Our Place in Our Galaxy

Where are we? How far to the stars? What is "The Milky Way"?

About the Activity
Mentally construct a model of our place in the Milky Way Galaxy and the distribution of stars, with a quarter (or other 1 inch/3cm coin) and some birdseed. This is a great introduction to the distances of objects your visitors will view in the telescopes and can be adapted to many venues.

Materials Needed
- One handout per visitor: "Quarter–North America Galaxy Model"
- Printed cut sheets for our galaxy and other CDs with seasonal star charts
- Solar System Images sheet
- 15+ used CDs
- Milo bird seed in plastic bag (find this type at a feed store or bird store)
- Film canister or small scoop for the bird seed
- Glue stick
- Scissors
- *(Optional)* Hubble Ultra Deep Field card

Topics Covered
- Scale and structure of our galaxy including how many stars are in it: a scale model of the width, depth, and distribution of stars in the Milky Way.
- What the Milky Way is and what it looks like in the night sky
- All the stars we can see naked eye in the night sky are in the Milky Way Galaxy
- Establish a standard to understand distances to objects we see in the telescope within our Galaxy

Participants
- Adults, teens, families with children 8 years and up.
- If working with a school/youth group, ages 10 and higher.
- From one person to an auditorium of participants.

Location and Timing
Perfect for before a star party, at the telescope, in a classroom or auditorium. It takes about **10 – 20 minutes** for the initial presentation or just a few minutes at the telescope. See suggested ways for adapting the activity to these locations under Helpful Hints.

Set Up Instructions

- You can print the CD covers on regular paper, cut them out and paste them on the CDs. Or you can buy pre-made CD labels and print the images on the labels. The Milky Way CD pages in the Manual fit Avery 5692 and 8692. Be careful that the central cutout on these labels also is removed and attached to the CD.

- Cut apart the Solar Systems images on the sheet – glue the image with the quarter to the back of the image without the quarter.
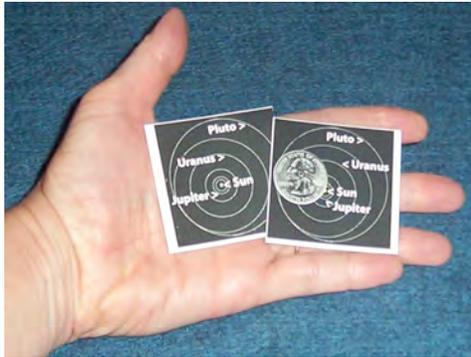
- You may want to insert your club information on the "Quarter-North America Galaxy Model" visitor handouts
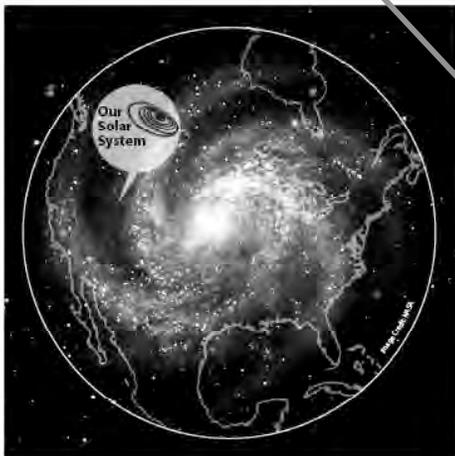
FRONT   BACK

Detailed Activity Description

Part 1: Build A Model of the Milky Way

| Leader's Role	Participants' Roles (Anticipated)
Introduction To Say: _When you look up in the sky at night, what do you see more of than anything else?_ Yes, we are surrounded by stars! Are all the stars you see in the Milky Way Galaxy? (Yes, all naked eye stars are in our Galaxy)	Stars! Offer answers.
Presentation Tip: Many people do not know the difference between the solar system, Galaxy, and universe. It is important to establish this difference at the beginning. Many people believe stars are sprinkled among the planets in the Solar System.	
To Ask participants • How many of you have seen the Milky Way in the sky? • What does it look like? _To Show_ • SOLAR SYSTEM (Sun and its planets) (Use the small image of the Solar System – without the quarter image) • MILKY WAY GALAXY (The island of stars we live in) (Use CD with galaxy on it – without the North America outline) • KNOWN UNIVERSE (All the galaxies) (Use Hubble Ultra Deep Field Card) _To Ask_ • What is the Solar System? • What is the Galaxy? • And the Universe? • Which one of the three is biggest? Smallest? • Which ones contain either of the others? • (Milky Way Galaxy contains our Solar System. Universe contains all the galaxies.)	Hands up. Offer answers. Solar System: Sun & planets Galaxy: All the stars surrounding us Universe: All the galaxies Offer suggestions.
Presentation Tip: Many people also do not understand: • Our Sun is a star, it's just a star that we are very close to. The rest of the stars are tremendously far away. • The Solar System is within the Milky Way Galaxy.	Solidify concepts of the Solar System, Galaxy, and Known Universe.

| Leader's Role	Participants' Roles (Anticipated)
Presentation Tip*: Most children and many adults in urban areas have never seen the band of the Milky Way across the sky. Even people who have seen it do not understand that this band they see is the plane of the Galaxy we live in and that all the stars we can see naked eye are within our Galaxy. This activity helps people to understand this concept. We recommend that you stop and check your audience's understanding throughout the discussion.	
The Milky Way Galaxy <u>To Say:</u> Our galaxy looks something like a pinwheel with a bulge of stars in the middle. It's called a spiral galaxy. This visible part of our Galaxy is very wide and very thin. *Show:* CD model of the Galaxy - without the North America outline. (NOTE: The ratio of the width to the thickness of the Milky Way is about 100:1. The bulge in the middle is about twice this thickness.) <u>To Say:</u> Where do you think our Solar System is in the Galaxy? We are about here. (Point to a spot about halfway out from the center.)	Responses.
Presentation Tip*: You must establish with your audience what a light year is. Many people mistakenly use this term as a unit of time rather than a unit of distance. For a deeper discussion of light year, see the "Telescopes as Time Machines" activity: http://nightsky.jpl.nasa.gov/download-search.cfm	
Distance in Light Years <u>To Ask:</u> Who can tell me what a light year is? (The distance light can travel in a year, traveling at 186,000 miles per second or 300,000 km per second). <u>To Ask:</u> So, what is a light minute? (The distance light can travel in one minute) And a light hour? How long does light, leaving the sun right now, take to get to Earth? (about 8 minutes) How long do you suppose it takes light leaving the Sun right now to reach our most distant planet, Pluto? (about 5-1/2 hours or about 40 times longer than sunlight takes to reach Earth)	Think about questions and share answers.
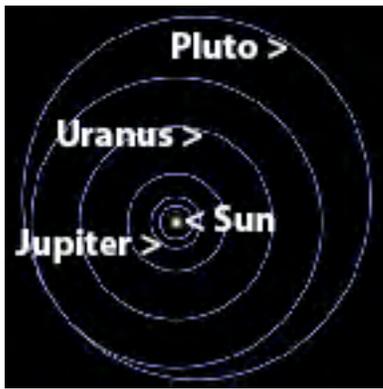
11 light hours across the Solar System;
5.5 hours for light from the Sun to reach Pluto. A quarter would cover the orbit of Uranus on the scale we're using.
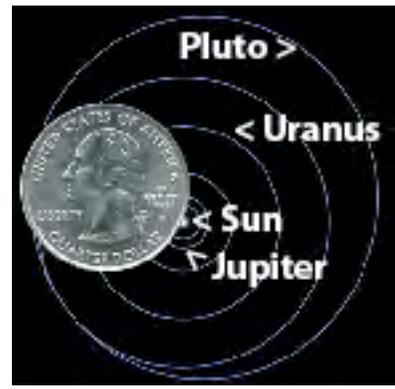
Cut out one of these Solar System images (above) and use it for the correct size, or use the sheet "Solar System Images".

NOTE: These images only show the Sun and the orbits of Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. The orbits of Earth, Venus, and Mercury are too small on this scale to place on the image. The Sun is actually much smaller than a grain of sand on this scale.

