelengths can be measured. The result is known as a spectrum. By looking at the resulting patterns in brightness, we can learn about the composition, surface temperature, density, and movement of objects in space like planets, stars, nebulas, and galaxies.
-
- Webb has different types of spectrographs, each designed for a slightly different purpose.
-
- Plus, Webb is the first telescope to have a multi-object spectrograph in space, which means we can get separate information about many objects, like individual stars, with one observation.
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- ______________________________
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- Resources:
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- Video, “How Do Space Telescopes Break Down Light?” https://webbtelescope.org/contents/media/videos/2018/37/1181-Video
-
- Webb’s scientific instruments overview: https://webbtelescope.org/news/webb-science-writers-guide/webbs-scientific-instruments
-
- Six-part series about spectroscopy: https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/spectroscopy-101--introduction
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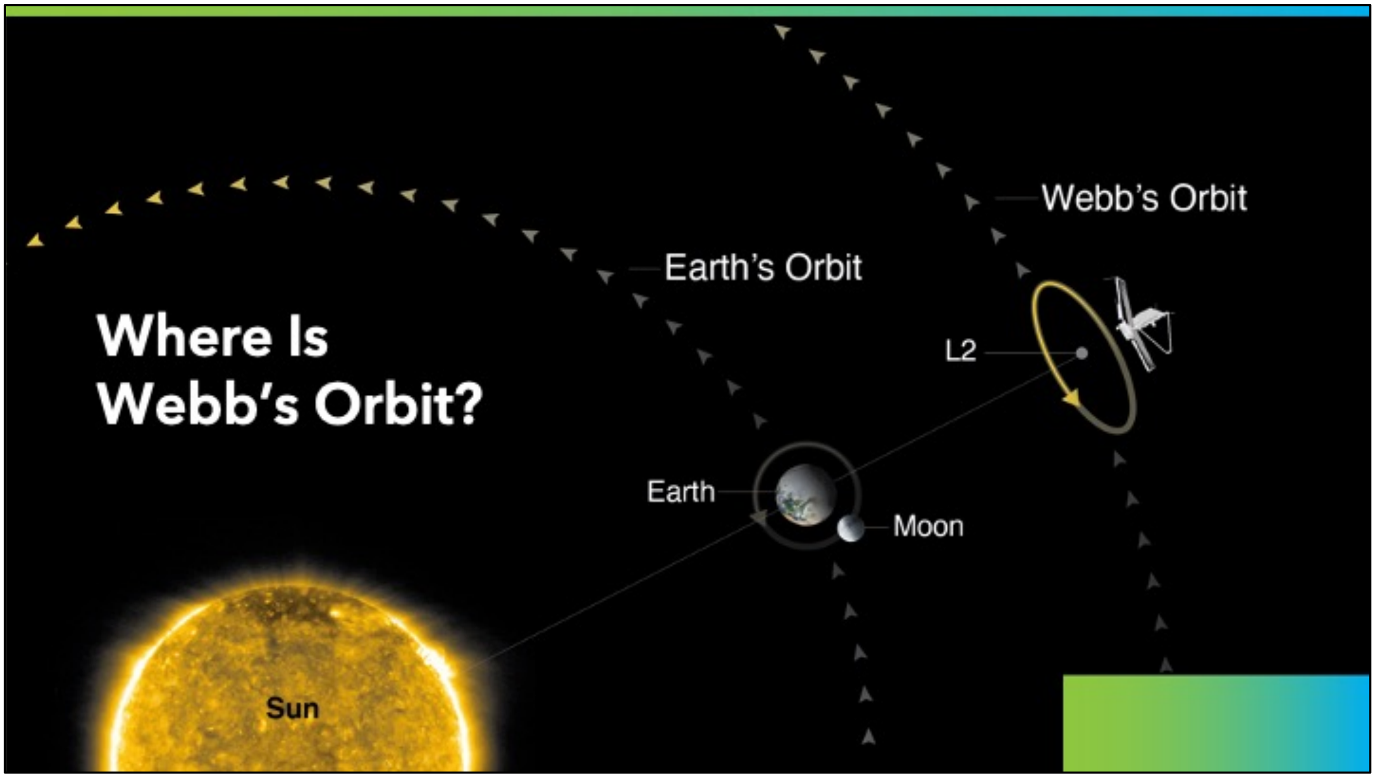
- Illustration Credit: NASA, ESA, Andi James (STScI)
- https://webbtelescope.org/contents/media/images/01FA0SYF73JT3N8DW5H664GD6P



