

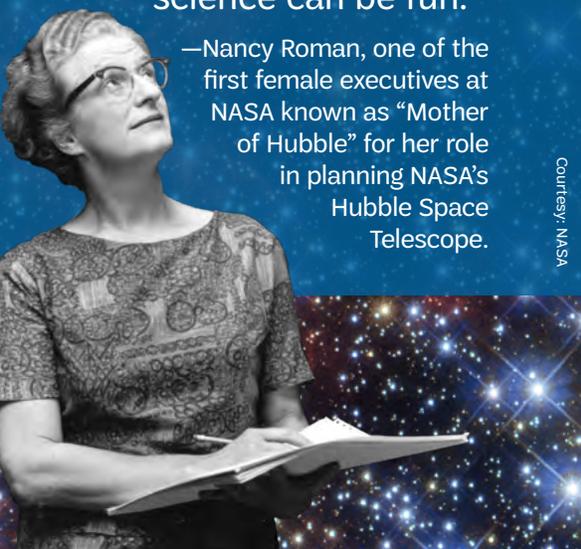


# Space Science Master

“One of the reasons I like working with schools is to try to convince [young] women that they can be scientists and that science can be fun.”

—Nancy Roman, one of the first female executives at NASA known as “Mother of Hubble” for her role in planning NASA’s Hubble Space Telescope.

Courtesy: NASA



Scientists and engineers who work on NASA space science projects are 21<sup>st</sup> century explorers. You can explore, observe, design, and communicate what you discover—just like they do. Since space science encompasses the entire Universe, there are lots of topics that might pique your interest. Dive in and explore NASA and space science!

## Steps

1. Discover worlds beyond Earth
2. Dive into NASA science
3. Explore your interests
4. Dig deeper
5. Share what you’ve learned

## Purpose

When I’ve earned this badge, I will understand more about space science and ways that I can be a part of NASA now and in the future.

Every step has three choices. Do ONE choice to complete each step. Inspired? Do more.

## STEP 1 Discover worlds beyond Earth

### Where are the small worlds?

Your mission is to step into the shoes of an astronomer as you seek out and locate 15 small worlds in our Solar System. Unlock all 15 small worlds by finding three in each “zone,” search for their hidden treasure, and discover significant scientific contributions from women in STEM fields. Keep in mind that some of these worlds move very slowly, and many haven’t been explored by orbiters or landers—so astronomers don’t yet know their shape or even what their surfaces look like!

#### Things to think about:

- What worlds have not been observed by orbiter or lander?
- How do those worlds look compared to worlds explored with orbiters or fly-by missions?
- What are the three zones small worlds are located within?
- What are the major differences between these three zones?

Get started by going to [www.girlscouts.org/SpaceScienceSmallWorlds](http://www.girlscouts.org/SpaceScienceSmallWorlds)

We live on planet Earth, an island of life in the Universe, but is there life beyond Earth? On Mars? Under the icy surfaces of Jupiter’s moon, Europa, or Saturn’s moon, Enceladus? Or on exoplanets orbiting distant stars? Today, using telescopes and spacecraft, scientists are seeking evidence of life elsewhere.

#### CHOICES—DO ONE:

- Design a habitat for an alien world.** Scientists and engineers are currently planning habitats for the Moon and Mars so that, in the near future, people can explore these worlds in person. The Moon and Mars are rocky like the Earth, but otherwise they are very different. What do you think it will take to live there? Work by yourself, or with friends, and make a list of essentials for life. Then gather recycled materials: paper tubes, straws, plastic food containers, egg cartons, or anything else you’d like, and build a prototype for a livable habitat on Mars or the Moon. Share your creation with other Girl Scouts and your family. Check out “All About Mars” [www.girlscouts.org/AllAboutMars](http://www.girlscouts.org/AllAboutMars), “The Moon” [www.girlscouts.org/AbouttheMoon](http://www.girlscouts.org/AbouttheMoon), “NASA’s Solar System Trek” [www.girlscouts.org/SpaceScienceMarsTrek](http://www.girlscouts.org/SpaceScienceMarsTrek) or Mars Community Builder AR from the App Store to learn more.

