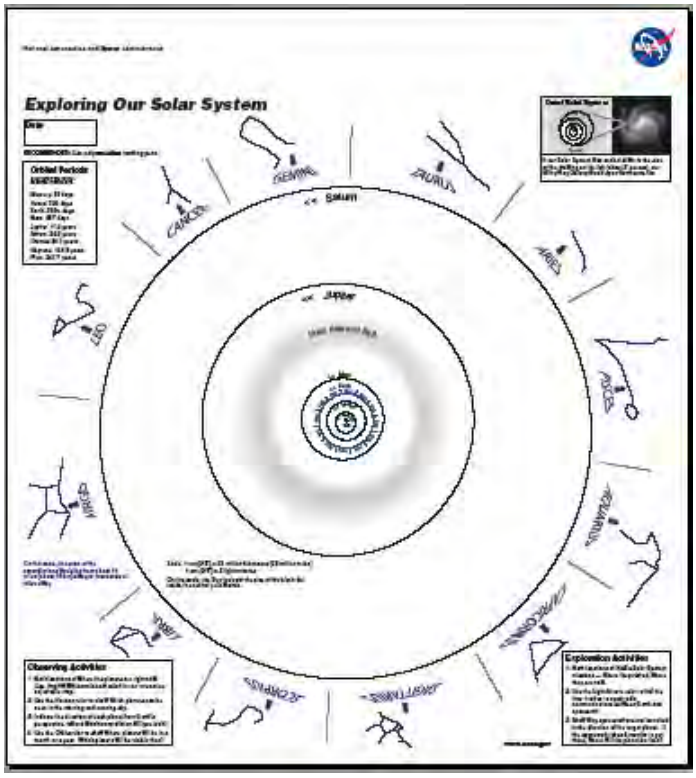
Exploring Our Solar System

What's this activity about?



Big Questions:

What planets can we see in the night sky? Why can't we see all the planets?
Where has NASA explored in the Solar System?
Where are the spacecraft now?

Big Activities:

Using a banner with accurately scaled orbits of all the naked eye planets, explain a variety of concepts regarding the planets we see (and don't see) in the sky, what missions are exploring the Solar System, and how long it takes to communicate with spacecraft.

Use star maps to connect the positions of the planets on the banner to where the planets can be observed in the sky.

Participants:

From the club: A minimum of one person.

Visitors: Most activities are appropriate for families, the general public, and school groups in grade 5 and up. Up to 10 visitors at a time may comfortably participate in the banner activities. Any number of visitors can participate using the star maps.

Duration:

A few minutes, up to a half hour, depending on the number of topics covered.

Topics Covered:

Where are the planets right now in relation to Earth?
Which planets can be seen in the morning and evening sky?
Where do I look in the sky to find the planets?
Where will the planets be in a month or a year? Which planets will be visible then?
Where are NASA's Solar System missions right now?
How long does it take to send messages between Earth and the spacecraft?

Where could I use this activity?

ACTIVITY	Star Party	Pre-Star Party – Outdoors	Pre-Star Party – Indoors	Girl Scouts / Youth Group Meeting	Classroom			Club Mtg	Gen Public Presentation (Seated)	Gen Public Presentation (Interactive)
					K-4	5-8	9-12			
1. Banner: "Exploring Our Solar System"	√	√	√	√		√	√	√	√	√
2. Banner Handout for visitors	√	√	√	√		√	√	√	√	√
3. "Where are the Planets" Star Maps	√	√						√		

What do I need to do 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
Cut out stickers for banner. Attach Velcro straps to banner. *Optional*: Cleaner	Fence, Table, or Vehicle to display banner Printout of current locations of planets: http://www.fourmilab.ch/cgi-bin/Solar Printout of current locations of NASA missions: http://space.jpl.nasa.gov/ *Optional*: Yardstick or other straight-edge	Make needed copies of handouts *Optional*: Copy your club information on the back of the handouts

Helpful Hints

Common misconceptions addressed by these resources:

- Planets are in a line.
- We can see all the planets anytime during the night.
- Planets don't move in their orbits.
- Planets all move together as they orbit the Sun.
- We have sent people to Mars.
- Communication with spacecraft is instantaneous.

Care of the Banner, Rulers, and Stickers

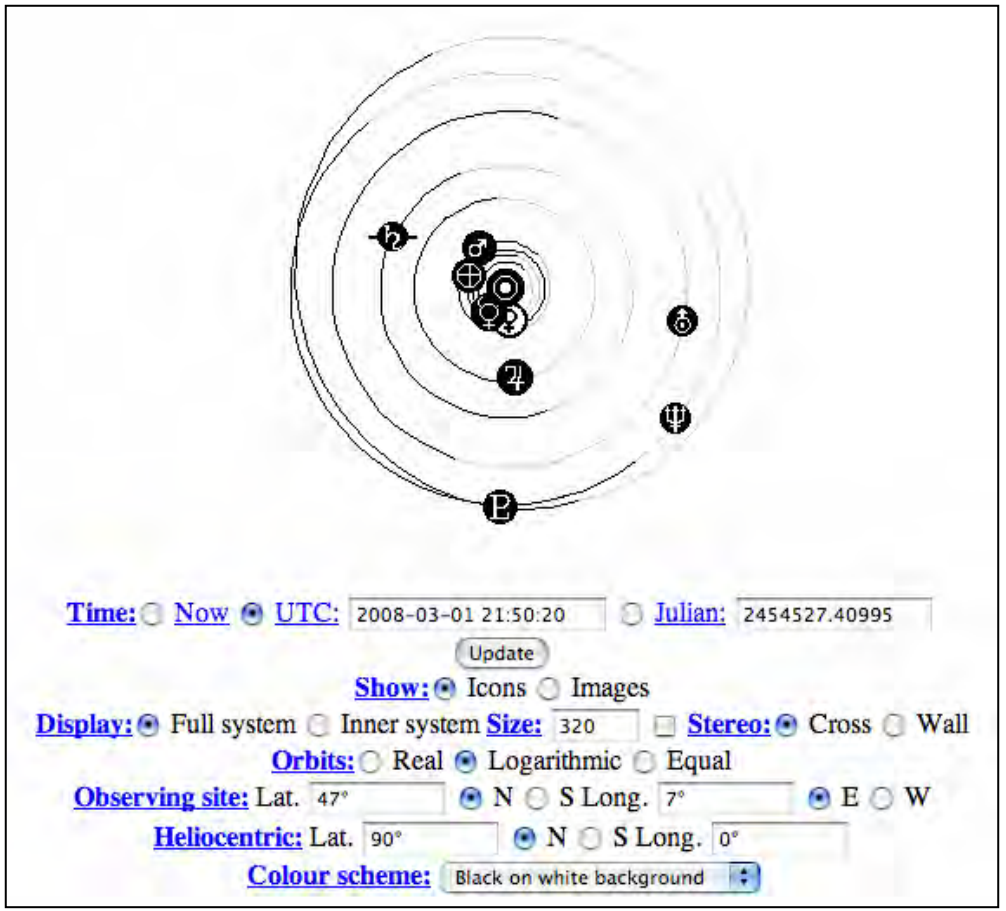
1. "Exploring Our Solar System" Banner
    a. Cleaning: Wash with a sponge and mild detergent. Rinse thoroughly.
    b. If marks remain, the banner can be cleaned with products like 409 or other spray cleaners, but be sure to rinse it thoroughly afterwards. The cleaner can degrade the vinyl if not rinsed off.
    c. Mark on the banner ONLY with wet-erase (also called "transparency") markers. The marks can be wiped off with a damp sponge or cloth. You can use dry-erase markers, but you'll need a cleaner (see "b." above) to remove the marks.
    d. If you are using the banner in a cold or damp area, the marks you make with a wet-erase marker may not dry, causing smearing. Under these conditions, use the included stickers or a dry-erase marker (discussed above in "c.").
    e. Keeping the banner clean will help keep the stickers sticky (see "3." Below).
2. Orbits, Light Minutes, and Horizon Rulers
    a. Clean with a damp sponge and mild soap.
3. Planet and Mission Stickers
    a. Try to keep the banner and stickers clean.
    b. Handling, grease, and dirt can cause the stickers to lose their stickiness.
    c. Wash stickers gently with a sponge and mild soap or detergent, rinse thoroughly, and allow to air dry. Much of the stickiness will be restored.