Leader's Role	Participants' Roles (Anticipated)
Presentation Tip: This presentation builds a **scale model** of the Milky Way. Some younger visitors may not understand scale models. To assist with understanding scale models, use this as an introduction:	
Show: Miniature house. *Ask* If we shrank your home down to the size of this little house, how big would you be? Yes, so small, we almost couldn't see you! Well, that's what we are going to do with the Sun and all the planets.	"Really small!"
To Say: We're going to shrink the Solar System using the average distance from the Sun to Pluto, down to a little bigger than the distance across a quarter. A quarter is one inch in diameter. The Sun is so small, you almost couldn't see it. Does anyone have a quarter? (Or use one of the Solar System images above as your model)	Listen. Offer a quarter.

To Say:	
Now how long did we say it takes light from the Sun to get to Pluto? So the distance from the Sun to Pluto is 5-1/2 light hours. We'll use the distance across this quarter to represent the distance from the Sun to Pluto. **NOTE to Presenter:** *On this scale, the Sun is 30 times smaller than a grain of sand. The Earth is microscopic.*	Five and a half hours.
To Say: Now the Millky Way Galaxy, the island of stars we live in, is 100,000 light YEARS across. How big do you think the Milky Way is if this quarter represents the Solar System, from the Sun to Pluto (5-1/2 light HOURS)? Bigger than this room? The city? The state?	Volunteer guesses.

100,000 light years
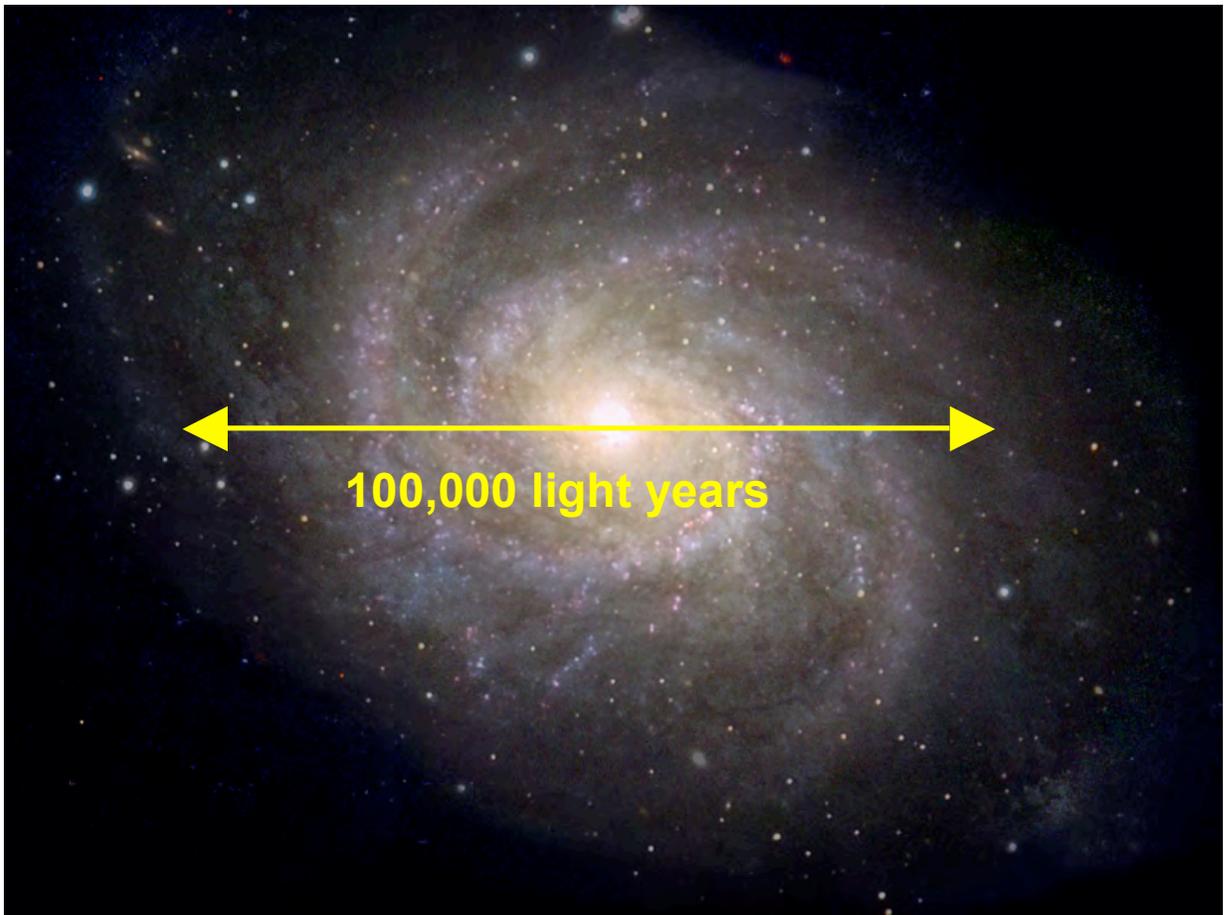
Credit: STScI

Leader's Role	Participants' Roles (Anticipated)
It's about 2500 miles (4,000 km) across on this scale. *To Ask:* **What can you think of that is about 2500 miles across?** **(United States is about 2500 miles across.)**	Guesses

Summarize:
    (Important to emphasize): So, if the Solar System is shrunk down to a size a bit bigger than this quarter, the Milky Way Galaxy would span North America!
 	
    So we now have a mental model of our Galaxy:
    In this model, how big is the Solar System?
 	
    And how big is the Galaxy?
	
	"Little bigger than quarter"
	"North America"
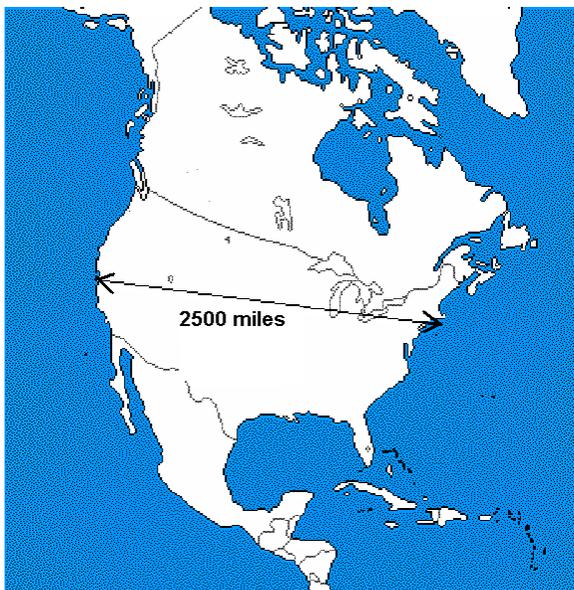
**OPTIONAL: Show a map of North America. Then put it away
OR
Show the CD with the outline of North America on the spiral galaxy. Then put it away.**

TIP: People get confused if you leave the map or the CD out and pull out the quarter again. Some will compare the size of the MAP or of the CD to the size of the quarter rather than comparing the mental image of North America.

Leader's Role	Participants' Roles (Anticipated)
To Say: Now that we know how wide the Galaxy is, how thick is it? Where we are, the Milky Way Galaxy is about 1000 light years thick: **The scaled size is 25 miles (40 km) for 1,000 light years** (RATIO: 2500 miles across by 25 miles thick – about 100:1 – on this scale, 1 mile represents 40 light years)	
To Say: Or about the distance between here and (pick a city in your area that is about 25 miles (40 km) away from where you are presenting this activity or between two well-known cities or landmarks). *OR ASK:* What's about 25 miles away? So, the thickness of the Galaxy is from here to there, straight up. The cruising altitude of commercial airplanes is about 7 miles (11 km) up. The thickness of our scale model of the Galaxy is about 3 times farther up than an airplane flies. How many of you have flown in an airplane? How small does an airplane that is seven miles high look from the ground? How small would a quarter look at that height?	Hands up. "Pretty small" "We couldn't see it!"
Summarize: So, on our scale model of our Galaxy, How big is the Solar System? What continent would our Galaxy span? So how thick is our Galaxy in this scale model? And this quarter is our Solar System. (Hold up quarter) Located about halfway out from the center of our Galaxy. Maybe over the Rocky Mountains. Is the Earth on the quarter? Now, imagine yourself shrunk down very, very tiny, sitting on this quarter, flying over the Rocky Mountains. Look around you at the vastness of our Galaxy.	Quarter North America 25 miles or about 3 times the cruising altitude of an airplane. Yes

PART 2. How many is 200 billion stars?

