STATEWIDE STAR PARTY

OUR PLACE IN OUR GALAXY

FACILITATOR GUIDE

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OBJECTIVE

Create a model of our place in the Milky Way Galaxy

SUGGESTED AGE RANGE

Adults, families with children ages 10 and up

ACTIVITY DURATION

10-20 minutes

MATERIALS

- Images of our solar system with and without quarter superimposed
- Illustration of Milky Way Galaxy
- Webb's First Deep Field
- Miniature house
- CD with image of Quarter-North America Galaxy Model
- Small clear container filled with millet

Optional: a quarter coin, map of North America

SETTING

Indoors or outdoors

PROCEDURE

Part 1. Solar system vs. galaxy vs. universe

1. You might begin by asking your participants what they see when they look up at the night sky. (They might mention the Moon, planets, stars.)
2. Hold up relevant images to establish the difference between our solar system, our galaxy, and our universe. For *solar system*, use the small image of our solar system—without the quarter. For *galaxy*, use an illustration of our Milky Way Galaxy. For *universe*, use the Webb telescope's First Deep Field image.

Our solar system

Our galaxy

A universe of galaxies

Credits: Night Sky Network; NASA/Adler/U. Chicago/ Wesleyan/JPL-Caltech; NASA, ESA, CSA, and STScI

Part 2. Create a model of the Milky Way Galaxy

3. Explain that all the stars you see with your unaided eye are part of a giant city of stars called the Milky Way Galaxy. Ask: Has anyone ever seen the Milky Way in the sky? What does it look like? (A hazy band of light.) We'll build a mental model that will help us understand our solar system's place within the Milky Way Galaxy.

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4. Show the illustration of the Milky Way Galaxy. Explain that our galaxy looks like a pinwheel with a bulge of stars in the middle.

5. Note that our solar system is about halfway out from the galaxy's center—in the "suburbs." Our solar system orbits the center of our galaxy at more than half a million miles an hour, taking 230 million years to complete one orbit around the galactic center.

6. Establish with your participants what a light-year is. Often someone will be able to report that a light-year is the distance light can travel in a year, traveling at 186,000 miles per second (300,000 kilometers per second), or roughly 6 trillion miles (9 trillion kilometers). Note that many people mistakenly think a light-year is a unit of time rather than a unit of distance.

7. Ask: What is a light-minute? (The distance light can travel in one minute.) What's a light-hour? (The distance light can travel in one hour.)

8. Establish some of the distances in our solar system. For example, explain that the Sun is about 8 light-minutes away from Earth. How long does light leaving the Sun right now take to reach Earth? (About 8 minutes.) If Pluto's average distance is about five and a half light-hours from the Sun, how long does it take light leaving the Sun right now to reach Pluto? (About 5.5 hours.)

9. Explain that we'll build a scale model of the Milky Way Galaxy, and figure out where our solar system is within the galaxy.

10. Show the miniature house. Ask: If we shrank your home to the size of this little house, how big would

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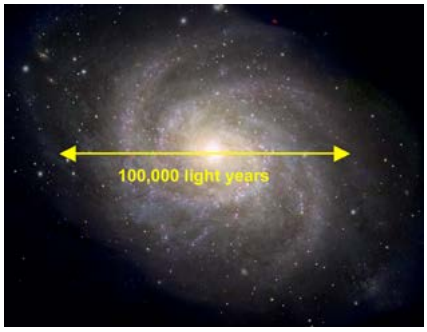
you be? (Really small.) Yes, so small we almost couldn't see you! This is what we're going to do with the Sun and all the planets.