Websites: Locations of Planets and Spacecraft

For locations of planets on any desired day:

Solar System Live (shown at right):
http://www.fourmilab.ch/cgi-bin/Solar

- Use the "Time" field to change the day or time.
- You can make the map larger (up to about 900) or smaller by changing the "Size" field.
- Change the background to white by using the "Colour Scheme" field.
- Press the "Update" button.
- Then just print the page or right-click on the map and save it as an image.

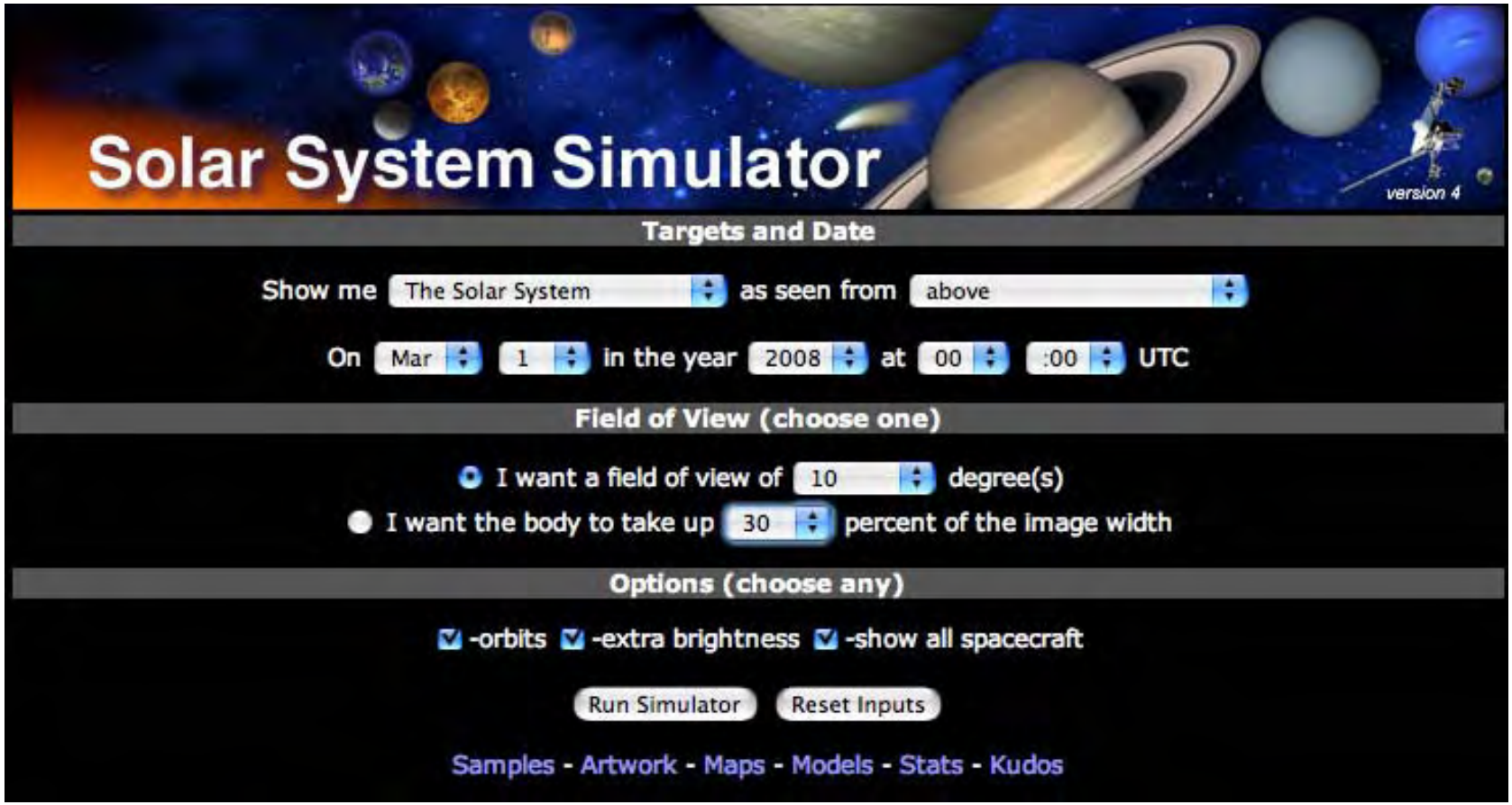


Heavens-Above: http://www.heavens-above.com/
You need to register and record your location. Once you are into the website, in the left-hand column under "Astronomy," choose "Solar System Chart." Scrolling down brings you to the controls to change the date and time and the size of the display.

For locations of spacecraft that are en route, use NASA's Solar System Simulator (shown below): http://space.jpl.nasa.gov/.

Set the settings as shown below, substituting the correct date. For a closer look at the inner Solar System, choose a field of view of 2 degrees.

Then press “Run Simulator.” The resulting display may not be oriented the same way as the banner. Print it out and line it up on the banner with the position of Earth and one other planet to get it oriented correctly.



More websites for spacecraft: Where are they now?

