October 2009
IYA Discovery Guide

This Month's Theme:

What is the Fate of the Universe?

Featured Activity:

Telescopes as Time Machines

Featured Observing Object:

The Andromeda Galaxy

The International Year of Astronomy is a global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
Join us as we look up! http://astronomy2009.us

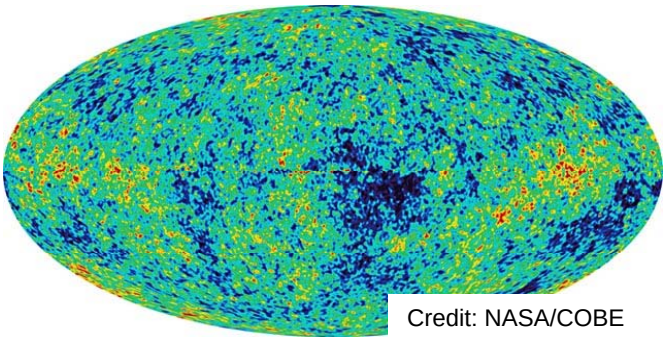
The Astronomical Society of the Pacific increases the understanding and appreciation of astronomy by engaging scientists, educators, enthusiasts and the public to advance science and science literacy.
http://www.astrosociety.org

October's Topic:
What is the Fate of the Universe?

Where do we come from and where are we going? Humans have been asking these questions since before recorded history. Over the past 400 years, science has used observations and experiments to attempt to answer them. Cosmologists study the nature of the whole universe as they look for the answers to these big questions.

Most astronomers today accept the abundant evidence that the universe began about 14 billion years ago. But because we cannot see into the future, the fate of the universe has been somewhat more perplexing. In 1929, Edwin Hubble discovered that the universe is expanding. Then in 1990 NASA's COBE satellite showed that the universe was originally extremely hot and dense. So the universe started small and hot and is getting bigger and cooler. Based on what was known for most of the past century, scientists saw two different options for the fate of the universe, depending on how much mass it contained. Since mass creates gravity, the more mass there is, the more gravity will pull things together. Thus the two possible outcomes are:

1) Either there isn't enough mass to stop the expansion and the universe will just keep expanding forever, or
2) There is enough mass and gravity to pull the universe back together, and there will be some kind of "Big Crunch" in our future.



Credit: NASA/COBE

In both of these models, the rate of expansion was expected to slow over time. Well, new discoveries sometimes mean that scientists have to change their models. That was the case in 1998, when two separate groups came to a shocking conclusion. Using observations with the Hubble Space Telescope and ground-based telescopes, the researchers found that not only is the universe *expanding*, it is also *accelerating!* It appears that there is some unknown force "pushing" the universe faster and faster apart. This acceleration has changed our understanding of the fate of the universe and created even more questions. NASA and the Department of Energy have jointly asked scientists to design a mission, to be launched in the next decade that will explore the nature of the so-called "Dark Energy[1]" that is causing the universe to expand ever faster.

The fate of the universe is all very far in the future. But in the not so distant future, about four billion years from now, the Milky Way Galaxy will collide with the Andromeda Galaxy. Amazingly, stars in galaxies are so far apart that few, if any, of them will actually collide. But the dust and gas will slam together, and if humans still inhabit the Earth, our distant ancestors should have quite a show as bright new stars are born in the night sky. You can see the Andromeda Galaxy now, while it is still over 2 million light years away. Use the finder chart in this guide to locate it.

Learn more about the Fate of the Universe from NASA.
Find more activities featured during IYA 2009.
See what else is planned for the International Year of Astronomy.

1 Dark Energy is not related to the Dark Matter, so the similarity of their names is unfortunate. They are both "dark" in the sense that we do not understand what they are.

Andromeda Galaxy (M31)

Andromeda Galaxy (M31)

The Andromeda Galaxy, M31, dominates an exclusive group of objects outside our own galaxy that are visible to the unaided eye. Under dark skies, M31 can be seen as a cloudy patch of light, although even small telescopes reveal its substructure in the form of a central bulge and spiral disk.