OR

- Make a postcard or a tourist brochure.** Sci-fi writers invent other worlds all the time, and now it’s your turn! Choose any Solar System body—from Mercury to Pluto, an asteroid, one of the hundreds of moons orbiting in our system, or one of the thousands of exoplanets orbiting distant stars. Why would it be an interesting place to visit? What would be some of the sights to see? Is it a great vacation spot? How far away is it from Earth? Here are some facts and figures to get started: Solar System: [www.girlscouts.org/Planets](http://www.girlscouts.org/Planets) Exoplanets: [www.girlscouts.org/Exoplanets](http://www.girlscouts.org/Exoplanets).

FASTEST SPEEDS

200 MPH



Sports Car

200 miles per hour  
(322 kilometers per hour)

375 MPH



Bullet Train

375 miles per hour  
(604 kilometers per hour)

### More to Explore

To help space tourists plan ahead, use the table to the right and figure out how long it would take to get to your world.

OR

□ **Explore new worlds.** NASA's robotic spacecraft have embarked on numerous missions, which have explored a variety of Solar System bodies—including moons, planets, asteroids, and comets. It's your turn to pick an object and design a mission to study it. Be sure to research the body that you want to explore in great detail—you don't want to end up with a failed mission! Learn more about planets and moons at: [www.girlscouts.org/Planets](http://www.girlscouts.org/Planets).

Learn more about NASA spacecraft at: [www.girlscouts.org/NASAMissions](http://www.girlscouts.org/NASAMissions).

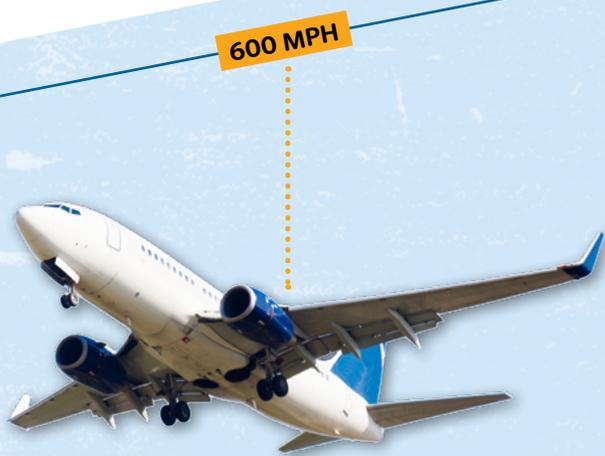
Things to think about:

- How do you wish to explore this object? Do you want to orbit it? Land on it? Explore it with a rover? Collect and return a sample from it?
- Did you see a specific part you want to explore?
- Is it safe to land there? (For example, it may be scientifically interesting, but you might not want to land in or near an active volcano.)
- Is there an atmosphere?
- Is there a surface to land upon?
- Is the surface icy or rocky?
- How strong is the gravity?



## Create a Notebook

Go retro! Carrying a notebook is a quick, low-tech way to make sure you're always ready to capture your ideas and discoveries. Successful scientists record everything—including their wildest ideas, the exact details of an experiment's setup, and all the things they've learned. Sometimes the results are surprising or even puzzling, which means that more experiments and observations may be needed!