Voyagers and Pioneers:
http://heavens-above.com/solar-escape.asp?/

Stardust:
http://stardust.jpl.nasa.gov/mission/scnow.html
(North is on the right- rotate image 1/4 turn to the left to orient the same way as the poster)

New Horizons:
http://pluto.jhuapl.edu/mission/whereis_nh.php
(North is to the left). Rotate 1/4 turn to the right

Projecting the Banner with an Overhead Projector

If you have a large group and want to project the banner onto a screen, you can print the banner handout onto a transparency and use an overhead projector. Use the wet-erase, transparency marker to mark it with planet and mission locations. Use a pencil or short ruler as your Horizon Ruler. When printing transparencies, remember to set it to print in reverse so you can display it on the overhead projector with the printed side down.

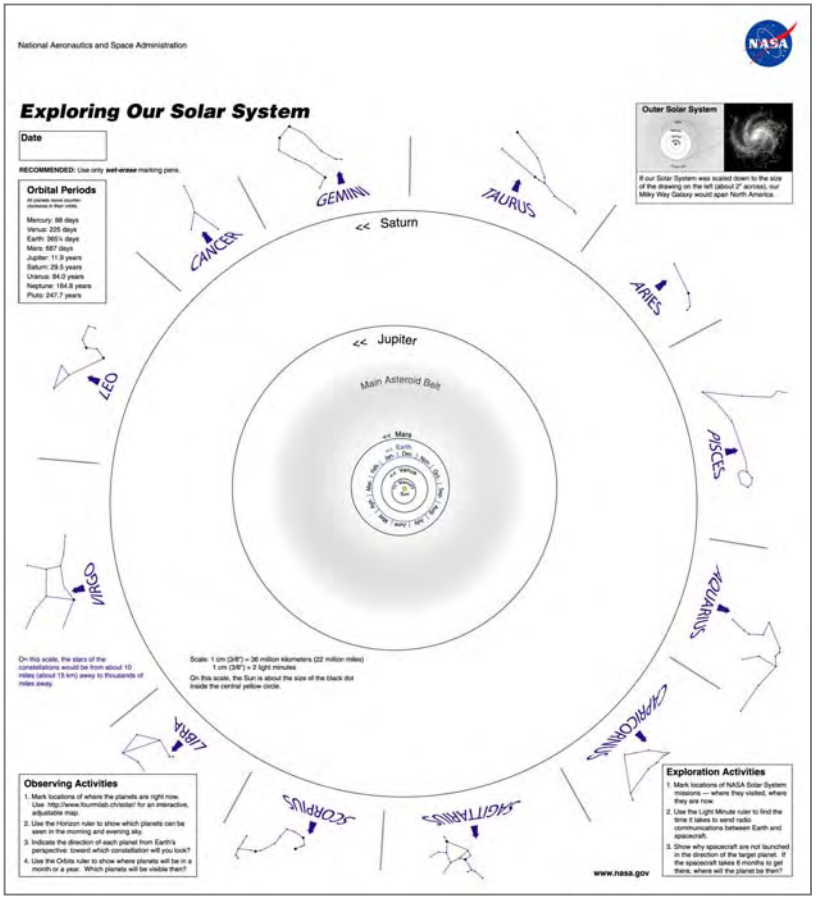
You can also print the PDF of the banner itself onto a transparency, making sure “Fit to Page” is set when printing.
On the smaller scale, 1mm = 1 light minute (approximately).

Background Information

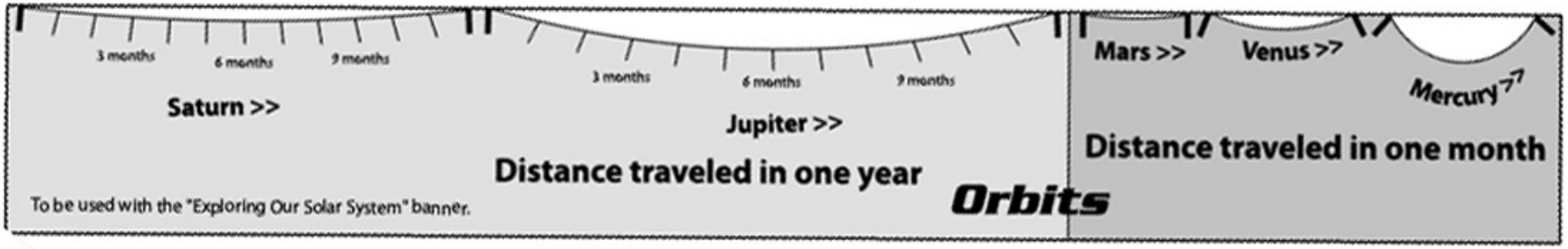
"Exploring Our Solar System" Banner and Rulers: Overview

The "Exploring Our Solar System" banner is made of vinyl and is about 47" x 42". An image of the Sun with a diameter of one meter is on the reverse side.

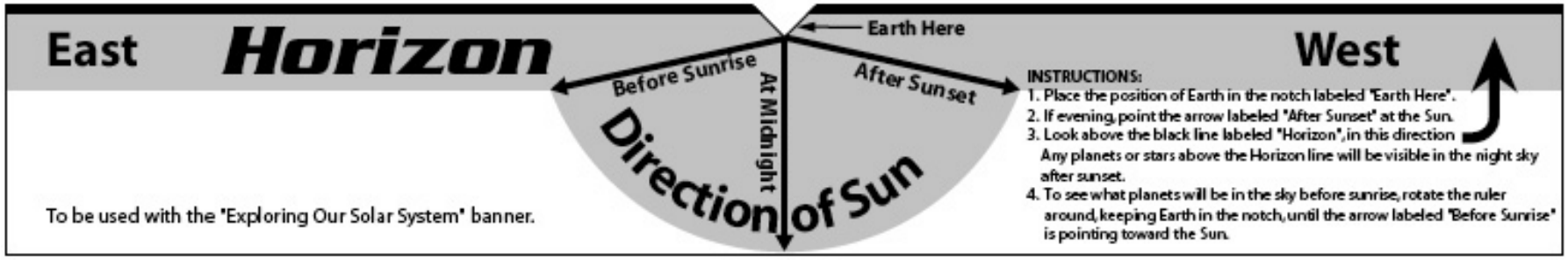
- The banner has accurate, scaled orbits of the planets of the Solar System.
- The Sun is in the center. The black dot in the center of the yellow circle is the size of the Sun on the scale of the banner.
- The scale is: 1cm = 36 million kilometers or 22 million miles or 2 light minutes
- The main part shows the naked-eye planets: Mercury through Saturn.
- The upper right includes the orbits of Uranus, Neptune, and Pluto, with Saturn to give a sense of the scale.
- The banner helps illustrate that the orbits of the planets are not perfectly circular.
- Orbital Periods are shown in a box in the upper left.
- See below for a discussion of the constellations shown on the banner (under "Constellations of the Zodiac").