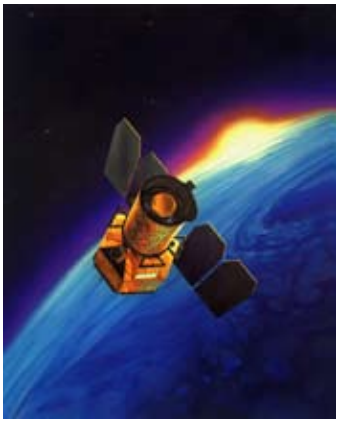
The Andromeda Galaxy and Milky Way are the largest, most massive galaxies in the "Local Group." Oddly, M31 seems to contain less mass than the Milky Way, even though its disk is more than double the diameter of the Milky Way's. Because it lies only 2.5 million light years away, M31 is an extremely well-studied spiral galaxy, giving us a detailed, external perspective of a galaxy similar to our own. However, much remains to be learned.

Revealing How Stars Form

GALEX Space Telescope images of the Andromeda Galaxy in the ultraviolet (UV) portion of the spectrum have provided new insight into the star formation process ultimately driving galaxy evolution. UV imaging traces primarily emission from the atmospheres of hot stars, most of which were formed in the past few hundred million years. The GALEX data vividly reveal the global pattern of "recent" star formation within M31, enhancing the contrast of these features by excluding the light originating from ordinary, cooler stars.

Though large-scale spiral arms dominate the GALEX image of the Andromeda Galaxy, it is the fine resolution and sensitivity of the UV data that make it especially scientifically valuable. GALEX resolves small associations of young, massive stars (and even luminous individual stars) over the entire extent of M31's disk, making it possible for astronomers to begin to understand the local physical conditions that promote or inhibit star formation. UV imaging is particularly well suited for studying regions with infrequent (but ongoing) star formation, such as the outermost part of the galactic disk.

A Different View of the Universe



The Galaxy Evolution Explorer was launched on April 28, 2003. Its mission is to study the shape, brightness, size and distance of galaxies across 10 billion years of cosmic history. The Explorer's 50-centimeter-diameter (19.7-inch) telescope sweeps the skies in search of ultraviolet-light sources.

Caltech leads the Galaxy Evolution Explorer mission and is responsible for science operations and data analysis. NASA's Jet Propulsion Laboratory, Pasadena, California, manages the mission and built the science instrument. The mission was developed under NASA's Explorers Program managed by the Goddard Space Flight Center, Greenbelt, Maryland. South Korea and France are the international partners in the mission.

For more GALEX images and information, visit http://www.galex.caltech.edu.

October 2009 Featured Observing Object:

M31: Andromeda Galaxy

Finder Chart

For information about M31:
http://seds.org/messier/M/m031.html

R.A. 0h 42.7m
Dec +41:16
Distance: 2.9 million light years
Visual Magnitude: 3.4
Apparent Dimension: 3 degrees by 1 degree