Leader's Role	Participants' Roles (Anticipated)
To Say: But at the beginning we said that when we look around us we can see that our Galaxy is full of stars. Anybody know how many stars? There are about 200 BILLION stars in our Galaxy.	Guesses.
NOTE to Presenter: Estimates of the number of stars in the Galaxy range from 100 billion to over 400 billion. We're using a generally accepted number: 200 billion. **Presentation Tip***: Many people do not understand that our Sun is a star. That it is just a star we are very close to. It is important to establish and confirm this fact.*	
To Say: Is our Sun one of these billions of stars? How many is 200 BILLION stars? Let's build a mental image of the volume of space taken up by 200 billion bird seeds. *Pass around:* Bird seed. *To Say:* We'll use this bird seed to represent the stars in the Milky Way Galaxy. These are actually too big for most of the stars on our North America sized galaxy scale, but we're just using them as an illustration. **NOTE to Presenter:** *On this scale, the size of stars is generally much smaller than the smallest grain of sand. The bird seed is about the size of red giant stars.*	Yes Take bird seed

Leader's Role	Participants' Roles (Anticipated)
To Say: Is there someone here about four feet (1.25 meters) tall? (If no kids, indicate on your body how high four feet is). Imagine a football field surrounded by a wall four feet high. Fill the football field with this birdseed to the top of the wall. That's 200 billion seeds representing the 200 billion stars in the Milky Way Galaxy. Is that a lot of stars? How deep is the birdseed on the football field?	Yes! Four feet
But we're not done yet … How big is the Galaxy on the scale we built? *To Ask:* What do we need to do with all those stars piled up on the football field? *To Say:* Imagine this: Take about a third of the stars and spread them over Kansas/Iowa for the central bulge of our Galaxy. Take the rest and distribute them all over North America, 25 miles (40 km) deep. Now does it seem like so many stars? Are the stars very close to each other?	2500 miles in diameter or North America Spread them out all over North America
To Ask: When you look at the stars in the sky, are they pretty spread out? *To Say* On this scale our nearest star (the Alpha Centauri system – 4+ light years away) is about 600 feet/200 meters or 2 football field lengths away. Sirius (8+ light years away) is about 1/4 mile/400 meters away (4 football field lengths). Polaris, the North Star, (430 light years away) is about 11 miles/18 km away. Our Solar System, shrunk down to this quarter, is about half-way out from the center of the Galaxy, maybe over the Rocky Mountains. Imagine yourself again very, very tiny, flying high over the Rocky Mountains. When you look straight up or straight down, you see a just few stars. But look across toward Kansas, and what do you see? Many, many stars, fading into a haze as they get more distant, like 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.	Yes.

Leader's Role	Participants' Roles (Anticipated)
If outside where you can see the Milky Way: _To Say:_ Look up in the sky and see that faint band of light? That's the plane of our Galaxy surrounding us. Our Solar System is suspended among the stars of the Galaxy. When you look above or below the plane of our Galaxy you see a few stars, but looking through the plane, you see the light from billions of distant stars.	Looking up – wow!
**NOTE:** In April and May, the plane of the Galaxy is low on the horizon in the early evening and difficult to see.	
NASA Missions _To Say:_ Scientists still have lots of questions about how galaxies formed in the first place. And, as we saw, the stars are not evenly distributed in our Galaxy. Do you think our Galaxy will always look like it does today? NASA has missions in the process of determining just how galaxies formed and how they evolve.	Responses
Conclusion and Visitor Handouts As you look through the telescopes tonight, some of the telescope operators will be using this scale model to help you understand how far away the objects you view are. (Pass out "Quarter-North America Galaxy Model" handout sheet) Here's a handout you can use to help you remember this scale model of our Milky Way Galaxy. Each night as you look at the stars surrounding us, imagine shrinking the Sun and the orbits of all the planets down to this quarter. You are a very small dot riding on one of those planets looking out at the billions of stars surrounding us in our North America-sized galaxy. And our Milky Way galaxy is but one of the billions of galaxies in the universe.	Take and pass around sheets – (You may want to have your visitors cut out and glue the sheets onto CDs, if you have the facility for this) Wow!

PART 3. OPTIONAL Sections

OPTIONAL: How far have we sent spacecraft?

Someone may ask: So how many stars have we explored with space ships?

To Say:
The Pioneer spacecraft has only gone just beyond the orbit of Pluto – about an inch or so from the edge of the quarter. It has been traveling for over 25 years. How much farther will it need to go to pass the distance of the nearest star? (2 football fields)

OPTIONAL: Size of the Known Universe

Someone may ask: So how big is the whole Universe?
To Say:
We now need to change the scale again.   If we crush the whole Milky Way Galaxy (the size of North America) down to the size of the Galaxy CD, the Andromeda Galaxy is about 8 feet* away (about 2.8 million light years from our Galaxy). On this new scale, the KNOWN Universe (13.7 billion light years out in any direction) is a sphere about 20 miles across (name two cities or landmarks about 20 miles apart) centered on the CD. There are about 200 billion galaxies in the known Universe.

13.7 billion light years is about 10 miles on the scale of the Galaxy CD. This is the known Universe. We cannot see any structures beyond this limit – we are looking back in time to the earliest known structures. We are not in the "center" of the Universe. We know of no center to the Universe.

* See the Universe of Galaxies activity for a metric model of this activity.

RECOMMENDED: Use "A Universe of Galaxies" activity from the Night Sky Network Resource Download Site which uses a CD to represent the size of the Milky Way Galaxy:
http://nightsky.jpl.nasa.gov/download-search.cfm

Presentation Tip*: Changing scale can be confusing to your audience. It is recommended that you maintain only one scale throughout any presentation.
If you do change scales, very clearly explain that you are doing so and make sure your audience understands that you have changed scale.

OPTIONAL: Traveling to the Stars!
Presentation Tip: By this time, most people are overwhelmed and need to think about what has just been discussed. You may want to postpone this part of the activity to a later date.

T o Say: The fastest speed attained by a craft with humans in it is 24,790 miles per hour (39,900 km per hour). This was the re-entry speed reached by the Apollo 10 craft. The fastest speed recorded for a craft with no humans in it was 150,000 miles per hour (241,000 km per hour), reached by the Helios satellite that is in orbit around the Sun. How many miles per second do you suppose that is? (42 miles or 66 km per second) *To Ask:* How long would it take to for someone living on Epsilon Eridani's planet about 10 light years away, to get into our Solar System if they were traveling at the speed of our fastest spacecraft (light travels at 186,000 miles per second/300,000 km per second and our fastest spacecraft travels at about 42 miles per second)? Or for us to reach them? The spacecraft would travel at 2/10,000th the speed of light (42 divided by 186,000 = 0.00022). So 1 light year would take 5000 years. Epsilon Eridani is about 10 light years from us. So . . . 10 years X 5,000 = 50,000 YEARS to get there. *To Discuss:* • What would we have to do to take such a trip? • How would we stay in communication with the spacecraft? • Would a manned or robotic spacecraft be a better idea? Why? • How long would it take for us to know the spacecraft had arrived? What would we need to do to make a faster trip?	

13

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Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov

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13

Helpful Hints

One of the hardest ideas for people to grasp is how vast the Milky Way Galaxy is, its general shape and organization, and our place in it. This activity gives you a story and some simple tools to convey an understanding of these difficult concepts.

This activity concentrates on our own Milky Way Galaxy and the objects visible within it. When we say that the Orion Nebula (M42) is 1600 light years away or Polaris is 430 light years away, this really means very little to our visitors at the telescope because they have no standard by which to imagine how far this is. This activity provides you with such a standard.