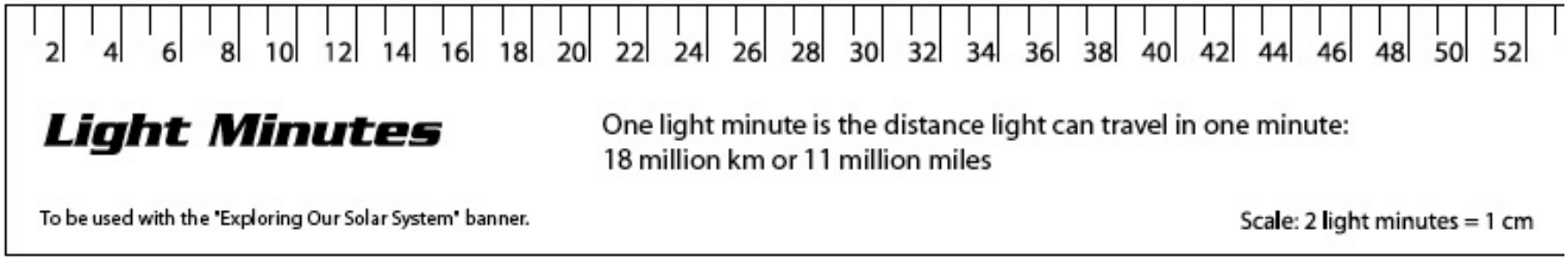
The **Orbits ruler** shows how far each planet moves in a month or a year. This is based on its orbital period, or the time it takes to make one orbit around the Sun (shown in the Orbital Periods box on the banner). The ruler shows the distance traveled in a month for the inner planets (Mercury, Venus, and Mars) and the distance traveled in a year for Jupiter and Saturn, with tick marks for the months. Earth is not on the Orbits ruler since its positions are marked on the banner. The arrows on the banner and on the Orbits ruler are a reminder that the planets move in a counterclockwise direction.



The **Horizon ruler** is used with the banner to show what constellations of the ecliptic and which planets can be seen above your local horizon from just after sunset, throughout the night, to just before sunrise. Instructions are written on the ruler.



The **Light Minutes ruler** is used to show light travel (therefore radio communication) time between Earth and NASA spacecraft exploring our Solar System. The scale is 1cm = 2 light minutes. A light minute is the distance light can travel in a minute: 18 million km or 11 million miles.



Constellations of the Zodiac

The 12 constellations shown on the Exploring Our Solar System banner are the classical astronomical constellations of the Zodiac. It is acknowledged that Ophiuchus is the "13th constellation" along the ecliptic: the apparent path of the Sun across the sky. The boundaries of the constellations are the gray lines between each constellation on the banner. The banner combines the boundaries of Scorpius and Ophiuchus.

Brief background on a person's "astrological sign":

A person's *astrological* sign or "Sun Sign" was traditionally the constellation that contained the Sun at the time the person was born. This is why the constellation with the same name as the person's astrological sign is not visible at night on their birthday – the Sun is very roughly in the direction of that constellation.

However, due to the Earth's precession, a 26,000-year wobble in the Earth's axis, the Sun no longer occupies its traditional constellations for astrological signs. The "signs" have all been carried about one constellation to the west (clockwise on the banner).

In addition, the astrological signs each cover 30 degrees of sky (12 signs in 360 degrees). The modern boundaries of the *astronomical constellations* are of varying sizes. So the Sun appears to be in front of each constellation along the ecliptic for varying periods of time.

So do not confuse astrological signs with astronomical constellations.

Dr. James Kaler and Dr. Phil Plait provide more information:

> http://www.astro.uiuc.edu/~kaler/celsph.html (See the chart of when the Sun crosses the boundary into each constellation of the Classical Astronomical Zodiac of 12 constellations).
>
> http://www.badastronomy.com/bad/misc/zodiac.html

Missions Featured on the Mission Stickers that are used the Banner

> Cassini-Huygens: http://saturn.jpl.nasa.gov/

Launched in 1997, Cassini-Huygens is an orbiter and probe. Cassini is the first spacecraft to orbit Saturn. The NASA orbiter is studying the features of Saturn's system of rings and moons. It also delivered the European Space Agency's Huygens Probe through the atmosphere to the surface of Saturn's moon Titan.

DSN (Deep Space Network): http://deepspace.jpl.nasa.gov/

DSN is an Earth-based worldwide network of antennas that supports interplanetary spacecraft missions and radio and radar astronomy observations for exploration of the Solar System. It collects data from spacecraft exploring the Solar System. The network also supports selected Earth-orbiting missions.

Dawn: http://dawn.jpl.nasa.gov/

Launched in 2007, Dawn's mission is to delve into the origins of our solar system through intense study of Ceres and Vesta, two minor planets that reside in the vast asteroid belt between Mars and Jupiter.

Deep Impact: http://deepimpact.jpl.nasa.gov/

On the evening of July 3, 2005, Deep Impact, a NASA Discovery mission, performed a complex experiment in space to probe beneath the surface of a comet and reveal the secrets of its interior. As its parent spacecraft released a smaller "impactor" spacecraft into the path of comet Tempel 1, the experiment became one of a cometary bullet chasing down a spacecraft bullet while a third spacecraft bullet sped along to watch. Results from this and other comet missions will lead to a better understanding of both the Solar System's formation and implications of comets colliding with Earth.

Lunar Reconnaissance Orbiter http://lunar.gsfc.nasa.gov/

Scheduled for launch in 2008, the LRO's mission is to search out sources of water ice that could be used for fuel, air, and growing plants when humans return to the Moon. It carries six different instruments to map the surface of the Moon in high detail.

Mars Reconnaissance Orbiter: http://mars.jpl.nasa.gov/missions/present/2005.html

Launched in 2005, the MRO's mission is to track changes in the water and dust in Mars' atmosphere, look for more evidence of ancient seas and hot springs and peer into past Martian climate changes by studying surface minerals and layering. The orbiter carries a camera capable of taking sharp images of surface features the size of a beach ball. At the conclusion of its science mission, Mars Reconnaissance Orbiter serves as a data relay station for future Mars missions.

Mars Exploration Rovers: http://marsrovers.jpl.nasa.gov/

Landing on the surface of Mars in 2004, the rovers are fully-equipped robot geologists. Both rovers are packed with sensors and cameras that have been revealing Mars in unprecedented detail from microscopic images of rocks to panoramic views of the rocky landscape.

MESSENGER: http://messenger.jhuapl.edu/

Launched in 2004, MESSENGER is a scientific investigation of the planet Mercury. Understanding Mercury, and the forces that have shaped it, is fundamental to understanding the terrestrial planets and their evolution.

New Horizons: http://pluto.jhuapl.edu/

Launched in 2006, New Horizons will help us understand worlds at the edge of our Solar System by making the first reconnaissance of Pluto in 2015. Then, as part of an extended mission, the spacecraft would head deeper into the Kuiper Belt to study one or more of the icy mini-worlds in that vast region beyond Neptune's orbit.