- Webb orbits the Sun near the second Sun-Earth Lagrange point—often referred to as L2—a point where the gravity from the Sun and Earth balance. This point is approximately 1.5 million kilometers (930,000 miles) from Earth on the far side of Earth from the Sun.
-
- Webb can't orbit the Earth like Hubble, because the visible and infrared light from the Sun, Earth, and Moon would heat up the telescope's mirror and scientific instruments, causing the telescope itself to glow in infrared light that would outshine the faint objects in space.
-
- Webb will not be located precisely at L2, but will move in a halo orbit around L2 as it orbits the Sun.
-
- At L2, Webb can maintain a safe distance from the bright light of the Sun, Earth, and Moon, while also maintaining its position relative to Earth.
-
- [Notes to presenter: If you're asked what Webb's lifetime is and why, here's an explanation:
- Webb will contain enough fuel for 10 years of maneuvers at L2, and the Webb Science and Operations Center at the Institute will have the

ability to adjust the science operations of the observatory to maximize potential as it ages.

-
- To ensure the required five-year mission, NASA has engineered Webb so that all critical subsystems are dual or will degrade gracefully with age. For instance, the Near Infrared Camera has two identical camera systems so that the optical quality can be maintained even if one fails.
-
- If you're asked about whether we can service Webb, here's a response:
-
- The quick answer is no. To meet Webb's science goals, the telescope has to be far away from the heat of the Earth. This is why the telescope had to be so thoroughly tested before launch. This isn't the first mission that is unserviceable. Other space telescopes, such as Spitzer and Herschel, have successfully completed their missions in unserviceable orbits.]
- ___________________________
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- Resources:
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- Webb Science Writers' Guide: https://webbtelescope.org/news/webb-science-writers-guide/telescope-overview
-
- Article about Webb's orbit: https://webb.nasa.gov/content/about/orbit.html
-
- Webb's Orbit illustration: https://webbtelescope.org/contents/media/images/4201-Image
-
- Video of Webb's orbit:
- https://webbtelescope.org/contents/media/videos/01F51C6VAPFHS6ZK5R29G2NDVG
-
- Answers to frequently asked questions: https://www.jwst.nasa.gov/content/about/faqs/faq.html
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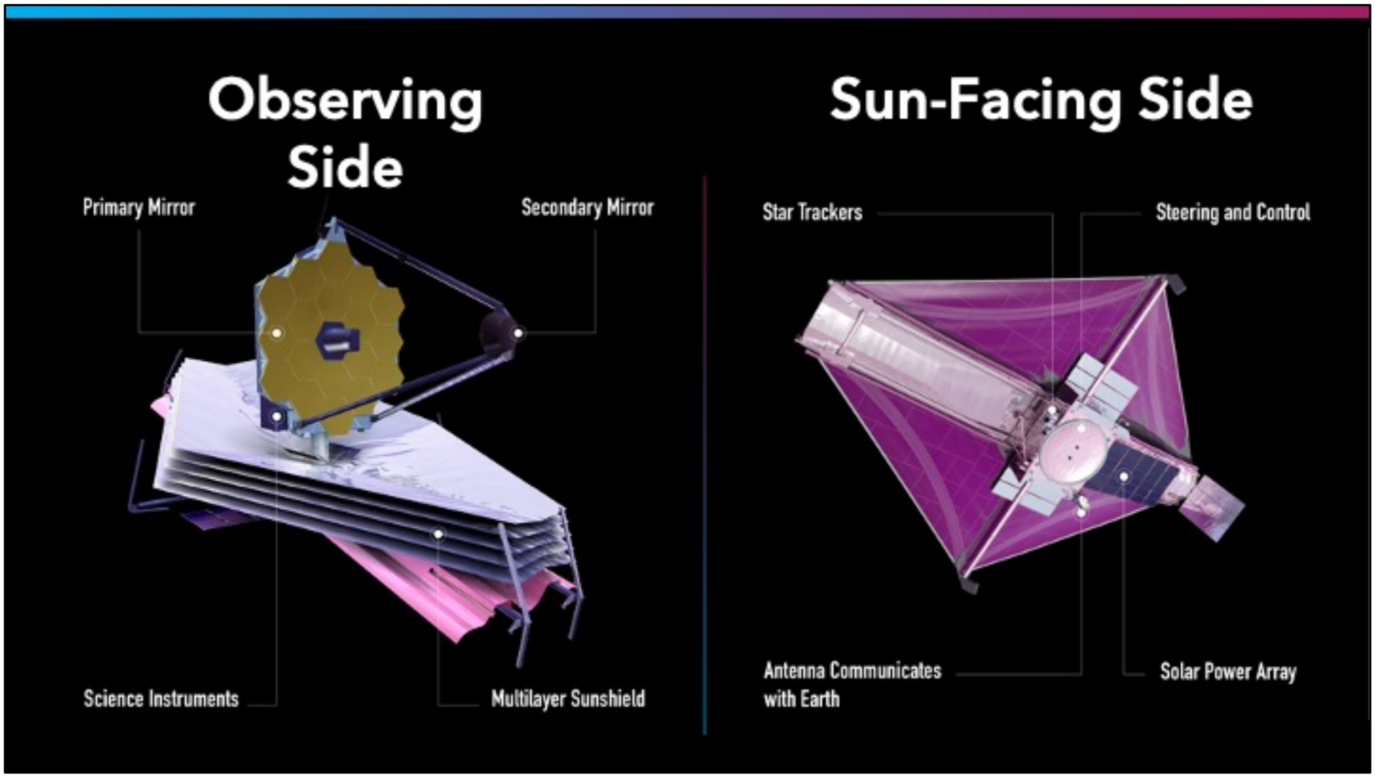
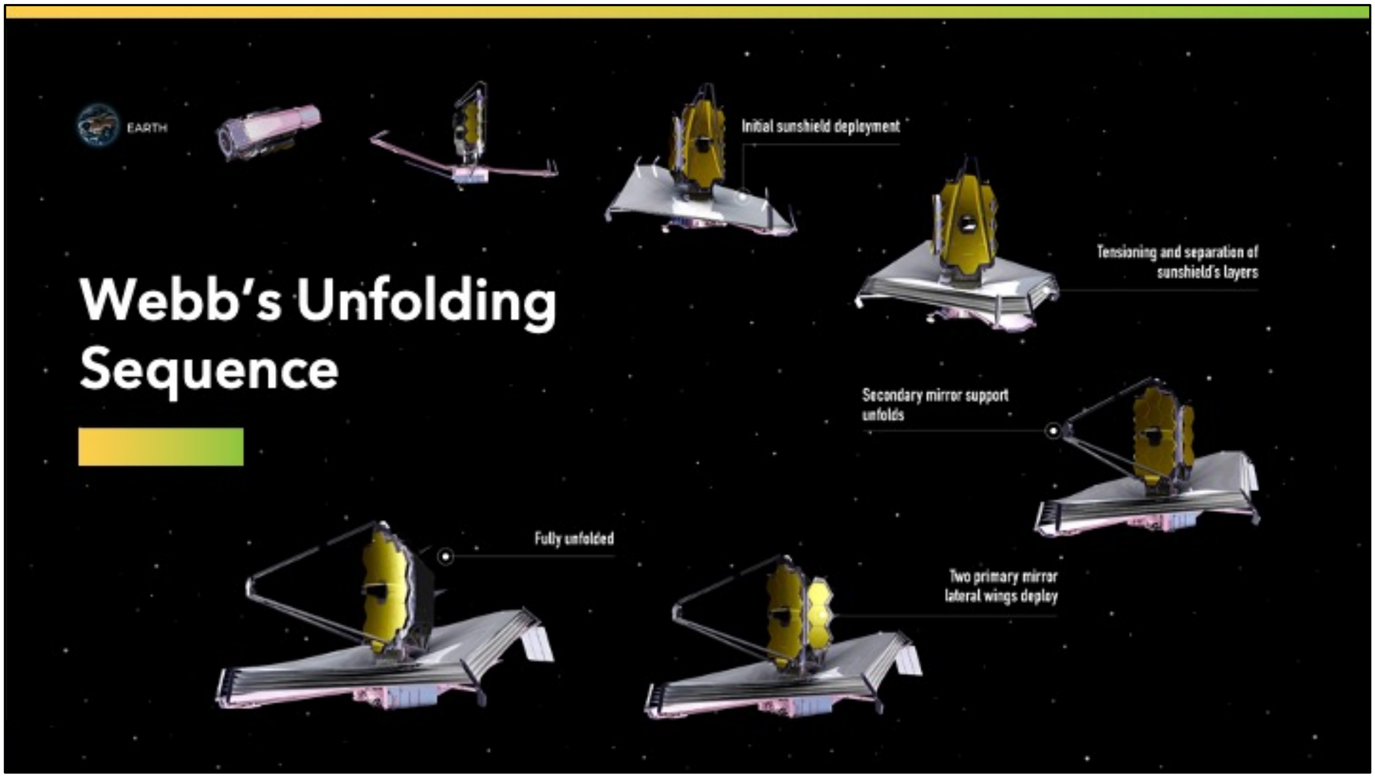
- Image Credit: STScI
- https://webbtelescope.org/contents/media/images/4201-Image