FOR A SCALE MODEL OF THE SOLAR SYSTEM: It has been our experience that almost every astronomy club has a favorite Solar System scale model that they use. All the way from the 40–foot model (where the Earth–Sun distance is 1 foot) to the 1000–foot model (where the size of the planets as well as distance is scaled correctly and Earth is a peppercorn). If you don't have a model, here are a few references:
• To create your own scale visit:
http://www.exploratorium.edu/ronh/solar_system/
All you need is the diameter of the Sun you want to use. This site will calculate the rest of the scale for the Solar System.

• For one that is fun and appropriate for indoors only:
http://www.astrosociety.org/education/family/materials/toiletpaper.pdf

• For the 1000–yard model:
http://www.noao.edu/education/work/Peppercorn/Peppercorn_Main.html

FOR A SCALE MODEL OF THE KNOWN UNIVERSE: Use the **"Universe of Galaxies" activity** to convey an understanding of the structure and size of the universe of which our Milky Way Galaxy is but one of billions of other galaxies.
http://nightsky.jpl.nasa.gov/download–search.cfm

Terms you will need to make sure your audience understands are:
• Scale Model
• Solar System
• Milky Way Galaxy
• Universe
• Light Year
These are each addressed in the presentation.

Some audience members might not understand:
1. The difference between the Solar System, Galaxy, and universe.
2. There is only one star in our Solar System: the Sun. Many people believe stars are sprinkled among the planets in the Solar System.
3. Our Sun is a star. It's just a star that we are very close to. The rest of the stars are tremendously far away.
4. The Solar System is within the Milky Way Galaxy.

These are addressed in the presentation.

Where can I use this activity?

1) **Star Party:** To introduce a star party and continue the theme as the visitors view objects in the telescopes, do a 10 to 20–minute pre–star–party presentation to establish the Quarter–North America model. See the **Detailed Activity Description**.

2) **Scout troop or classroom:** Use copies of the Milky Way CD sheets as handouts, provide a stack of old CDs, scissors, and glue and have the participants make their own CD Galaxy after doing the presentation.

3) **Meeting/Presentation:** You might want to use the PowerPoint on the Resource lookup Page (http://nightsky.jpl.nasa.gov). If you do not have access to a computer projector, you can print the slides onto transparencies for use with an overhead projector. See the **Detailed Activity Description** for a suggested script to go with the PowerPoint.

4) A basic explanation can be **done at the telescope** as you show objects in the Milky Way Galaxy. Use the star charts on the CDs as a reference when discussing the relative distance to the object you are viewing.

   a) Example #1: Viewing the double star **Mizar** in the handle of the Big Dipper, the amateur astronomer can point out that on the Quarter–North America scale this star is about 2 miles (3 km)

Big Dipper/Little Dipper
OUR PLACE IN OUR GALAXY

SCALE:
Solar System = A bit larger than a Quarter (2" across)
Milky Way Galaxy = North America (2500 mi across)
40 light years = 1 mile

Object	Type	Distance (Actual)
M51 (Whirlpool)	Galaxy	925,000 mi (37 million ly)
M81	Galaxy	300,000 mi (12 million ly)
M101(Pinwheel)	Galaxy	675,000 mi (27 million ly)

< 2.5 mi (101 ly)
M101
3.7 mi (147 ly)
M51
< 2 mi (78 ly)
9 mi (347 ly)
3 mi (126 ly)
< 2 mi (81 ly)
2 mi (84 ly)
< 2 mi (81 ly)
11 mi (431 ly)
< 3 mi (124 ly)
< 2 mi (79 ly)   M81

away (pick a city or landmark at that distance).

b) Example #2: Viewing the **Orion Nebula (M42)**, the amateur

astronomer can point out that on the Quarter–North America scale this region where new stars are forming is about 40 miles (65 km) away (pick a city or landmark at that distance) and would be a cloud of gas and dust 3/4 of a mile (1 km) wide. Compare that to the quarter representing our Solar System.
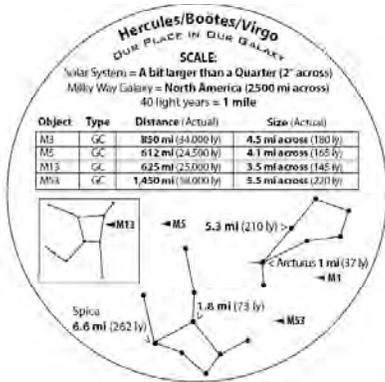
c) Example #3: Viewing the **Hercules globular cluster (M13)**, on the Quarter–North America scale this swarm of thousands of ancient stars is over 600 miles (960 km) away and would span almost 4 miles (6 km). Compare that to the quarter representing our Solar System.

d) Example #4: **Viewing a galaxy**, the amateur astronomer can explain that we are looking out through the stars of our own Milky Way Galaxy at another galaxy outside of our own. That galaxy is outside of and far away from the North–America–sized Milky Way Galaxy. Foreground stars that the person sees are stars in our own Galaxy. It's like looking out through a spotted window at a distant city. The galaxies are tens of thousands to hundreds of thousands of miles away on the quarter–NorthAmerica scale. You might want to compare these distances with the distance to the moon (average distance: 240,000 miles/380,000 km).

e) Example #5: Example of a story you might want to tell at the telescope about **stars and their distances**, when comparing distances on the constellation/asterism CDs:

Deneb vs. Vega: Deneb is only a little dimmer than Vega, the brightest star in the summer evening skies. But Deneb is 1500 light years distant (or 37 miles/60 km on the Quarter–NorthAmerica scale model) while Vega is quite close: only 25 light years away (or 0.6 miles/1 km on the model). What does this tell us about Deneb?
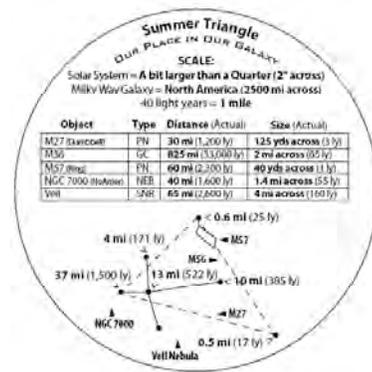
Deneb must be a really big, really bright star! It is one of the most distant stars we can see without a telescope, and yet it is much brighter than many of the stars we see. It is a hot blue supergiant. If Deneb were as close as Vega, it would outshine everything else in the night sky except the full moon – you would cast a faint shadow from its light!

f) Example #6: Distance of **globular clusters**: If a globular cluster is more than 28,000 light years away (700 miles/1,100 km on the scale model), we are probably looking beyond the center of our Galaxy, over to the far side of our Milky Way Galaxy.

Constellation/Asterism CDs

These CDs are intended for use as a reference at the telescope for the telescope operator. See the examples under the "Venues" section above for suggestions on using these CDs at the telescope.

The distances to most of the brightest Messier (and a few other) objects and stars within the Milky Way Galaxy are marked on the CDs.

Abbreviations used on the CDs:
GC = Globular Cluster
NEB = Nebulous star–forming region
OC = Open Star Cluster
PN = Planetary Nebula (dying star)
SNR = Supernova Remnant (nebula around the site of an exploded star)
Galaxy = Galaxy outside of the Milky Way Galaxy

Listing of Objects on CDs:
For an Excel spreadsheet listing the objects on the Constellation/Asterism CDs, see the file on the *Resource Download Page:*
http://nightsky.jpl.nasa.gov/download–search.cfm
You may add your favorite objects to this list and print it out as a reference at the telescope if you prefer to use a list instead of the CDs.