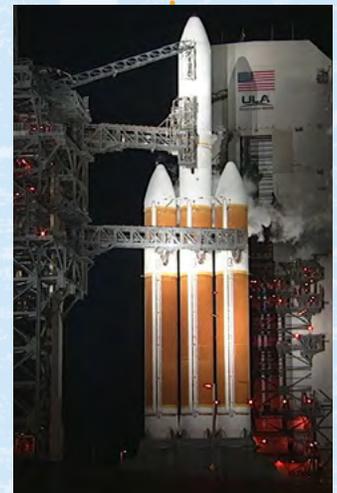
600 MPH

**Commercial Airplane**  
600 miles per hour  
(966 kilometers per hour)



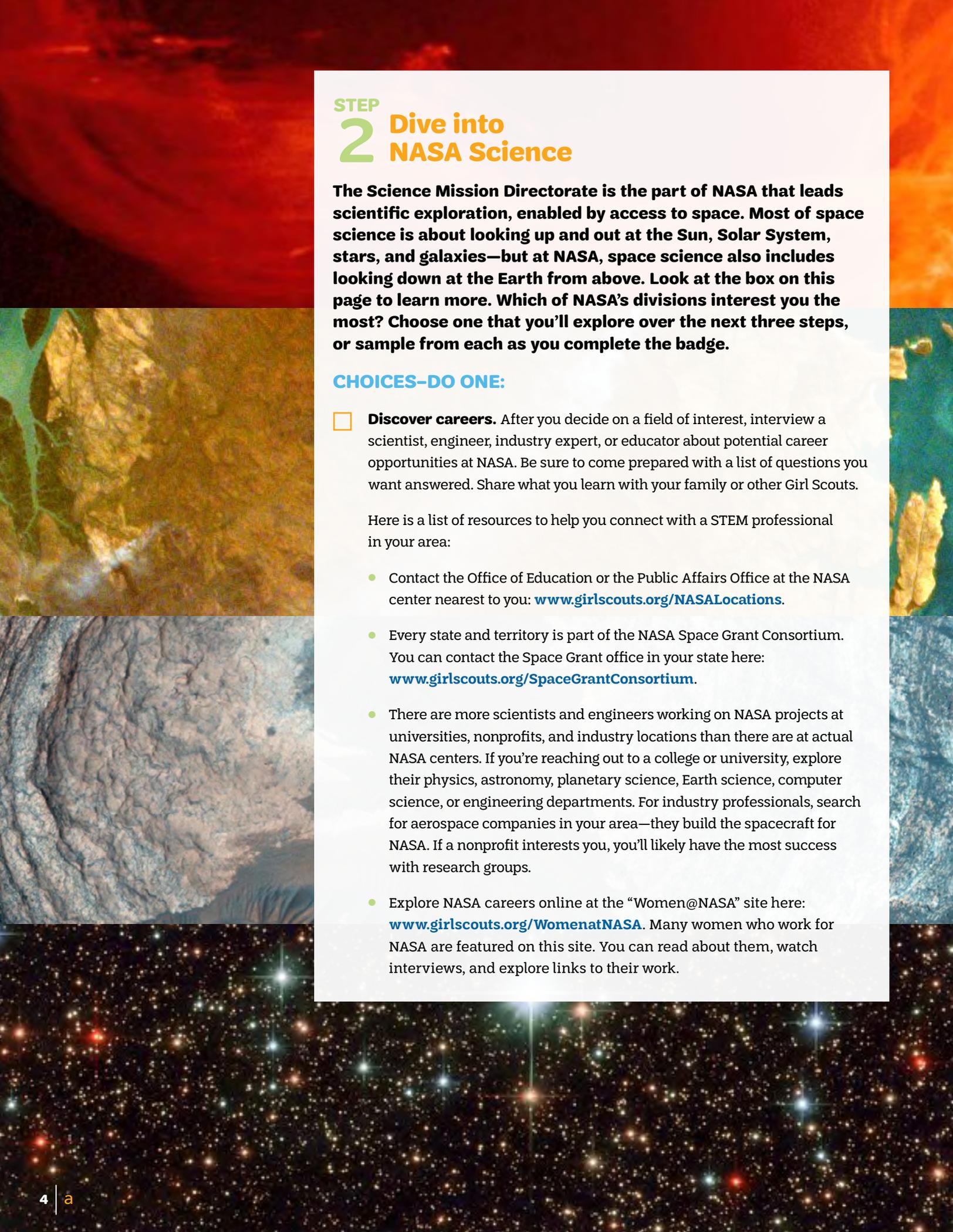
17,100 MPH

**International Space Station**  
17,100 miles per hour  
(27,250 kilometers per hour)



213,000 MPH

**Parker Space Probe**  
213,000 miles per hour  
(342,790 kilometers per hour)



## STEP 2 Dive into NASA Science

The Science Mission Directorate is the part of NASA that leads scientific exploration, enabled by access to space. Most of space science is about looking up and out at the Sun, Solar System, stars, and galaxies—but at NASA, space science also includes looking down at the Earth from above. Look at the box on this page to learn more. Which of NASA’s divisions interest you the most? Choose one that you’ll explore over the next three steps, or sample from each as you complete the badge.

