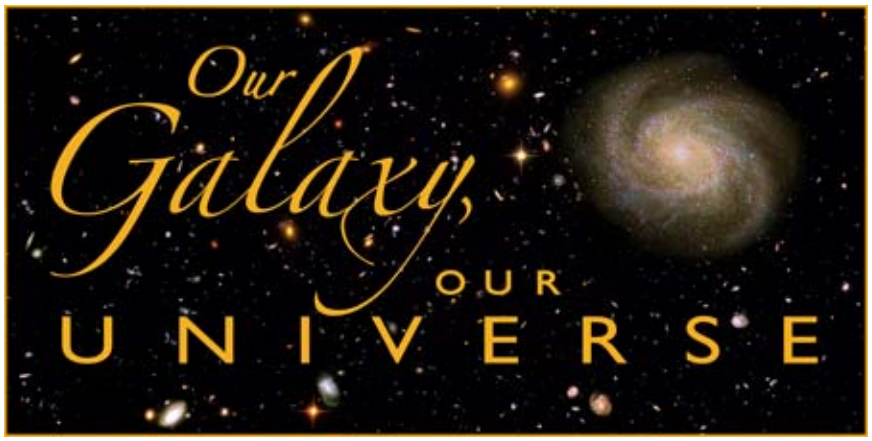


Outreach ToolKit Manual

DISTRIBUTED FOR MEMBERS OF THE NASA NIGHT SKY NETWORK

THE NIGHT SKY NETWORK IS SPONSORED AND SUPPORTED BY:

JPL'S PLANETQUEST PUBLIC ENGAGEMENT PROGRAM,
NASA'S ORIGINS FORUM,
NASA'S STRUCTURE AND EVOLUTION OF THE UNIVERSE FORUM.

THE NIGHT SKY NETWORK WAS FOUNDED BY:

JPL'S NAVIGATOR (PLANETQUEST) PUBLIC ENGAGEMENT PROGRAM

NASA NIGHT SKY NETWORK: *http://nightsky.jpl.nasa.gov/*

Contacts

The non-profit Astronomical Society of the Pacific (ASP), one of the nation's leading organizations devoted to astronomy and space science education, is managing the Night Sky Network in cooperation with NASA and JPL. Learn more about the ASP at http://www.astrosociety.org.

For support contact:

Astronomical Society of the Pacific (ASP)
390 Ashton Avenue
San Francisco, CA 94112
415-337-1100 ext. 116
nightskyinfo@astrosociety.org

Introduction: Our Galaxy, Our Universe Outreach ToolKit

Amateur astronomers doing public outreach report that two of the most misunderstood concepts in astronomy are distance and scale. Related to those are the difference between the Solar System, the Galaxy, and the universe.

NASA missions are exploring the beginnings of our universe, how galaxies formed, and how galaxies evolve. To promote understanding of this exploration, NASA's Origins Education Forum and NASA's Structure and Evolution of the Universe Forum present:

The ToolKit consists of activities and resources that are designed to help your audiences:

- Visualize the basic structure and organization of our Galaxy and the rest of the universe, and the place of our Solar System within it.
- Understand the vast distances to the stars, nebulae, and other galaxies viewed through the telescope.

The variety of activities and materials are designed for use at the telescope, during star parties, and are appropriate for daytime and nighttime venues.

We hope you and the audiences you reach enjoy this ToolKit of materials and activities featuring topics on scale and distances in our Galaxy and our universe.

Summary of Activities & Materials

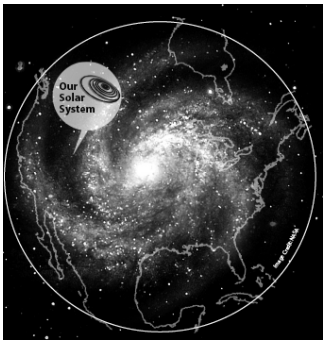
Activities

Three basic structures and the relationships among them are referred to throughout this ToolKit:

- Our Solar System
- Our Galaxy
- Our Universe

By involving your audiences in the learning experience, this ToolKit provides guidelines allow you to help your visitors question their own understanding and come to new awareness regarding these basic structures.

Each of these three activities has opportunities to involve your audience in a hands-on, participatory experience, allowing the presenter or telescope operator to discuss questions and ideas with the audience. **These activities are appropriate for ages 10 to adult.**



1. **Our Place in our Galaxy:** Mentally construct a model of our place in the Milky Way Galaxy and the distribution of stars … with a quarter and some birdseed. At the telescope, help your visitors have a clear understanding of the distances to the objects they are viewing.

2. **A Universe of Galaxies:** Using a set of used CDs to represent the Milky Way and other galaxies build a scale model of the relative distances to other galaxies and to the limit of the known universe.

3. **Telescopes as Time Machines:** Looking through a telescope is like looking back in time. Your visitors take a journey through time to view in the telescopes at least one object from within our solar system, within the Milky Way, within the rest of the universe. The farther the object, the longer the light has been traveling to reach the eye. Were the pyramids being built when the light you are seeing now left that nebula?

Thanks to the ToolKit Testers

NASA and the ASP wish to thank the members of the astronomy clubs around the country who took the time and made the commitment to test these activities in a variety of settings and with a range of audiences. Their dedication and feedback helped to make this ToolKit appropriate, fun, and useful for the members of the Night Sky Network.

Primary Tester	Astronomy Club	State
Ray Shapp	Amateur Astronomers Inc. New Jersey Astronomical Association	NJ
Bob Moody	Arkansas Oklahoma Astronomical Society	AR
JanaRuth Ford	Barnard-Seyfert Astronomical Society	TN
Paul Kronenwetter	Central Florida Astronomical Society, Inc.	FL
Ray Stonecipher	Door Peninsula Astronomical Society	WI
Paul Hoy	Eastbay Astronomical Society	CA
Steven (Scott) Conner	Evansville Astronomical Society	IN
Marni Berendsen	Mount Diablo Astronomical Society	CA
Gerry Kocken	Neville Public Museum Astronomical Society	WI
Andy Oliver	San Angelo Amateur Astronomy Association	TX
Bob Havner	San Jose Astronomical Association	CA
David C. Hutchison	Texas Astronomical Society of Dallas	TX
Ricky Cosby	West Texas Astronomers	TX
Brian Eney	Westminster Astronomical Society, inc.	MD

Check the next two pages for suggestions and advice from the ToolKit testers.

Suggestions from the ToolKit Testers

Here are some comments from some of the astronomy clubs who tested "Our Galaxy, Our Universe" ToolKit in answer to the following questions.

"If you had just 2 minutes to tell someone in your club about this ToolKit, what would you say?"

Arkansas Oklahoma Astronomical Society

This set of materials is the most comprehensive ever devised (to date) for helping us explain the scale of our Solar System and Milky Way to the public. Every member should take advantage of these ideas and materials to assist you at your telescope every time you entertain friends or family from now on.

Door Peninsula Astronomical Society

These are great activities that can help our club in our outreach activities. ASP and NASA have put these together in a way that the presenter does not need to be an authority on the subject to relate the concepts. These programs save our club hours of planning and even provide direction for public viewing sessions rather than just randomly pointing to whatever happens to be in the sky that night.

Neville Public Museum Astronomical Society

This toolkit is fantastic! It brings those hard to comprehend distances in our universe down to an easily remembered scale that can be understood by almost anyone. It doesn't take a lot of time or a lot of materials and can be done in the classroom or on the observing field. It's simple and easy to use and answers those questions of how far "far" is.

Evansville Astronomical Society

One of the most difficult things for most people to understand when they are looking at things through a telescope or on a slide show is distances in space. This is a good tool to help people understand the vast distances of space. It uses some common things here on Earth to depict our galaxy and universe on a much smaller scale. None of the activities require a lot of work to start using.

Barnard-Seyfert Astronomical Society

This ToolKit really does help people understand just how many stars are in our Galaxy and how vast our Universe really is. It also helps with understanding that the light-year is a unit of distance. The concept of telescopes being time machines especially caught public attention!

Texas Astronomical Society of Dallas
This is a good toolkit to teach people about the scale of the universe. Also included with the toolkit is a Hubble Collections DVD which will be useful for indoor presentations. I think most of the activities will work well for our star parties.

San Jose Astronomical Association
If you want to teach anybody about the basics of astronomical distances, sizes, and timescales then this kit is for you! Each focuses on a different aspect delivering a wealth of hands-on tools and very well thought out concepts and analogies. The kits provide examples, templates, and instructions ensuring a foolproof result.

Westminster Astronomical Society
I am impressed. This toolkit finally brings the scale of the universe down to Earth using everyday measurements.

"If you were to give advice to other clubs regarding this ToolKit, what would it be?"

Arkansas Oklahoma Astronomical Society
This toolkit has the potential to help any layperson gain a better understanding of the scale of our Solar System, our Milky Way galaxy, and our Universe. Help fight scientific illiteracy. It's probably the most potent set of materials to assist in your astronomical society's public observing sessions for Education and Public Outreach ever devised.

San Angelo Amateur Astronomy Association
The activity "Our Place in the Galaxy" and the Hubble DVD are quite easy to use. I suggest doing a couple of practice runs with "Universe of Galaxies" to familiarize yourself with the galaxies and distant objects mentioned.

Neville Public Museum Astronomical Society
Give a copy of this toolkit to each of your members. This toolkit can answer the questions of distance and time in a fun and easy manner.

Central Florida Astronomical Society
Practice. These are effective demonstrations of some concepts that are difficult for many people to grasp.

Texas Astronomical Society of Dallas

Try to get creative with how you apply scale. The ToolKit suggests some scale and sizes though you are not limited to this. Try setting up an observing field where distances to the scope are related to what they are pointed to.
Start with a short lecture and re-enforce with a telescope-related activity.

San Jose Astronomical Association

Prepare Prepare Prepare! Imagine your setting and make sure you have enough of all supplies that you will use. You may want to consider having a second person to help with logistics – like handing out stuff.

Evansville Astronomical Society

Plan your activities in advance. It is good to do a dry run on some of the activities before doing the presentation. None of them are difficult but a smooth flow helps people to follow it.
Have a good time using these tools. We had a good time testing them out.

Media and Resources

The "Training Video DVD" should be viewed as soon as you receive the ToolKit. This will provide an introduction to the activities and materials.

Explore the "Manual and Resources CD":

- For the ToolKit Manual, open the "OGOU_Manual.pdf"
- For PowerPoints, go to the folder labeled "PowerPoints"

View the "Hubble Collections" DVD for video clips to share with your club members and the public.

Feel free to make copies of the **DVDs and CD** for distribution to other club members or educators. All materials must be provided free or at your cost. Labels for the CD and DVDs can be found in the "Logos and Labels" folder on the "Manual and Resources CD".

Materials for Media & Resources

For online access to the booklet "how big is our universe?" included in the Media and Resources bag, go to:
http://cfa-www.harvard.edu/seuforum/howfar/index.html
After you enter the website, click on "download pdf" or "print-friendly pdf" to download a copy of the booklet.

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

Copies of the CD and DVD can be made at your local photo center or other media duplication service.

Night Sky Network Log Event Form

Starred fields are required.

***Name of Event:**	
***Submitted By (Person):**	
***Club:**	
***Name of Primary Presenter/Organizer:**	
Presenter's Profession:	

***Event Type: (Check ONE)**

- ☐ Star Party (Astronomy Night):School/Public/Other Group
- ☐ Star Party for club members
- ☐ Classroom Presentation
- ☐ Club Meeting
- ☐ Astronomy Convention/Conference
- ☐ Family/Friends Event
- ☐ Girl Scout Event/Meeting
- ☐ Other Youth Group Event/Meeting
- ☐ Other organization's mtng/convention/conference
- ☐ Club newsletter article
- ☐ Newspaper/magazine article
- ☐ Television/radio show
- ☐ Other (please specify):

Name of Group the Event was for:	
*** Event Date:**	
*** Length of Event:**	(specify # of mins,hrs, or days - or approx # of words if an article):
*** Event Location:**	*City: *State: Zip:

***Facility Type (Check ONE):**

- ☐ K-12 School
- ☐ College/University
- ☐ Museum/planetarium/observatory
- ☐ Community/Gov't Facility (e.g. Library, Park, Sidewalk)
- ☐ Private Facility (e.g. hotel, private home)
- ☐ Media (newspaper, newsletter, magazine, TV)
- ☐ Other (please specify):

*** Number of your club members participating as presenters:** ☐

Toolkit Activities Used	
PlanetQuest Kit: (Check all that apply)	☐ Telescope Treasure Hunt ☐ Where are the Distant Worlds (Star maps) ☐ How do we find planets around other stars? ☐ Why do we Put Telescopes in Space? ☐ Used ToolKit materials, media, or information not related to specific activities
Our Galaxy, Our Universe (Check all that apply)	☐ Our Place in Our Galaxy ☐ A Universe of Galaxies ☐ Telescopes as Time Machines ☐ Hubble Video Collection DVD ☐ Used ToolKit materials, media, or information not related to specific activities

(Continue to Page 2)

	***Total Number of Visitors or Audience Members (if unknown, please estimate)**

Demographics of audience members are requested by government agencies. If exact numbers are unknown, please try to estimate. Otherwise, leave the space blank.

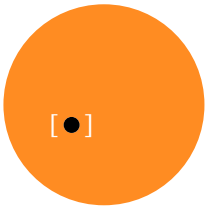
Estimated #	How many visitors or audience members were...		
	Minority?		Adults?
	Female?		Teens?
			Children?

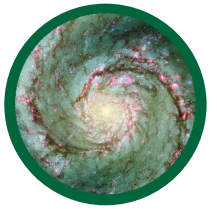
IF A SCHOOL EVENT:

Estimated #	How many audience members were...		
	Non-teacher adults?		
	K-8th Grade Teachers?		K-8th Grade Students?
	High School Teachers?		High School Students?
	Community College Instructors?		Community College Students?
	Other College or University Instructors?		Other College or University Students?

What materials (and how many) did you hand out at the event, if any?
Provide a few comments or interesting anecdotes about the event:

- **PHOTOS:** If you wish to include electronic photos, you will need to log your event online.
- **Please use this form as a reference to log your event online on the Night Sky Network:** http://nightsky.jpl.nasa.gov
- **OR send the form to your Night Sky Network Club Coordinator**
- **OR mail this form to:**
  Night Sky Network
  Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112
- **OR FAX this form to:** 415-337-5205





how big is our universe?

[an exploration through space and time]

contents

how far away?

On a beautiful, clear night, the stars seem so close you could almost reach out and touch them. How far away are the stars? What lies beyond them? How large is the universe as a whole?

Without knowing distances, the sky is just a starry bowl over our heads – like the dome of a planetarium. If we can figure out the distance to the stars, we will begin to see what the universe looks like in three dimensions, and we will begin to answer some of the greatest of questions: How old is the universe? Is it infinitely large? What is our place in the cosmos?

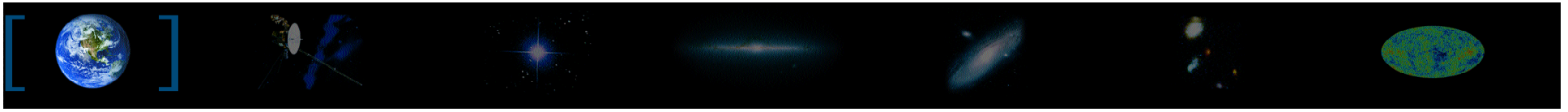
This booklet shows how generations of explorers have taken us, step by step, ever further into the vast expanse of the universe. It is a journey of discovery that has only just begun.

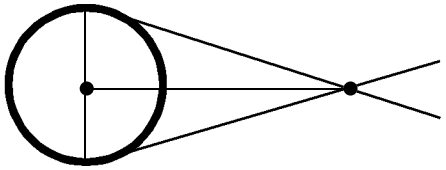
Third century BC. Aristarchus of Samos measures the distance to the Moon by looking at the shadow of the Earth during a lunar eclipse.

imagine this:

This picture shows all the places in the universe that humans have been to.

Our view starts here.



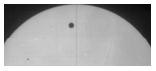


how far are the sun and planets?

The Sun is so far away that it would take the Space Shuttle seven months to fly there. That's why the Sun, which is a million times the size of the Earth, looks so small!

Three hundred years ago, astronomer **Edmund Halley** found a way to measure the distance to the Sun and to the planet Venus. Knowing these distances helped find the true scale of the entire Solar System for the first time.

Halley knew that every 121 years the planet Venus passes in front of the Sun. Venus' position, relative to the Sun behind it, appears very different when viewed from two different places on Earth. How different depends on how far away Venus and the Sun are from the Earth.



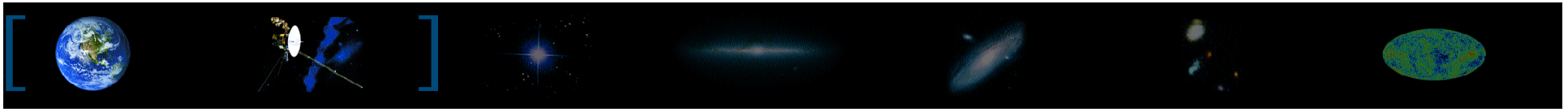
1761. Using observations of the "transit of Venus" made by astronomers around the world, the distance to the Sun is determined to be 93 million miles. This photograph is from the 1882 transit of Venus.

try this:
your "point of view" makes a difference!

Hold up your thumb at arm's length. With one eye closed, line up your thumb with an object in the distance. Now switch eyes so that only the other eye is open. Does your thumb suddenly change position? Move your thumb closer to your nose and try again. Can you see your thumb jump even more?

Astronomers call this effect "parallax." The closer an object, the more it appears to shift against the distant background, when viewed from two different spots.

The furthest human object is the space probe Voyager 1. Launched in 1977, it is now over twice as far as Pluto, the most distant of the Sun's planets.

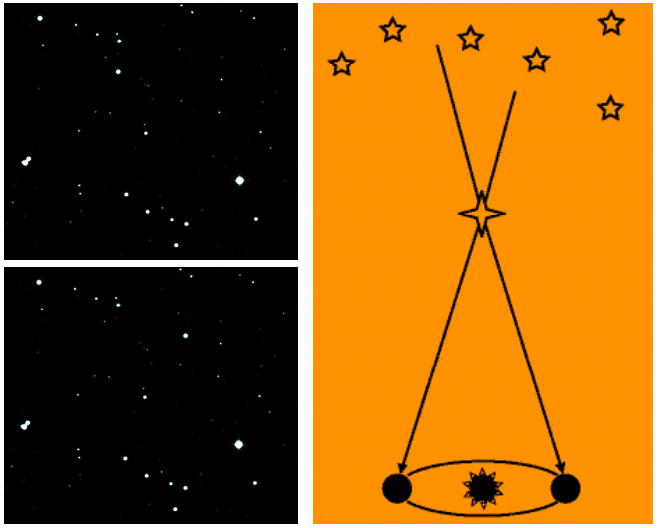


how far are the stars?

Traveling to the stars? Don't pack for a week or a month. Pack for 70,000 years – the travel time to the nearest star using our fastest spaceship!

As the Earth moves around the Sun, our view of nearby stars changes slightly against the background of other stars that are further away. Astronomers use this effect, called parallax, to determine the distance to the nearest stars.

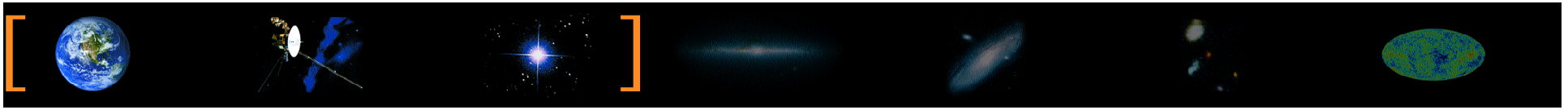
1836. German scientist **Friedrich Bessel**, using a specially designed telescope, is the first to see a star's position appear to change as the Earth moves around the Sun. He finds the star to be 700,000 times further away than our Sun!



try this: jumping stars

These pictures were taken six months apart, when Earth was on opposite sides of its orbit. Can you tell which star is closer than the rest? Look for the star that appears to change postion, like your thumb when seen from two points of view.

Deneb, in the constellation Cygnus, is one of the most distant stars you can see by eye. It takes light from Deneb 1600 years to reach us.



how far is it across the milky way?

Our Milky Way galaxy of stars is so huge that even at the speed of light it would take 100,000 years to travel across it!

The further a star, the fainter it looks. Astronomers use this clue to figure out the distance to very distant stars. But there's a big challenge to this method: You need to know the star's "wattage"– how bright it really is – to begin with.

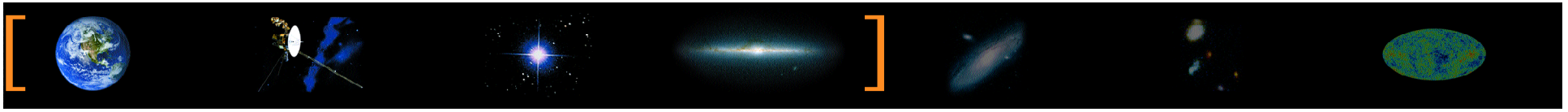
1908. Henrietta Leavitt discovers a way to tell the "wattage" of certain pulsating stars by observing how long it takes them to brighten and dim. The method opens the way to measuring distances all the way across the Milky Way galaxy.

making a mental model: how big is the milky way?

Imagine that our entire Solar System were the size of a quarter. The Sun is now a microscopic speck of dust, as are its nine planets, whose orbits are represented by the flat disc of the coin.

On this scale, the diameter of our Milky Way galaxy will be about the size of the United States! How far away is the nearest star to our sun? In our model, Proxima Centauri (and any planets that might be around it) would be another quarter, two soccer fields away. This is the typical separation of stars in our part of the galaxy.

Our solar system is about 2/3 of the way from the center of our Milky Way galaxy.



how far are other galaxies?

Even “nearby” galaxies beyond our own Milky Way galaxy are so far that it takes their light millions of years to reach us. The images we take today show how these galaxies looked millions of years ago.

The further a galaxy, the smaller it appears. You can use this method to get a rough idea which galaxies are closer and which are further. Although galaxies come in different shapes and sizes, the spiral galaxies similar to our own Milky Way are thought to be roughly the same size. So if a spiral galaxy looks half as big as another, it is probably twice as far away.

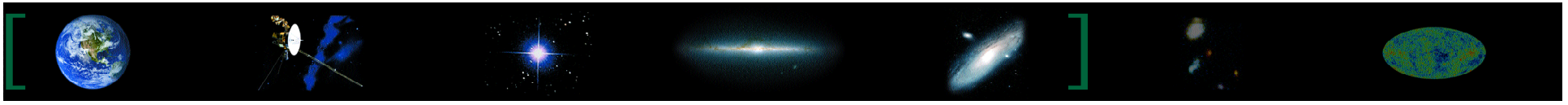
1924. Edwin Hubble presents the first evidence that galaxies lie far beyond the Milky Way. To date, billions of galaxies have been discovered.

try this: far and small

You’ve been asked to award a prize to the balloon that has traveled the furthest from the starting line. But you have only this photo taken from the starting line to go on.

What clues will you use? How do you know that the balloons that look smaller are further away and not just smaller balloons? Which balloon would you choose, and why? Astronomers face the same challenges trying to determine the distance between galaxies.

The furthest thing you can see by unaided eye is the Andromeda Galaxy, the nearest large galaxy to our Milky Way. Light from Andromeda takes 2 million years to reach us!



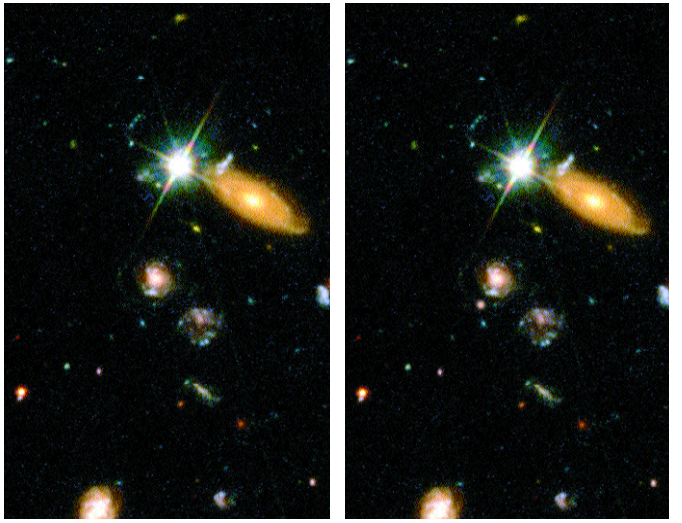
how far are the distant galaxies?

They're so far that the light arriving on Earth today set out from the galaxies billions of years ago. We see the galaxies not as they are today, but as they looked long before there was life on Earth.

Some galaxies are so far away that they appear as tiny smudges, even through the largest telescopes. It's tough to determine how large or bright these fuzzy distant galaxies are. But astronomers can figure out the distance to these galaxies, by watching for incredibly bright exploding stars called supernovae.