- The lower part of Webb, where it’s five-layered sunshield is, faces the Sun. This is where its ambient-temperature equipment, like its solar panel, antennae, computer, gyroscopes, and navigational jets are.
-
- Its tennis court-sized sunshield protects Webb from external sources of light and heat, which ensures it can detect faint heat signals from very distant objects. It’s very important for its observing side to be very, very cold.
-
- Webb’s science instruments are housed behind the mirror, separated from the warm communications and control technology by the sunshield.
-
- Webb needs both passive and active cooling.
-
- Its five-layered sunshield provides passive cooling. The first layer of the sunshield is two-thousandths of an inch (0.005 centimeters) thick, while the other four layers are only one-thousandth of an inch thick.
-
- In-depth:
-

- Sun-facing layer estimated maximum temperature: ~400 K (260°F, 125°C)
- Innermost layer estimated minimum temperature: ~40 K (-390°F, -235°C)
- Keeps science instruments and mirrors at a cool 40 K (roughly -390°F, -235°C)]
-
- There is also a cryocooler, essentially a sophisticated refrigerator or air conditioner, to support one of its instruments (MIRI). This is the active cooling element.
-
- Maintaining these temperatures ensures that Webb can gather a greater range of infrared light in space.
-
- Without cooling, the only thing that Webb would see would be itself! Since warm things glow in infrared light, Webb has to be cold or else its self-emission would produce enough background light that it would overwhelm faint sources. The colder Webb is, the fainter things it can see (up to a point, where other background sources become more important). Webb's glow is still the greatest background source at mid-infrared wavelengths.
- ______________________________
-
- Resources:
-
- Webb Science Writers' Guide: https://webbtelescope.org/news/webb-science-writers-guide/telescope-overview
-
- Webb's Observing Side and Sun-facing Side: https://webbtelescope.org/contents/media/images/4197-Image
-
- Technical details: https://jwst-docs.stsci.edu/jwst-observatory-functionality/jwst-background-model
-
- Image Credits: NASA, ESA, and J. Kang (STScI)



- In 2021, Webb was carefully folded up and loaded onto a ship, which passed through the Panama Canal on its way to French Guiana in South America, where it reached its launch site at the European Spaceport located near Kourou. It is beneficial for launch sites to be located near the equator: The spin of the Earth can help give an additional push to the rocket.
-
- After launch and during the first month in space, on its way to the second Langrange point (L2), Webb will undergo a complex unfolding sequence.
-
- Steps include:
-
- Deploying, tensioning, and separating Webb's sunshield, a five-layer, diamond-shaped structure the size of a tennis court,
-
- Extending its secondary mirror support structure, and
-
- Unfolding its primary mirror, which has a honeycomb-like pattern of 18 hexagonal, gold-coated mirror segments.
-