Stardust: http://stardust.jpl.nasa.gov

In early 2004, Stardust flew within 236 kilometers of Comet Wild 2 and captured thousands of particles in its aerogel collector, then returned these tiny particles to Earth in January 2006.

Voyagers: http://voyager.jpl.nasa.gov/

Launched in 1977, Voyager 1 and 2 explored all the giant planets of our outer solar system, Jupiter, Saturn, Uranus and Neptune; 48 of their moons; and the unique system of rings and magnetic fields those planets possess. The Voyager spacecraft will be the third and fourth spacecraft to fly beyond all the planets in our solar system. Pioneers 10 and 11 preceded Voyager but on February 17, 1998, Voyager 1 passed Pioneer 10 to become the most distant human-made object in space.

For more information on any of the worlds of the Solar System: http://solarsystem.nasa.gov/planets/

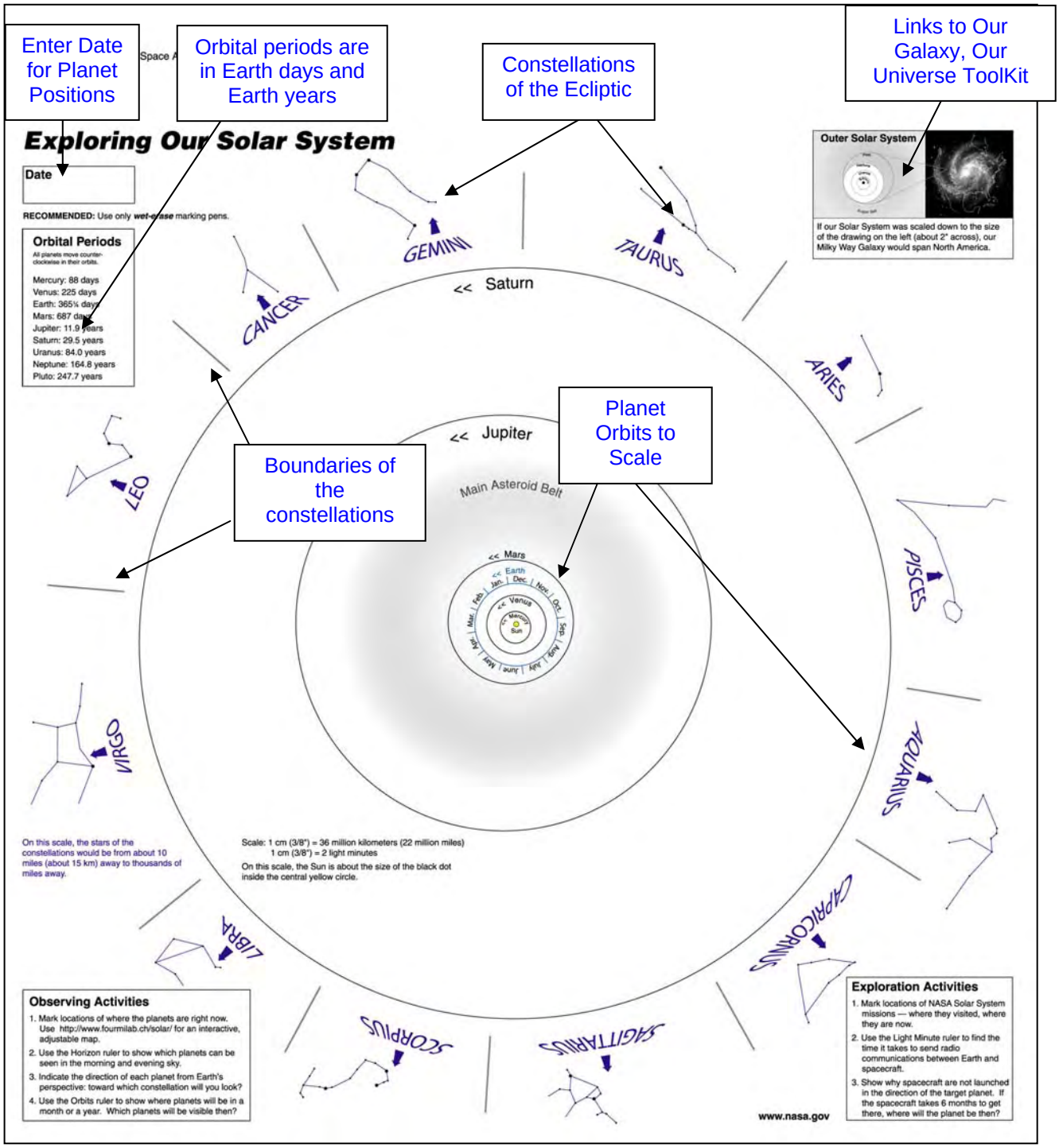
For information on NASA Solar System missions: http://solarsystem.nasa.gov/missions/

Animation of retrograde motion: http://mars.jpl.nasa.gov/allabout/nightsky/nightsky04-2003animation.html

Overview of Solar System mission timeline: http://solarsystem.nasa.gov/multimedia/download-detail.cfm?DL_ID=1

Amateur Astronomy Observing Campaigns and opportunities: http://education.jpl.nasa.gov/amateurastronomy

Solar System Banner Diagram



Detailed Activity Descriptions

1. Banner: "Exploring Our Solar System"

Discussion of Banner

Materials: "Exploring Our Solar System" Banner, planet and Mission stickers, Orbits, Light Minutes, and Horizon rulers, printout of planet positions and NASA spacecraft positions for your selected date.
Current locations of planets: http://www.fourmilab.ch/cgi-bin/Solar
Current locations of NASA missions: http://space.jpl.nasa.gov/ (Instructions for using this site are under "Helpful Hints" on page 66 of this manual).
Optional: Wet-erase marker, damp sponge, copies of "Communication and Exploration" handout, copies of "Where are the Planets" star maps
Optional (you supply): Yardstick

Objectives:

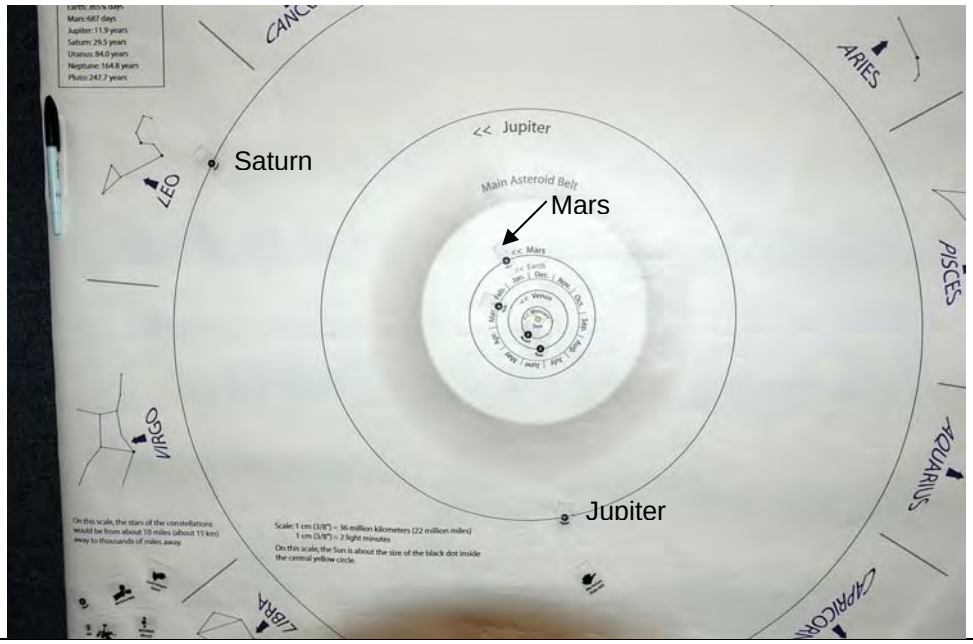
- Dispel misconceptions regarding the arrangement of the planets in our Solar System and how they move
- Introduce NASA missions exploring the Solar System and the concept that the speed of communication with spacecraft is limited to the speed of light

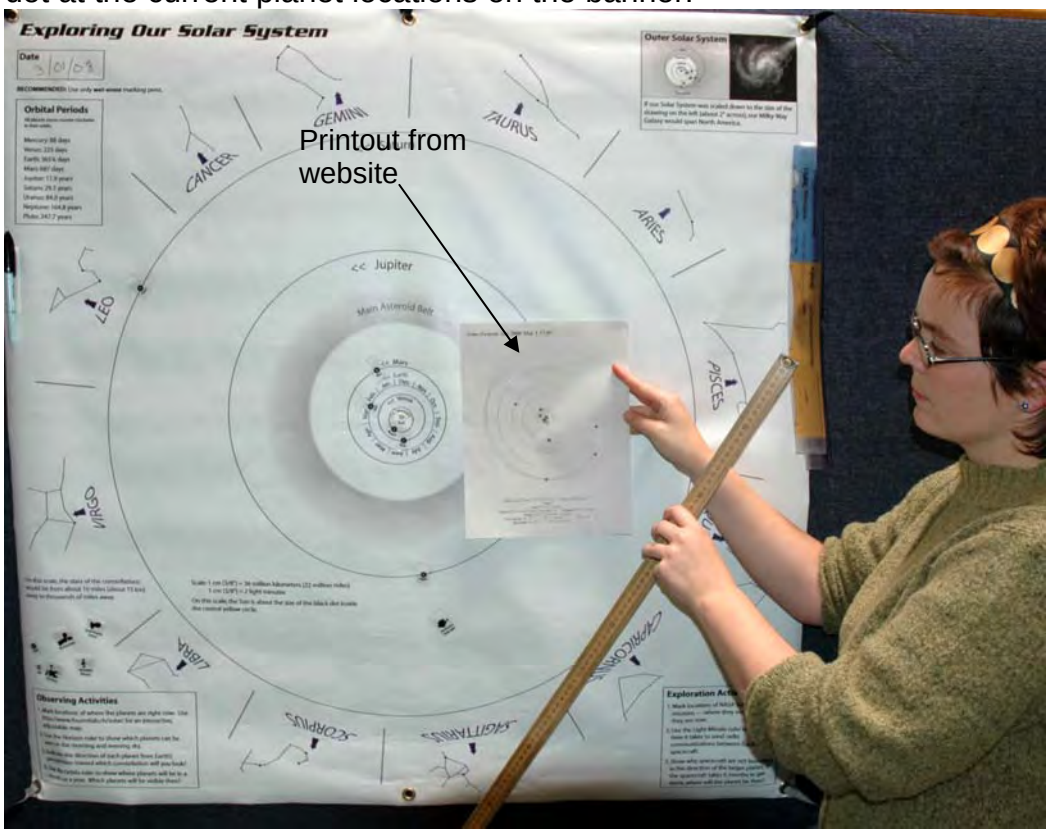
The "Exploring Our Solar System" Banner has accurate, scaled orbits of the planets of the Solar System. The main part shows the naked-eye planets. The upper right includes the orbits of Uranus, Neptune, and Pluto, with Saturn to give a sense of the scale. The banner helps illustrate that the orbits of the planets are not perfectly circular.

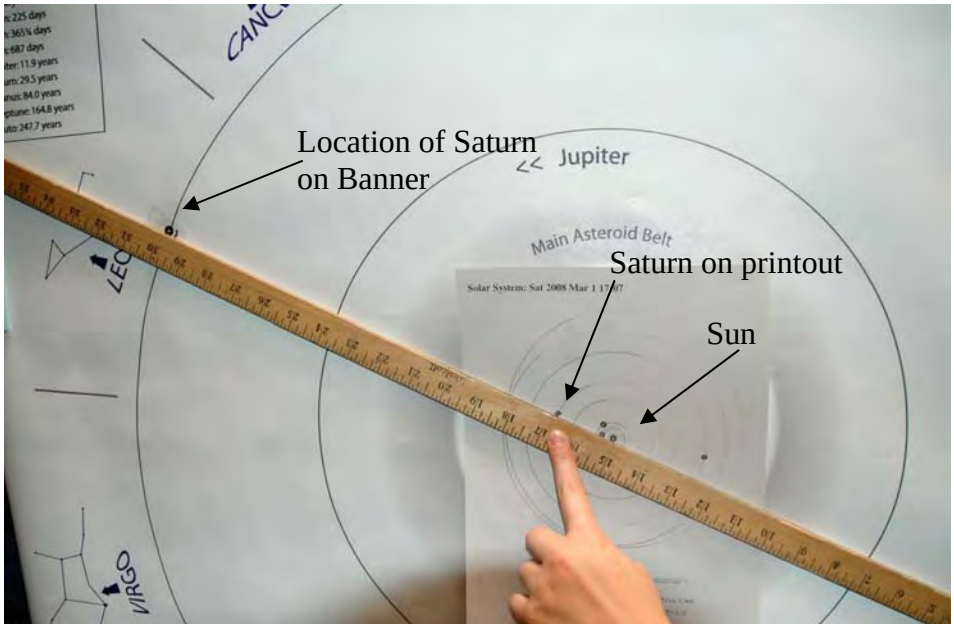
Summary of Activities to do with the Banner (most are also listed on the Banner):