Background Information
To get more info on the Milky Way Galaxy and other galaxies
http://imagine.gsfc.nasa.gov/docs/ask_astro/galaxies.html
http://amazing-space.stsci.edu/capture/galaxies/

Diagrams of the basic structures of the Milky Way:
http://www.astro.unibas.ch/forschung/rb/structure.shtml
http://etacar.umn.edu/~martin/rrlyrae/galstrct.htm

For a tour of Our Place in Space:
http://cfa-www.harvard.edu/seuforum/opis_tour_earth.htm

References used for distances and extent of stars and objects on the constellation/asterism CDs:
Observer's Handbook 2004, Editor: Rajiv Gupta, The Royal Astronomical Society of Canada
SEDS Messier Catalog: http://seds.org/messier

Calculation Details

Galaxy the size of North America

BREADTH: 100,000 light years
Sun to Pluto is represented by a quarter: 1" (3 cm): 5.5 light hours
Diameter of Solar system: 11 light hours or 2" (6 cm)
How many inches or feet in a light year on this scale?
365 days in a year
x 24 hrs in a day
= 8760 hrs in a yr
÷ 5.5 light hrs in 1 inch (3 cm)
= 1592 inches (40 meters) in a light yr
÷ 12 inches (30 cm) in a foot
= 132 feet (40 m) **for one light yr**

How many feet or miles (m or km) across the Galaxy on this scale?
132 feet (40 m) for one light yr
X 100,000 light years
= 13,200,000 feet
÷ 5280 feet in one mile
= 2,500 miles (4,000 km) **for 100,000 light years**

The Milky Way Galaxy is about 2500 (4,000 km) **miles across on this scale.**

THICKNESS: 1,000 light years

132 feet for one light yr
X 1,000 light years
= 132,000 feet
÷ 5280 feet in one mile
= **25 miles (40 km) for 1,000 light years**

RATIO: 2500 miles across by 25 miles thick – about 100:1

200 BILLION STARS – a football field full of birdseed

Use a 4"x 4"x 2" (10cm x 10cm x 5cm) box and a 35mm film canister as a scoop.   Use a big bag of the milo birdseed. Count the number of birdseed in one scoop, then calculate how many stars will fit in the box, as follows:

Scoop up level scoopfuls of stars and count how many scoops it takes to fill the box. It should be about 14 scoops. How many "stars" does a 4"x 4"x 2" box hold?
There are approximately 1300 "stars" in one scoop.

4x4x2 box holds about 14 scoops
1300 x 14 = ~**18,000 stars in a box**

So how many boxes do we need to fill up to get 200 billion stars?

200,000,000,000 ÷ 18,000 stars in a box
= ~ **11 million boxes**

A football field, goal line to goal line is 300 feet (91 m) and about 160 feet (50 m) wide or 3600" by 1920".

Using 4x4x2 box …

300 Ft or 3600" (Goal line to Goal line)

160 Ft or 1980"

900 boxes by 480 boxes to cover the playing field
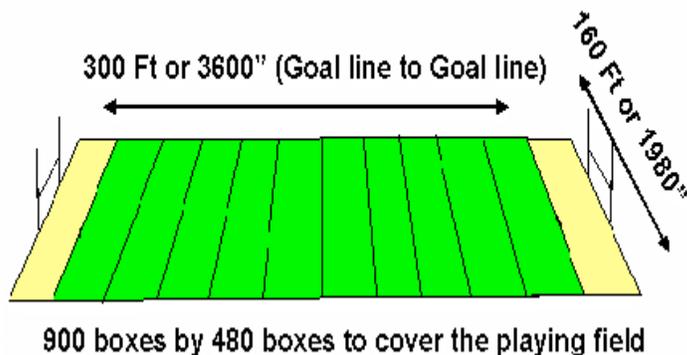
How many boxes in one layer?
3600" divided by 4" (width of box) = 900 boxes from goal line to goal line.
1920" divided by 4" (length of box) = 480 boxes sideline to sideline.
To cover the field one layer deep:
900 x 480 boxes = 432,000 boxes

How many layers to make 11 million boxes (using our example above)?
11,000,000 boxes needed
÷ 432,000 boxes in one layer
= **~ 25 layers of boxes**

How high is 25 layers?
25 layers x 2" per layer = 50 inches or ~4 feet (1.25 m)

Imagine football field surrounding by four walls and filled 4 feet deep with birdseed. That's 200 billion seeds representing the 200 billion stars in the Milky Way Galaxy.
Now spread them 25 miles (40 km) deep all over North America, with about 1/3 of them on the middle over Kansas/Iowa. Enjoy your trip!

Pluto >
< Uranus
< Saturn

Pluto >
Uranus >
Saturn >

Pluto >
< Uranus
< Saturn

Pluto >
Uranus >
Saturn >

Pluto >
< Uranus
< Saturn

Pluto >
Uranus >
Saturn >

Pluto >
< Uranus
< Saturn

Pluto >
Uranus >
Saturn >
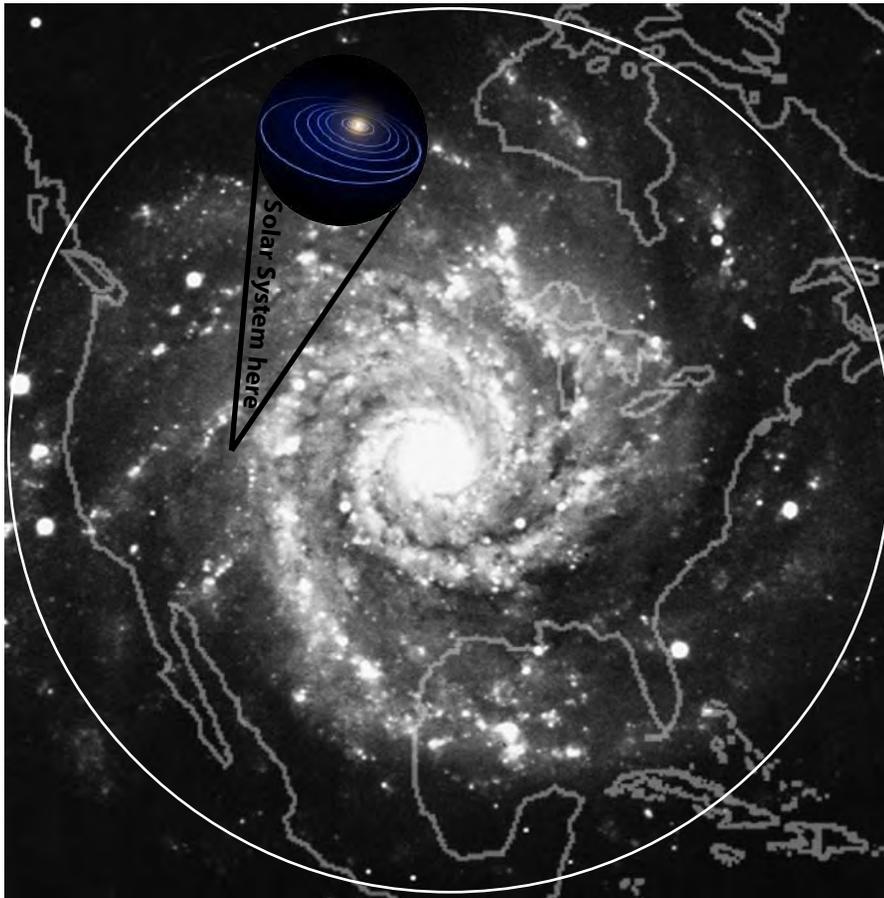
Solar System here

Front

February - September
Our Place in Our Galaxy

SCALE:
Solar System = **A bit larger than a Quarter (2" across)**
Milky Way Galaxy = **North America (2500 mi across)**
40 light years = **1 mile**

Object	Type	Distance (Actual)
M101 (Pinwheel)	Galaxy	**675,000 mi** (27 million ly)
M51 (Whirlpool)	Galaxy	**925,000 mi** (37 million ly)
M81	Galaxy	**300,000 mi** (12 million ly)

< **2.5 mi** (101 ly)
< M101

3.7 mi (147 ly)

< **2 mi** (78 ly)

9 mi (347 ly)

< M51

< **2 mi** (81 ly)

3 mi (126 ly)

Big Dipper/Little Dipper

2 mi (84 ly)

< **2 mi** (81 ly)

11 mi (431 ly) >

< **3 mi** (124 ly)