- Deployment and commissioning will take time at least six months. Engineers and scientists will carefully activate and confirm each and every instrument is working properly before the first—but still unfocused—image of a star field is delivered about two months after it launches.
-
- In the third month after launch, Webb will complete it's first orbit around L2—and take the first focused, science-quality images.
-
- After the six-month mark, Webb will begin its science mission and start to conduct routine science operations.
- ______________________________
-
- Resources:
-
- Detailed post-launch deployment timeline: https://webbtelescope.org/contents/media/images/4180-Image
-
- Webb's orbit and view of the sky: https://webbtelescope.org/news/webb-science-writers-guide/telescope-overview
-
- Graphic showing Webb's unfolding sequence: https://www.esa.int/ESA_Multimedia/Images/2021/06/Webb_unfolding_sequence
-
- Video of Webb's deployment sequence: https://www.youtube.com/watch?v=vpVz3UrSsE4
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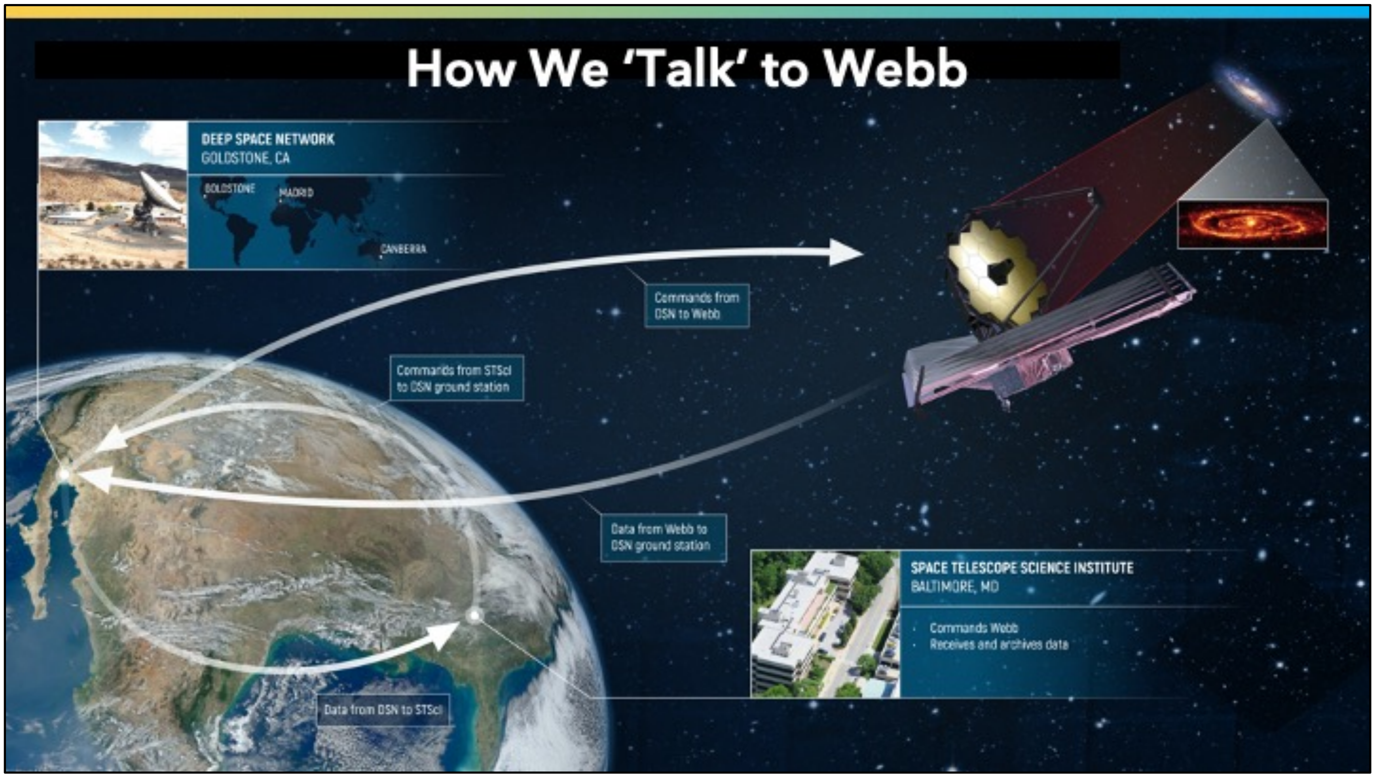
- Illustration Credit: NASA, ESA, and J. Kang (STScI)



- Every great relationship is based on excellent communication, right?
-
- The Space Telescope Science Institute (STScI) in Baltimore, Maryland, plays a key role in communicating with Webb—it hosts Webb's mission operations center, where engineers and scientists command and control the telescope.
-
- Commands from STScI travel to the Deep Space Network (DSN), which transmits them to Webb.
-
- Webb's data then returns through the DSN to STScI, where the data Webb took are then processed, distributed to the scientific community, and archived.
- ______________________________
-
- Resources:
-
- Details about how STScI will communicate with Webb (replace "testing" references with actual commands if you add these details to your presentation notes): https://www.stsci.edu/contents/annual-reports/2019/rehearsing-for-launch

-
- Image Credit: NASA, ESA, CSA, Elizabeth Wheatley (STScI) https://webbtelescope.org/contents/media/images/01F6850HZ2K7FY8P8A8KBC54FQ