Some types of supernovae have a known brightness – or "wattage" – so we can figure out how far they are, and therefore the distance to their home galaxy.

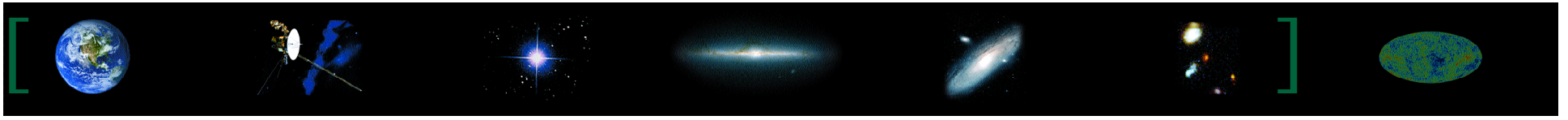
1986. Astronomers begin to use supernovae to find the distance to the furthest galaxies we can see.



try this:
can you spot the exploding star?

The picture on the right was taken three weeks after the one on the left. In that time, a star at the edge of one of these distant galaxies has exploded — "gone supernova." Can you spot the supernova in the picture at right? Even though the explosion is as bright as a billion suns, it is so far away that it is just a speck of light!

Light from the furthest galaxies we can see has taken more than ten billion years to reach us!

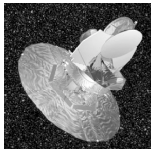


how far can we see?

Time, not space, limits our view of the universe. Beyond a certain distance, light hasn't had time to reach us yet since the beginning of the universe.

The image at left is the oldest and youngest picture of the universe ever taken. Oldest, because it has taken the light nearly 14 billion years to reach us. Youngest, because it is a snapshot of our newborn universe, long before the first stars and galaxies formed. The bright patterns show clumps of simple matter that will eventually form stars and galaxies.

Although this light fills the entire night sky, it is so faint and has so little energy that it is detectable only with special instruments. This colorized image was taken by NASA's Wilkinson Microwave Anisotropy Probe.



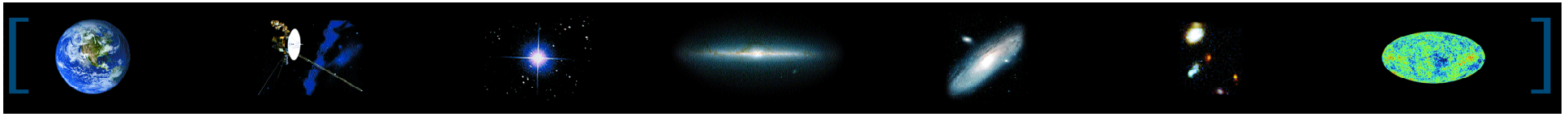
2003. NASA's WMAP satellite takes images of the most distant part of the Universe observable from Earth. The image shows the furthest we can see using any form of light.

making a mental model: how big is the universe that we can see?

Imagine that our entire Milky Way galaxy were the size of a CD. On this scale, the nearest spiral galaxy, Andromeda, would be another CD about eight feet away.

The furthest galaxies we have ever seen, pictured in the Hubble Deep Field above, would be CDs about nine miles away. The edge of the observable Universe, the furthest we can possibly see, is only another mile beyond that.

The universe of 14 billion years ago was so hot and dense that living then would have been like living *inside* the Sun!



how big is the universe?

No one knows if the universe is infinitely large, or even if ours is the only universe there is.

Although our view of the universe is limited, our imaginations are not. Astronomers have indirect evidence that the universe of galaxies extends far beyond the region we can see. But no one knows if the whole universe is infinitely large — large beyond limit.

According to the leading theories, other parts of the universe may look very different from our own — and may even have different laws of nature. We may never be able to find out for sure. But it is possible that clues to the answer lie in plain view, just waiting to be discovered!

The Future. NASA's LISA mission will look for ripples in the fabric of space, predicted by Albert Einstein. Such clues may help refine theories about what the rest of the universe is like.

try this: picturing your local universe

Is the view from your window typical of planet Earth?

Is there any thing that would suggest the Earth is flat or round?

Is there anything that gives you a clue that the larger world may be very different?

There is a limit to what we can see, but is there a limit to what we can understand?

$$d\tau^2 = dt^2 - R^2(t)\left\{\frac{dr^2}{1-kr^2} + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right\}$$

credits

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To continue the exploration, visit: http://cfa-www.harvard.edu/seuforum

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Pantheon, Giovanni Paolo Panini, Italian, 1691-1765. Interior of the Pantheon, Rome, 1747. Oil on canvas, 127 x 97.8 cm. © The Cleveland Museum of Art, 2003. Purchase from the J.H. Wade Fund, 1974.39
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Page 3:
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Page 8:
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Galaxy, Hubble Heritage Team (AURA/STScI/NASA)
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Galaxy cluster, Gemini Observatory - GMOS-S Commissioning Team

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Cosmic Microwave Background, NASA/WMAP Science Team

Page 14:
WMAP satellite, NASA/WMAP Science Team
Galaxy field, R. Williams (STScI), the Hubble Deep Field Team and NASA

Page 15:
Night sky view, Gemini Observatory, Peter Michaud and Kirk Pu'uohau-Pummill

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Distance Scale Bar:
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Voyager probe, Courtesy of NASA/JPL/Caltech
Deneb, © 1993-1995 by the California Institute of Technology, Palomar Observatory, STScI/DSS
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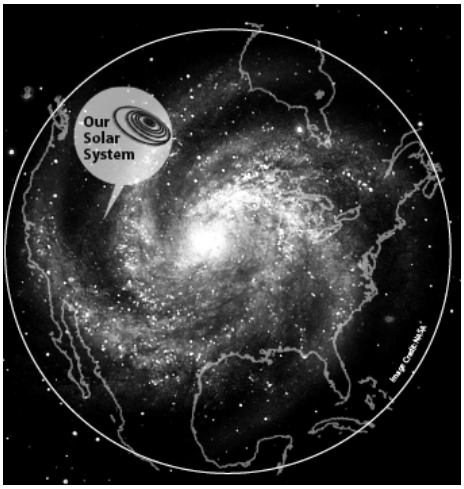
Cosmic Microwave Background, NASA/WMAP Science Team


Produced by the NASA-SAO Education Forum on the Structure and Evolution of the Universe.



OUR PLACE IN OUR GALAXY

What's this activity about?

Big Question: Where are we in the Milky Way Galaxy? How far to the stars? What is "The Milky Way" we see in the sky?

Big Activity: **Presentation:** Mentally construct a model of our place in the Milky Way Galaxy and the distribution of stars … with a quarter and some birdseed.
At the Telescope: Use the scale model to allow visitors to better understand distances to objects they view in your telescope.

Participants: Adults, teens, families with children 8 years and up
If a school/youth group, 5th grade and higher
From one person to an auditorium of participants

Duration: **Presentation (with or without the PowerPoint):** 10 – 20 minutes
At the telescope: 1 – 5 minutes

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

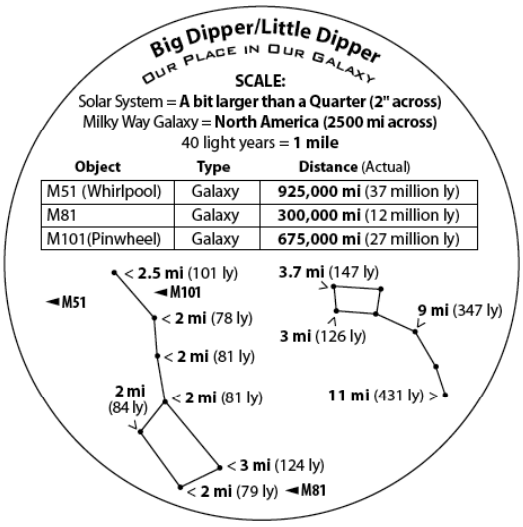
Where can I use this activity?

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.

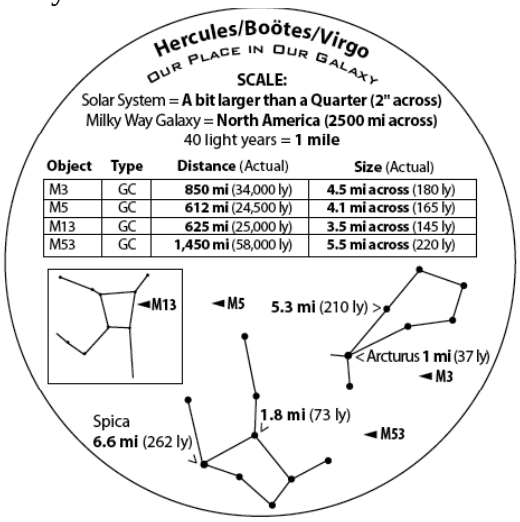
3) **Meeting/Presentation:** You might want to use the PowerPoint in the "PowerPoint" folder on the *ToolKit Manual and Resources CD*. If you do not have access to a computer projector, you can print the slides onto transparencies for use with an overhead projector. See the **Detailed Activity Description** 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 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 away (pick a city or landmark at that distance) and would be a cloud of gas and dust 3/4 of a mile wide. Compare that to the quarter representing our Solar System.

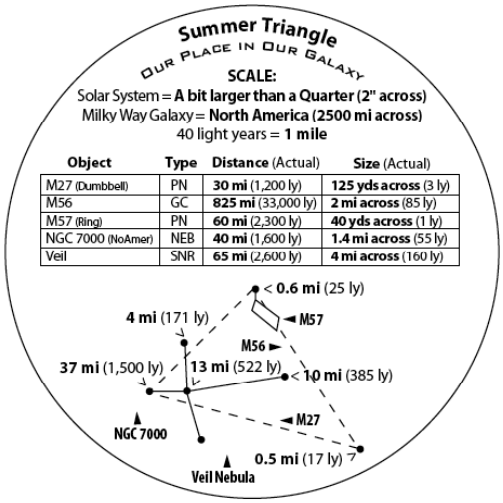


   c) Example #3: Viewing the **Hercules globular cluster (M13**), on the Quarter-North America scale this swarm of thousands of ancient stars is over 600 miles away and would span almost 4 miles. Compare that to the quarter representing our Solar System.

   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).

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 on the Quarter-NorthAmerica scale model) while Vega is quite close: only 25 light years away (or 0.6 miles 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 on the scale model), we are probably looking beyond the center of our Galaxy, over to the far side of our Milky Way Galaxy.

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.

There are **Presentation Tips** noted throughout this presentation.

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.

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

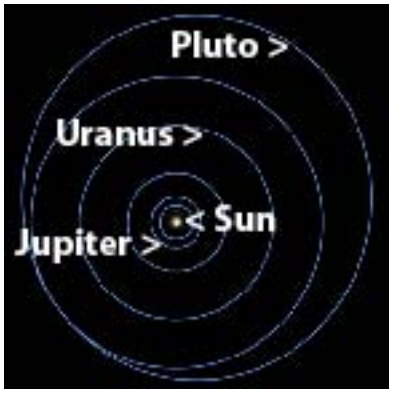
References used for distances and extent of stars and objects on the constellation/asterism CDs:
Observer's Handbook 2004, Editor: Rajiv Gupta, The Royal Astronomical Society of Canada
SEDS Messier Catalog: http://seds.org/messier

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 *To Say:* 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.) *To Say:* 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.	
Distance in Light Years *To Ask:* 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). *To Ask:* 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.



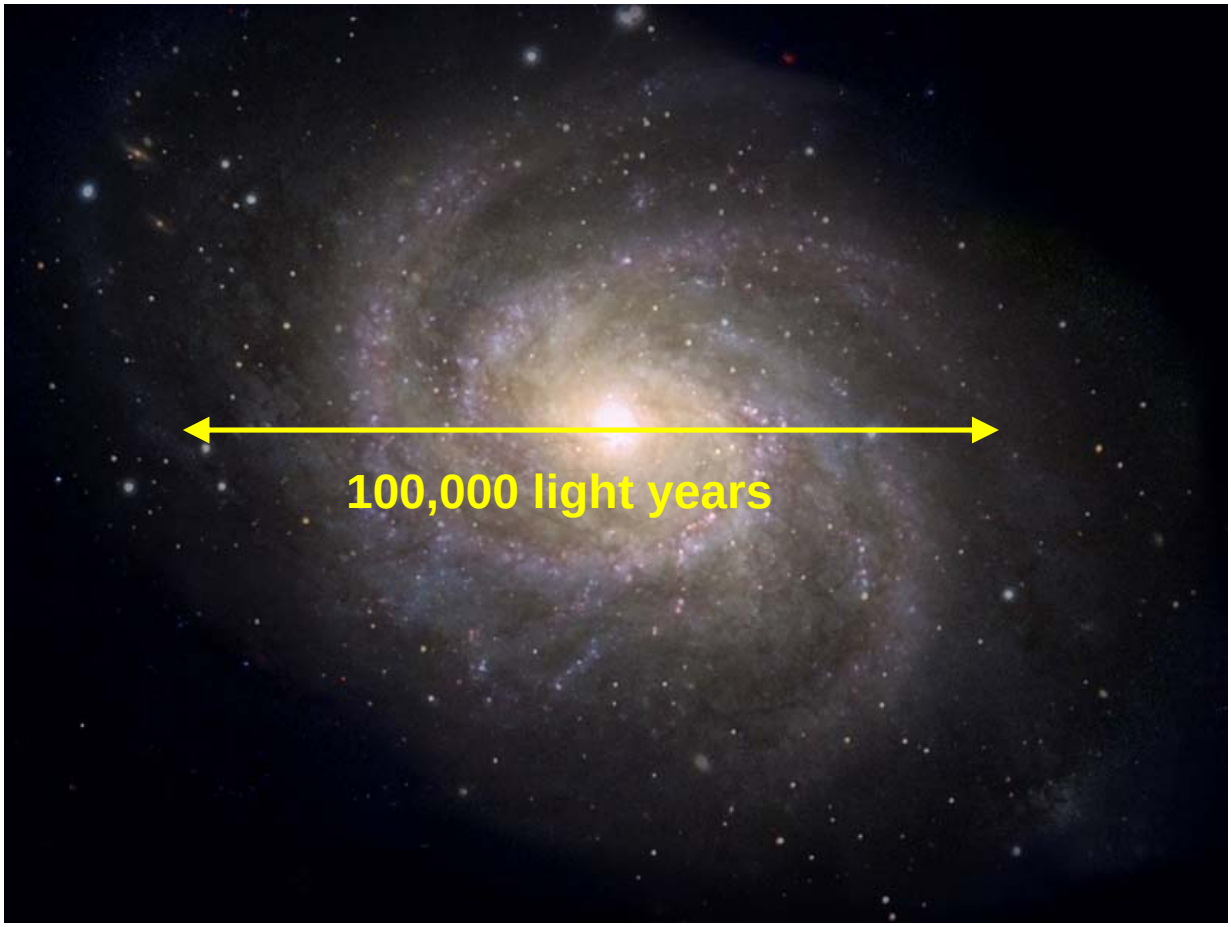
11 light hours across the Solar System;
5.5 hours for light from the Sun to reach Pluto. A quarter would cover the orbit of Uranus on the scale we're using.

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.

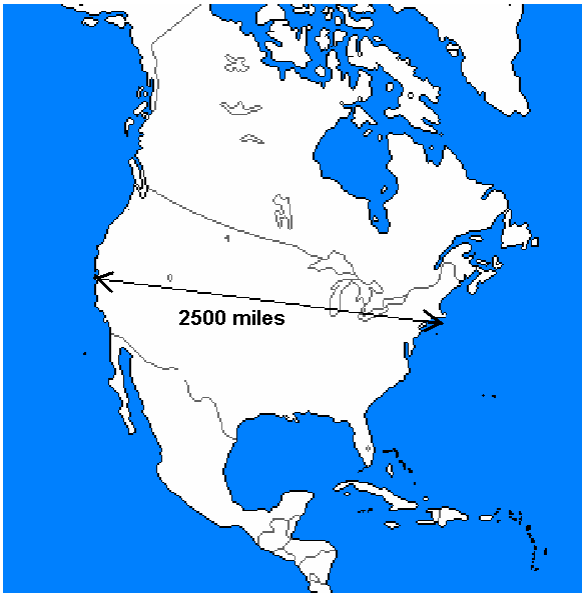
Leader's Role	Participants' Roles (Anticipated)
Presentation Tip: This presentation builds a **scale model** of the Milky Way. Some younger visitors may not understand scale models. To assist with understanding scale models, use this as an introduction:	
Show: Miniature house. *Ask* If we shrank your 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.



Credit: STScI

Leader's Role	Participants' Roles (Anticipated)
It's about 2500 miles 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 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 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 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
To Say: Is there someone here about four feet 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

Leader's Role	Participants' Roles (Anticipated)
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 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 or 2 football field lengths away. Sirius (8+ light years away) is about 1/4 mile away (4 football field lengths). Polaris, the North Star, (430 light years away) is about 11 miles 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.
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.	

Leader's Role	Participants' Roles (Anticipated)
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.

RECOMMENDED: Use "A Universe of Galaxies" activity in this ToolKit which uses a CD to represent the size of the Milky Way Galaxy.

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!

<u>Presentation Tip</u>: 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.

<u>T o Say:</u>

The fastest speed attained by a craft with humans in it is 24,790 miles 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, reached by the Helios satellite that is in orbit around the Sun.

How many miles per second do you suppose that is? (42 miles per second)

<u>To Ask:</u>

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 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.

<u>To Discuss:</u>

- 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?

Materials

What materials from the ToolKit do I need?

In the bag:

1. CD Holder
2. Stack of used CDs
3. One printed cut sheet of the Galaxy by itself on one side and the Galaxy with outline of North America on the other. To be attached to one of the used CDs.
4. Printed cut sheets for the other CDs with seasonal star charts
5. Flashlight
6. Lanyard
7. Miniature houses
8. Set of visitor handouts: "Quarter-North America Galaxy Model" – for gluing onto a CD
9. Milo bird seed in plastic bag
10. Film canister – to be used as a scoop for the bird seed
11. Glue stick
12. Solar System images sheet – you need to cut these apart and assemble
13. Hubble Ultra Deep Field (UDF) card from NASA

On the *ToolKit Manual and Resources CD* in the OGOU_Manual.pdf:

- Masters for Milky Way CDs with seasonal star charts
- Masters for "Quarter-North America Galaxy Model" visitor handouts
- Hubble Ultra Deep Field
- Solar System Images sheet

On the *ToolKit Manual and Resources CD* in the "PowerPoint" folder:

- PowerPoint "Our Place in Our Galaxy" – if you do not have access to a computer projector, you can print the slides on transparencies for use with an overhead projector.

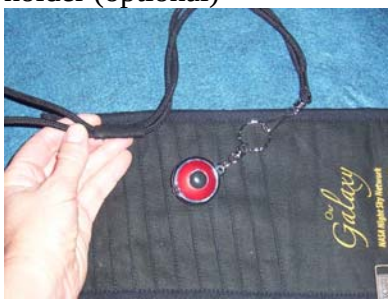
What do I need to prepare?

- Set of CDs with Milky Way and seasonal star charts – peel off the circles

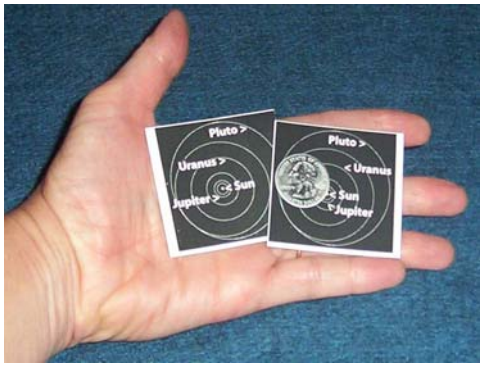
and attach to used CDs as instructed on the sheets.

- Insert CDs into CD Holder

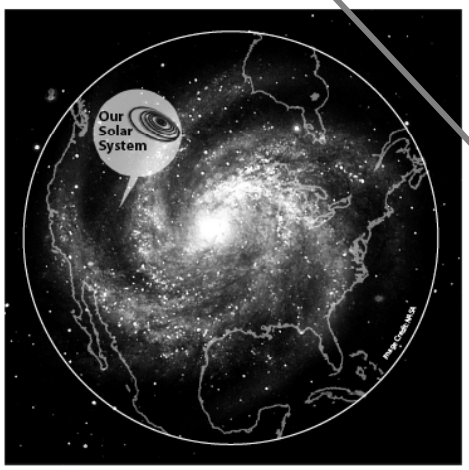
- Attach the lanyard with the flashlight to the CD holder through the loop on the CD holder (optional)



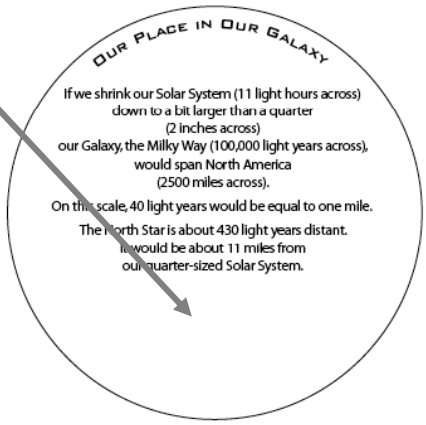
- Cut apart the Solar Systems images on the sheet – glue the image with the quarter to the back of the image without the quarter. You may want to store these in the zipper pocket of the CD holder.



- You may want to insert your club information on the "Quarter-North America Galaxy Model" visitor handouts



FRONT



BACK

What must I supply?

- One Quarter (25-cent piece)
- Telescopes

Where do I get additional materials?

- **Milo bird seed:** Almost any feed store will have this kind of round bird seed
- **Small scoop**: Empty 35 mm film canister
- **Small Solar Systems**: The master for these can be found on the *ToolKit Manual and Resources CD* in the OGOU_Manual.pdf.
- **Miniature houses**: Use houses from a Monopoly® game.

To make the seasonal Milky Way CDs:
The pages for the Milky Way CDs with the seasonal star charts are on the *ToolKit Manual and Resources CD* in the OGOU_Manual.pdf..
Here are three options for making more sets:

1. Photocopy or print the pages, then cut them out and glue them to used CDs.
2. 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.
3. Order sheets pre-cut with circles (like the ones that came with the ToolKit) from rippedsheets.com by calling 1-888-791-9590 and print the template pages onto these sheets. Be sure to tell rippedsheets.com that it is for the "Astronomical Society of the Pacific" so they will use the correct dietool. Minimum order is 50 sheets.

CD Holders: These may be purchased at most music stores, department stores, or online in bulk from www.quantumpromotions.com, Item # HEYLH-BFUNN (Description: CD Visor Organizer).

Hubble Ultra Deep Field image:

- The master for this is on the *ToolKit Manual and Resources CD* in the OGOU_Manual.pdf.
- You may also get it from:
  http://hubblesite.org/newscenter/newsdesk/archive/releases/2004/07/image/c
  and for the Ultra Deep Field press release:
  http://hubblesite.org/newscenter/newsdesk/archive/releases/2004/07/

Calculation Details

Galaxy the size of North America

BREADTH: 100,000 light years

Sun to Pluto is represented by a quarter: 1": 5.5 light hours
Diameter of Solar system: 11 light hours or 2"

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
= 1592 inches in a light yr
÷ 12 inches in a foot
= **132 feet for one light yr**

How many feet or miles across the Galaxy on this scale?

132 feet for one light yr
X 100,000 light years
= 13,200,000 feet
÷ 5280 feet in one mile
= 2,500 miles for 100,000 light years

The Milky Way Galaxy is about 2500 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 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" 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?

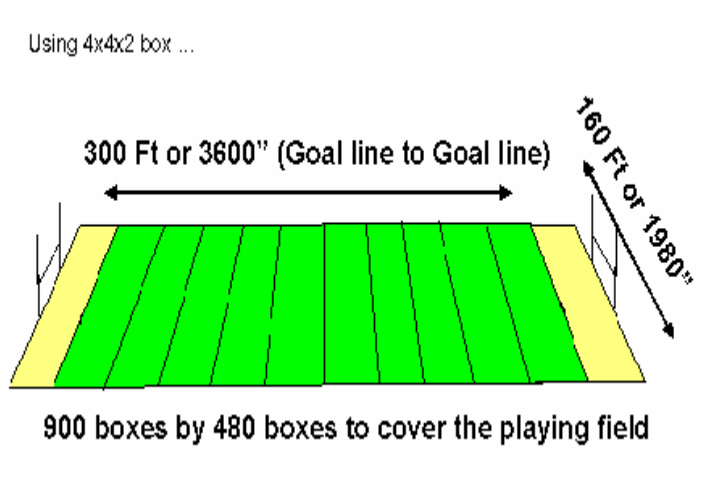
There are approximately 1300 “stars” in one scoop.

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 and about 160 feet wide or 3600” by 1920”.



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

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 deep all over North America, with about 1/3 of them over Kansas/Iowa. Enjoy your trip!

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.

NASA and the Astronomical Society of the Pacific wish to thank YesVideo.com, a video transfer service, for donating the used CDs provided with this ToolKit.