To view: unaided eyes under dark skies, binoculars, or telescope

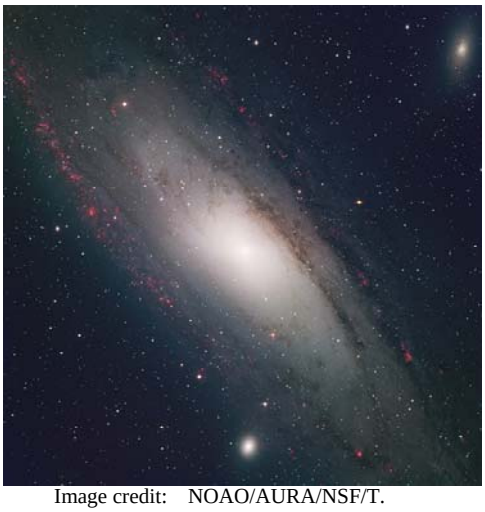
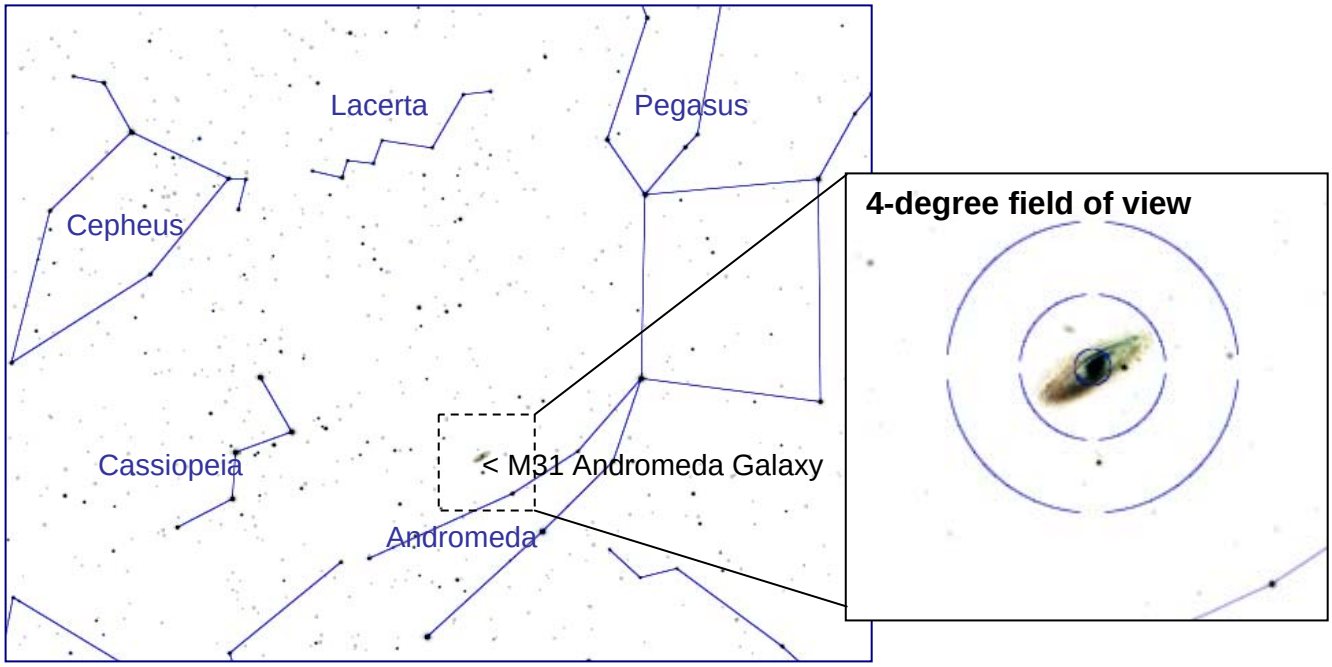


Image credit: NOAO/AURA/NSF/T. Rector & B.A.Wolpa

In October 2009, in the evening the Andromeda Galaxy (M31) is toward the northeast from the Northern Hemisphere in the direction of the constellation of Andromeda. From the Southern Hemisphere, M31 is low on the northeastern horizon and may be difficult to see.



Telescopes as Time Machines

How long has the light from different objects in the universe been traveling to reach us tonight?

About the Activity

The "Passport Through Time" handout shows visitors the difference between each of three different distance categories: within our Solar System, within the Milky Way, and within the rest of the universe.

Topics Covered

- How long does it take the light from distant objects to reach us?
- How is looking farther away looking back in time?

Participants

Best for families, the general public, and school groups ages 9 and up.

Location and Timing

The "Passport through Time" can be used for the duration of a star party, typically up to one or two hours.

Materials Needed

- Telescopes
- Copies of the Passport through Time handout
- *Optional:* Pencils
- *Optional:* Completion stickers

Included in This Activity

Preparation Instructions
Detailed Activity Description
Helpful Hints
Background Information
Passport through Time Handout

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

Preparation Instructions

- Make enough copies of the Passport so each visitor can have one.
- You may wish to customize the Passport master to include your club information.
- Prepare telescope operators with a copy of the passport and inform them of the activity.

Detailed Activity Description

Set Up:

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 amateur astronomer 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 another galaxy outside our own Galaxy.

Leader's Role	***Participant's Role***
Introduction: Tonight, you will be on a Journey Through Time as you tour the telescopes. We want you to think of those telescopes as time machines. Usually we think of light as traveling so fast, that you don't notice its travel time. It doesn't take any time for light to fill a room when you flip a light switch on, you flip the switch and the room is bright. Distances are so vast in space that it *does* take time for that light to reach us. The light has been traveling from a few minutes to millions of years. Travel from time machine to time machine and hunt for these amazing objects whose light has been traveling for minutes, years or even millions of years. You will receive a Passport Through 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. (Hold up the Passport) (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").	At each telescope, participants can mark their Passport with the object they saw.