< **2 mi** (79 ly) < M81

M74 Photo Credit: NOAO/AURA/NSF

Back

Instructions:
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Front

Back
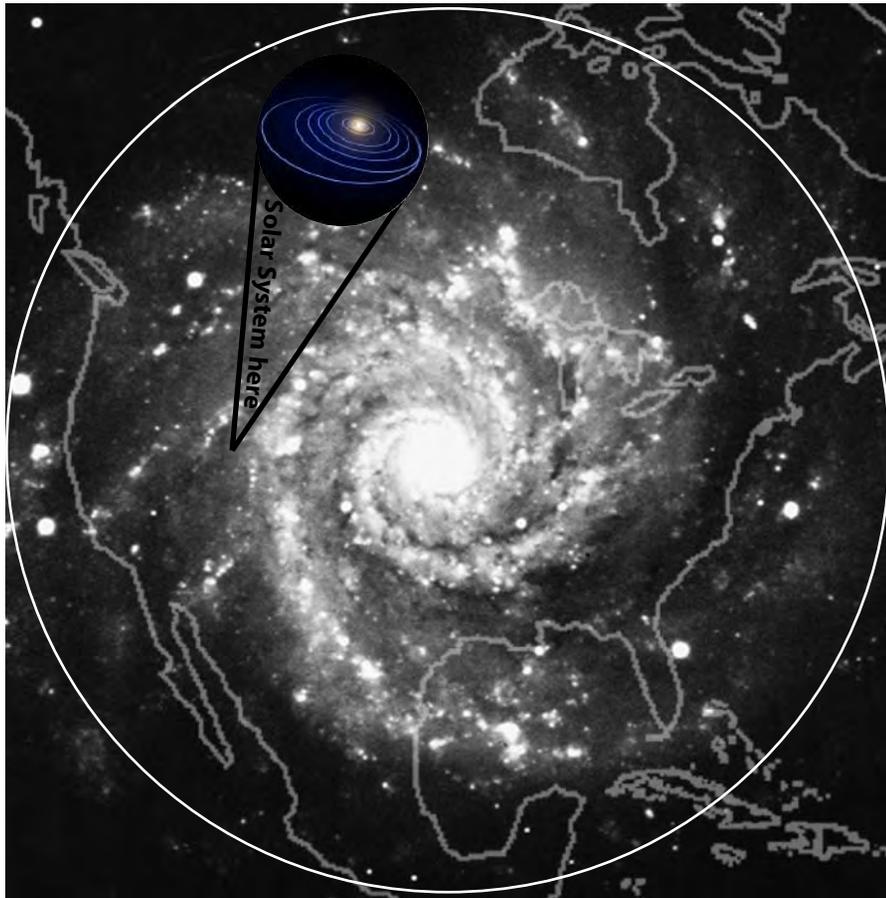
July - September
Our Place in Our Galaxy

SCALE:
Solar System = **A bit larger than a Quarter (2" across)**
Milky Way Galaxy = **North America (2500 mi across)**
40 light years = **1 mile**

Object	Type	Distance (Actual)	Size (Actual)
M8 (Lagoon)	NEB	**130 mi** (5,200 ly)	**3.5 mi across** (140 ly)
M7	OC	**20 mi** (800 ly)	**1/2 mi across** (20 ly)
M6	OC	**40 mi** (1,600 ly)	**1/3 mi across** (12 ly)
M20 (Trifid)	NEB	**130 mi** (5,200 ly)	**1 mi across** (42 ly)
Galactic Center	Black Hole	**700 mi** (28,000 ly)	**Poppy Seed** (6 mil. miles)

▽ M20

< M8

6 mi (224 ly)

2.4 mi (96 ly) Galactic Center

8 mi (306 ly) >

< M6

Sagittarius

2 mi (89 ly)

< M7

3.6 mi (145 ly)

M74 Photo Credit: NOAO/AURA/NSF

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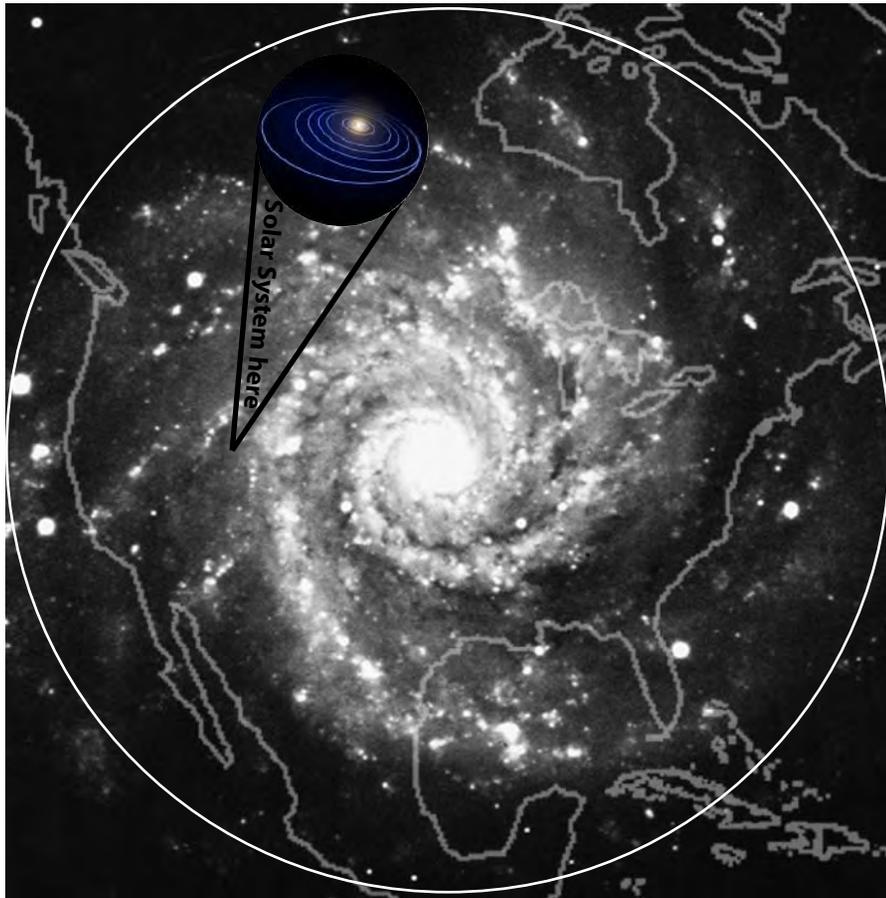
Front

June - December
Our Place in Our Galaxy

SCALE:
Solar System = **A bit larger than a Quarter (2" across)**
Milky Way Galaxy = **North America (2500 mi across)**
40 light years = **1 mile**

Object	Type	Distance (Actual)	Size (Actual)
M57 (Ring)	PN	**60 mi** (2,300 ly)	**40 yds across** (1 ly)
M27 (Dumbbell)	PN	**30 mi** (1,200 ly)	**125 yds across** (3 ly)
M56	GC	**825 mi** (33,000 ly)	**2 mi across** (85 ly)
NGC 7000 (NoAmer)	NEB	**40 mi** (1,600 ly)	**1.4 mi across** (55 ly)
Veil	SNR	**65 mi** (2,600 ly)	**4 mi across** (160 ly)

< **0.6 mi** (25 ly)
4 mi (171 ly)
< M57
< M56
37 mi (1,500 ly) **13 mi** (522 ly) < **10 mi** (385 ly)
< NGC 7000 < M27
0.5 mi (17 ly)
Summer Triangle