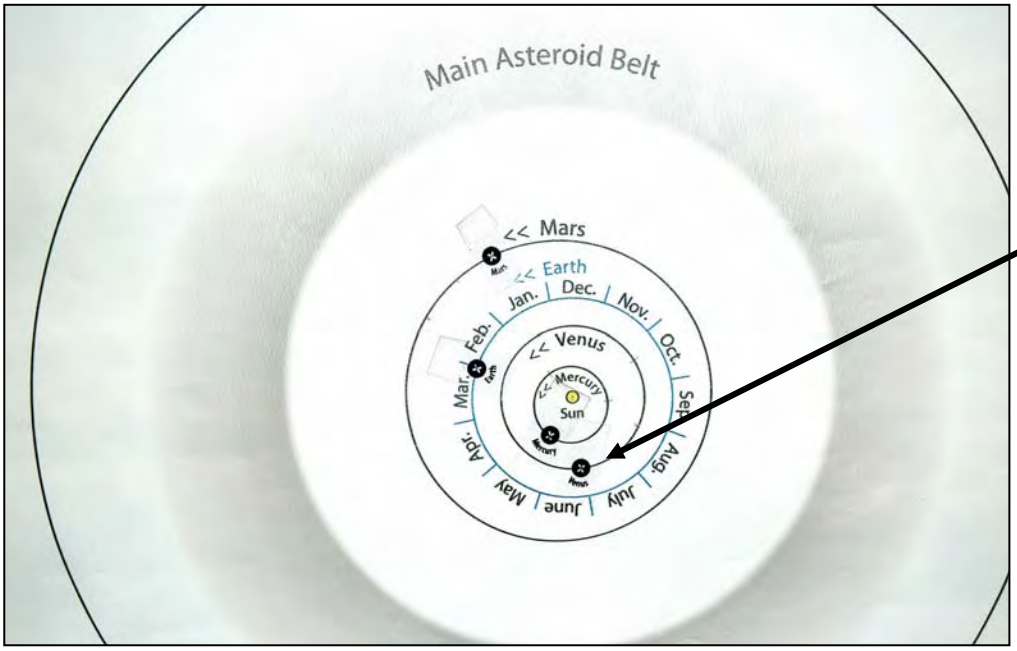
1. **Observing Activities**
   a) Mark locations of where the planets are right now.
   b) Indicate the direction of the planet from Earth's perspective: toward which constellation will you look?
   c) Use the Horizon ruler to show which planets can be seen in the morning and evening sky.
   d) Use the Orbits ruler to show where planets will be in a month or a year. Which planets will be visible in the evening then?
   e) Use a five-foot Pocket Solar System to show the orbits of Uranus and Neptune.
   f) Link the Solar System to its place in our Milky Way Galaxy.
2. **Exploration Activities**
   a) Mark the locations of NASA Solar System missions.
   b) Use the Light Minutes ruler to find the time it takes to send radio communications between Earth and spacecraft.
   c) Use the Orbits ruler to show why spacecraft are not launched in the direction of the target planet. If the spacecraft takes 6 months to get there, where will the planet be then?
   d) As you view planets in the telescope, discuss the missions that have visited that planet and/or its moons.

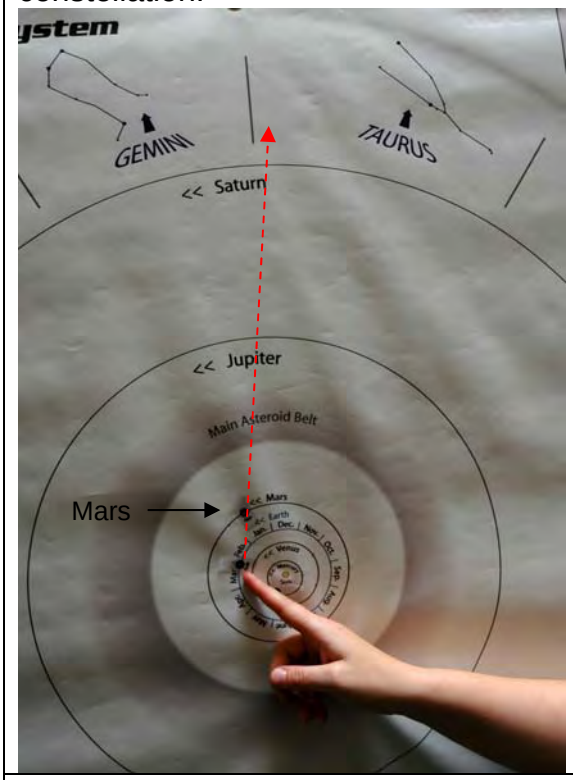
2. Banner: Observing Activities

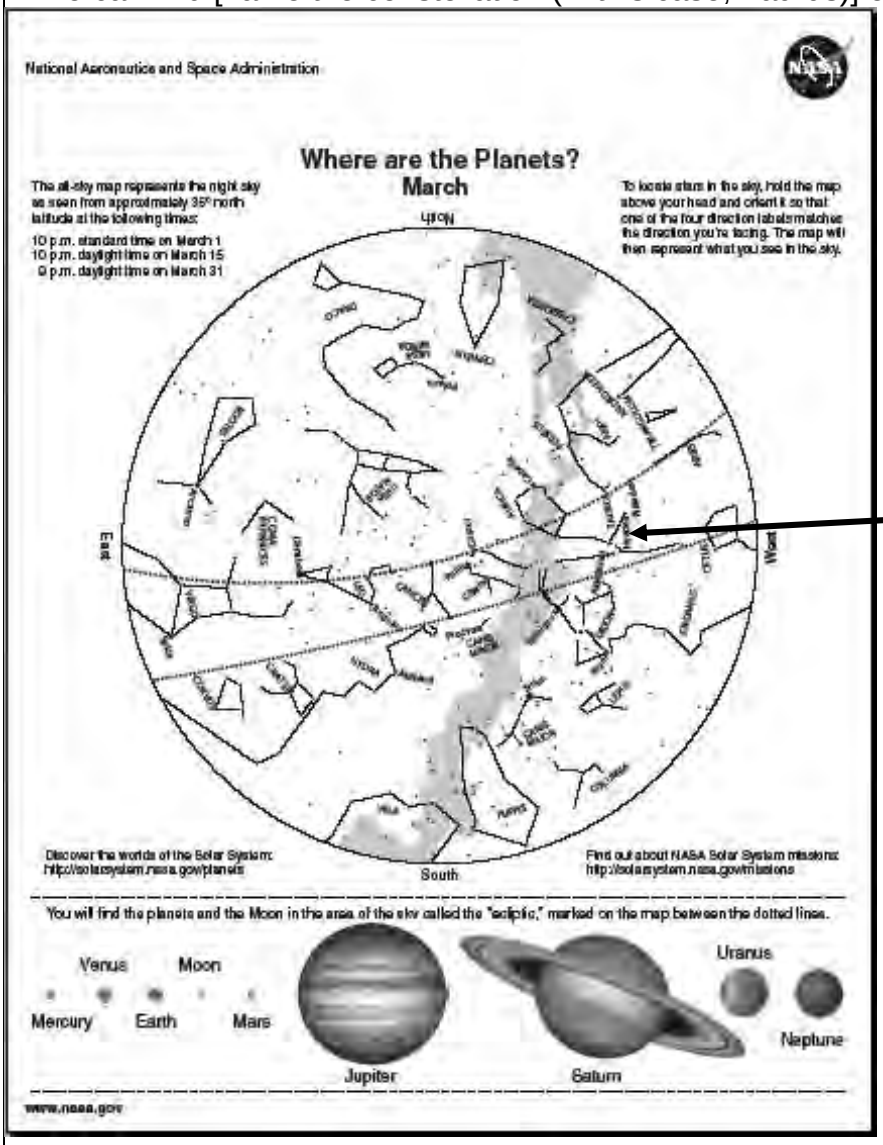
Leader's Role	**Participants' Role (Anticipated)**
Materials: Banner, planet and mission stickers, copies of "Where are the Planets" star maps, wet-erase marking pen, sponge. Orbits Ruler Horizon Ruler Light Minutes Ruler Printout of current locations of the planets: http://www.fourmilab.ch/cgi-bin/Solar *Optional*: A five-foot Pocket Solar System	
Objectives: Provide visitors with an understanding that the planets are not all in a line, that they don't all move together, and that it is not easy to get from one planet to another. Help visitors understand why they see only a few planets at a time in the night sky. Provide an understanding that NASA has a variety of missions exploring the Solar System using a variety of methods: includes where the missions are in relation to Earth and how we communicate with them.	
LOCATIONS OF THE PLANETS	
To Do: **NOTE: In the examples here, we are using a date of March 1, 2008. You will be using the date of your presentation to set the locations of the planets.** Mark the locations of where the planets are right now and indicate the direction of the planet from Earth's perspective: toward which constellation will you look?  	** If you are working with an organized group, such as a classroom or Scouts, it is recommended that you let your visitors locate the planets on the banner themselves. Doing is the best way to learn and understand!