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

Assembly:

Cut out each disk and glue to a used CD.
Insert assembled disks into a CD holder or other container for easy reference.

Listing of Objects on CDs:

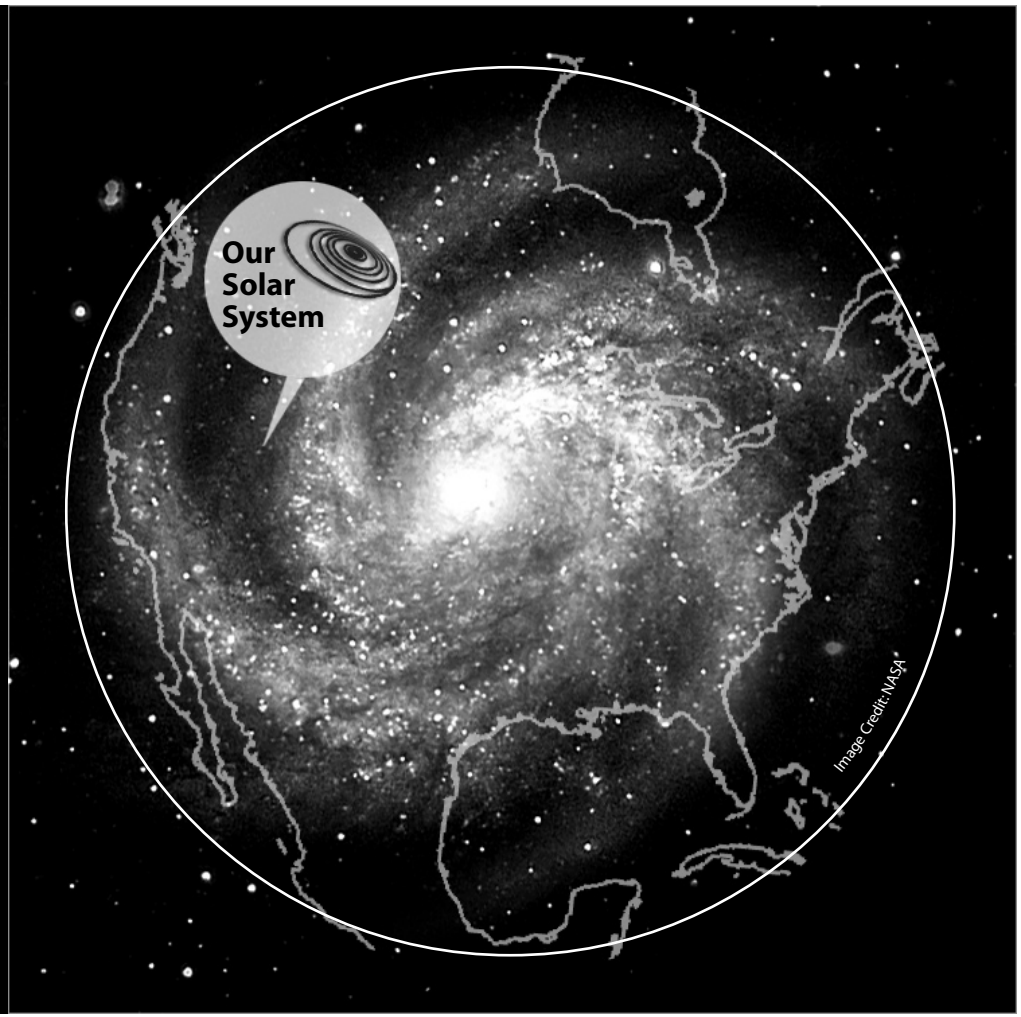
For an Excel spreadsheet listing the objects on the Constellation/Asterism CDs, see the file on the *ToolKit Manual and Resources CD* named "OPIOG_ObjectList.xls". You may add your favorite objects to this list and print it out as a reference at the telescope if you prefer to use a list instead of the CDs.

Our Place in Our Galaxy

Cut out each circle and glue the "FRONT" to the label side of a used CD.

Glue the "BACK" to the other side of the CD.

FRONT



BACK

Instructions:
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Sagittarius

OUR PLACE IN OUR GALAXY

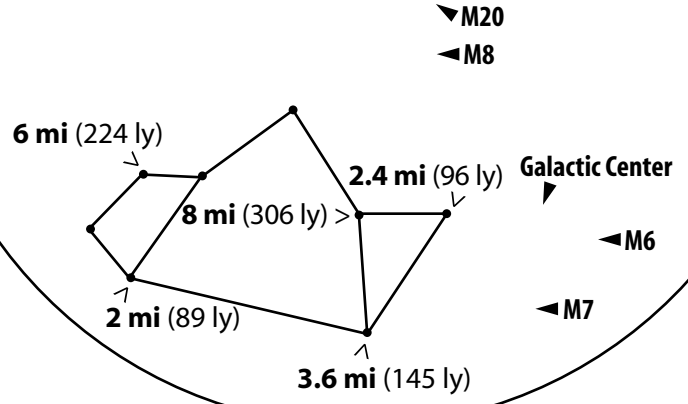
SCALE:

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)
M6	OC	**40 mi** (1,600 ly)	**1/3 mi across** (12 ly)
M7	OC	**20 mi** (800 ly)	**1/2 mi across** (20 ly)
M8 (Lagoon)	NEB	**130 mi** (5,200 ly)	**3.5 mi across** (140 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)



FRONT

Ophiuchus/Scutum

OUR PLACE IN OUR GALAXY

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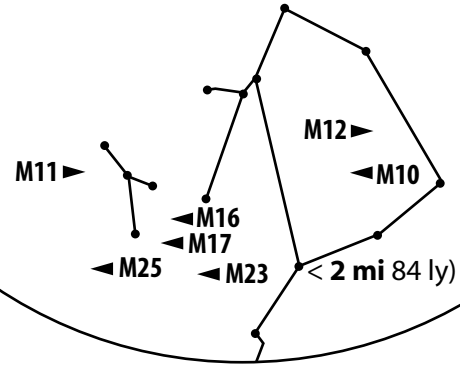
Object	**Type**	**Distance** (Actual)	**Size** (Actual)
M10	GC	**360 mi** (14,300 ly)	**2 mi across** (83 ly)
M11 (Wild Duck)	OC	**150 mi** (6,000 ly)	**0.6 mi across** (24 ly)
M12	GC	**400 mi** (16,000 ly)	**1.9 mi across** (75 ly)
M16 (Eagle)	NEB	**175 mi** (7,000 ly)	**0.4 mi across** (15 ly)
M17 (Omega)	NEB	**125 mi** (5,000 ly)	**0.4 mi across** (15 ly)
M23	OC	**54 mi** (2,150 ly)	**0.4 mi across** (15 ly)
M25	OC	**50 mi** (2,000 ly)	**0.6 mi across** (23 ly)



BACK

Instructions:

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Orion/Taurus

OUR PLACE IN OUR GALAXY

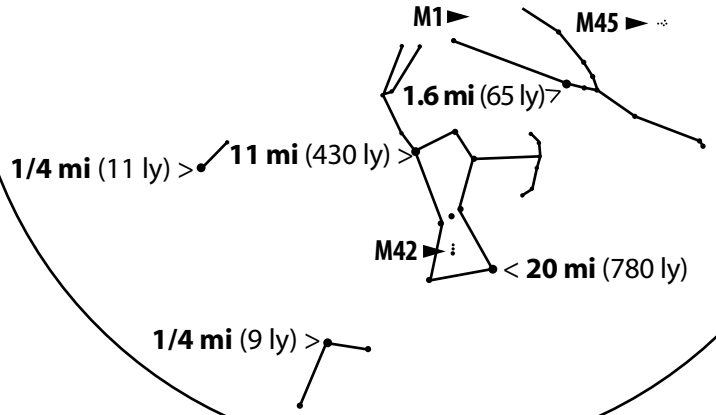
SCALE:

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 across** (10 ly)
M42	Neb	**40 mi** (1600 ly)	**3/4 mi across** (30 ly)
M45	OC	**10 mi** (380 ly)	**1/3 mi across** (12 ly)



FRONT

Leo/Cancer

OUR PLACE IN OUR GALAXY

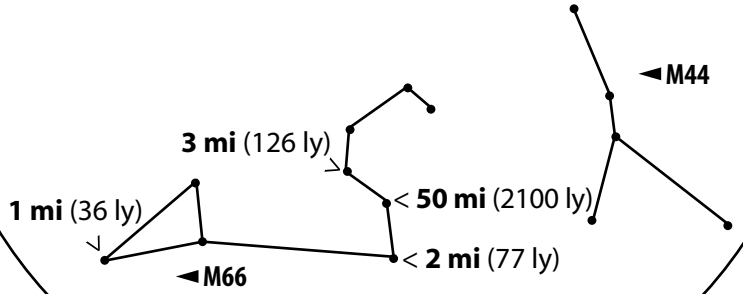
SCALE:

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)
M66	Galaxy	**875,000 mi** (35 million ly)	



BACK

Instructions:

Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.

Summer Triangle

OUR PLACE IN OUR GALAXY

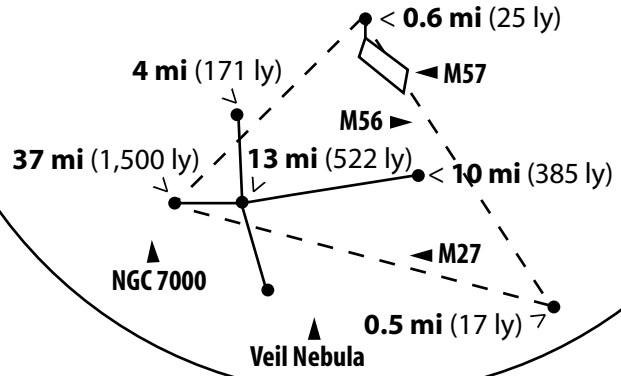
SCALE:

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)
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)
M57 (Ring)	PN	**60 mi** (2,300 ly)	**40 yds across** (1 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)



FRONT

Hercules/Boötes/Virgo

OUR PLACE IN OUR GALAXY

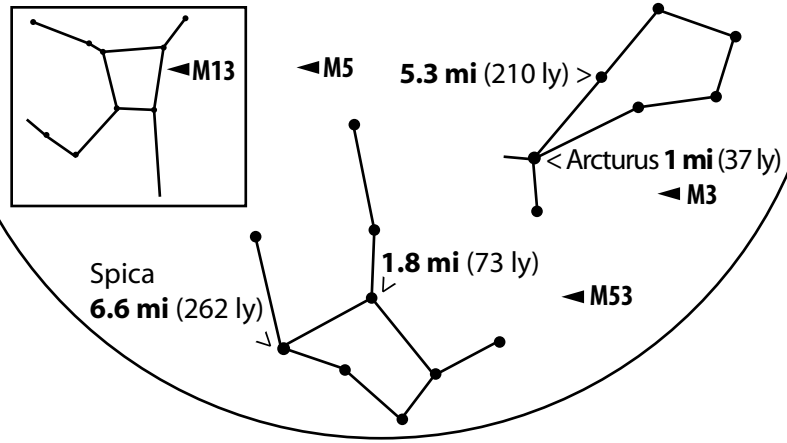
SCALE:

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)
M3	GC	**850 mi** (34,000 ly)	**4.5 mi across** (180 ly)
M5	GC	**612 mi** (24,500 ly)	**4.1 mi across** (165 ly)
M13	GC	**625 mi** (25,000 ly)	**3.5 mi across** (145 ly)
M53	GC	**1,450 mi** (58,000 ly)	**5.5 mi across** (220 ly)



BACK

Instructions:

Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.

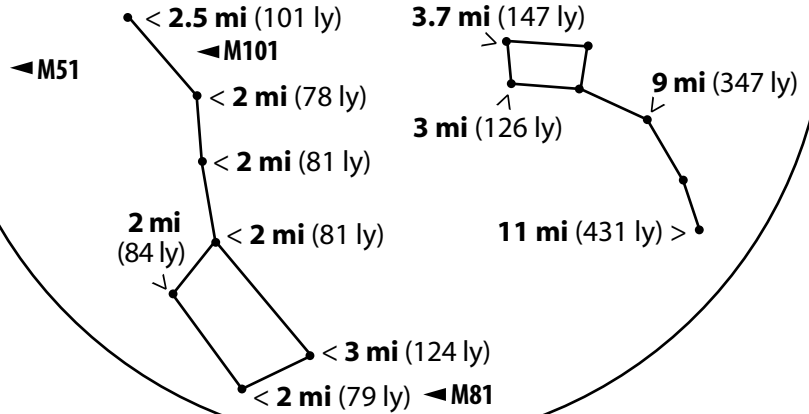
Big Dipper/Little Dipper

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)



FRONT

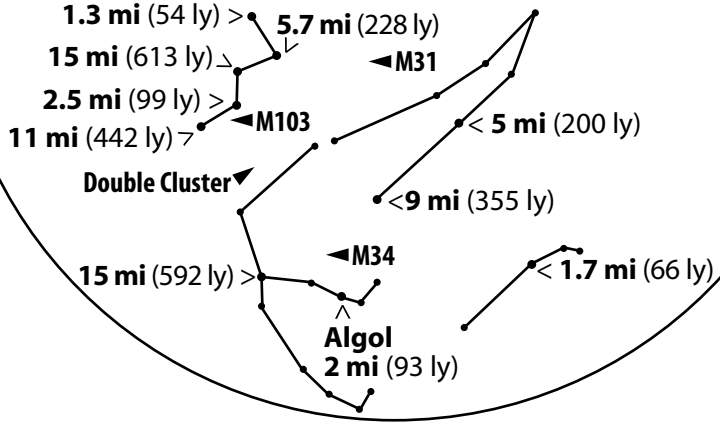
Cassiopeia/Andromeda/Perseus

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)
M34	OC	**35 mi** (1400 ly)	**0.4 mi** (14 ly across)
M103	OC	**213 mi** (8500 ly)	**0.4 mi** (15 ly across)
Dbl Cluster	OC (2)	**177 mi** (7100 ly)	**1.6 mi** (64 ly across)
M31	Galaxy	**57,500 mi** (2.3 million ly)	



BACK

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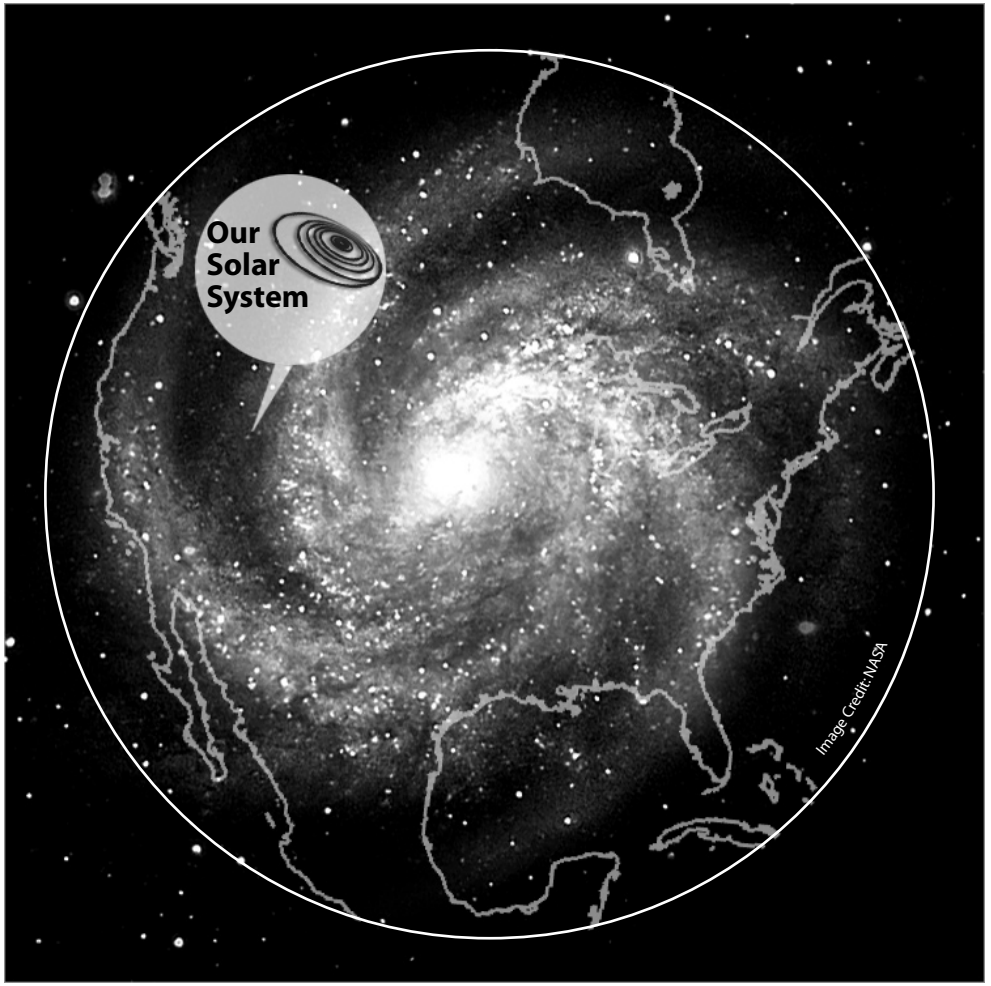
Quarter-North America Galaxy Model



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.

BACK

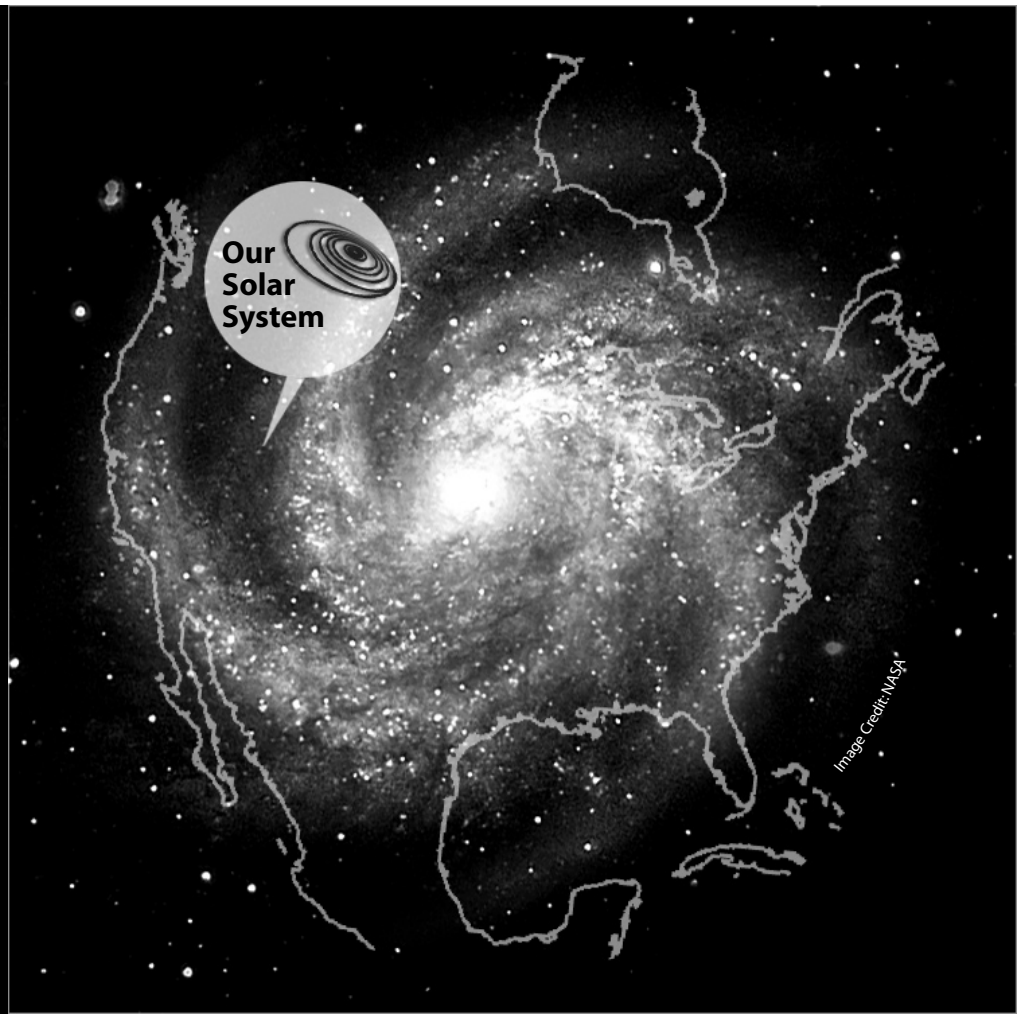
Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.

Our Place in Our Galaxy

Peel off each circle and attach the "FRONT" to the label side of a used CD.

Attach the "BACK" to the other side of the CD.

FRONT



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Sagittarius

OUR PLACE IN OUR GALAXY

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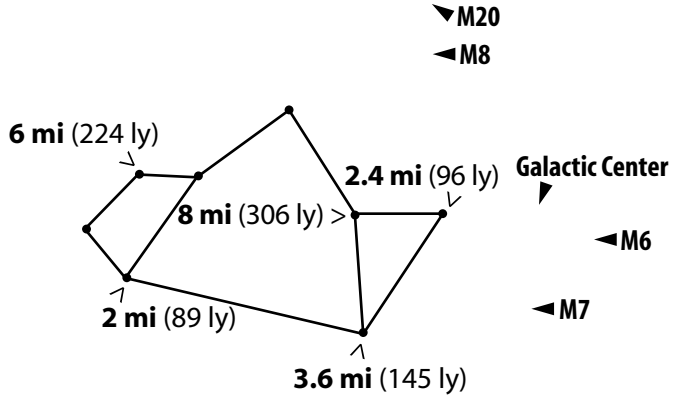
40 light years = **1 mile**

Object	**Type**	**Distance** (Actual)	**Size** (Actual)
M6	OC	**40 mi** (1,600 ly)	**1/3 mi across** (12 ly)
M7	OC	**20 mi** (800 ly)	**1/2 mi across** (20 ly)
M8 (Lagoon)	NEB	**130 mi** (5,200 ly)	**3.5 mi across** (140 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)



FRONT

Ophiuchus/Scutum

OUR PLACE IN OUR GALAXY

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Object	**Type**	**Distance** (Actual)	**Size** (Actual)
M10	GC	**360 mi** (14,300 ly)	**2 mi across** (83 ly)
M11 (Wild Duck)	OC	**150 mi** (6,000 ly)	**0.6 mi across** (24 ly)
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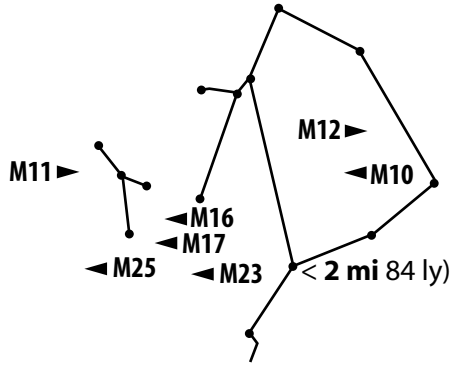

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Orion/Taurus

OUR PLACE IN OUR GALAXY

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Object	**Type**	**Distance** (Actual)	**Size** (Actual)
M1	SNR	**160 mi** (6300 ly)	**1/4 mi across** (10 ly)
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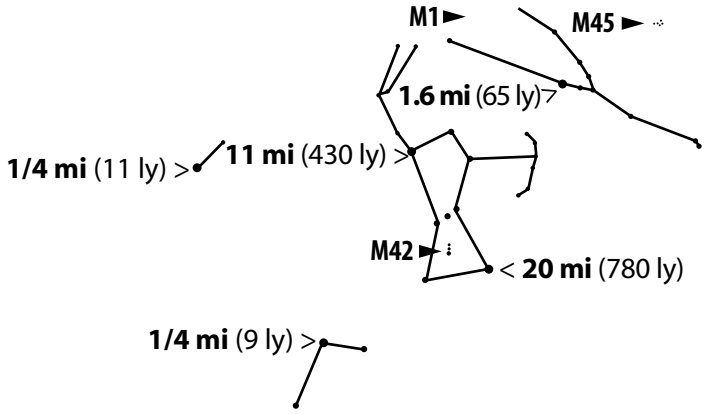

FRONT

Leo/Cancer

OUR PLACE IN OUR GALAXY

SCALE:

Solar System = **A bit larger than a Quarter (2" across)**

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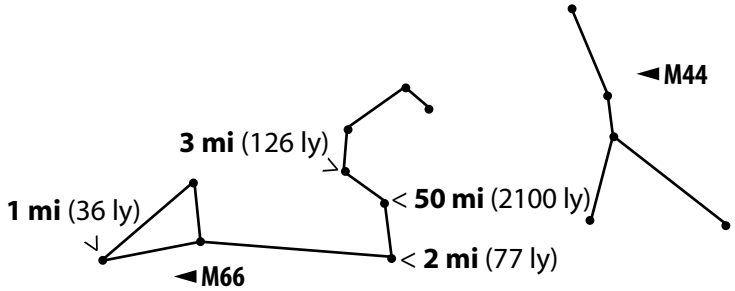
40 light years = **1 mile**