### CHOICES—DO ONE:

- Discover careers.** After you decide on a field of interest, interview a scientist, engineer, industry expert, or educator about potential career opportunities at NASA. Be sure to come prepared with a list of questions you want answered. Share what you learn with your family or other Girl Scouts.

Here is a list of resources to help you connect with a STEM professional in your area:

- Contact the Office of Education or the Public Affairs Office at the NASA center nearest to you: [www.girlscouts.org/NASALocations](http://www.girlscouts.org/NASALocations).
- Every state and territory is part of the NASA Space Grant Consortium. You can contact the Space Grant office in your state here: [www.girlscouts.org/SpaceGrantConsortium](http://www.girlscouts.org/SpaceGrantConsortium).
- There are more scientists and engineers working on NASA projects at universities, nonprofits, and industry locations than there are at actual NASA centers. If you’re reaching out to a college or university, explore their physics, astronomy, planetary science, Earth science, computer science, or engineering departments. For industry professionals, search for aerospace companies in your area—they build the spacecraft for NASA. If a nonprofit interests you, you’ll likely have the most success with research groups.
- Explore NASA careers online at the “Women@NASA” site here: [www.girlscouts.org/WomenatNASA](http://www.girlscouts.org/WomenatNASA). Many women who work for NASA are featured on this site. You can read about them, watch interviews, and explore links to their work.

OR

- **Explore NASA's Science Mission Directorate.** Dig into one of NASA's science divisions:

**Heliophysics:** [www.girlscouts.org/NASAHeliophysics](http://www.girlscouts.org/NASAHeliophysics)

**Planetary Sciences:** [www.girlscouts.org/NASAPlanetaryScience](http://www.girlscouts.org/NASAPlanetaryScience)

**Earth Sciences:** [www.girlscouts.org/NASAEarthScience](http://www.girlscouts.org/NASAEarthScience)

**Astrophysics:** [www.girlscouts.org/NASAAstrophysics](http://www.girlscouts.org/NASAAstrophysics)

**Additional Resource:** [www.girlscouts.org/AboutNASAScience](http://www.girlscouts.org/AboutNASAScience)

What are the big questions? What do we know? What is unknown? What missions are scheduled for the near future?

Record your findings and share what inspires and intrigues you with your family and Girl Scout friends.

OR

- **Get involved with STEM at NASA.** Studying science, technology, engineering, and mathematics can open doors to exciting opportunities. Explore potential careers in the Science Mission Directorate division that most interests you through internships, competitions, webcasts, and remote lectures: [www.girlscouts.org/NASAStudentOpportunities](http://www.girlscouts.org/NASAStudentOpportunities).

The offerings change throughout the year, so check back often!

## NASA's Space Science Mission Directorate

NASA scientists and engineers explore the Earth, Solar System, and beyond to the farthest reaches of the Universe. There are four divisions:

- **Heliophysics:** the study of the Sun and space weather
- **Earth Science:** the study of our home planet, Earth, from space
- **Planetary Science:** the study of our Solar System—planets, moons, asteroids, comets, and more
- **Astrophysics:** the study of stars and exoplanets, galaxies, dark matter and energy as well as the origins of the Universe

Courtesy: NASA (4)

# Women in Science, Technology,



Courtesy: NASA/Dominic Hart



Courtesy: Andrea Frazetta



Courtesy: Seth Shostak, SETI Institute



Courtesy: JCP Portrait Studios

## Astrophysics

### Dr. Kimberly Ennico Smith

is a NASA research astrophysicist who loves drinking tea, communicating science, and inspiring the next generation of scientists and engineers. She has embarked on a highly multidisciplinary career, spanning space instrumentation, telescopes, and mission concepts. She has served as Deputy Project Scientist, leading the calibration of the New Horizons Pluto flyby mission and most recently the project scientist for the SOFIA infrared flying observatory. She is currently in the role of science advisor to the Office of Public Affairs at NASA Ames's Research Center in Silicon Valley, California.

## Planetary Science

### Nathalie A. Cabrol

is a planetary scientist at the SETI Institute and director of the Carl Sagan Center. Ms. Cabrol leads projects in planetary science and astrobiology, developing exploration strategies for Mars. She was chosen to help select Gusev Crater as the landing site for Spirit, the Mars Exploration Rover, because of her extensive studies of similar environmental conditions that existed on early Mars and here on Earth.