M74 Photo Credit: NOAO/AURA/NSF

Back

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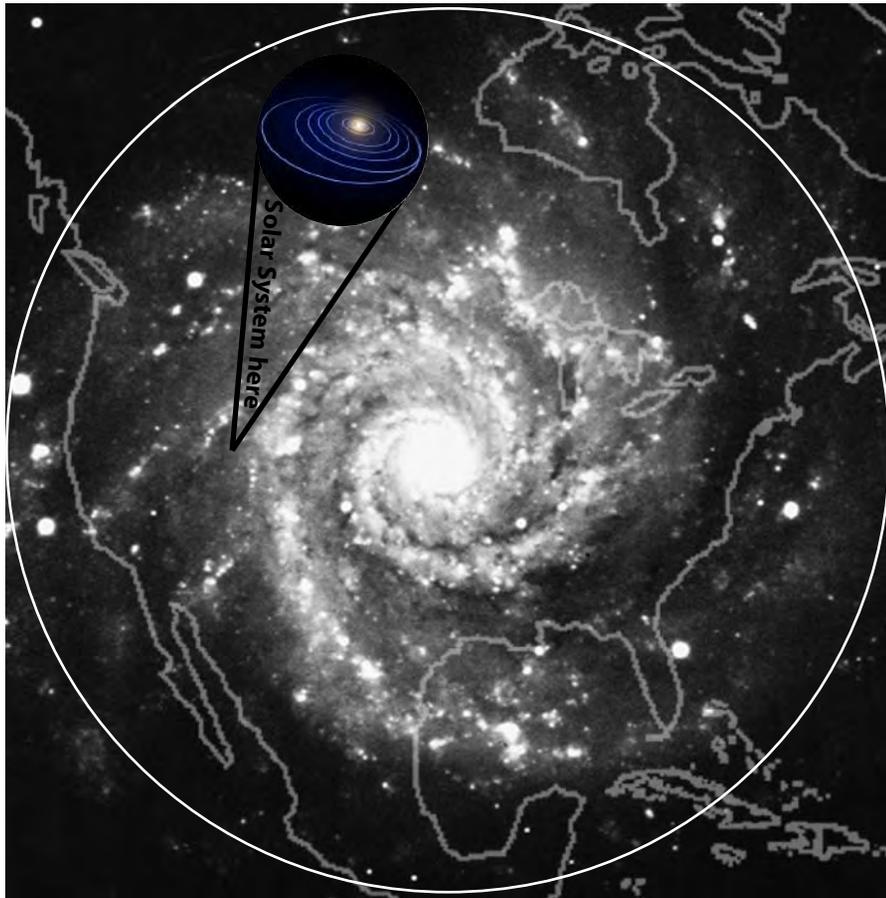
Front

March - May
Our Place in Our Galaxy

SCALE:
Solar System = **A bit larger than a Quarter (2" across)**
Milky Way Galaxy = **North America (2500 mi across)**
40 light years = **1 mile**

Object	Type	Distance (Actual)	Size (Actual)
M44	OC	**14 mi** (577 ly)	**1/4 mi across** (10 ly)
M3	GC	**850 mi** (34,000 ly)	**4.5 mi across** (180 ly)
M13	GC	**625 mi** (25,000 ly)	**3.5 mi across** (145 ly)

< M44

3 mi (126 ly)

< **50 mi** (2100 ly)

< **2 mi** (77 ly)

1 mi (36 ly)

Leo

M74 Photo Credit: NOAO/AURA/NSF

Back

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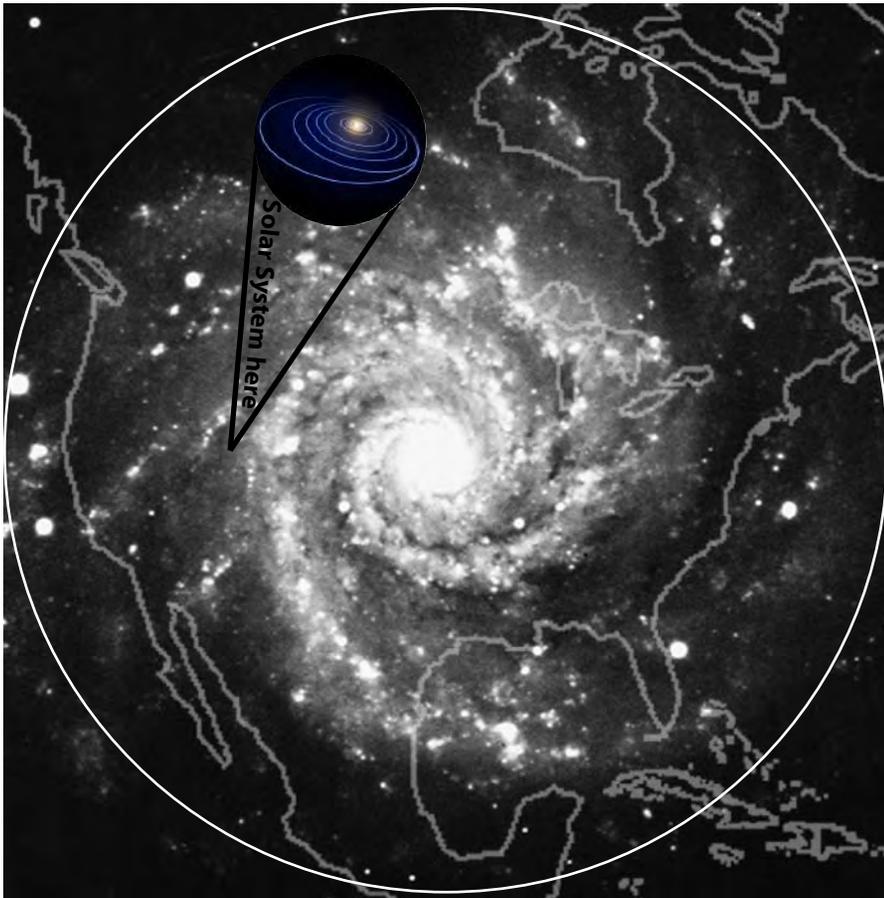
Front

December - March
Our Place in Our Galaxy

SCALE:
Solar System = **A bit larger than a Quarter (2" across)**
Milky Way Galaxy = **North America (2500 mi across)**
40 light years = **1 mile**

Object	Type	Distance (Actual)	Size (Actual)
M1	SNR	**160 mi** (6300 ly)	**1/4 mi** (10 ly across)
M42	Neb	**14 mi** (1600 ly)	**3/4 mi** (30 ly across)
M45	OC	**10 mi** (380 ly)	**1/3 mi** (12 ly across)

M1 >   M45 >

1.6 mi (65 ly)

1/4 mi (11 ly) >   **11 mi** (430 ly) >

M42 >   < **20 mi** (780 ly)

1/4 mi (9 ly) >

Orion

M74 Photo Credit: NOAO/AURA/NSF

Back

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Solar System here

Front

Our Place in Our Galaxy

If we shrink our Solar System (11 light hours across)
down to a bit larger than a quarter
(2 inches across)
our Galaxy, the Milky Way (100,000 light years across),
would span North America
(2500 miles across).

On this scale, 40 light years would be equal to one mile.

The North Star is about 430 light years distant.
It would be about 11 miles from
our quarter-sized Solar System.