Object	**Type**	**Distance** (Actual)	**Size** (Actual)
M44	OC	**14 mi** (577 ly)	**1/4 mi across** (10 ly)
M66	Galaxy	**875,000 mi** (35 million ly)	



BACK

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Summer Triangle

OUR PLACE IN OUR GALAXY

SCALE:

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Object	**Type**	**Distance** (Actual)	**Size** (Actual)
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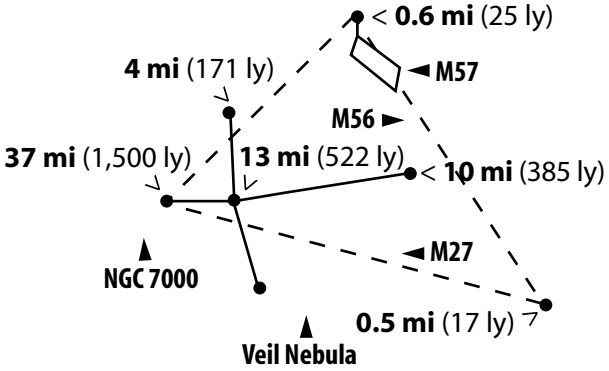

FRONT

Hercules/Boötes/Virgo

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M13	GC	**625 mi** (25,000 ly)	**3.5 mi across** (145 ly)
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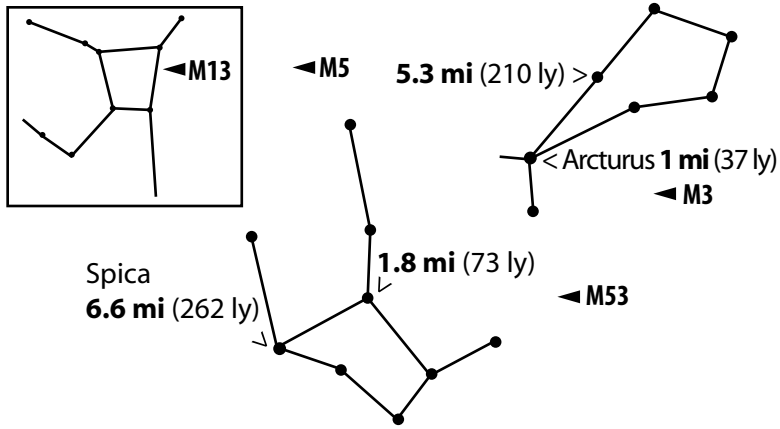

BACK

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Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

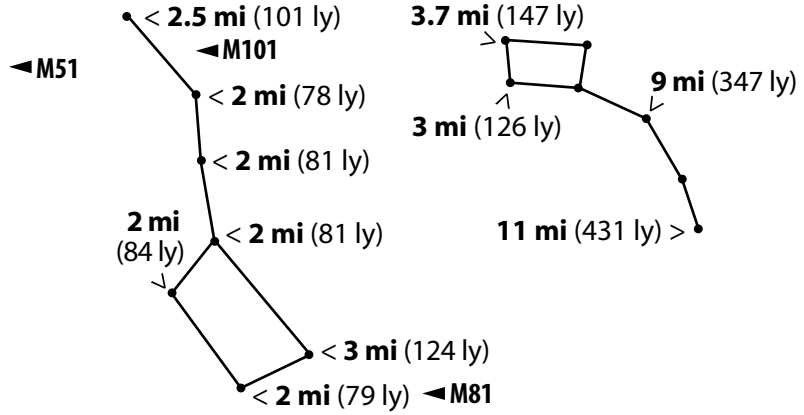
Big Dipper/Little Dipper

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)



FRONT

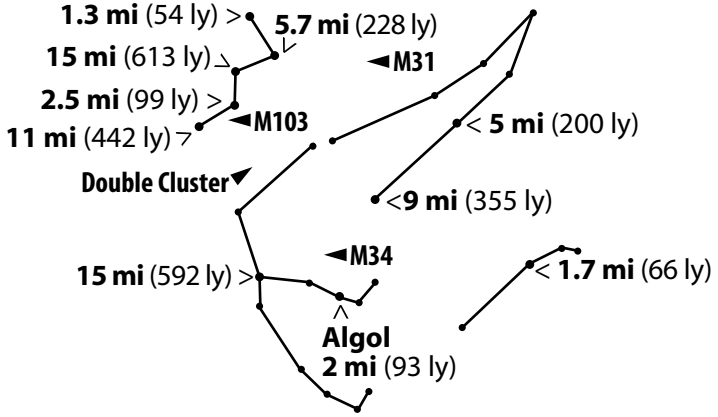
Cassiopeia/Andromeda/Perseus

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)
M34	OC	**35 mi** (1400 ly)	**0.4 mi** (14 ly across)
M103	OC	**213 mi** (8500 ly)	**0.4 mi** (15 ly across)
Dbl Cluster	OC (2)	**177 mi** (7100 ly)	**1.6 mi** (64 ly across)
M31	Galaxy	**57,500 mi** (2.3 million ly)	

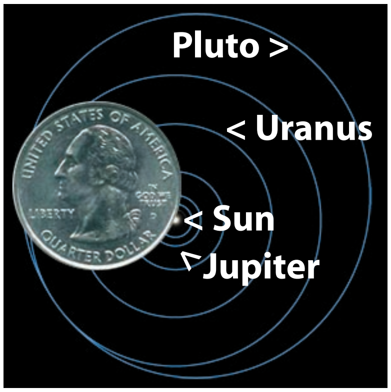


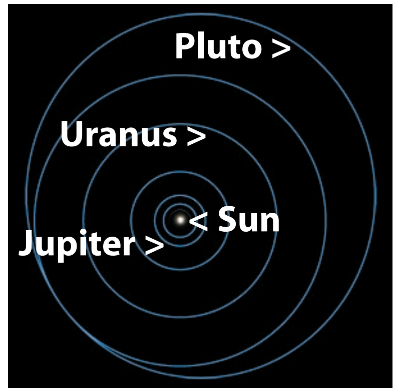
BACK

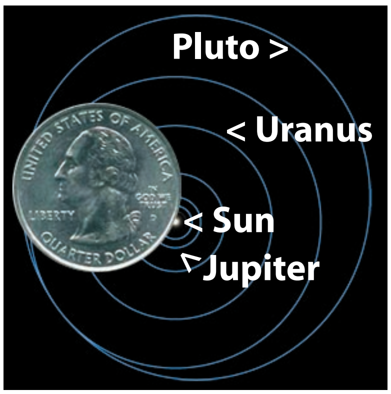
Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

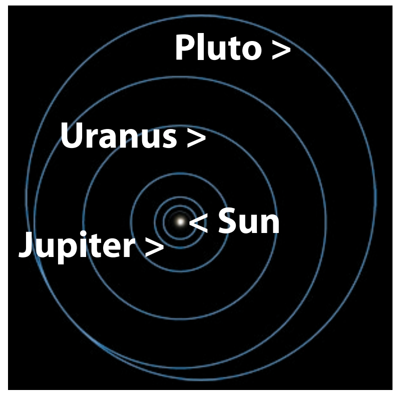
Cut out each image and glue the Solar System image with the quarter onto the back of the image without the quarter.

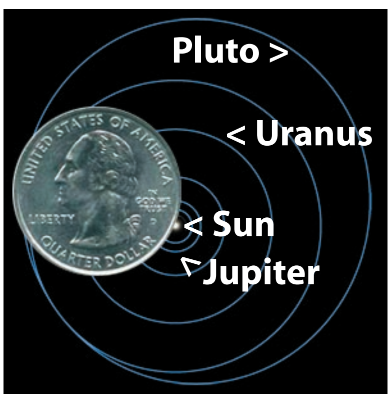
NOTE: These images only show the Sun and the orbits of Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. The orbits of Earth, Venus, and Mercury are too small on this scale to place on the image. The Sun is actually much smaller than a grain of sand on this scale.

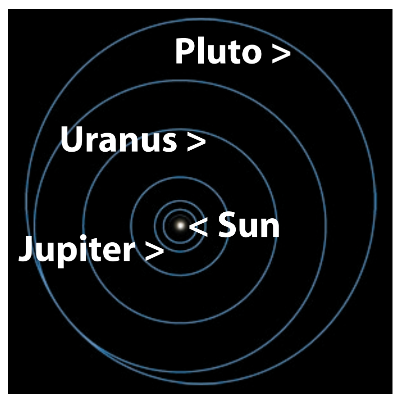


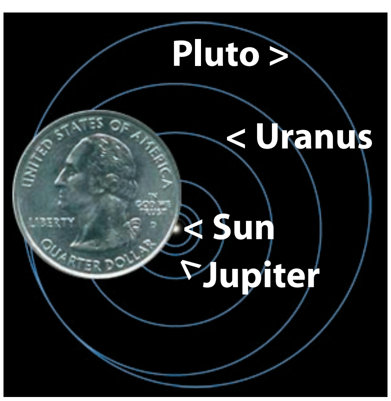


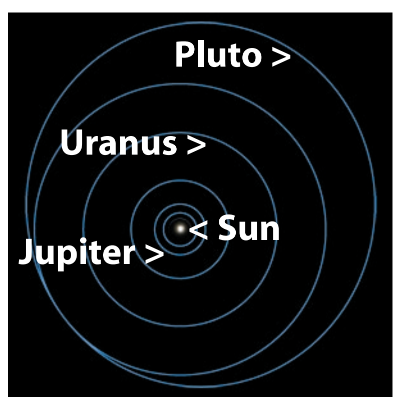






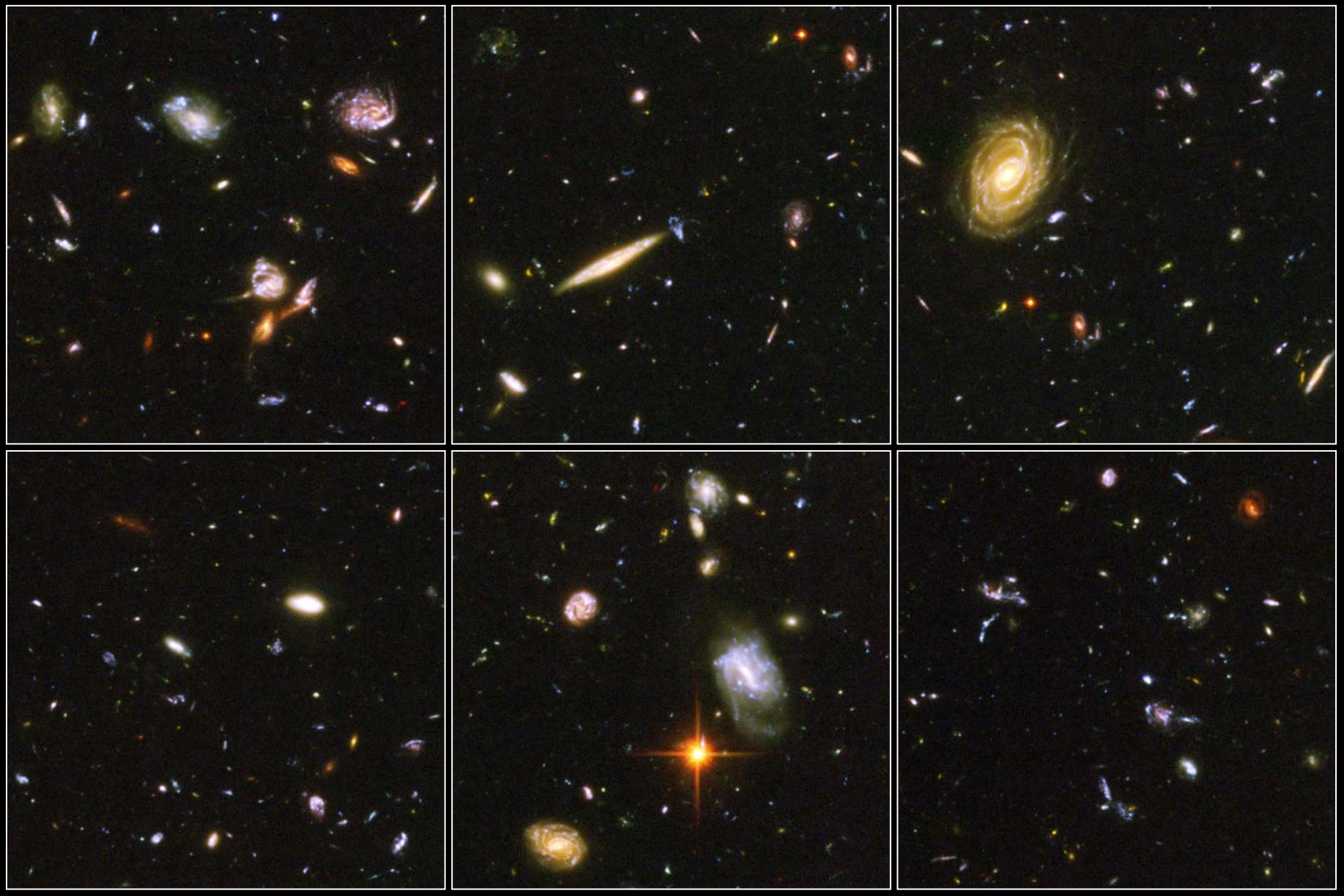






Cut out each image and glue the Solar System image with the quarter onto the back of the image without the quarter.

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.

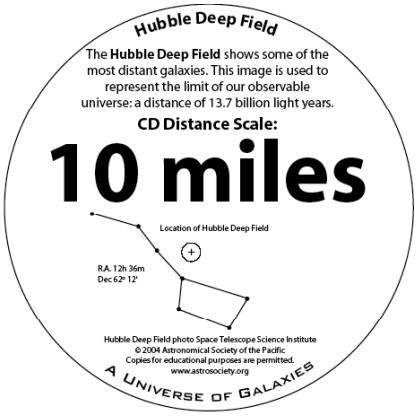


Hubble Ultra Deep Field Details

Hubble Space Telescope • Advanced Camera for Surveys

NASA, ESA, S. Beckwith (STScI) and the HUDF Team

STScI-PRC04-07c



A Universe of Galaxies

What is this activity about?

Big Question: How is the universe structured? How far away are the other galaxies? How far to the limit of the observable universe? Where are we located with respect to other galaxies we see in the telescope?

Big Activity: Use the Milky Way Galaxy CD and the set of other galaxies to indicate relative distances to other galaxies.

Participants: General public
Schools 5th grade and up

Duration: **Activity/Presentation**: 15 minutes
At the telescope: 1 or 2 minutes

Topics Covered:

- Our location in the Milky Way
- Relative distances to other galaxies and limit of the observable universe.

Venues:

1. Star Party
2. Pre-star party, youth groups, classroom (students or participants can construct the CD galaxy models and make a model of the distances to other galaxies). In order to do the activity of building the universe, you will need a large area, e.g. parking lot, playground, park, football field.

Where can I use this activity?

1) **Before a Star Party**:
   To introduce a star party and continue the theme as the visitors view galaxies in the telescopes, do a 10 to 20-minute pre-star-party presentation to build a model of the universe. **See the Detailed Activity Description.**

2) **Scout troop or school**:
   Go outside and build the universe. Use copies of the "Make Your Own!" 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) At the telescope:

Preparation

To Do:

1. Each participating amateur astronomer may pick any object(s) he or she wishes to show and that his or her telescope is capable of viewing.
2. For those amateur astronomers who wish to use the Milky Way CD as a reference, make sure each person has one. For those who wish to have the whole set of galaxies, make sure they have the copies to make their own set.

At the Telescope

In the kit is a CD with an artist's drawing of the Milky Way, which represents what our Milky Way Galaxy might look if we could go far out in space and take a photo of it. The pointer on the image marks the approximate position of our star, the Sun. The reverse shows the relative distances to other galaxies if our Milky Way was shrunk down to the size of the CD.

You can use the Milky Way CD at the telescope. When showing people a variety of galaxies you can give them the sense of distance in relation to our own place in our Milky Way Galaxy.

For example when pointing out M31, the Andromeda Galaxy, from our position on the Milky Way CD, M31 would be 8 feet away. Other galaxies like those listed on the back of the CD are at even greater distances. The limit of the observable universe is out approximately 10 miles on this scale.

When showing objects within our Galaxy, you can say that the object is on the CD within an inch or two of our position (marked by the pointer).

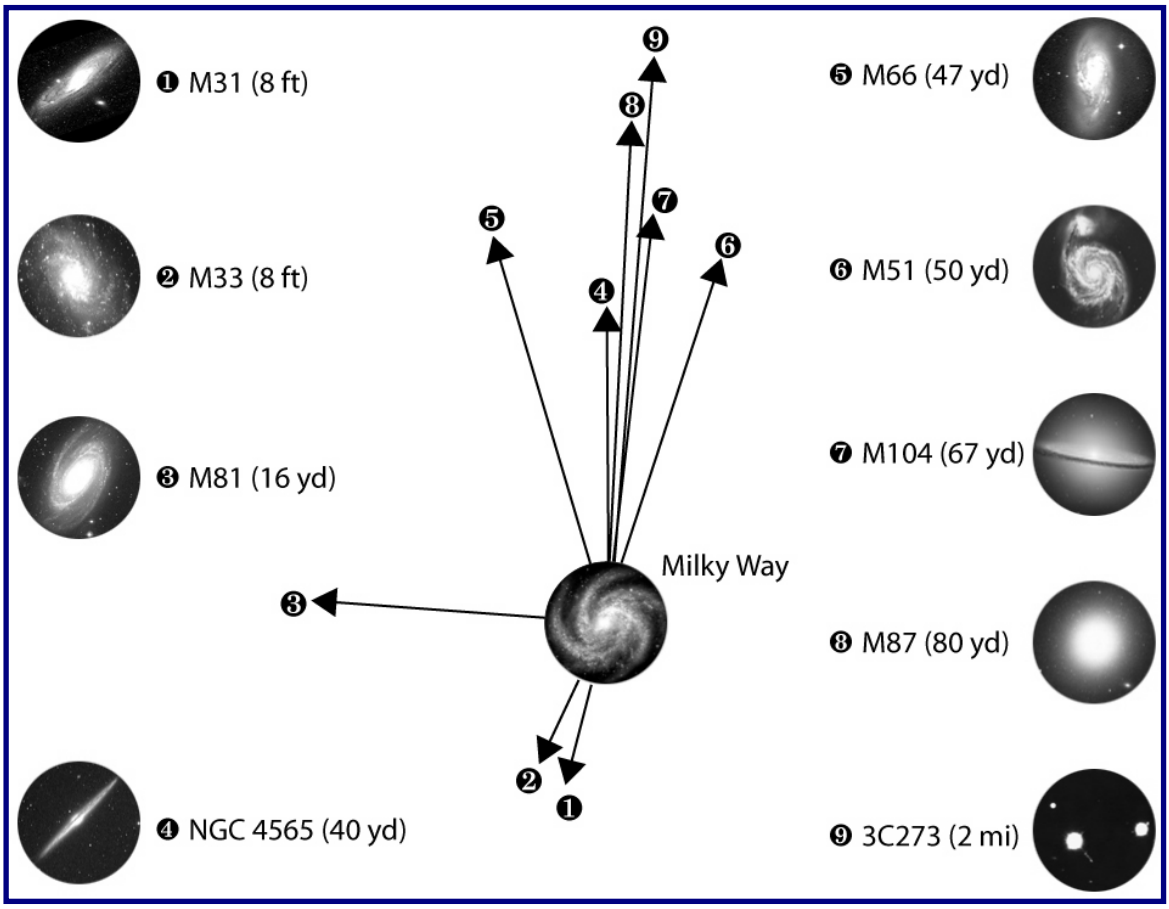
Here's a suggested script for what you might say:
(Let's assume you are looking at M51 – the Whirlpool Galaxy)
"If the galaxy we live in, the Milky Way, was shrunk down to the size of this CD, the Whirlpool galaxy which we're looking at in the telescope would be 50 yards away – halfway down a football field."

Helpful Hints

For online access to the booklet "how big is our universe?" go to:
http://cfa-www.harvard.edu/seuforum/howfar/index.html
After you enter the website, click on "download pdf" or "print-friendly pdf" to download a copy of the booklet.
For a tour of Our Place in Space:
http://cfa-www.harvard.edu/seuforum/opis_tour_earth.htm

GALAXY LAYOUT DIAGRAM (Not to scale)

If you want to send your visitors in approximately the right direction for each of the galaxies, here is a layout of the directions for each galaxy in the set – on a 2-dimensional plane based on Right Ascension - ignoring Declination.



Terms you will need to make sure your audience understands, with some basic definitions, are:

- *Scale Model:* a smaller, approximate version of a real object.
- *Solar System*: Sun and all its planets
- *Milky Way Galaxy*: All the stars surrounding us – the isalnd of stars we live in
- *Universe:* All the galaxies.
- *Light Year:* distance light can travel in a year
- *Big Bang:* the beginning of our universe.

For more details on explaining these terms, see the "Our Place in our Galaxy" activity.

Background Information:

When we show people galaxies through the telescope or describe our own galaxy, it is often difficult for people to get a sense of the distances involved. This activity provides visual props to help to clarify the scale of the galaxies in the universe.

The individual stars in each of the photographs of a galaxy can be confusing to some people. Explain that the stars in the photos are here in our own galaxy – we are looking out through the stars in our Galaxy to other galaxies beyond our own – a bit like standing in a swarm of flies and looking out through them to a house several yards away. Or looking out through a dirty, speckled window to the scenery outside.

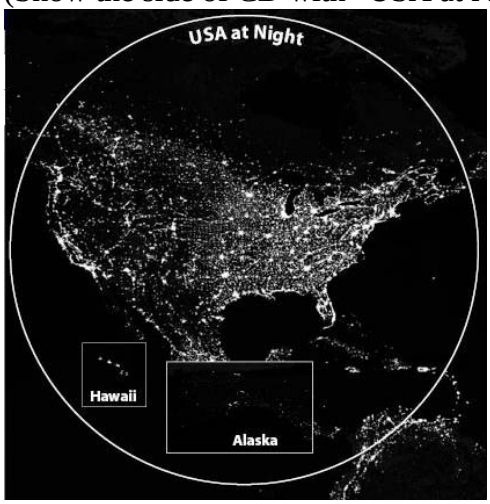
We cannot see our own star, the Sun, on the Milky Way Galaxy CD. It would be like trying to pick out your porch light on a satellite photo of the USA at night.

Credit: NASA

To read about NASA missions exploring the beginnings of the universe and origins of galaxies:
http://cfa-www.harvard.edu/seuforum/bb_whycare.htm
http://origins.stsci.edu/under/galaxies.shtml

To get more information 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/

Detailed Activity Description

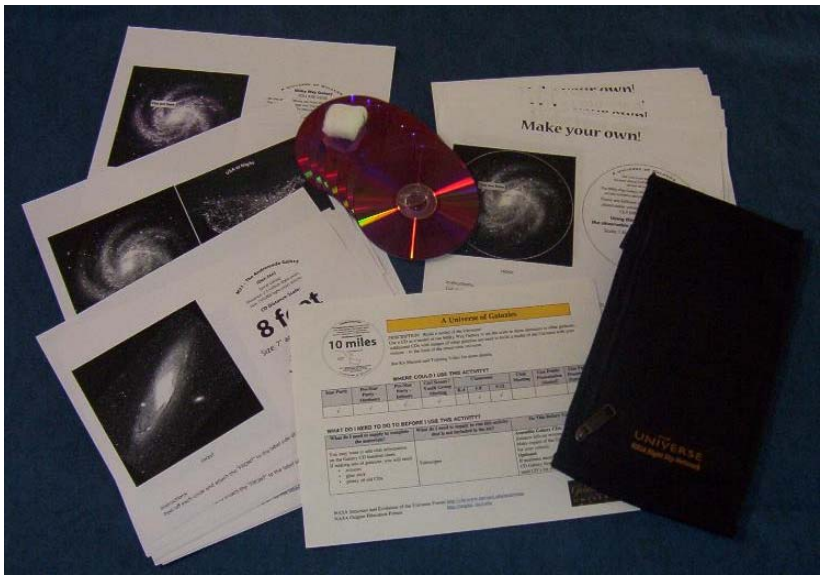
Leader's Role	**Participants' Roles**
Introduction: Introduce the activity and explain to the visitors what to expect. You can use the following script, if you wish: <u>*To Say:*</u> What's the difference between the Solar System, the Galaxy, and the universe? (Have a discussion – make sure most people understand the difference – for more details, see the "Our Place in our Galaxy" activity).	Discuss ideas.
Our Galaxy, the Milky Way, is a spiral galaxy, the visible parts is shaped roughly like this CD – wide, round, and flat. And it has a bulge of stars in the middle. We're going to shrink our Milky Way Galaxy down to the size of this CD. You can't see our own star, the Sun. It would be a bit like trying to pick out your porch light on this satellite photo of the USA at night. Who wants to try? (Show the side of CD with "USA at Night")  So with our Galaxy the size of this CD, how far away do you suppose the rest of the galaxies in the known universe are?	Laugh.
Who wants to be the Milky Way Galaxy? Who wants to be [other] galaxy? <u>*To Do:*</u> Pass out galaxies or have someone pass them out. Don't pass out the Quasar or the Hubble Deep Field.	Volunteer

To Say: Who has a galaxy within 10 feet of the Milky Way? You are in our local group of galaxies – living in the same yard. Who has galaxies within 100 yards? Those are our neighbor galaxies – in the same block. *To Do:* With the Milky Way Galaxy person in the middle, distribute the others around the Milky Way and have them pace off the distance to each of their galaxies (child's pace is about 2-3 feet, adult is 4-5 feet). You may want to use the **Galaxy Layout Diagram** under **"Helpful Hints"** if you want to have your visitors distribute the galaxies in approximately the correct directions.	Respond. Take galaxies and go out to appropriate distances.
	