## Heliophysics

### Dr. Madhulika Guhathakurta

(also known as Lika) is a NASA astrophysicist who has worked as a scientist, mission designer, instrument builder, manager of science programs, teacher, and spokesperson for NASA's mission and vision in the Heliophysics Division. Occasionally, she performs all of these roles in a single day.

## Earth Science

### Margaret (Maggi) Glasscoe

is a geophysicist in the Earth Surface and Interior Group at the Jet Propulsion Laboratory (JPL), California Institute of Technology. She works as a Disaster Coordinator for JPL and is a member of the NISAR project science team. Her research includes modeling the Earth's crust to study postseismic responses to large earthquakes, numerical models of the crust, simulations and analysis of fault systems, and analysis of geodetic data.

# Engineering, and Math Fields



Courtesy: NASA Glenn Research Center



Courtesy: Jens Umhach Photography



Courtesy: Aerojet Rocketdyne



Courtesy: VEON

## Engineering Mary J. Lobo

grew up in a community where many people did not graduate from high school, let alone excel in college and have accomplished careers. She believes that her opportunity to work at NASA was a result of her dedication and belief that there are no limits imposed on us, only those we place on ourselves. She is now the acting Deputy Director for the Technology Incubation and Innovation Office for NASA Glenn Research Center (GRC) where she focuses on strategic partnering for economic development in the Cleveland area, the transfer and licensing of NASA GRC-developed technologies to private industry, and supporting Agency and Center-programs.

## Technology and Industry Ginni Rometty

has led IBM through the most significant transformation in its history as Chairman, President and CEO. She lead in the new era of artificial intelligence (AI), cloud, blockchain, cybersecurity, and quantum technologies—ensuring ethical and enduring development and deployment. Under her leadership, IBM is also helping young people build the STEM skills that are prerequisites for many exciting careers. IBM has played a key role in developing a new kind of school called P-TECH, a six-year high school/college that provides a tech-focused education, mentors, and internships to enable young people to enter the tech work force.

## Technology and Industry Eileen Drake

is the President and CEO of Aerojet Rocketdyne. Previously, she managed production operations at both the Ford Motor Company and Visteon Corporation. She is a distinguished military graduate of the U.S. Army Aviation Officer School and served on active duty for seven years as a U.S. Army aviator and airfield commander of Davison Army Airfield in Fort Belvoir, Virginia.

## Technology and Industry Ursula M. Burns

is Chairman and CEO of VEON, the NASDAQ-listed telecommunications group, and she is also a director of the boards of Exxon Mobil, Nestlé, and Uber. As CEO of Xerox Corporation from 2009 to 2016, Ms. Burns became the first female African American to head a Fortune 500 company.



## Careers in Space Science

Have you ever thought about being a space scientist? Organizations of STEM professionals offer tools to help investigate different paths of study for a variety of careers—some even offer scholarship assistance.

Learn more:

Women in Aerospace: [www.girlscouts.org/WomeninAerospace](http://www.girlscouts.org/WomeninAerospace)

Society of Women Engineers: [www.girlscouts.org/SWE](http://www.girlscouts.org/SWE)

MAES: Latinos in Science and Engineering: [www.girlscouts.org/MAES](http://www.girlscouts.org/MAES)

National Society of Black Physicists: [www.girlscouts.org/NSBP](http://www.girlscouts.org/NSBP)

National Society of Black Engineers: [www.girlscouts.org/NSBE](http://www.girlscouts.org/NSBE)

American Indian Science and Engineering Society: [www.girlscouts.org/AISES](http://www.girlscouts.org/AISES)

American Astronomical Society:  
[www.girlscouts.org/SpaceScientistEducation](http://www.girlscouts.org/SpaceScientistEducation)

Be sure to check out “A New Universe to Explore: Careers in Astronomy,” an AAS Committee on the Status of Women in Astronomy:  
[www.girlscouts.org/AASWomen](http://www.girlscouts.org/AASWomen)

Division of Planetary Sciences:  
[www.girlscouts.org/PlanetaryScienceGradSchool](http://www.girlscouts.org/PlanetaryScienceGradSchool)

Although this is a list of graduate programs, these schools also offer exceptional undergraduate courses of study.