Leader's Role	***Participant's Role***
If you'd like to expand on the story of time machines, try this line of presentation and questioning: Have any of you gone on any great vacations lately where you have explored new places? (If your star party is in an interesting location like a state or national park, you could ask if this is their first trip to the park.) Well, when you look through our club members' telescopes tonight, you will be doing a different kind of exploring. With each peek in the eyepiece you will be exploring the universe, not only through space, but also through time.	These are not rhetorical questions, try to get real responses from the visitors. How about local exploring, has anyone been to (pick a favorite local attraction)?
This Passport can be used to guide your journey. As you explore farther and farther away from Earth, think about how long it takes the light from each of these objects to get to us. In the case of those objects in our solar system, it is on the scale of minutes and hours. <u>*To do:*</u> *(Pick an object that is visible now, say the moon.)* <u>*To Say:*</u> That light just left the moon a second and half ago, but the light from Jupiter left 40 or 50 minutes ago. Where were you 40 minutes ago? Finishing up supper? On your way here? For everything within our solar system, it takes less than a day for its light to reach us. For objects within the Milky Way it is much longer. Not just days, but years, perhaps tens of thousands of years. <u>*To Do:*</u> *Pick a nearby star, for example, Sirius.* <u>*To Say:*</u> Are there any 9 year olds in the crowd? That star's light has been traveling as long as you have been alive and is just getting here tonight. So ask the various people sharing their telescopes with you tonight how long the light has been traveling. Did it leave today (in our solar system), during the time modern humans have been on Earth (objects in the Milky Way) or does that light predate modern humans? Could it have started out during the reign of dinosaurs? Ask these questions of the amateur astronomers at the telescopes as you complete your Passport and take a journey back in time each time you look through an eyepiece.	*Individuals should call out answers*

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.

Pre Star Party:
Have one representative introduce the story of distances as laid out on the Passport through Time. Use the analogy of exploring a new continent to establish the categories of distances to be explored. Equate the distances of the types of objects to be observed to the time it takes the light from them to reach us.
You might also consider using the activities *A Universe of Galaxies** or the *Our Place in our Galaxy**, as an introduction.

At the Telescope:
The participating club members might want to refer to the cards from *The Universe in a Different Light** for talking points about the object they are viewing. The exact distance of the object 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.

The galaxy CDs from *A Universe of Galaxies** and the constellation/asterism CDs from *Our Place in Our Galaxy** can be useful references for distances to the objects being observed.

* These activities can be found on the Night Sky Network website:
http://nightsky.jpl.nasa.gov/

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 has been traveling for **less than a day** if it is coming from objects in the Solar System: Check your favorite magazine or website to find out which planets will be observable the night of your event.
- Light has been traveling for **a few years to thousands of years** if it comes from stars or Messier objects that are not galaxies. These are all within the Milky Way Galaxy.
- Light has been traveling for **more than a million years** if it comes from most other galaxies.

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

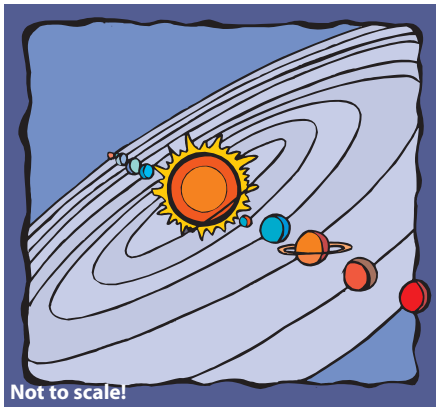
Tour Completed!

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: _____

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NASA Education Forum on the Structure and Evolution of the Universe
NASA Education Forum on Solar System Exploration
NASA Education and Public Outreach at Sonoma State University
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NASA's Kepler Discovery Mission

The Night Sky Network is a nationwide coalition of amateur astronomy clubs bringing the science, technology, and inspiration of NASA's missions to the general public.

We share our time and telescopes to provide you with unique astronomy experiences at science museums, observatories, classrooms, and under the real night sky.
http://nightsky.jpl.nasa.gov

The International Year of Astronomy (http://astronomy2009.us) aims to help citizens of the world rediscover their place in the Universe through the daytime and nighttime sky. Learn more about NASA's contributions to the International Year of Astronomy at http://astronomy2009.nasa.gov