To Say: So here are just a few of the billions of galaxies in our universe. These are all fairly close to us. We are able to see some of these galaxies in the telescopes you'll be looking through tonight. *To do:* Call back all the people holding the galaxies	

To do: Hold up the 3C 273 Galaxy *To Say:* Now here's one that is over 2 billion light years away. On this scale, it is 2 miles away. (Hand it to someone) Would you like to take this one to where it belongs? *To do:* Hold up the Hubble Deep Field CD *To Say:* And this is an image of very distant galaxies taken by the Hubble Space Telescope – some of these galaxies are as far away as our best telescopes can see – over 12 billion light years away! Many of the galaxies in this photo are near the limit of the observable universe, which is 13.7 billion light years away. How far away is the limit of the observable universe in our model? (Turn over the CD and show the audience the distance on the other side) About 10 miles. Who wants to take this one? That would be about as far away as _____ (Pick a city or landmark about 10 miles away from your location. Fill up a football stadium to the top with CDs to represent the galaxies within the observable universe. Imagine these CDs distributed all around us – from a few feet out to 10 miles away in any direction.	Volunteer
Presentation Tip 1: Of course, not all galaxies are spirals. Some are shaped like giant balls of cotton: ellipticals. Some have irregular shapes – these are appropriately called "irregulars". Judge if your audience is ready to absorb more information at this point – most need to digest what they have just learned before moving on to more. Each galaxy CD describes the type of galaxy, its approximate shape and size compared to the Milky Way CD. Except for the Hubble Deep Field, which is used as an icon for the limit of the observable universe.	
Presentation Tip 2: When you say that the observable universe extends 10 miles in any direction, your audience may have the mistaken impression that we are the center of the universe. One way to answer this is to say: No matter which of these galaxies you might happen to live in, you would still only be able to see light coming from galaxies no more distant than about 13 billion light years – back to just after the Big Bang. Or 10 miles on this scale. So there is no "center" to the universe. Every galaxy will appear from its perspective to be at the "center". **NOTE**: You may want to define "Big Bang" as the beginning of our universe.	

To Say: So, to review: On the scale we've built, how big is our Galaxy, the Milky Way? (Hold up the Milky Way CD) And from how far away can we see light from the most distant galaxies? (Hold up the CD with the Hubble Deep Field on it) We are seeing light that left these galaxies billions of years ago, so we are seeing them as they looked billions of years ago in the very young universe. NASA is sponsoring a series of missions to study this light and find out more about the very early universe and how galaxies formed within it. So enjoy your evening looking through the telescopes at all the wonderful things within our own Galaxy and at galaxies outside of our own!	The size of a CD 10 miles away

Materials

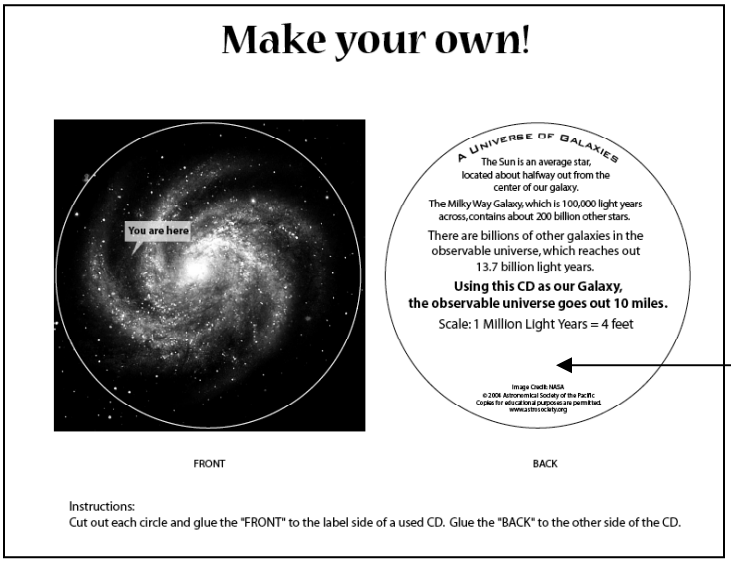


What Materials from the ToolKit do I need?

1. CD Holder
2. Used CDs
3. Printed galaxy sheets (pre-cut sticky labels) to attach to used CDs
4. Set of visitor handouts (labeled "Make your own!") for gluing to a CD
5. Cotton ball

What do I need to prepare?

- Assemble the galaxy CDs. The labels are pre-cut. Just peel them off and attach them to the used CDs. See the Training Video for more information.
- Insert CDs into the CD Holder
- You may want to pull off a small piece of cotton to glue to the center of the Milky Way CD – to represent the central bulge.



You may want to add club information in the space on the "Make your own!" Milky Way Galaxy CD handout sheet.

What must I supply?

- Telescopes
- If making sets of galaxies as part of the activity with your visitors, you will need:
    - scissors
    - glue stick
    - plenty of old CDs
    - Copies of the handout sheets

Where do I get additional materials?

To make more galaxy CDs:
The pages for the Galaxy CDs are in the OGOU_Manual.pdf on the *ToolKit Manual and Resources CD*.
Here are 3 options for making more sets:

1. Photocopy or print the pages, then cut them out and glue them to used CDs.
2. You can buy pre-made CD labels and print the images on the labels. The Galaxy CD pages fit Avery 5692 and 8692. Be careful that the central cutout on these labels also is removed and attached to the CD.
3. Order sheets pre-cut with circles (like the ones that came with the ToolKit) from rippedsheets.com by calling 1-888-791-9590 and print the template pages onto these sheets. Be sure to tell rippedsheets.com that it is for the "Astronomical Society of the Pacific" so they will use the correct dietool. Minimum order is 50 sheets.

Used CDs: Ask your club members to save old CDs and bring them to the next club meeting.

CD Holders: These may be purchased at most music stores, department stores, or online in bulk from www.quantumpromotions.com, Item # HEYLH-BFUNN (Description: CD Visor Organizer).

Cotton Balls: Drug store or variety store.

Galaxy CDs

These CDs are intended for use as a reference at the telescope and as props during the presentation.

NASA and the Astronomical Society of the Pacific wish to thank YesVideo.com, a video transfer service, for donating the used CDs provided with this ToolKit.

Assembly:

Cut out each disk and glue to a used CD.
Insert assembled disks into the CD holder for easy reference.

A Universe of Galaxies

Cut out each circle and glue the "FRONT" to the label side of a used CD.

Glue the "BACK" to the other side of the CD.

FRONT

A UNIVERSE OF GALAXIES

Milky Way Galaxy

YOU ARE HERE

- We live about halfway out from the center of our galaxy
- The Sun is an average star. The Milky Way Galaxy, which is 100,000 light years across, contains about 200 billion other stars.
- The ratio of our galaxy's width to thickness is almost the same as this CD approximately 100:1

Scale: 1 Million Light Years = 4 feet

Using this CD as our Galaxy, other galaxies would be at the following approximate distances from us:

M31:	8 ft	**M33:**	8+ ft	**M81:**	16 yds
NGC4565:	40 yds	**M66:**	47 yds	**M51:**	50 yds
M104:	67 yds	**M87:**	80 yds	**3C273:**	2 Miles

Hubble Deep Field

(representing the limit of observable universe)**:** 10 Miles.

Image Credit: NASA

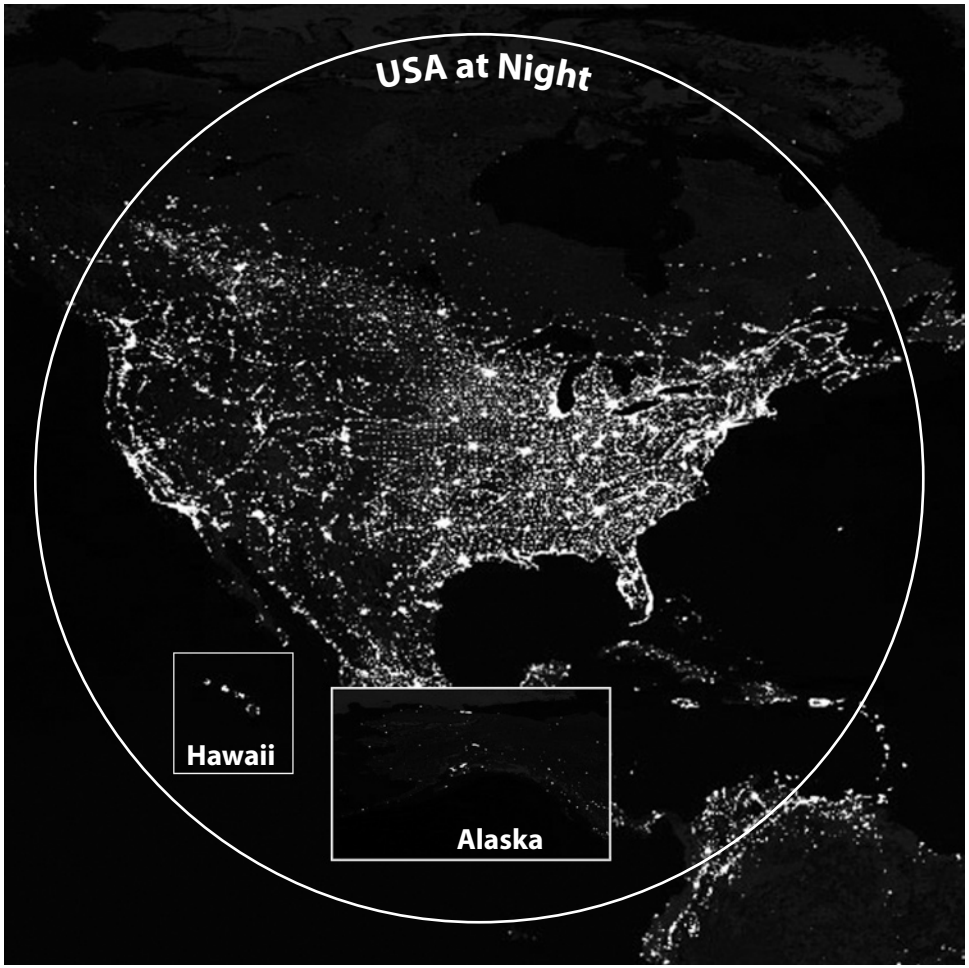
www.astrosociety.org

BACK

Instructions:

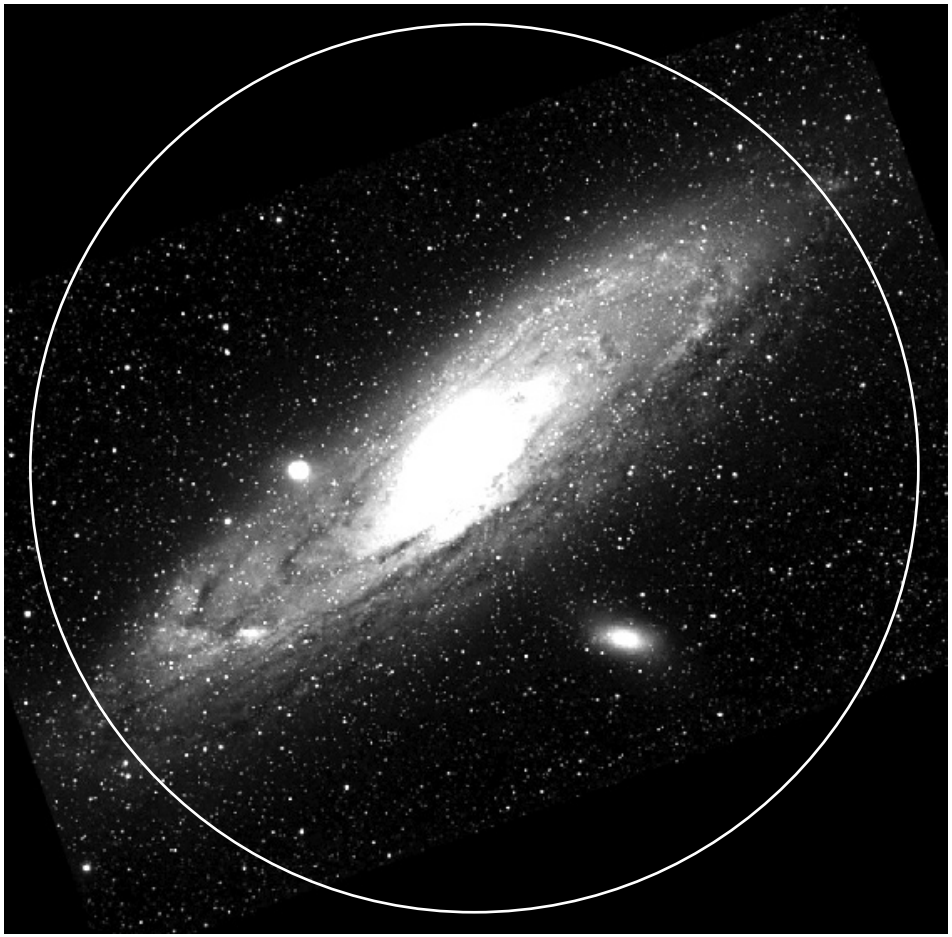
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.

FRONT



BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M31 – The Andromeda Galaxy

(Oct-Jan)

Spiral Galaxy
Distance: 2.3 million light years
Size: 150,000 light years across

CD Distance Scale:

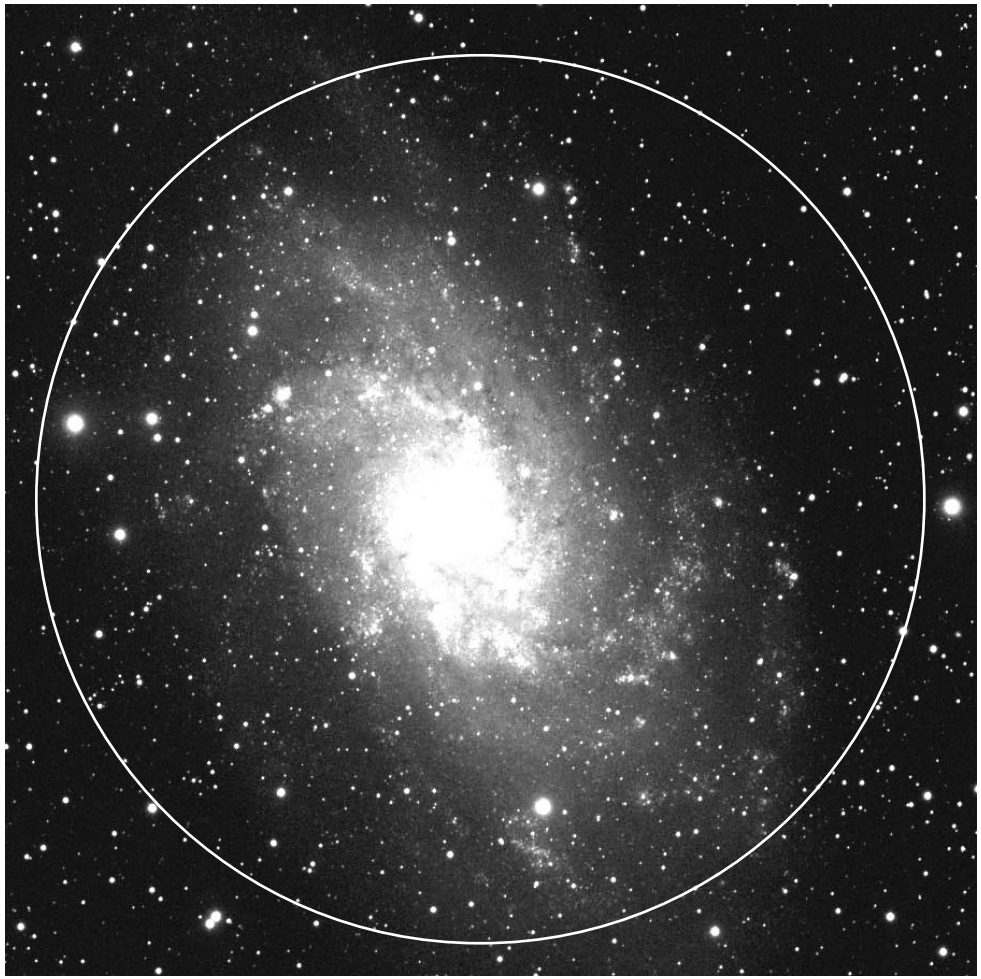
8 feet

Size: 7" across (salad plate)

A UNIVERSE OF GALAXIES

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M33 – The Pinwheel Galaxy

(Oct-Jan)

Spiral Galaxy
Distance: 2.4 million light years
Size: 60,000 light years across

CD Distance Scale:

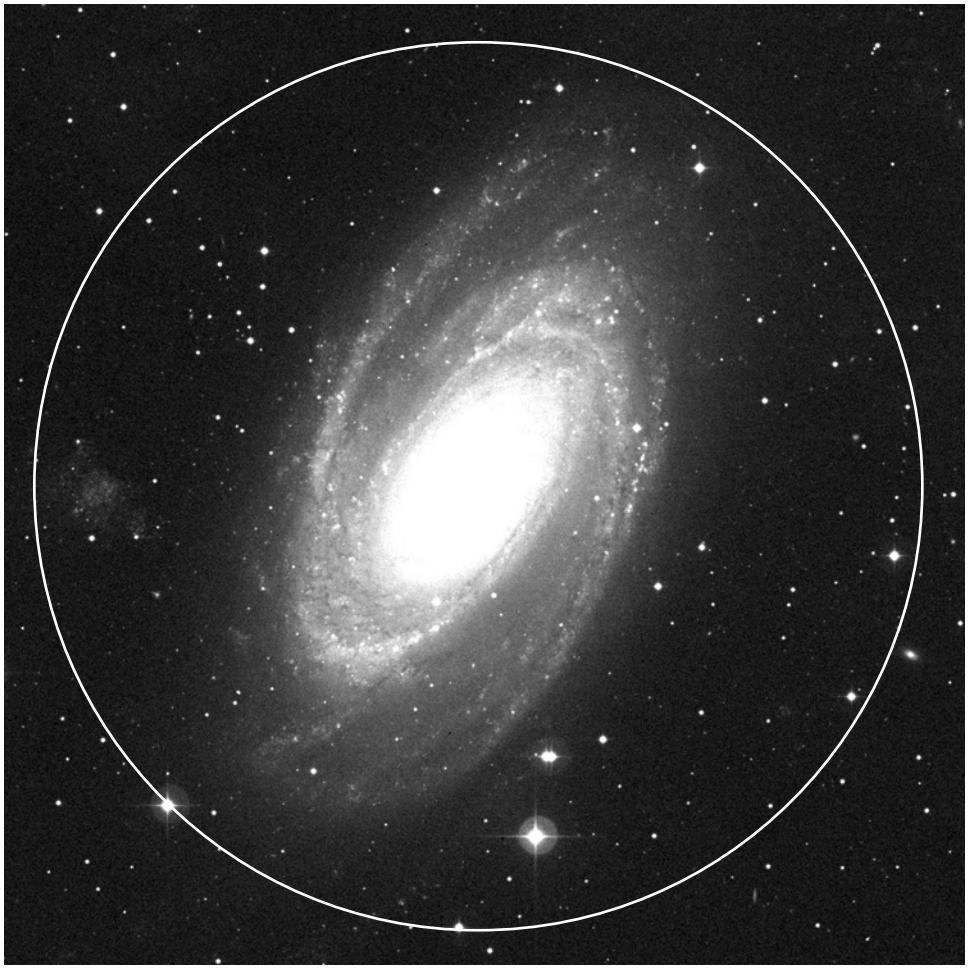
8 feet

Size: 3" across

A Universe of Galaxies

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M81

(Feb-Jun)

Spiral Galaxy
Distance: 12 million light years
Size: 75,000 light years across

CD Distance Scale:

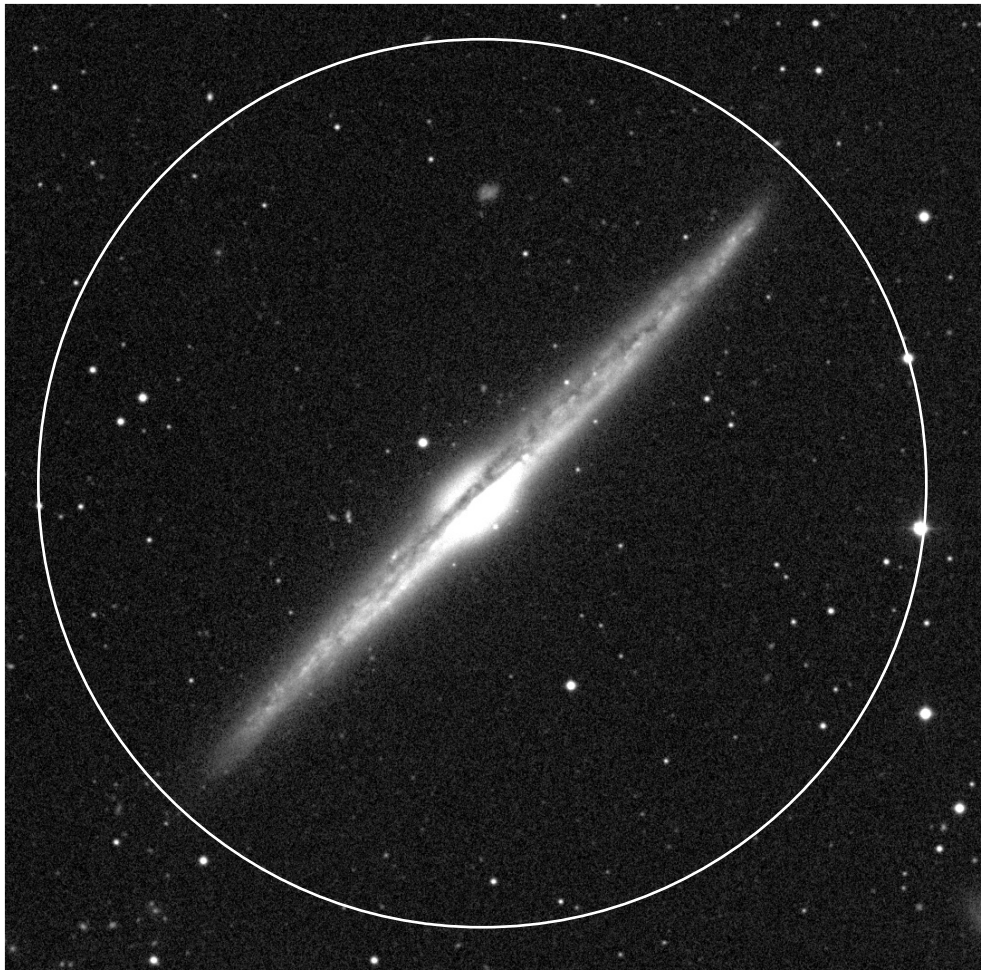
16 yards

Size: 4" across

A UNIVERSE OF GALAXIES

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

NGC4565

(Apr-Jul)

Spiral Galaxy – viewed edge-on
Distance: 31 million light years
Size: 150,000 light years across

CD Distance Scale:

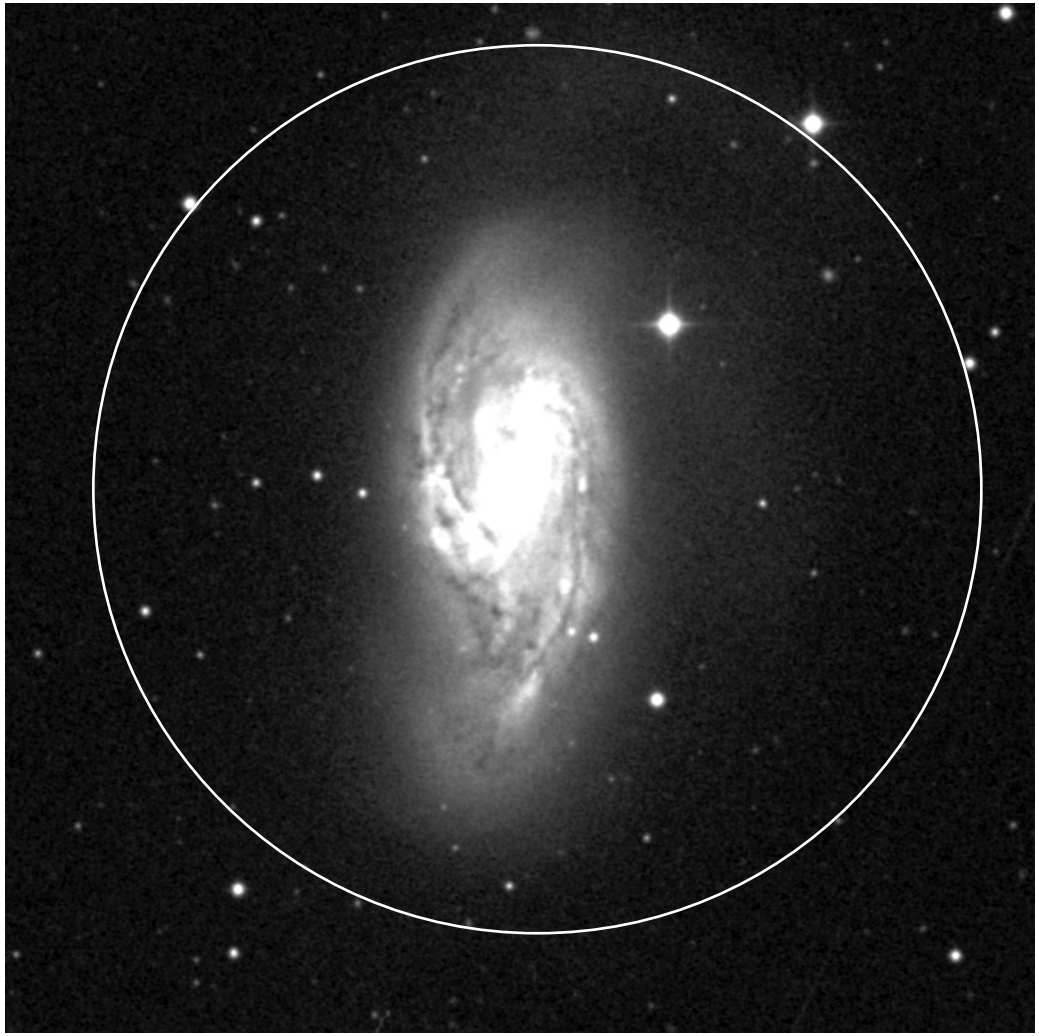
40 yards

Size: 7" across (salad plate)

A UNIVERSE OF GALAXIES

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M66

(Apr-Jun)

Spiral Galaxy
Distance: 35 million light years
Size: 80,000 light years across

CD Distance Scale:

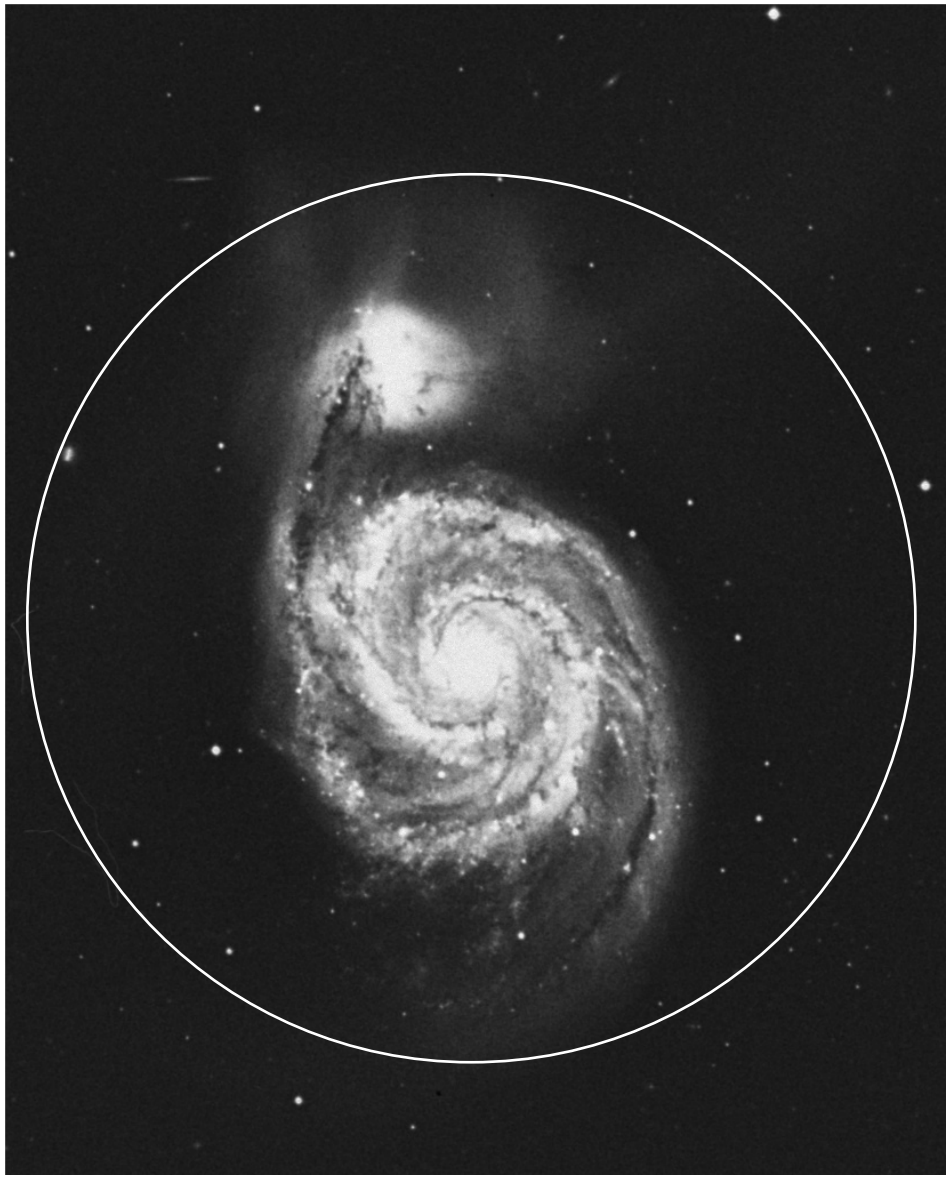
47 yards

Size: 4" across

A Universe of Galaxies

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M51 – Whirlpool Galaxy

(Apr-Aug)

Spiral Galaxy with companion galaxy
Distance: 37 million light years
Size: 120,000 light years across

CD Distance Scale:

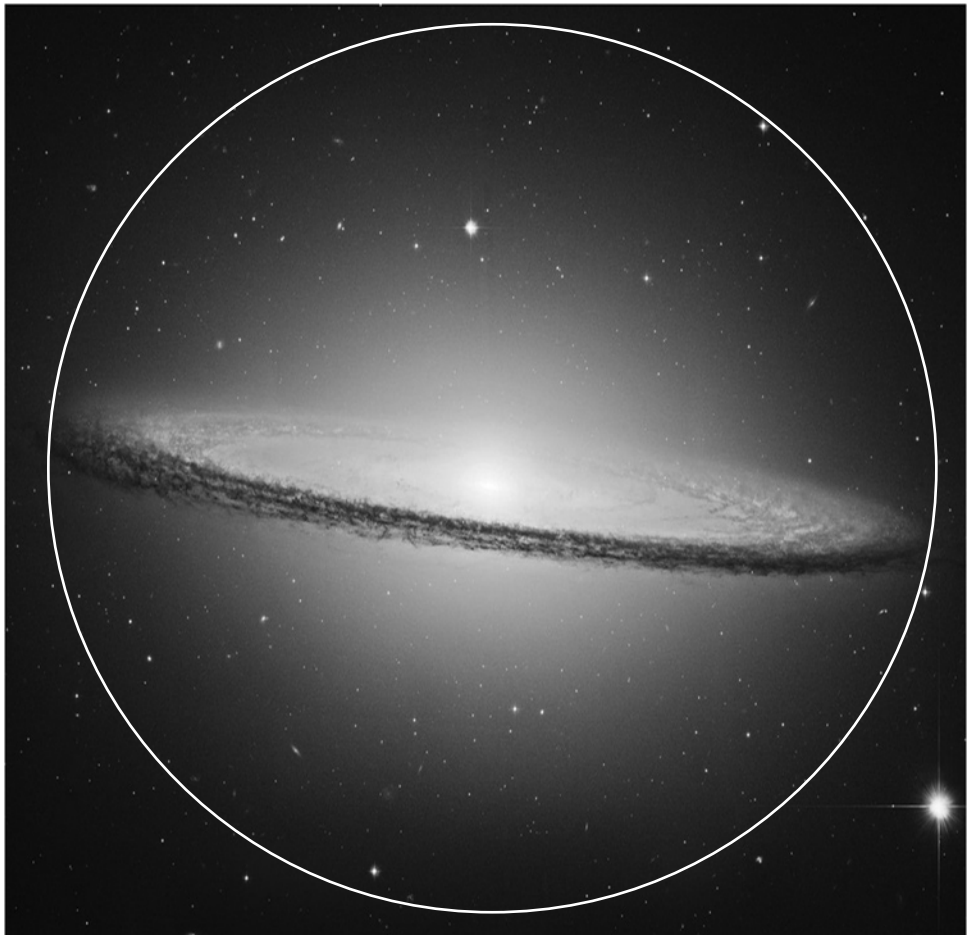
50 yards

Size: 5" across

A Universe of Galaxies

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M104 – Sombrero Galaxy

(May-Jun)

Spiral Galaxy – viewed edge-on
Distance: 50 million light years
Size: 75,000 light years across

CD Distance Scale:

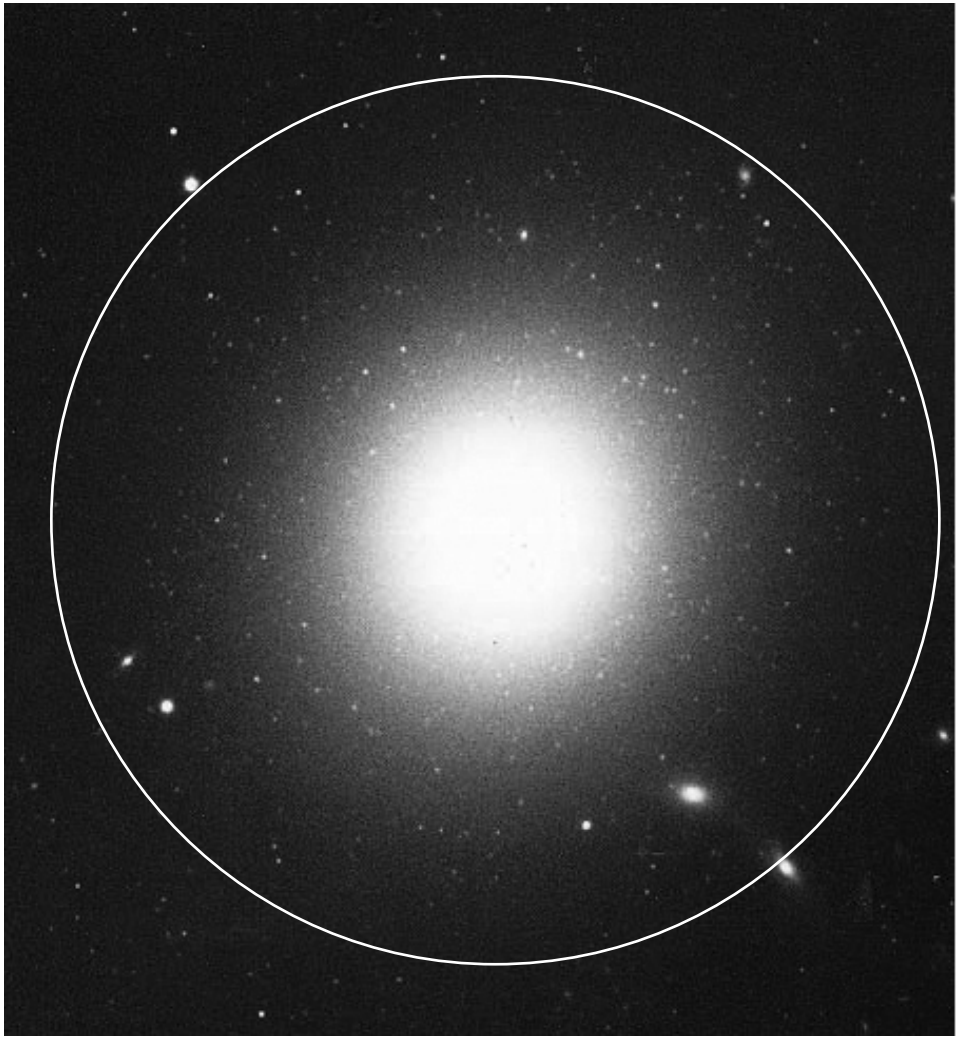
67 yards

Size: 6" across

A Universe of Galaxies

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

M87

(Apr-Jul)

Elliptical Galaxy
Distance: 60 million light years
Size: 120,000 light years across

CD Distance Scale:

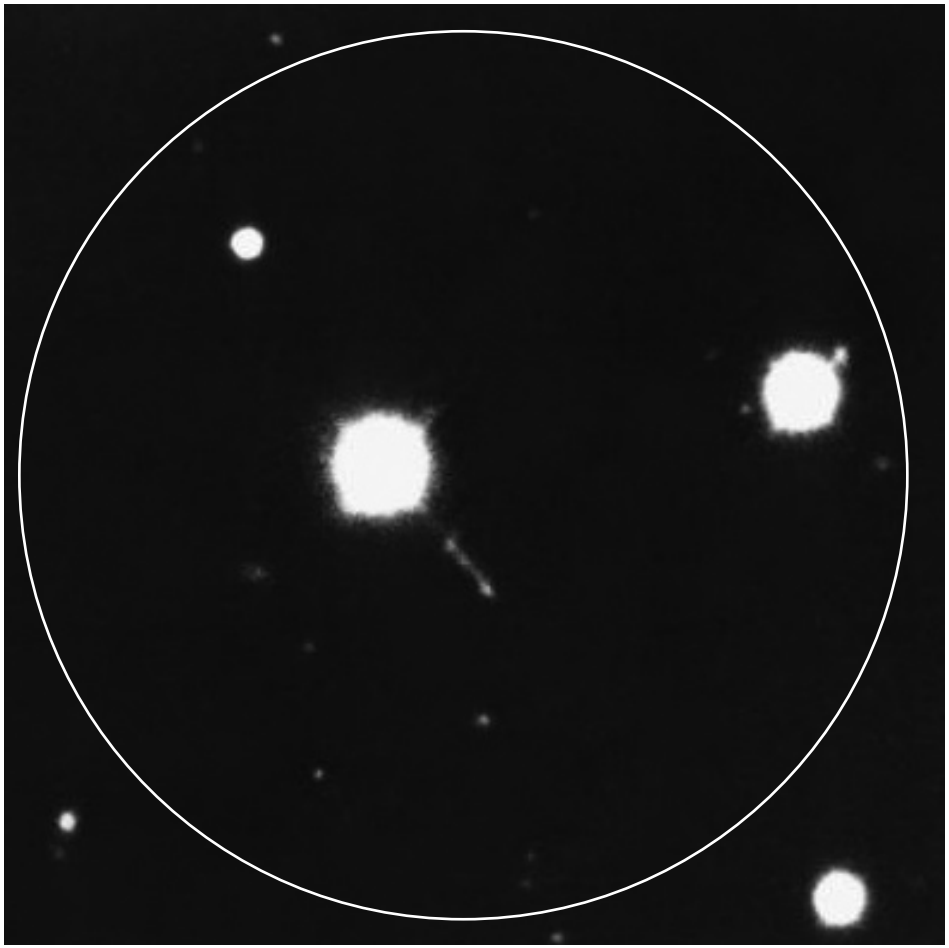
80 yards

Size: 5" across – like a softball

A UNIVERSE OF GALAXIES

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



FRONT

Quasar 3C-273

(Apr-Jul)

Elliptical Galaxy
Distance: 2.5 billion light years
Size: 120,000 light years across

CD Distance Scale:

2 miles

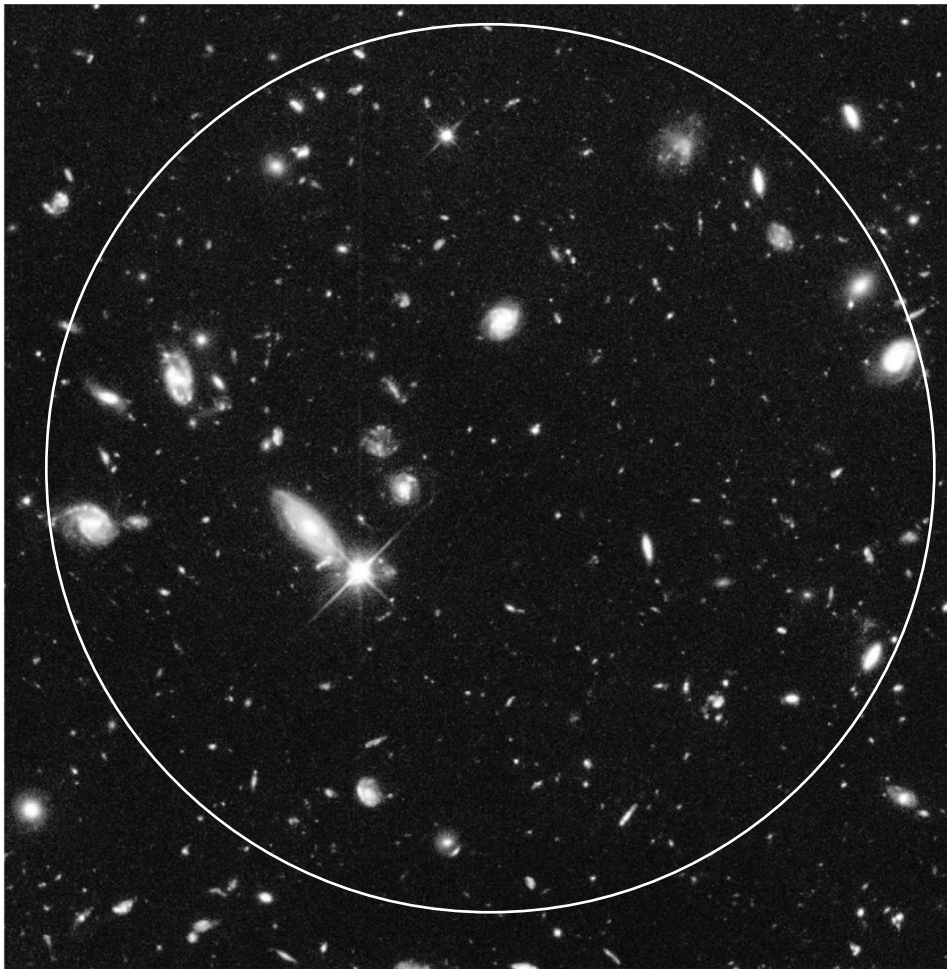
Size: 5" across – like a softball

This is the most distant object that can be seen with most backyard telescopes.

A Universe of Galaxies

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.



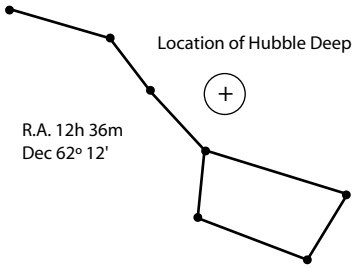
FRONT

Hubble Deep Field

The **Hubble Deep Field** shows some of the most distant galaxies. This image is used to represent the limit of our observable universe: a distance of 13.7 billion light years.

CD Distance Scale:

10 miles

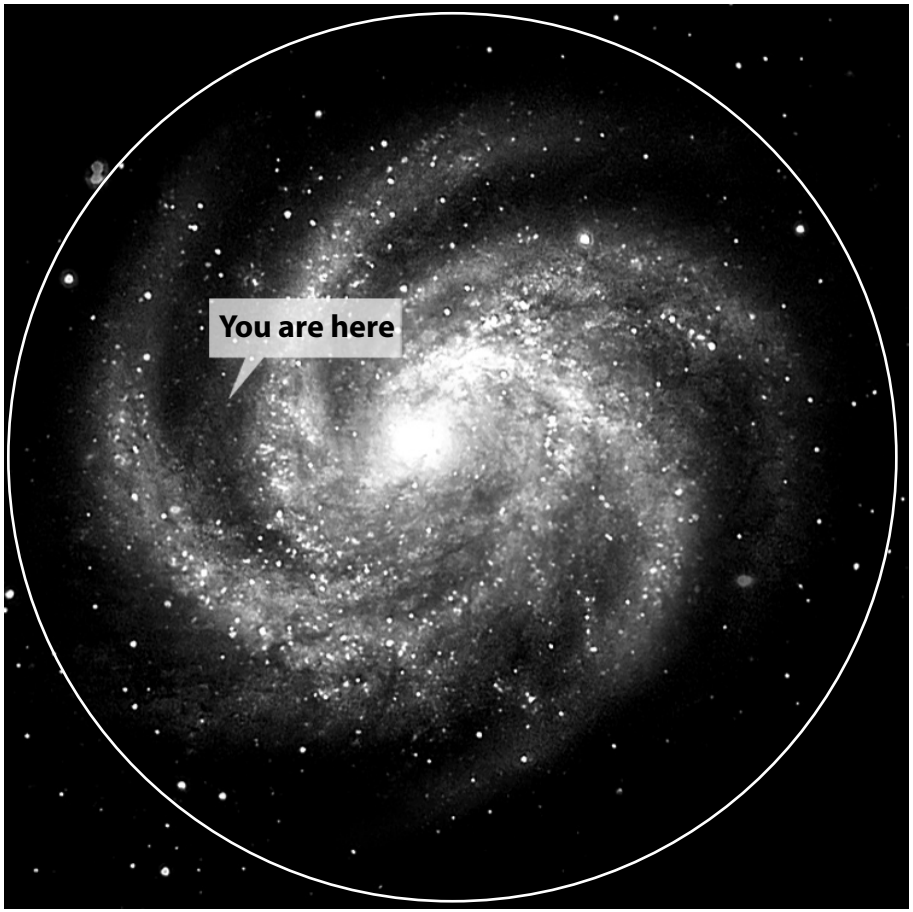


A Universe of Galaxies

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.

Make your own!



FRONT

A UNIVERSE OF GALAXIES

The Sun is an average star, located about halfway out from the center of our galaxy.

The Milky Way Galaxy, which is 100,000 light years across, contains about 200 billion other stars.

There are billions of other galaxies in the observable universe, which reaches out 13.7 billion light years.

Using this CD as our Galaxy, the observable universe goes out 10 miles.

Scale: 1 Million Light Years = 4 feet

Image Credit: NASA

www.astrosociety.org

BACK

Instructions:
Cut out each circle and glue the "FRONT" to the label side of a used CD. Glue the "BACK" to the other side of the CD.

A Universe of Galaxies

Peel off each circle and attach the "FRONT" to the label side of a used CD.

Attach the "BACK" to the other side of the CD.

FRONT

A UNIVERSE OF GALAXIES

Milky Way Galaxy

YOU ARE HERE

- We live about halfway out from the center of our galaxy
- The Sun is an average star. The Milky Way Galaxy, which is 100,000 light years across, contains about 200 billion other stars.
- The ratio of our galaxy's width to thickness is almost the same as this CD approximately 100:1

Scale: 1 Million Light Years = 4 feet

Using this CD as our Galaxy, other galaxies would be at the following approximate distances from us:

M31:	8 ft	**M33:**	8+ ft	**M81:**	16 yds
NGC4565:	40 yds	**M66:**	47 yds	**M51:**	50 yds
M104:	67 yds	**M87:**	80 yds	**3C273:**	2 Miles

Hubble Deep Field

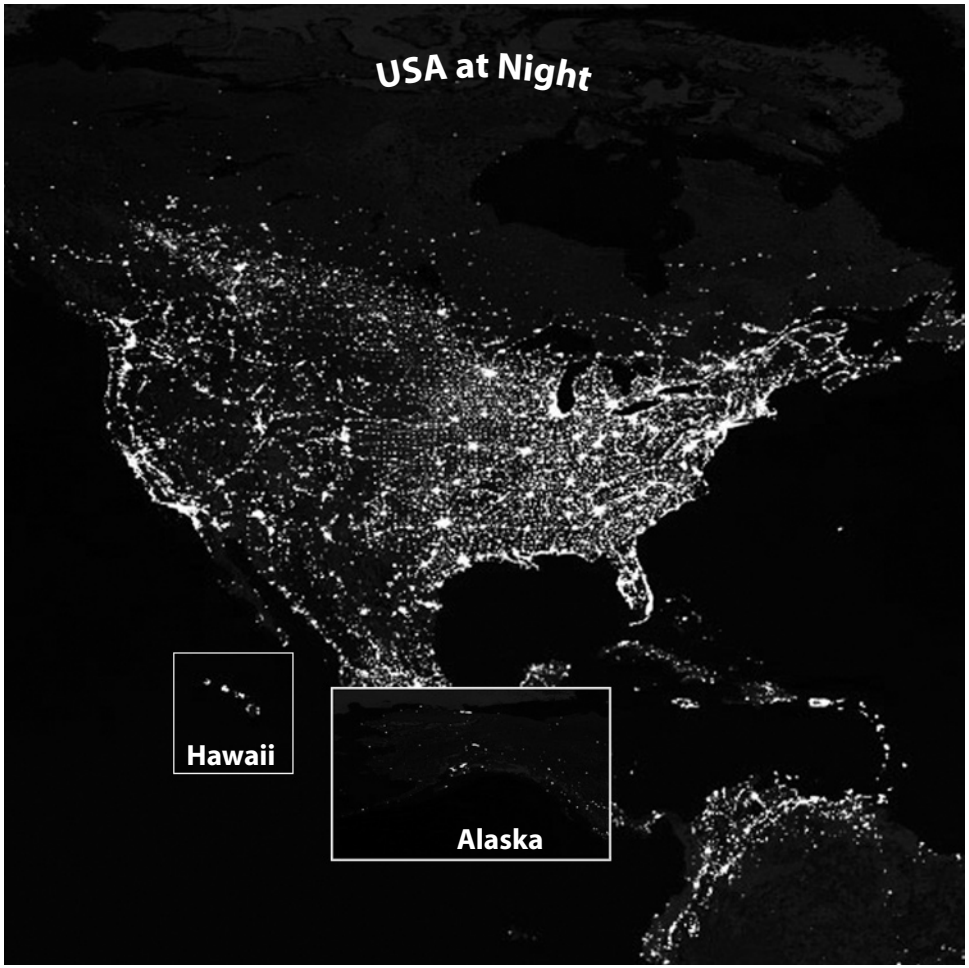
(representing the limit of observable universe)**:** 10 Miles.