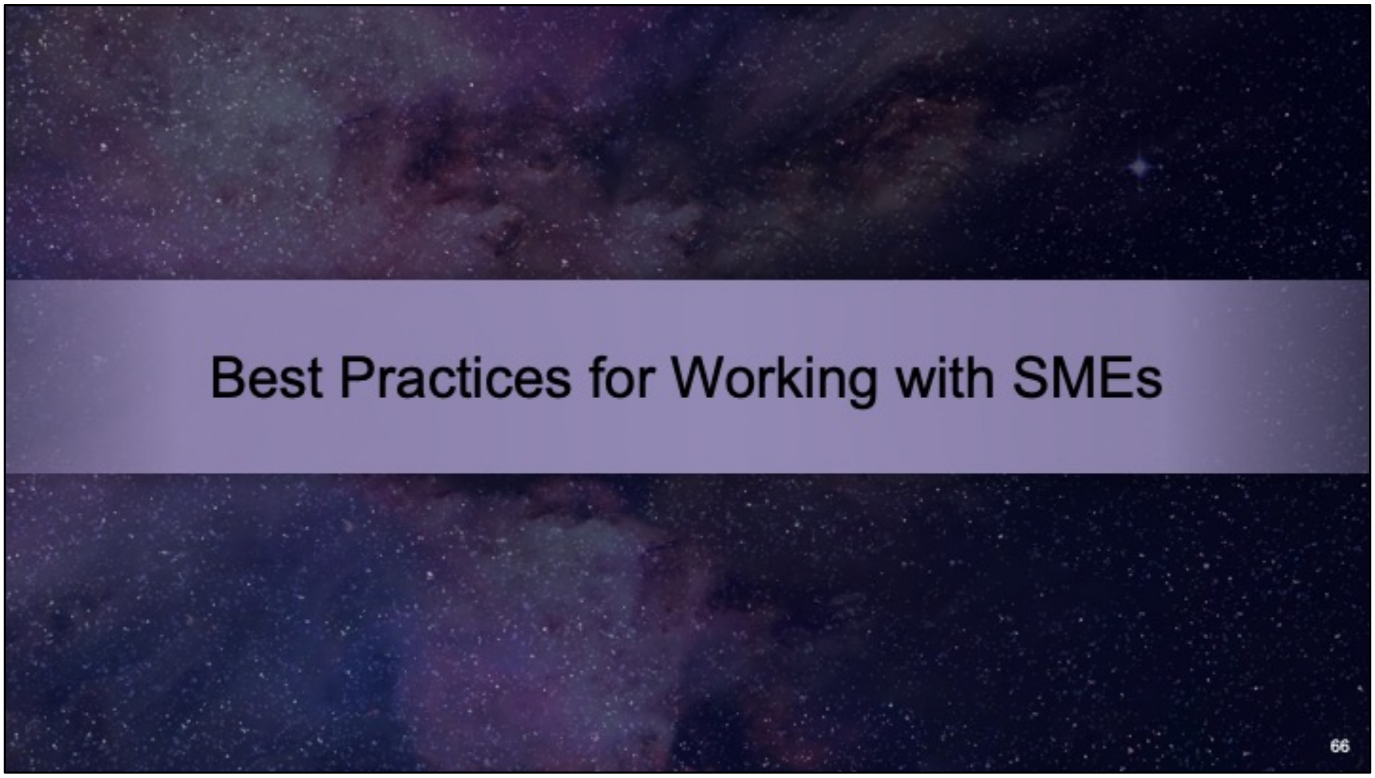
- Webb has been an international collaboration since the beginning. In addition to the United States, 13 countries are involved in building the Webb telescope: Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom.
-
- Additional member states in Europe also contribute to the European Space Agency (ESA).
-
- NASA is the lead partner on the project, working in conjunction with ESA and the Canadian Space Agency (CSA).
-
- The Space Telescope Science Institute (STScI) conducts the science and mission operations from its Baltimore, Maryland, headquarters.
-
- As the lead agency, NASA has overall responsibility for the Webb mission.
-
- More than 120 American, European, and Canadian universities, organizations, and companies in 14 different countries and over 29 U.S. States contribute to Webb.

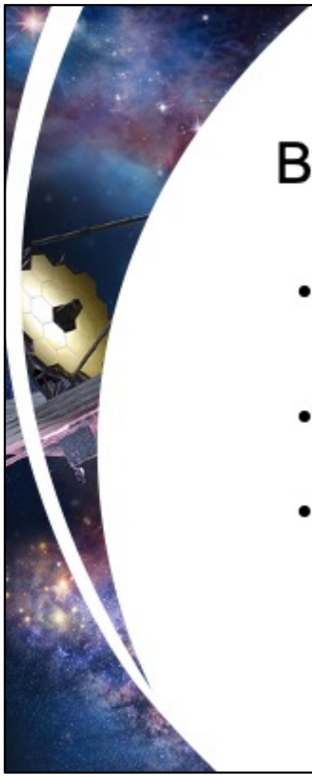
- ______________________________
-
- Resources:
-
- Details about the international partnership: https://webbtelescope.org/other-webb-sites
-
- Image Credit: NASA
- https://www.nasa.gov/mission_pages/webb/team/index.html