M74 Photo Credit: NOAO/AURA/NSF
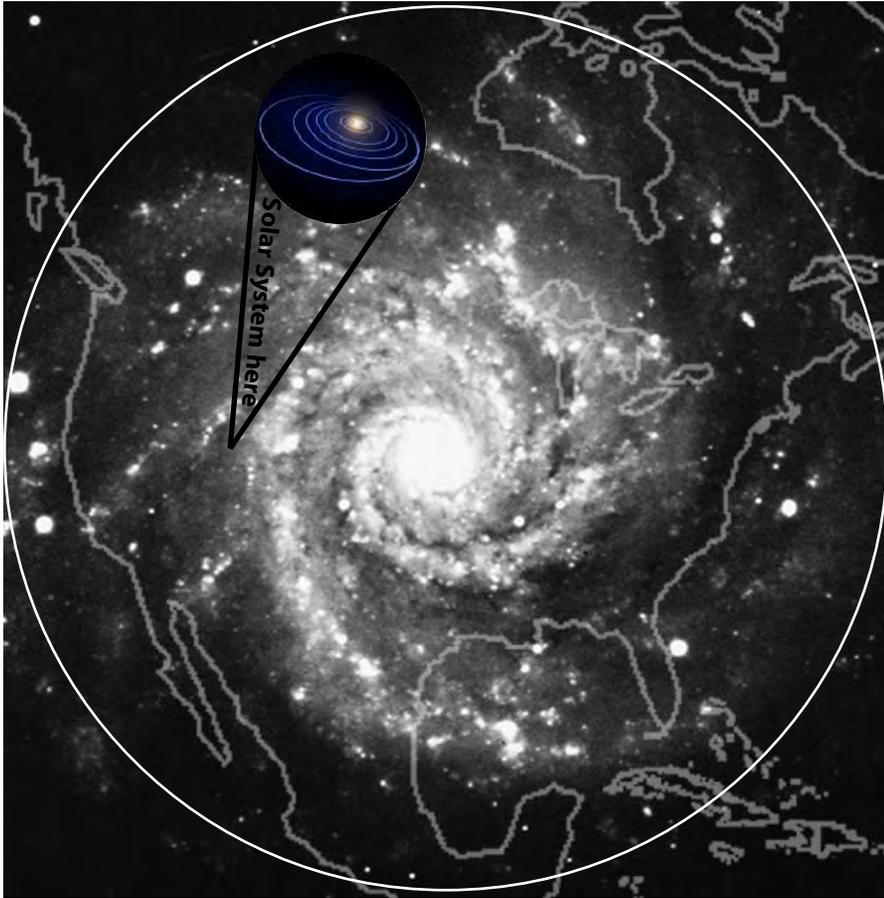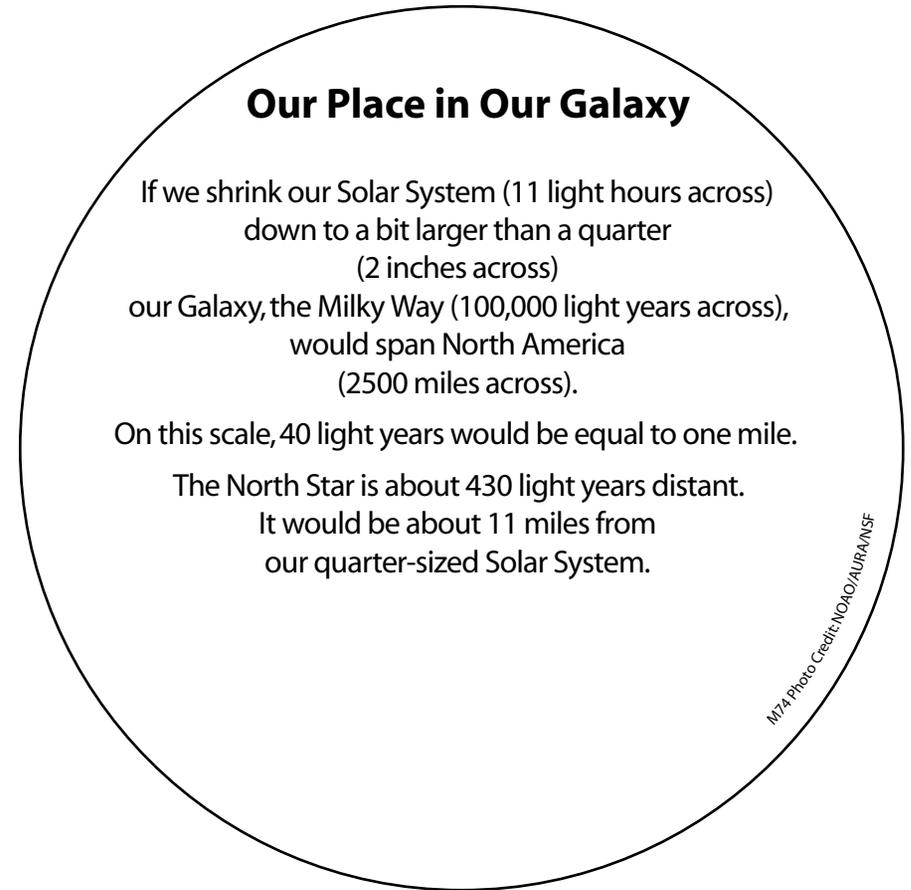
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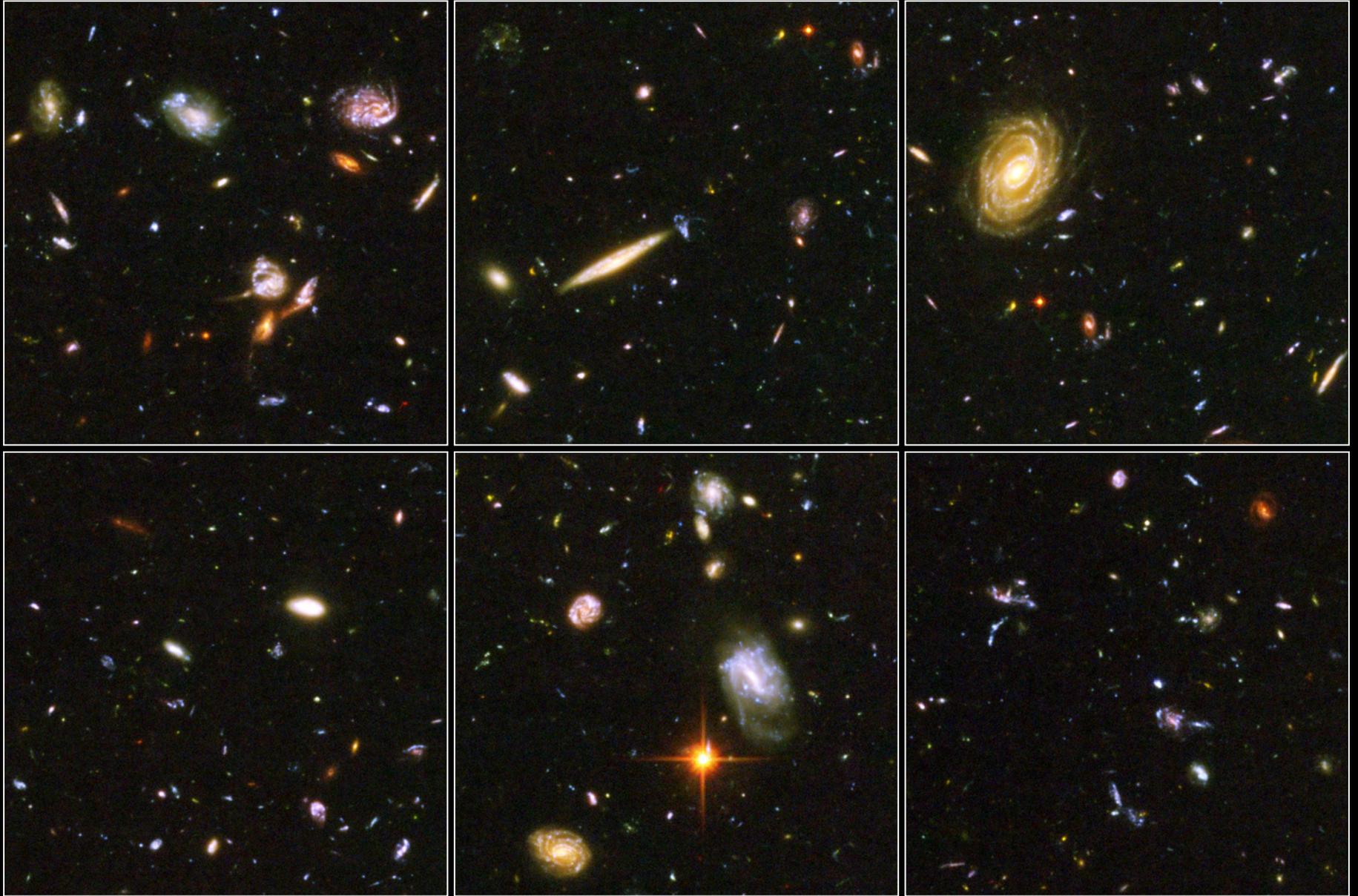
Hubble Ultra Deep Field Details
Hubble Space Telescope • Advanced Camera for Surveys