BACK

Instructions:

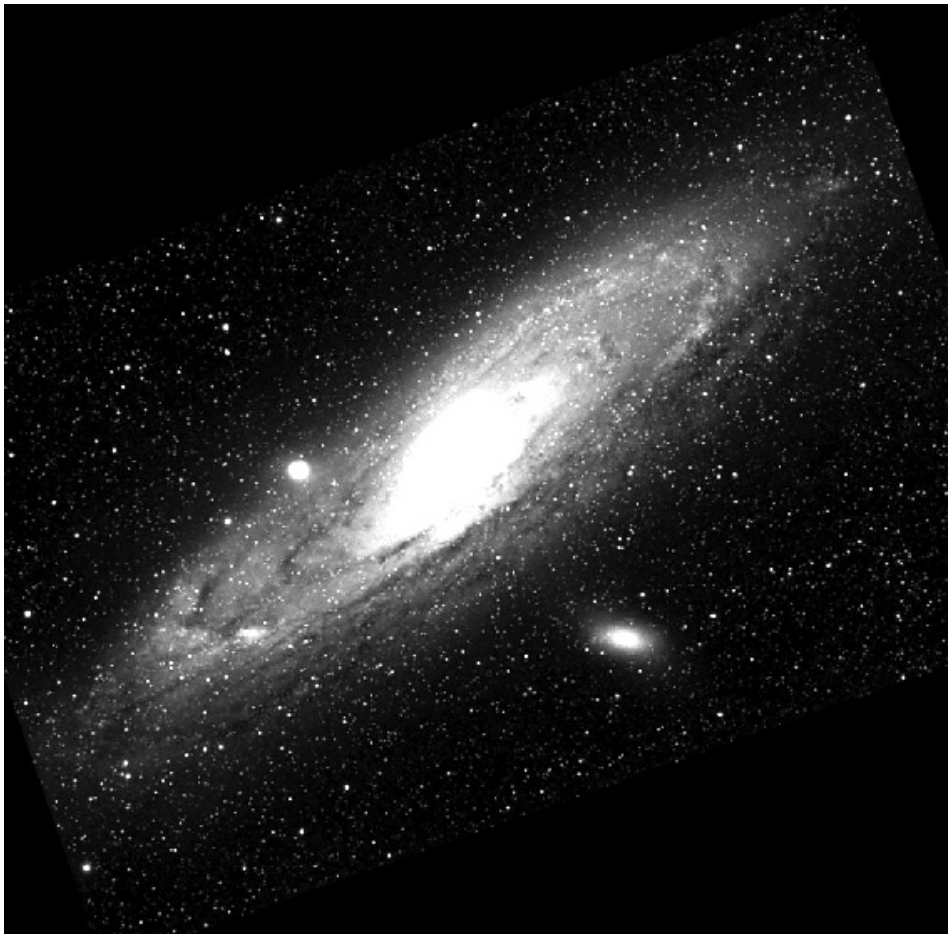
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

FRONT



BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

M31 – The Andromeda Galaxy

(Oct-Jan)

Spiral Galaxy
Distance: 2.3 million light years
Size: 150,000 light years across

CD Distance Scale:

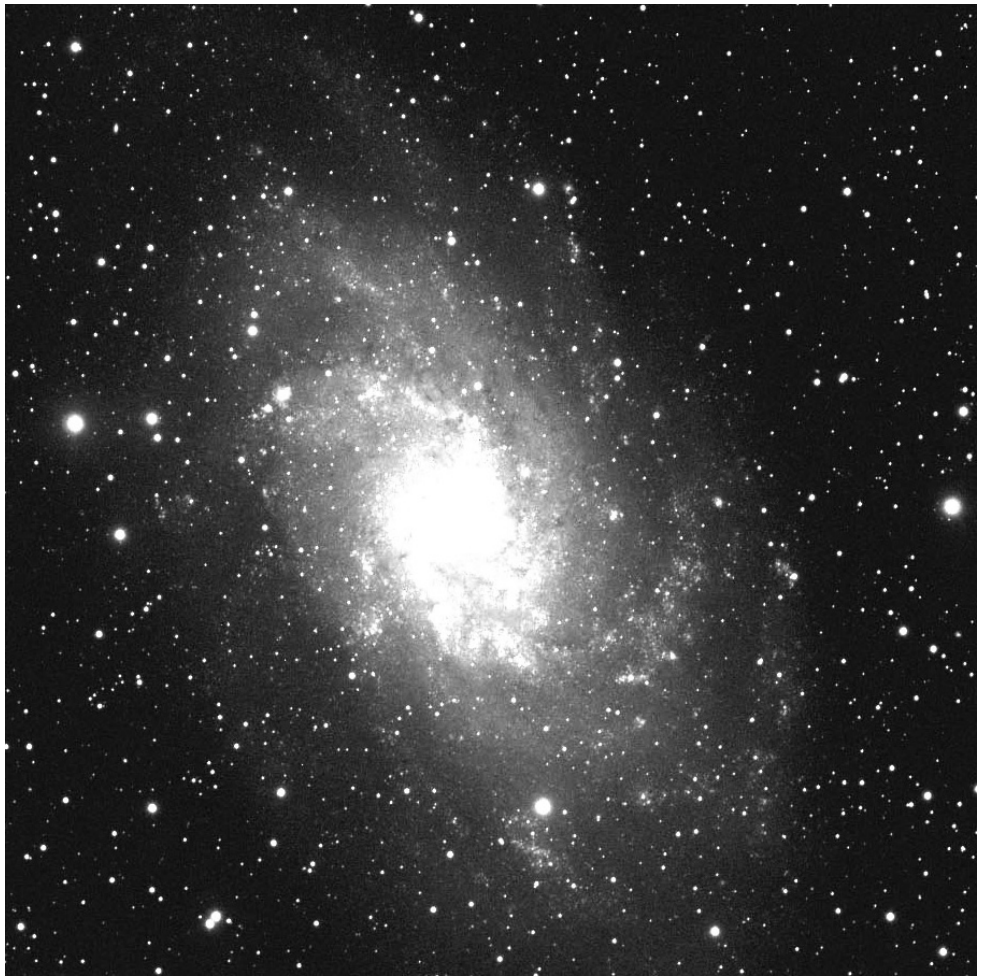
8 feet

Size: 7" across (salad plate)

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

M33 – The Pinwheel Galaxy

(Oct-Jan)

Spiral Galaxy
Distance: 2.4 million light years
Size: 60,000 light years across

CD Distance Scale:

8 feet

Size: 3" across

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

FRONT

M81

(Feb-Jun)

Spiral Galaxy
Distance: 12 million light years
Size: 75,000 light years across

CD Distance Scale:

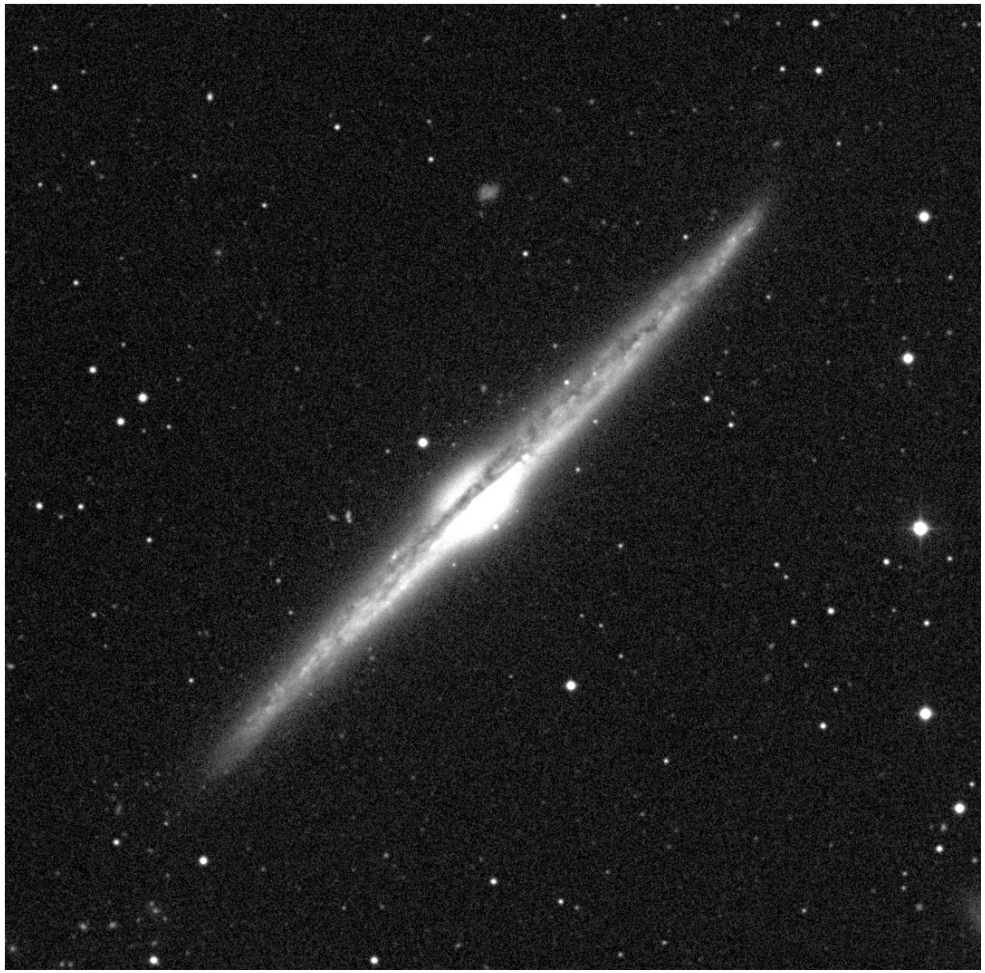
16 yards

Size: 4" across

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

NGC4565

(Apr-Jul)

Spiral Galaxy – viewed edge-on
Distance: 31 million light years
Size: 150,000 light years across

CD Distance Scale:

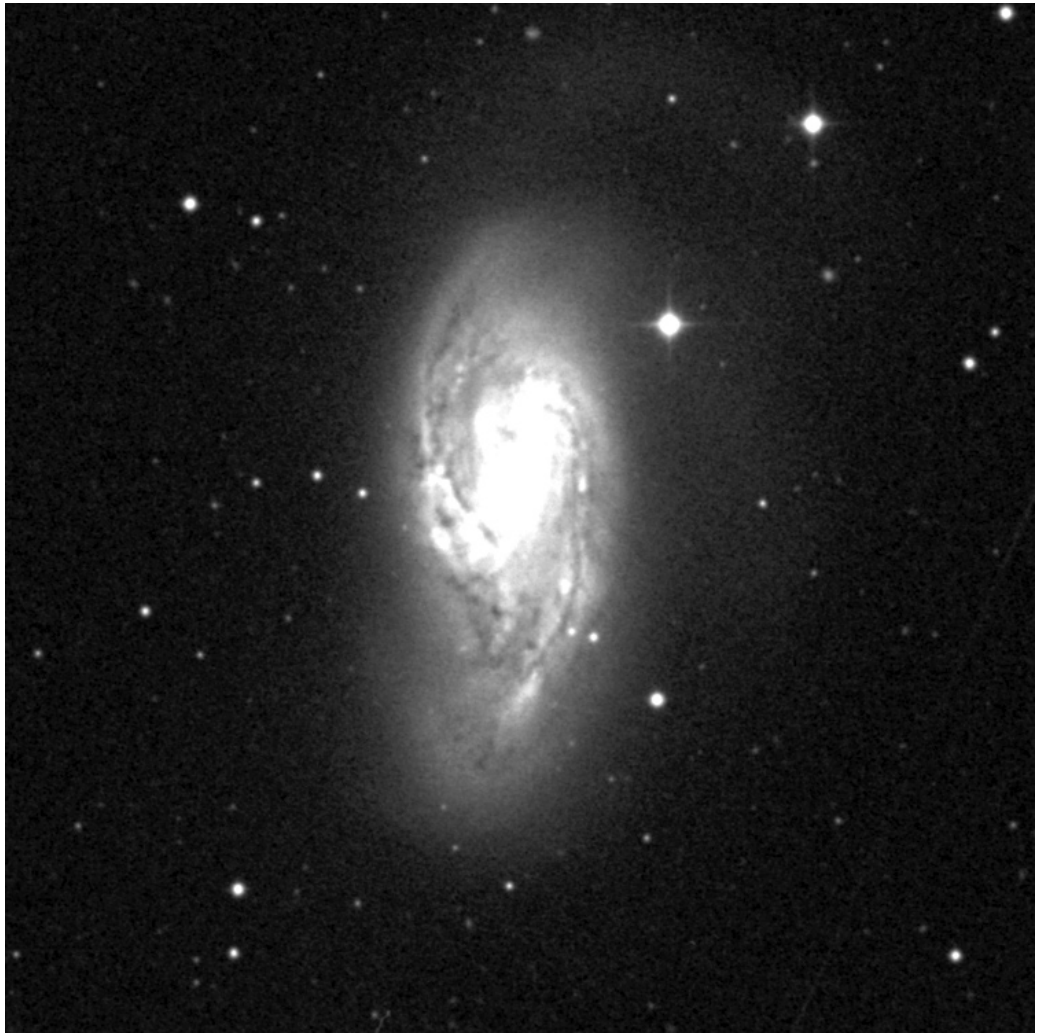
40 yards

Size: 7" across (salad plate)

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

M66

(Apr-Jun)

Spiral Galaxy
Distance: 35 million light years
Size: 80,000 light years across

CD Distance Scale:

47 yards

Size: 4" across

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

FRONT

M51 – Whirlpool Galaxy

(Apr-Aug)

Spiral Galaxy with companion galaxy
Distance: 37 million light years
Size: 120,000 light years across

CD Distance Scale:

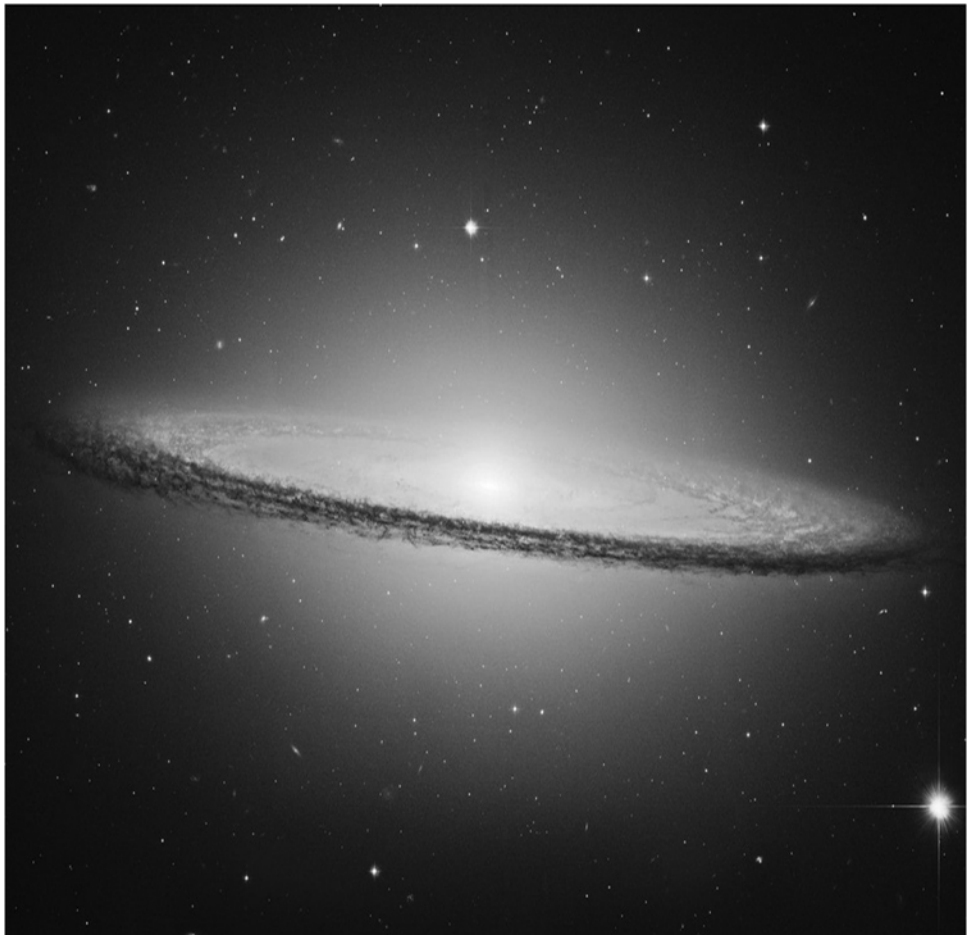
50 yards

Size: 5" across

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

M104 – Sombrero Galaxy

(May-Jun)

Spiral Galaxy – viewed edge-on
Distance: 50 million light years
Size: 75,000 light years across

CD Distance Scale:

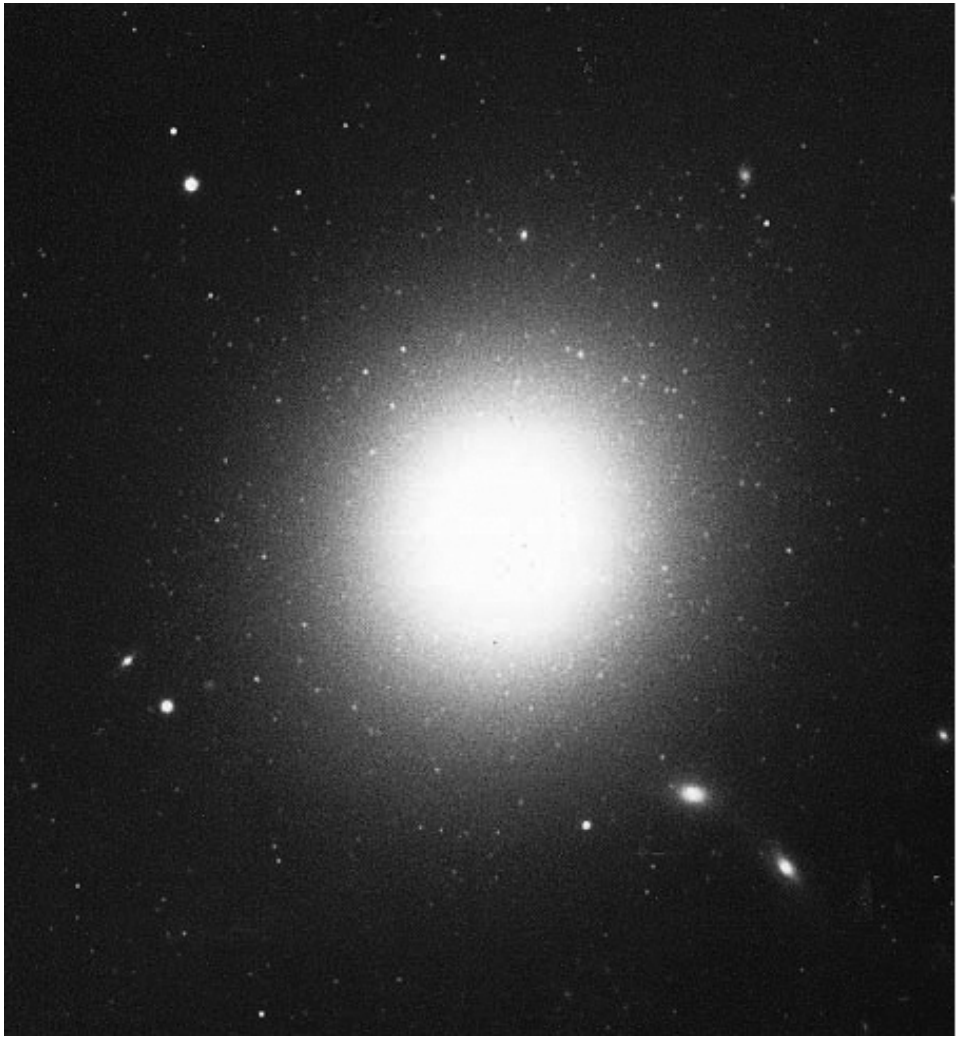
67 yards

Size: 6" across

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

M87

(Apr-Jul)

Elliptical Galaxy
Distance: 60 million light years
Size: 120,000 light years across

CD Distance Scale:

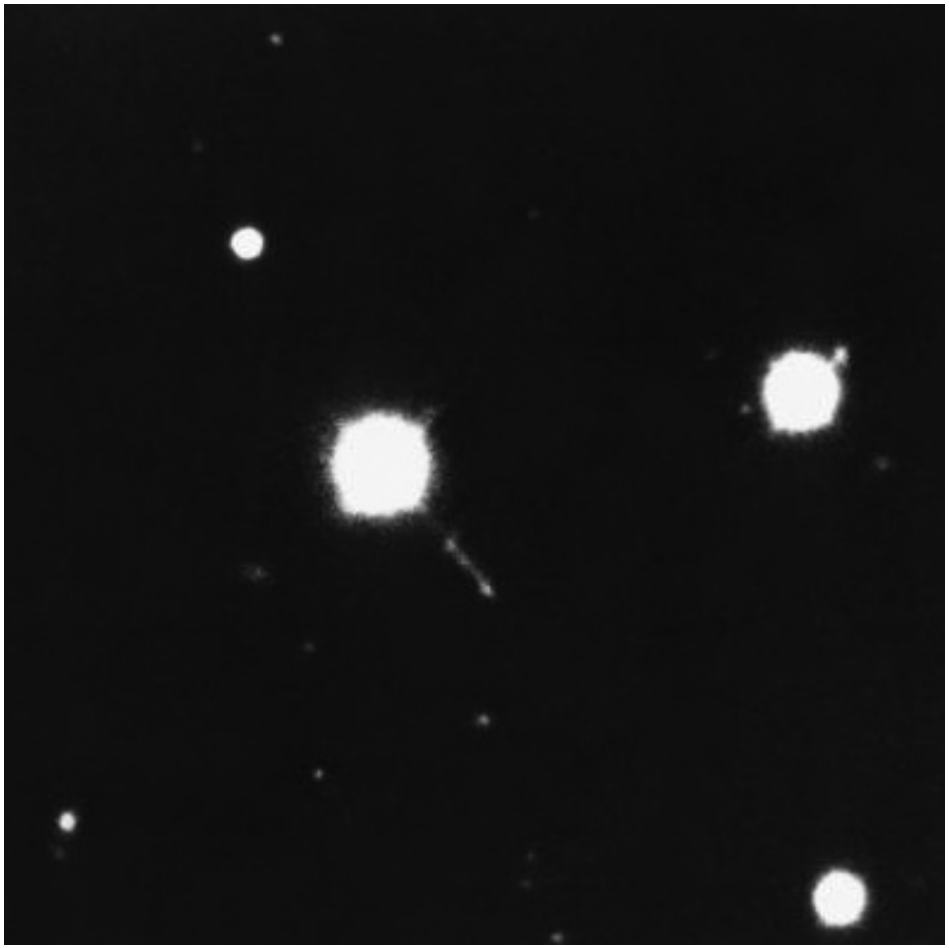
80 yards

Size: 5" across – like a softball

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



FRONT

Quasar 3C-273

(Apr-Jul)

Elliptical Galaxy
Distance: 2.5 billion light years
Size: 120,000 light years across

CD Distance Scale:

2 miles

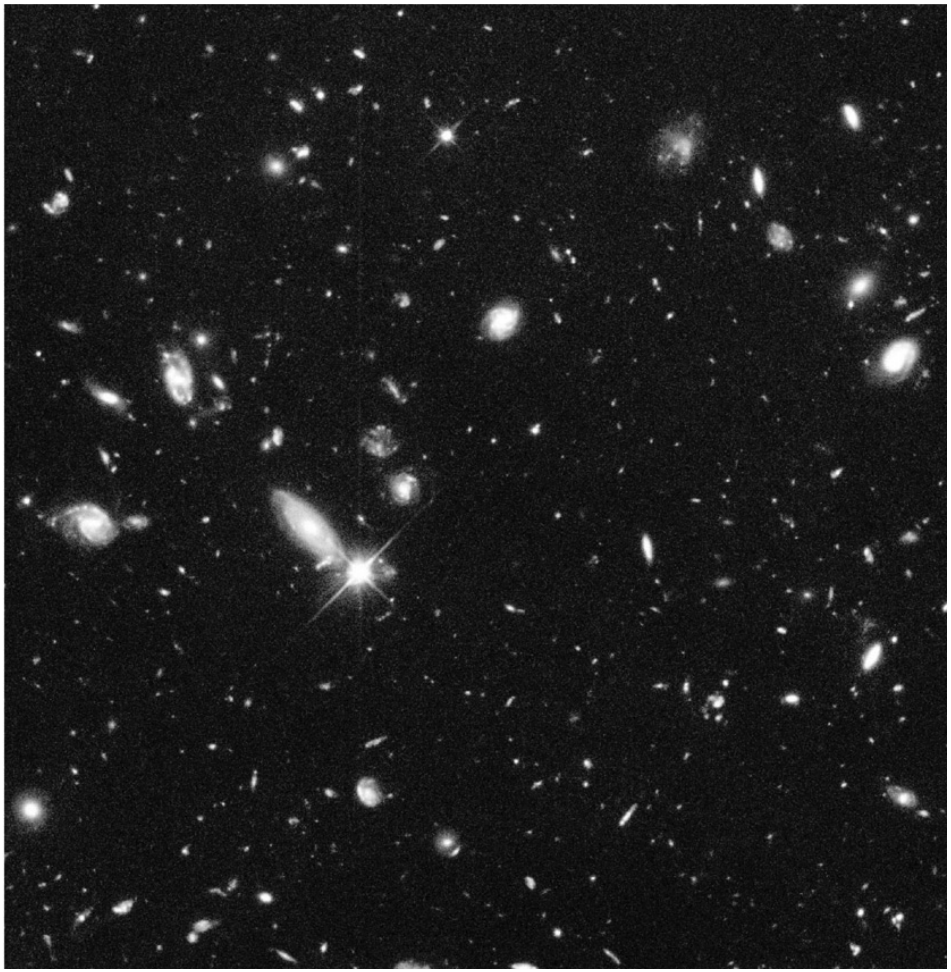
Size: 5" across – like a softball

This is the most distant object that can be seen with most backyard telescopes.