- Who's ready for Webb's images, data, and discoveries to start rolling in?
-
- About six months after it launches, Webb will begin its science mission and start to conduct routine science operations—and the news releases will start making exciting announcements.
- ______________________________
-
- Image Credits:
-
- Early Universe: GOODS-S/ERS2 Field
- Credit: NASA, ESA, Rogier Windhorst (ASU), S. Cohen (ASU), M. Mechtley (ASU), M. Rutkowski (ASU), Robert O'Connell (UVA), P. McCarthy (OCIW), N. Hathi (UC Riverside), R. Ryan (UC Davis), Haojing Yan (OSU), Anton M. Koekemoer (STScI)
- https://webbtelescope.org/contents/media/images/2021/004/01EX2AXKF1EKA0J7K1965PCNBC
-
- Galaxies over Time: Stephan's Quintet
- Credit: NASA, ESA, and the Hubble SM4 ERO Team
- https://hubblesite.org/contents/media/images/2009/25/2606-Image.html

-
- Star Lifecycle: Carina Nebula
- Credit: Hubble Image: NASA, ESA, N. Smith (University of California, Berkeley), and The Hubble Heritage Team (STScI/AURA); CTIO Image: N. Smith (University of California, Berkeley) and NOAO/AURA/NSF
- https://hubblesite.org/contents/media/images/2007/16/2099-Image.html
-
- Other Worlds: Illustration of a planet in a dusty debris disk
- Credit: NASA, ESA, and L. Calcada (ESO for STScI)
- https://webbtelescope.org/contents/media/images/4193-Image

- Resources:
-
- Overview of the telescope: https://webbtelescope.org/webb-science/the-observatory
-
- Image Credit: NASA


Best Practices for Working with SMEs
66



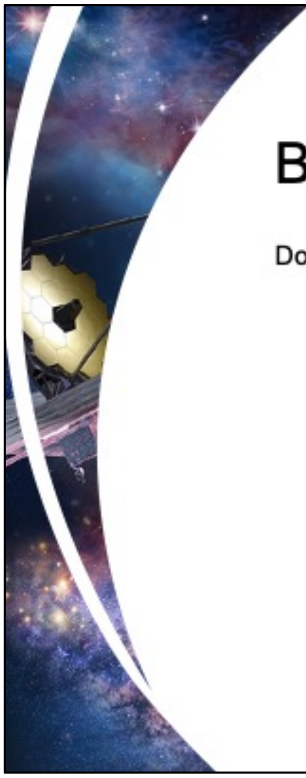
Building a Relationship

- Your SME is an expert in Webb science and/or engineering, you are an expert in your audience and venue
- Work together to design an event that is meaningful for your audience!
- Consider using your SME in future events and programming

Before Your Event

Map out a plan with your SME:

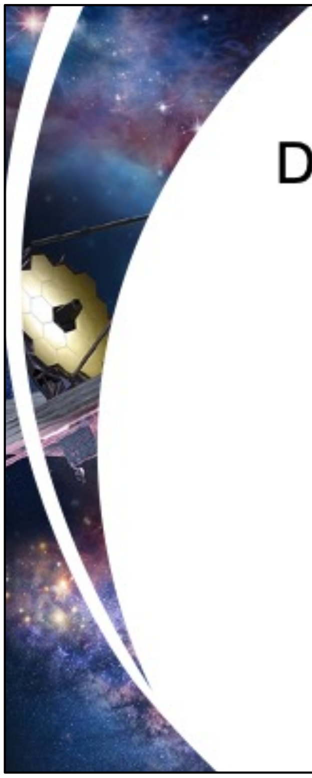
- Who is your audience? What are their needs?
  - Children/youth/adults
  - What communities do they belong to?
  - How much to they know about astronomy?
  - What do they want to know more about?
  - What, if anything, should the SME avoid?
- What would you like your SME to talk about? For how long?
  - Encourage the SME to share how they are personally excited about Webb and/or how will Webb impact their research.
- Will this be in-person or virtual? How will you accommodate a virtual SME at an in-person event?
- What is the plan for the rest of the event? What material will be covered?