11. We're going to shrink down our solar system so the average distance from the Sun to Pluto is just a little bigger than a quarter. A quarter is about 1 inch in diameter. On this scale the Sun is so small, you almost couldn't see it

12. Ask if anyone has a quarter. (Or you can use the solar system image with the quarter superimposed.).

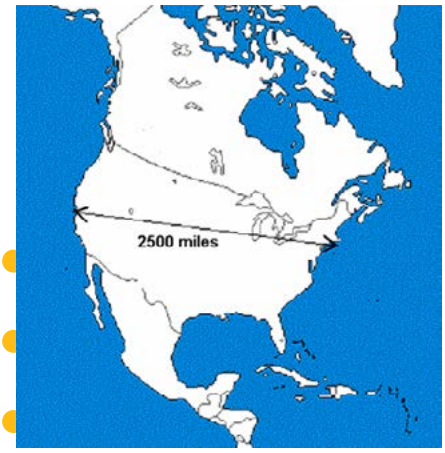
13. Review: how long did we say it takes light from the Sun to get to Pluto? (About five and a half hours.) So the distance to Pluto is 5.5 light-hours. We'll use the distance across this quarter to roughly represent the distance from the Sun to Pluto.



Credit: STScI

14. Explain that the Milky Way Galaxy, the island of stars we live in, is 100,000 light-YEARS across. Invite your participants to make some guesses: If this quarter represents our solar system from the Sun to Pluto (five and a half light-HOURS), then how big do you think the Milky Way Galaxy would be on this scale? Bigger than this room? This city? Our state?

15. Explain that on this scale, the Milky Way Galaxy would be about 2500 miles (4000 km) across. Ask if anyone can think of something about that big across (North America).



16. Summarize: If our solar system from the Sun to Pluto were shrunk down to a size a bit bigger than a quarter, the Milky Way Galaxy would span North America. Optional: Show a map of North America, or show the CD with the outline of North America on the spiral galaxy. (Tip: If you show a map or image

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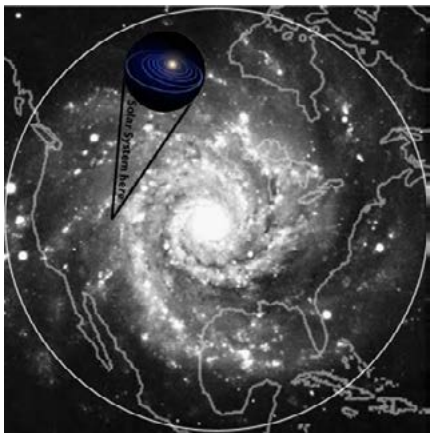

of North America, put it away soon after—and don't show it side by side with the quarter. Some people may mistakenly compare the size of the map or CD to the size of the quarter, rather than comparing the mental image of North America. You want to emphasize that on this scale the Milky Way Galaxy would span 2500 miles, or the width of North America itself—not merely the width of a map of it!)

17. Explain that now we've established how wide our galaxy is, we'll consider how thick it is. At our solar system's location in the Milky Way Galaxy, the galaxy is about 1,000 light-years thick. On our scale, that would be 25 miles (40 km).

18. Ask if anyone can think of any landmarks or towns about 25 miles away. (Tip: Have an appropriate place in mind.)

19. Explain that the thickness of our galaxy, on our scale, is that distance from here to there, but straight up. One way of imagining this distance is to consider the cruising distance of a commercial airplane, about 7 miles up. The thickness of our scale model of the Milky Way Galaxy is about 3 times farther up than an airplane flies.

20. Ask if anyone has ever seen an airplane flying in the sky. How small does an airplane look from the ground? (Pretty small.) How small would a quarter look if it were 3 times higher than that? (Too small to see!)

21. Summarize: In our scale model of the Milky Way Galaxy, our solar system (the part of it from the Sun to Pluto) would be a bit bigger than a quarter, and our galaxy would span the continent of North America and much of it would be about 25 miles

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high in thickness or 3 times the cruising altitude of an airplane.

22. Explain that our solar system is located about halfway out from the center of the Milky Way. In this model, that could mean over the Rocky Mountains.

23. Invite your participants to imagine themselves shrunk down very, very tiny, sitting on a tiny Earth on the quarter, looking around at the vastness of our galaxy.

Part 3. How many is 200 billion stars?