American Geophysical Union: Check out “Paths Through Science”  
[www.girlscouts.org/PathsThroughScience](http://www.girlscouts.org/PathsThroughScience)  
Explore the *AGU Blogosphere*: [www.girlscouts.org/AGUBlogosphere](http://www.girlscouts.org/AGUBlogosphere)

IEEE: Institute of Electrical and Electronics Engineers:  
[www.girlscouts.org/TRYEngineeringUniversities](http://www.girlscouts.org/TRYEngineeringUniversities)

American Institute of Aeronautics and Astronautics:  
[www.girlscouts.org/AIAA](http://www.girlscouts.org/AIAA)

Careers in Aerospace: [www.girlscouts.org/CareersinAerospace](http://www.girlscouts.org/CareersinAerospace)

## STEP

# 3 Explore your interests

**Dive in and explore space science firsthand. For example: As a scientist, it's important to dig deep and ask questions. By doing so, you will learn that this can lead to even more questions and discoveries. Find avenues to explore your interests, and see where your observations lead you.**

### CHOICES—DO ONE:

- Discover citizen science and NASA.** You can be a citizen scientist right now, no degree required! Scientists and engineers worldwide collect an immense amount of data—this is the first step to making discoveries about our natural world. You can join them as a citizen scientist and contribute by collecting data and helping to analyze what's already been amassed. All it takes is your computer, an internet connection, time, and your willingness to explore. Find out how you can get involved: [www.girlscouts.org/NASACitizenScientists](http://www.girlscouts.org/NASACitizenScientists) or [www.girlscouts.org/GSCitizenScientists](http://www.girlscouts.org/GSCitizenScientists). Once you've begun making contributions, share what you've learned with your friends and family.

OR

- Use a telescope remotely.** Join other astronomy enthusiasts and use telescopes to take images of the night sky. Interested in galaxies? Star clusters? Planets? The Moon? Using an online telescope, schedule observations and get a taste for what it's like to be an astronomer. Or dig into live data and explore space weather—check out sunspots, solar storms, and auroras. Use these sites to get you started:

**MicroObservatory** is a great place to try out online observing. Check it out at [www.girlscouts.org/MicroObservatory](http://www.girlscouts.org/MicroObservatory).

**SkyNet Junior** taps into an international network of robotic telescopes. Learn more at [www.girlscouts.org/SkyNetJuniorScholars](http://www.girlscouts.org/SkyNetJuniorScholars).

**Space Weather Action Center** provides live data from the Sun. Check it out at [www.girlscouts.org/SWACData](http://www.girlscouts.org/SWACData) or collect data and watch for trends here: [www.girlscouts.org/SWAC](http://www.girlscouts.org/SWAC).

OR

- Build a telescope.** Learn how the optics in a telescope work as you assemble one. There are several telescope kits available for purchase online—find one you might like to build. After you've finished building, go observe! Stabilize your telescope using a bag of rice or, better yet, a tripod. What can you see? To get more out of your stargazing, check out this observing guide from the National Optical Astronomy Observatory: [www.girlscouts.org/TeachingwithTelescopes](http://www.girlscouts.org/TeachingwithTelescopes).

## Citizen Science

Citizen scientists—like you—can dive into space science data online. Here are some sample projects:

**Heliophysics:** Aurorasaurus—report auroras from your location. [www.girlscouts.org/AuroraSaurus](http://www.girlscouts.org/AuroraSaurus)

**Planetary Science:** Backyard Worlds—help find planet nine or ten or . . . [www.girlscouts.org/BackyardWorlds](http://www.girlscouts.org/BackyardWorlds)

**Earth Science:** Globe Observer—photograph clouds and compare your observations with NASA's. [www.girlscouts.org/GlobeObserver](http://www.girlscouts.org/GlobeObserver)

**Astrophysics:** Galaxy Zoo—help classify galaxies. [www.girlscouts.org/GalaxyZoo](http://www.girlscouts.org/GalaxyZoo)

Courtesy: NASA

## STEP

# 4 Dig deeper

Take everything you've learned and put it into practice. Use this opportunity to share your discoveries with your friends and family. As a scientist, it's important to share findings with colleagues—explore a medium that speaks to you.