Before Your Event

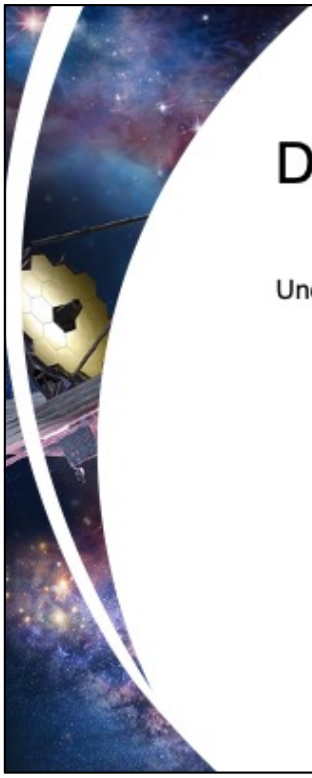
Do a sound check

- Test everything before your event: camera, mic, software, etc
  - Technical issues are harder to fix on the fly
  - Ask if they are comfortable recording or streaming the event (if applicable)
- If in person:
  - Make sure the speaker knows how to get to your venue and will arrive on time
  - Test the AV setup and backups
- If virtual:
  - Do a test run with the software you are using
  - Make sure everything works:
    - Screen share
    - Cameras and Mics
    - Internet connections



During the Event

- Establish a code of conduct that everyone agrees to abide by
- Have a person other than the speaker:
  - deal with technical issues
  - moderate the chat / Q&A
  - manage the participants.
- Save questions for the end, unless the speaker expresses another preference



During the Event

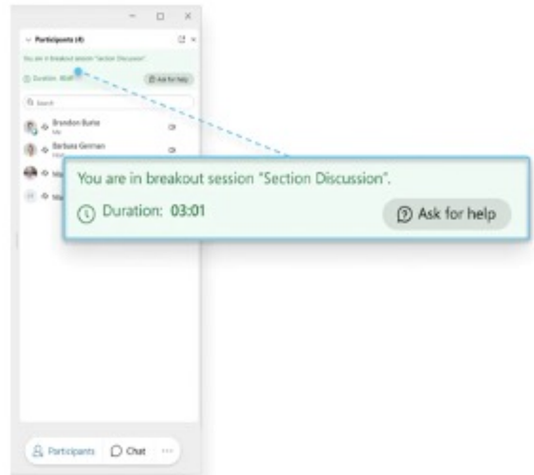
Unconstrained Q&As can be daunting (no one is an expert in everything!)

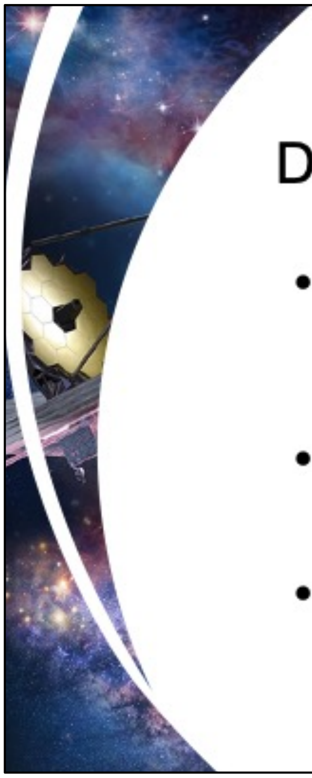
- Consider having at least some questions prepared in advance.
- Ask Me Anything sessions can work better if most/all questions are submitted in advance and shared with the SME.
- Have a plan to deal with disruptive question askers/people who will not leave the speaker alone.
- Try to ensure a wide range of people get to ask questions. Don't let one person dominate the conversation.
- Your first question asker sets the tone for the rest of the Q&A. Try to pick someone who is otherwise underrepresented in your audience.
  - A child in a mostly adult audience, a woman in a mostly male audience, a new person in an audience of mostly regulars, etc.

Breakout Session

What To Do

- We will break you into small groups
- A few of us will be available to answer questions
  - If you need help during your breakout, look for the "I need help" button →
- Your session will end on its own
- Each group should have a note-taker & timekeeper
  - Send summary to Yessi Perez (yperez@stsci.edu)





Discussion Prompts

- What plans have you made to adjust to the virtual environment? What does your safety plan look like and do you have a back-up plan to go virtual?
- How have you engaged other organization in your communities? How have you “met” someone new in the virtual environment?
- How are you coordinating with your SME virtually? How are you going to use your SME in a virtual environment?

https://stsci.box.com/s/ztkc0kqrof86u3jsgwy48c0wc8gbvtcp

Questions

Thank You!

Coming up: STEAM Day, Sept. 30

https://www.nasa.gov/press-release/nasa-announces-virtual-webb-steam-day-event-for-students-educators

Training Evaluation

https://grginc.co1.qualtrics.com/jfe/form/SV_07lZTFymtDU0Ydw

Please complete this by Sept. 28

Recording and slides at https://outerspace.stsci.edu/x/KoPMBQ