24. Remind your participants that earlier you mentioned that the Milky Way Galaxy is like a giant city of stars, which includes our Sun and all the stars we can see at night—and many, many more stars. You might ask if anyone can guess how many total stars are in our galaxy. (Estimates vary, but it's roughly about 200 BILLION stars.)

25. Note that it's difficult to imagine numbers this large, so we'll build a mental image of the volume of space taken up by 200 billion of something, such as 200 billion grains of millet.

26. Hold up a clear container of millet. You might sprinkle some into people's hands. Explain that we're pretending each grain of millet is a star in the Milky Way Galaxy. These grains are actually too big for many of the stars on our North America sized galaxy scale, but we're just using them as an illustration.

27. Help everyone imagine the volume that 200 billion grains of millet would take up: you'd need to take the playing area of an American football field, surround it with a wall 11 inches high (tip: you can

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use the long side of a standard sheet of paper to show 11 inches), and fill the playing field with millet to the top of the wall. That's 200 billion grains representing the 200 billion stars in the Milky Way Galaxy.

28. Now imagine those 200 billion grains of millet spread over the width of North America, roughly 25 miles deep (deeper at the central bulge over Kansas/Iowa).

29. Encourage your participants to make connections between this mental model and their experience of looking at the night sky: The stars look pretty spread out. On this scale, the brightest star in the night sky, Sirius (8.6 light-years away), would be about a quarter of a mile away. Imagine a grain of millet at that distance, about where (fill in an appropriate landmark) is. Polaris, the North Star, would be about 11 miles away, about where (fill in an appropriate town or landmark) is.

30. Help your participants make connections between the model and the hazy band of the Milky Way in the night sky: Imagine yourself in the model as our solar system, very, very tiny, flying high over the Rocky Mountains. When you look straight up or down, you see just a few stars, because you're looking above or below the geometric plane of the galaxy. But when you look across, toward Kansas, you'd see many, many stars, fading into a haze as they get more distant, like how distant city lights fade into a haze. This is what the Milky Way in the sky is: we are looking at our galaxy edge-on in that direction. The hazy band of light of the Milky Way is the geometric plane of our galaxy surrounding us.

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BACKGROUND AND PRESENTER TIPS

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Watch Night Sky Network's activity demo (7 minutes): https://nightsky.jpl.nasa.gov/news/388/

CREDIT

Adapted with permission from NASA's Night Sky Network, http://go.nasa.gov/nightskynetwork

The Statewide Star Party is made possible by the generous grant support of the North Carolina Space Grant.

1. Often people mistakenly think that the terms *solar system, galaxy,* and *universe* are interchangeable. Many people do not understand that: our solar system has only 1 star, the Sun, and that the Sun is very close to us compared with all the other stars, which are tremendously far away; our solar system is within the Milky Way Galaxy; and the universe contains all the galaxies.
2. The solar system image in this activity shows only the Sun and the orbits of Mars, Jupiter, Saturn, Uranus, and dwarf planet Pluto. On this scale, a quarter would cover the orbit of Uranus. The orbits of Mercury, Venus, and Earth are too small to see on the image, and the Sun would be 30 times smaller than a grain of sand. Earth is microscopic!
3. This activity focuses on the part of our solar system where the Sun, planets, and Pluto reside, a region of space about 11 light-hours in diameter. A more complete definition of our solar system would go far past that, to the region of the Oort Cloud (about 1 light-year out from the Sun), where long-period comets are thought to come from.
4. The term "Milky Way" can be confusing because it can refer to either the entire Milky Way Galaxy or to just to the geometric plane of the galaxy, which we see as a hazy band of starlight stretching across the sky ("the Milky Way"). All the stars we see with our unaided eyes—whether they're in that hazy band or not—are part of the Milky Way Galaxy.
5. In our scale model, the size of stars is generally much smaller than the smallest grain of sand. Think of the millet grains as pretty large stars.
6. Need to simply this activity? Focus only on the relative size of our solar system vs. our galaxy (quarter vs. North America), and skip discussion of thickness and number of stars. Or focus only on the number of stars in our galaxy (millet).