### CHOICES—DO ONE:

- **Contribute to the science community.** Throughout the year, NASA offers competitions for students just like you. The competitions are inclusive of a variety of hands-on opportunities, including art, essay writing, filmmaking, designing experiments for the Space Station, or creating a cube satellite for launch. Some of the competitions require little time commitment and are a great way for you to dig deeper into the topics you've started exploring in this badge. Identify an open competition offered by NASA: [www.girlscouts.org/NASASTudentCompetitions](http://www.girlscouts.org/NASASTudentCompetitions).

Once you've found an activity that speaks to you—be sure to share your final product with other Girl Scouts and your family.

OR

- **Plan a field trip.** Many communities have science centers, planetariums, and observatories—often these are at museums or universities. Find out what is available in your community and arrange a field trip. Take photos and share your experience with other Girl Scouts and your family.

OR

- **Become a researcher.** Now that you've had a taste of the work that NASA scientists do, consider becoming a scientist on your own. Start by doing original research and ask a STEM professional for guidance. Enter your work into a science fair or find creative ways to share it. Your project could advance to the International Science and Engineering Fair, where you'd have the chance to meet future scientists and engineers from around the world. Find out how to get started here: [www.girlscouts.org/AdvancedScienceProject](http://www.girlscouts.org/AdvancedScienceProject).

## STEP

# 5 Share what you've learned

An important part of the research process is sharing what you've discovered. Scientists present at conferences and seminars and publish their findings. In this step, you will share what you learned, observed, and enjoyed in the process of earning this badge.

### CHOICES—DO ONE:

- **Go digital.** From your exploration of science and engineering in Step 2 and your hands-on experience in Step 3, prepare a digital presentation to communicate what you learned and discovered. Share with other Girl Scouts or your family.

Here are some ideas:

- Create a digital collage about women in STEM. Include images of the women and their work and share how they inspire you.
- Design a presentation using images from one division of space science, or all four, and share what NASA is exploring.
- Make an ad for a citizen science project that you are participating in.
- Make an image gallery of your remote telescope observations and share it.
- Create a video showing how to build a telescope and upload it to the internet. Then, create a teaser video for social media, directing people to the full version.

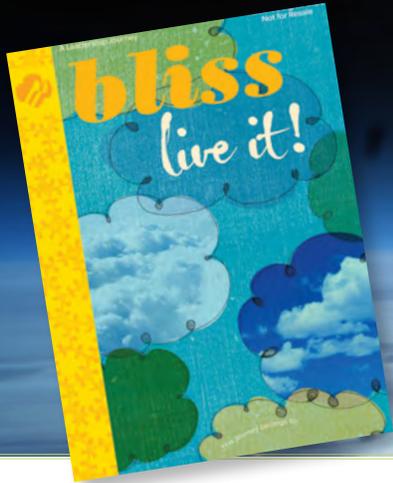
OR

- **Express yourself through visual art.** From your exploration of science and engineering in Step 2 and your hands-on experience in Step 3, design and create art to communicate what you have learned and discovered! Here are some ideas to get you started:

- Make a comic book or graphic novel.
- Build a model of a spacecraft.
- Print space images on fabric and make a quilt or a pillow cover.
- Paint space images.
- Create a mobile of the Solar System.
- Create a game.

OR

- **Design and present a performance piece.** Share it with other Girl Scouts and your family. Perform a skit or a play, do a reading of space-related poems, play music, sing songs, present at a star party, or host a web lecture—whichever medium speaks to you.



## Going on a Journey? Do some badge work along the way.

As you explore your strengths and passions in *Bliss*, find ways to integrate your love of science. Use your deepening knowledge of the cosmos to propel your dreams to new heights—finding ways to include science in the story of you. Rely on the things you discovered in this badge to guide you as you continue to learn about yourself and forge your ultimate path to success—accomplishing all of your wildest dreams.

### Now that I've earned this badge, I can give service by:

- Sharing what I've learned about NASA's Science Mission Directorate with my family and friends.
- Using what I learned about myself and my interests to chart my future.
- Empowering younger girls to pursue their love of STEM.

### I'm inspired to:

Courtesy: NASA

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