A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.



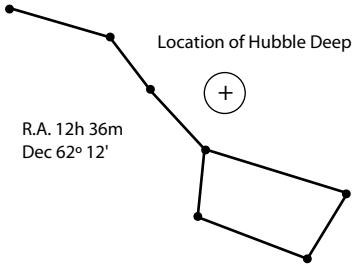
FRONT

Hubble Deep Field

The **Hubble Deep Field** shows some of the most distant galaxies. This image is used to represent the limit of our observable universe: a distance of 13.7 billion light years.

CD Distance Scale:

10 miles



A UNIVERSE OF GALAXIES

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

Make your own!

FRONT

A UNIVERSE OF GALAXIES

The Sun is an average star,
located about halfway out from the
center of our galaxy.

The Milky Way Galaxy, which is 100,000 light years
across, contains about 200 billion other stars.

There are billions of other galaxies in the
observable universe, which reaches out
13.7 billion light years.

Using this CD as our Galaxy,
the observable universe goes out 10 miles.

Scale: 1 Million Light Years = 4 feet

BACK

Instructions:
Peel off each circle and attach the "FRONT" to the label side of a used CD. Attach the "BACK" to the other side of the CD.

Telescopes as Time Machines

What is this activity about?

Big Question: How long has the light we see now from different objects in the universe been traveling to reach us tonight?

Big Activity: A journey through time to view in the telescopes at least one object from each of three different distance categories: within our Solar System, within the Milky Way, within the rest of the universe. The guide is a "Passport through Time." Visitors can view multiple objects within each category and keep a record of what objects they saw.

Participants: **From the club**: A minimum of one person with a telescope up to all telescope providers at a public star party.

Visitors: Appropriate for families, the general public, and school groups in grades 4 and up.

Duration: The “Passport Through Time” can be used for the duration of the star party, typically one or two hours.

Topics Covered:

- How long did it take the light we are seeing tonight from distant objects to reach us?
- How is looking farther away looking back in time?

Where can I use this activity?

Telescopes as Time Machines is designed for use at a **star party** or public astronomy night.

Pre Star Party:
Provide an introduction to your visitors. Refer to the **Detailed Activity Description** for a suggested script.

You might also consider using the activities in the ToolKit, "A Universe of Galaxies" or the "Our Place in our Galaxy", as an introduction.

At the Telescope:
The participating club members at the telescopes should have a copy of the passport so they know what their visitors are referring to. The exact distance of the object they are viewing is not important, just whether it is in our solar system, in the Milky Way, or a galaxy outside the Milky Way. Be prepared to relate that distance to historical events in human history or the history of life on earth. This helps to give your visitors a concrete reference point that leads to a clearer understanding.

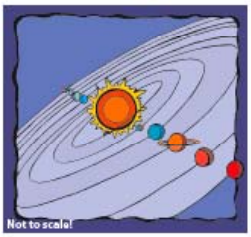
The telescope operators may want to refer to the galaxy CDs from "A Universe of Galaxies" and the constellation/asterism CDs from "Our Place in Our Galaxy" for distances to the objects being observed.

Completion Stickers:
Instead of (or in addition to) completion stickers, you may want to provide a small prize or other giveaway. Use of the stickers is optional.

Helpful Hints

Distances in astronomy are so vast, that it is often difficult to put them perspective. In this activity, visitors are given a passport with three categories: objects in the Solar System, objects outside the Solar System but still within the Milky Way Galaxy, and galaxies outside of our own. Their challenge is to view at least one object from each category during the course of the star party. By giving an overview of the categories when the passports are handed out, you are empowering your visitors to ask questions as they travel through the telescopes.

Solar System



Most light we see from objects in the solar system has traveled for minutes or hours.

minutes → hours

Moonlight takes less than 2 seconds to reach you. Sunlight takes about 8 minutes. Light from Saturn has traveled for over an hour. Light from Pluto's surface has traveled over 5 hours.

Where were you when the light from the planet you saw tonight started on its way to your eye?

What I saw in our Solar System:

Sun: _____

Moon: _____

Planet: _____

Satellite: _____

_____

_____

Milky Way Galaxy

Light from objects in our Galaxy has traveled a few years to thousands of years.

few years → thousands of years

All the individual stars you see when you look up at the sky, or through the telescope are in our Milky Way Galaxy.

Some of the light you see began its journey before your grandfather was born, before Columbus came to America, or even before the Great Pyramid was built.

What I saw in our Milky Way Galaxy:

Star Nursery: _____

Young star cluster: _____

Dying or exploded star: _____

Old star cluster: _____

Double star: _____

_____

A Universe of Galaxies

Most light from other galaxies has traveled millions to billions of years.

few million → billions of years

As we look past the stars in our Milky Way Galaxy, we can peek out and see other galaxies in the rest of the Universe.

Some of the light started its journey before modern humans were on Earth, some before the time of the dinosaurs, and some even before the Earth existed!

What I saw outside of our Galaxy:

Galaxy: _____

Galaxy: _____

Galaxy: _____

Galaxy: _____

Background Information

A frequent question by a visitor at the eyepiece is, "How far can you see with your telescope?" This activity helps to answer this question in a fun way by keeping the categories of distant objects simple and linked to the amount of time it takes that light to reach us.

Light we are seeing now from objects in the Solar System has been traveling for less than a day. For all objects except the Sun, we are seeing reflected sunlight coming from these objects. Check your favorite magazine or website to find out which planets, or the Moon, will be observable the night of your event.

Light we see now from stars and nebulae within our Milky Way Galaxy has been traveling for a few years to tens of thousands of years. You may choose stars or favorite Messier objects that are not galaxies.

Light we see tonight from most of the other galaxies has been traveling for more than a million years.

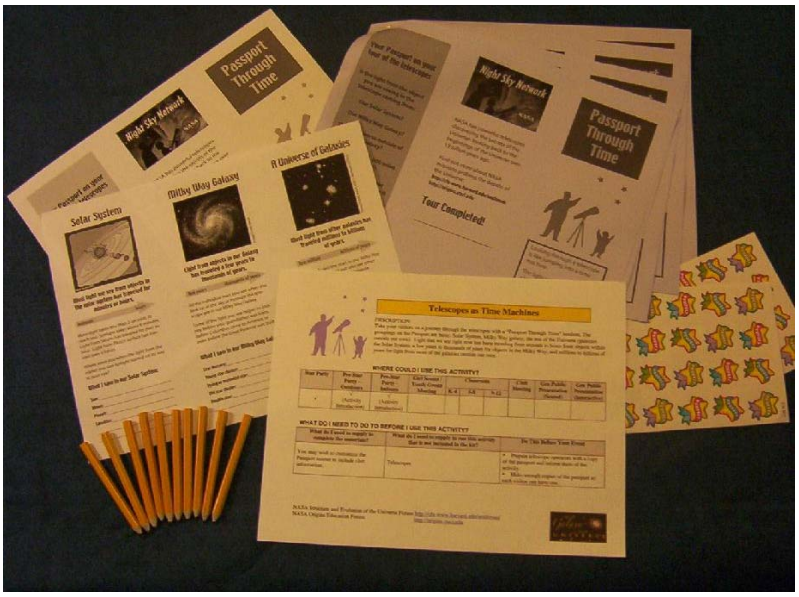
Detailed Activity Description

Leader's Role	***Participant's Role***
Preparaton: ***To do:*** 1. Each participating amateur astronomer may pick any object(s) he or she wishes to show and that his or her telescope is capable of viewing. ***2.*** Give each participating club member a copy of the Passport. Explain that your visitors will have these and be on a "Tour" to look at objects in these categories. The amateur astronomers need to be prepared to tell the visitor what kind of object they are viewing and whether it is within the Solar System, the Milky Way, or if it another galaxy outside our own Galaxy. 	
***Introduction with your visitors*:** <u>*To Ask:*</u> Have any of you ever wished you could travel back in time? <u>*To Say:*</u> Well, when you look through our club members' telescopes tonight, you will be doing just that. Think of these telescopes as time machines. The light we are seeing tonight from planets, stars, and other galaxies traveled for a few minutes to a few years to a few million years to reach us, As you see objects farther and farther away from Earth, the longer the light takes to reach us.	Responses

Leader's Role	***Participant's Role***
<u>*To do:*</u> Turn on your red flashlight so your visitor can see the light. <u>*To Ask:*</u> After I turn on this flashlight, how long before you see the light from it? <u>*To Say:*</u> Usually we think of light as traveling so fast, you don't notice its travel time. But distances are so vast in space that it *does* take time for that light to reach us. Light only travels 186,000 miles per *second* or a little more than 11 million miles in a *minute*. <u>*To Ask:*</u> How far away is the sun from Earth? So how long does it take light leaving the sun right now to reach Earth?	 Instantly. 93 million miles about 8-1/2 minutes!
(Solar System) <u>*To Say:*</u> In the case of those objects in our solar system, light reaches our eyes in seconds, minutes, or hours. <u>*To do:*</u> *(Pick an object that is visible now, say the moon.)* <u>*To Say:*</u> That light we see right now just left the moon a second and half ago, but the light from Saturn left over an hour ago. What were you doing an hour ago? Finishing up supper? On your way here? So is Saturn farther away than the Moon? For everything within our Solar System, it takes less than a day for the light to reach us.	 Individuals should shout out answers Yes.
(Milky Way Galaxy) <u>*To Say:*</u> For objects outside our Solar System, but within our Milky Way Galaxy it is much longer. Not just days, but years, from a few years to tens of thousands of years. <u>*To Do:*</u> *Pick a nearby star, for example, Sirius. (or Vega, at 25 light years)* <u>*To Say:*</u> If there are any nine year olds in the crowd, that starlight has been traveling as long as you have been alive and is just getting here tonight. So you are seeing that star as it was how many years ago?	 Nine!

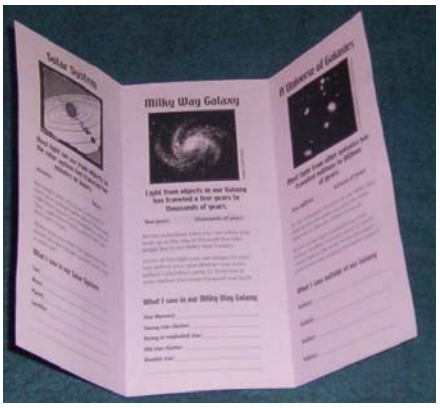
Leader's Role	*Participant's Role*
(Rest of the Universe) *To Ask:* When you view most of the galaxies outside our Milky Way Galaxy, you are looking at light that left *millions* of years ago. Before modern humans were on Earth – before the Stone Age - over 2 million years ago. Even back to the time of the dinosaurs – when was that? *To Say:* NASA scientists study this light from long ago to learn about how stars and galaxies form. By studying more and more distant galaxies, we can learn how galaxies looked millions and even billions of years ago.	Before 65 million years ago.
To Do: Hold up the Passport and point to the three different categories *To Say:* This Passport can be used to guide your journey back in time. For each object you see in the telescope, determine if it is in our Solar System, in our Milky Way Galaxy or somewhere outside of our galaxy. Ask the various people sharing their telescopes with you tonight how long the light has been traveling that is reaching your eye. If the light you are seeing now left that object *today*, would it be in the Solar System, out in the rest of the Milky Way Galaxy, or in a Galaxy beyond our own Milky Way? How long ago were the dinosaurs on Earth? If you are seeing light that has been traveling since the time of the dinosaurs, which of these categories would that object be in? (Optional): You will also be given a pencil to record which objects you viewed, (Optional): After you have seen at least one object in each category, you will have earned a completion sticker. (Explain the procedure you have chosen to distribute the completion stickers – or other prize). *(Hand out Passports, pencils*) So enjoy your trip into the past and take a journey back in time each time you look through an eyepiece.	Solar System 65 million years ago. Galaxies beyond the Milky Way.

Materials



What Materials from the ToolKit do I need?

- Master of the "Passport through Time" handout (both sides)
- Copies of the Passport – this is designed as a tri-fold (see photos of folded passport)
- Pencils (optional)
- Completion stickers (optional)



What must I supply?

- Telescopes

What do I need to prepare?

- Prepare telescope operators with a copy of the passport and inform them of the activity.
- Make enough copies of the passport so each visitor or family can have one.
- You may wish to customize the Passport master to include your club information. On the back of the Passport is a space for this:

Where do I get additional materials?

- Passport master is in the OGOU_Manual.pdf on the *ToolKit Manual and Resources CD*.

- You can order more completion stickers from: http://www.teachercreated.com/. The item number is TCM4219. The item description is "Perfect Star Stickers".

- You can purchase golf pencils from www.amazon.com. Search on "golf pencils". Or from any golf supply store.

Your Passport on your tour of the telescopes

Is the light from the object you are seeing in the telescope coming from:

Our Solar System?

Our Milky Way Galaxy?

Or the Universe outside of our Galaxy?

Light travels 186,000 miles each second !

Consider how long that light was traveling before it reached your eye.

Keep a log of each object you see on your tour!

NASA has powerful telescopes discovering the secrets of the Universe–looking back to the beginnings of the Universe over 13 billion years ago.

Find out more about NASA missions probing the depths of the Universe:
http://cfa-www.harvard.edu/seuforum
http://origins.stsci.edu

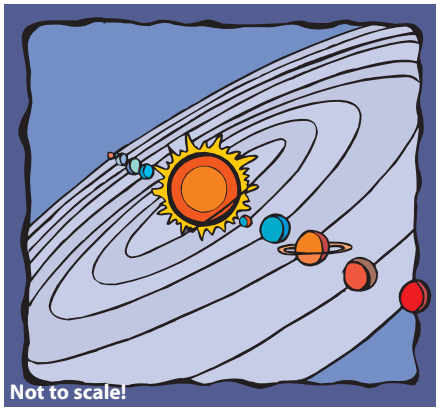
Tour Completed!

Passport Through Time

Looking through a telescope is like jumping into a time machine.

The light we see from most objects out in space has been traveling from a few minutes to millions or even billions of years.

Solar System



Most light we see from objects in the solar system has traveled for minutes or hours.

minutes → hours

Moonlight takes less than 2 seconds to reach you. Sunlight takes about 8 minutes. Light from Saturn has traveled for over an hour. Light from Pluto's surface has traveled over 5 hours.

Where were you when the light from the planet you saw tonight started on its way to your eye?

What I saw in our Solar System:

Sun: _____

Moon: _____

Planet: _____

Satellite: _____

_____

_____

Milky Way Galaxy

Image Credit: NASA

Light from objects in our Galaxy has traveled a few years to thousands of years.

few years → thousands of years

All the individual stars you see when you look up at the sky, or through the telescope are in our Milky Way Galaxy.

Some of the light you see began its journey before your grandfather was born, before Columbus came to America, or even before the Great Pyramid was built.

What I saw in our Milky Way Galaxy:

Star Nursery: _____

Young star cluster: _____

Dying or exploded star: _____

Old star cluster: _____

Double star: _____

_____

A Universe of Galaxies

Photo Credit: NASA, ESA, S. Beckwith (STScI)

Most light from other galaxies has traveled millions to billions of years.

few million → billions of years

As we look past the stars in our Milky Way Galaxy, we can peek out and see other galaxies in the rest of the Universe.

Some of the light started its journey before modern humans were on Earth, some before the time of the dinosaurs, and some even before the Earth existed!

What I saw outside of our Galaxy:

Galaxy: _____

Galaxy: _____

Galaxy: _____

Galaxy: _____

Media & Resources

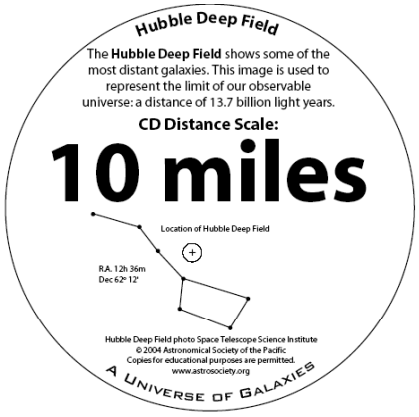
GETTING STARTED WITH THE *OUR GALAXY, OUR UNIVERSE* OUTREACH TOOLKIT

1. **INSERT "OUTREACH TOOLKIT MANUAL AND RESOURCES" CD INTO YOUR COMPUTER. Click on OGOUManual.pdf to navigate through the Outreach ToolKit Manual. You need the free Adobe Acrobat Reader to view the manual: http://www.adobe.com/products/acrobat/readstep2.html**
2. **VIEW THE TRAINING VIDEO as you review materials in the ToolKit.– this is a DVD labeled "Outreach ToolKit Training".**
3. **Review the PowerPoint in the PowerPoint folder on the "ToolKit Manual and Resources CD".**
4. **View the selections on the DVD labeled "Hubble Collections".**
5. **PLAN EVENTS. You might want to start by taking the passports in "Telescopes As Time Machines" to your next star party.**
6. **AFTER EACH EVENT, log your events on the Night Sky Network. A Club Coordinator will need to approve each event.**
7. **See Outreach ToolKit Manual for more details.**

WHERE COULD I USE THE ANIMATIONS AND OTHER RESOURCES INCLUDED HERE?

MEDIA / RESOURCE	Pre-Star Party - Indoors	Girl Scouts / Youth Group Meeting	Classroom			Club Meeting	Gen Public Presentation (Seated)
			K-4	5-8	9-12		
Hubble Collections DVD	√	√		√	√	√	√
Booklet: How big is our universe?		√		√	√	√	

NASA Structure and Evolution of the Universe Forum http://cfa-www.harvard.edu/seuforum/
NASA Origins Education Forum http://origins.stsci.edu



A Universe of Galaxies

DESCRIPTION: Build a model of the Universe!
Use a CD as a model of our Milky Way Galaxy to set the scale to show distances to other galaxies. Additional CDs with images of other galaxies are used to build a model of the Universe with your visitors – to the limit of the observable universe.

See Kit Manual and Training Video for more details.

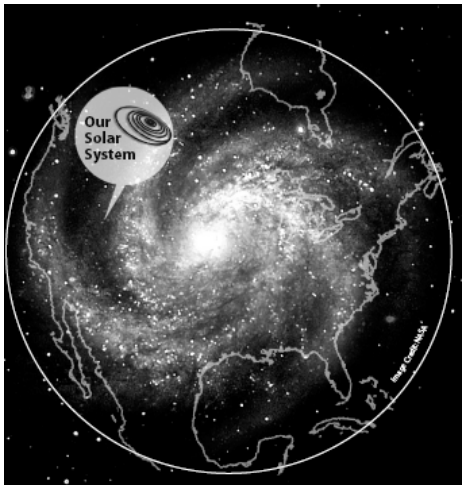
WHERE COULD I USE THIS ACTIVITY?

Star Party	Pre-Star Party - Outdoors	Pre-Star Party - Indoors	Girl Scouts / Youth Group Meeting	Classroom			Club Meeting	Gen Public Presentation (Seated)	Gen Public Presentation (Interactive)
				K-4	5-8	9-12			
√	√	√	√		√	√			√

WHAT DO I NEED TO DO TO BEFORE I USE THIS ACTIVITY?

What do I need to supply to complete the materials?	What do I need to supply to run this activity that is not included in the kit?	Do This Before Your Event
You may want to add club information on the Galaxy CD handout sheet. If making sets of galaxies, you will need: • scissors • glue stick • plenty of old CDs	Telescopes	**Assemble Galaxy CDs:** image on one side, distance info on reverse. Make copies of the Galaxy CD handout sheet for your visitors. ***Optional***: If audience members are making their own CD Galaxy from the handout, collect enough used CD's for everyone.

NASA Structure and Evolution of the Universe Forum http://cfa-www.harvard.edu/seuforum/
NASA Origins Education Forum http://origins.stsci.edu



Our Place in Our Galaxy

DESCRIPTION:
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.

Convey the size of our Galaxy and distances to objects within it. Mentally construct a model of our place in the Milky Way Galaxy and the distribution of stars … with a quarter and some birdseed

WHERE COULD I USE THIS ACTIVITY?

Star Party	Pre-Star Party - Outdoors	Pre-Star Party - Indoors	Girl Scouts / Youth Group Meeting	Classroom			Club Meeting	Gen Public Presentation (Seated)	Gen Public Presentation (Interactive)
				K-4	5-8	9-12			
√	√	√	√		√	√	√	√	√

WHAT DO I NEED TO DO TO BEFORE I USE THIS ACTIVITY?

What do I need to supply to complete the materials?	What do I need to supply to run this activity that is not included in the kit?	Do This Before Your Event
CDs, scissors and glue if making sets of Galaxy CDs from the visitor handouts	Telescopes Quarter	**Assemble CDs:** galaxy image on one side, constellations and distance info on reverse. • Inform participating club members about activity • Prepare constellation CDs for all participating club members or print out and copy the Milky Way Reference Sheet • Make copies of the visitor handout

NASA Structure and Evolution of the Universe Forum http://cfa-www.harvard.edu/seuforum/
NASA Origins Education Forum http://origins.stsci.edu

Telescopes as Time Machines

DESCRIPTION:
Take your visitors on a journey through the telescopes with a "Passport Through Time" handout. The groupings on the Passport are basic: Solar System, Milky Way galaxy, the rest of the Universe (galaxies outside our own). Light that we see right now has been traveling from seconds to hours from objects within the Solar System, a few years to thousands of years for objects in the Milky Way, and millions to billions of years for light from most of the galaxies outside our own.

WHERE COULD I USE THIS ACTIVITY?

Star Party	Pre-Star Party - Outdoors	Pre-Star Party - Indoors	Girl Scouts / Youth Group Meeting	Classroom			Club Meeting	Gen Public Presentation (Seated)	Gen Public Presentation (Interactive)
				K-4	5-8	9-12			
√	√ (Activity Introduction)	√ (Activity Introduction)							

WHAT DO I NEED TO DO TO BEFORE I USE THIS ACTIVITY?

What do I need to supply to complete the materials?	What do I need to supply to run this activity that is not included in the kit?	Do This Before Your Event
You may wish to customize the Passport master to include club information.	Telescopes	• Prepare telescope operators with a copy of the passport and inform them of the activity. • Make enough copies of the passport so each visitor can have one.