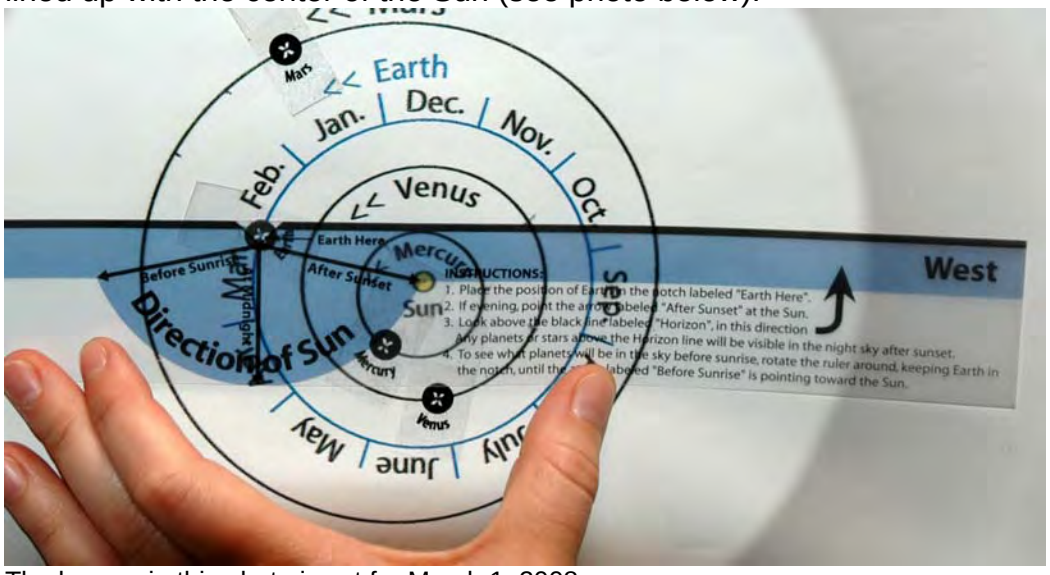
Leader's Role	Participants' Role (Anticipated)
Using a printout from one of the websites to get the correct planet locations, use the planet stickers or the wet-erase marking pen to place a dot at the current planet locations on the banner.  When using the stickers, place the center of the "X" over the location of the planet. On the websites, the center of the icon for the planet is the correct location for the planet.	

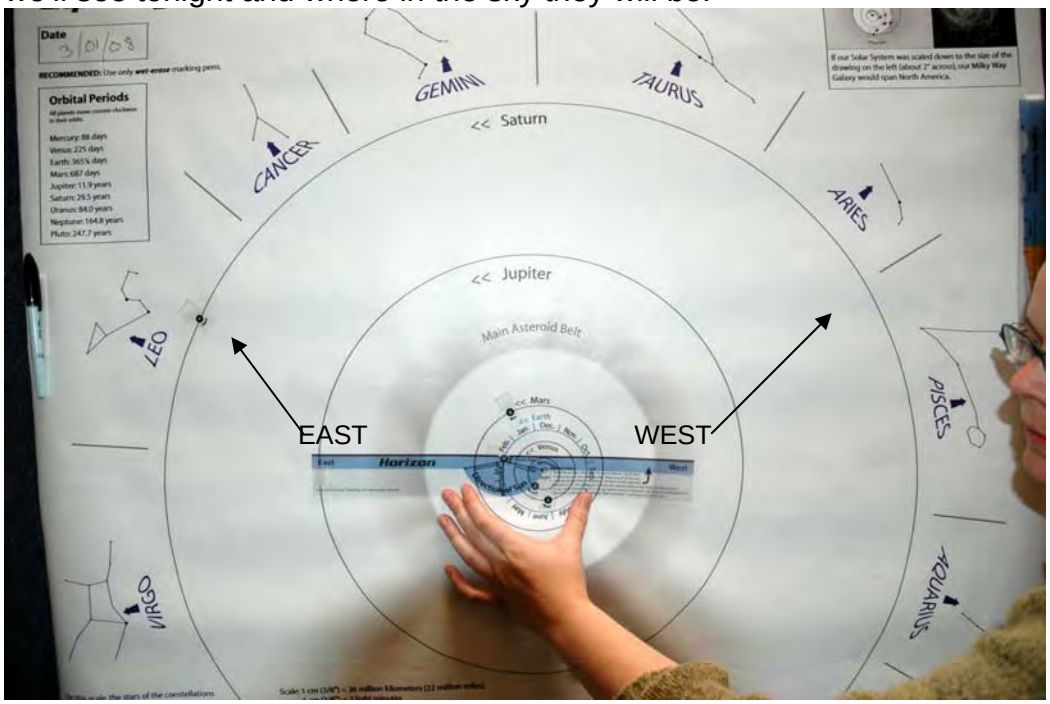
Leader's Role	Participants' Role (Anticipated)
An easy way to correctly locate Jupiter and Saturn is to line up the Sun on the printout with the Sun on the banner and get a straight-edge to line up the Sun and the planet on the printout. Place the planet's sticker on the planet's orbit where the straight-edge intersects the orbit.  	

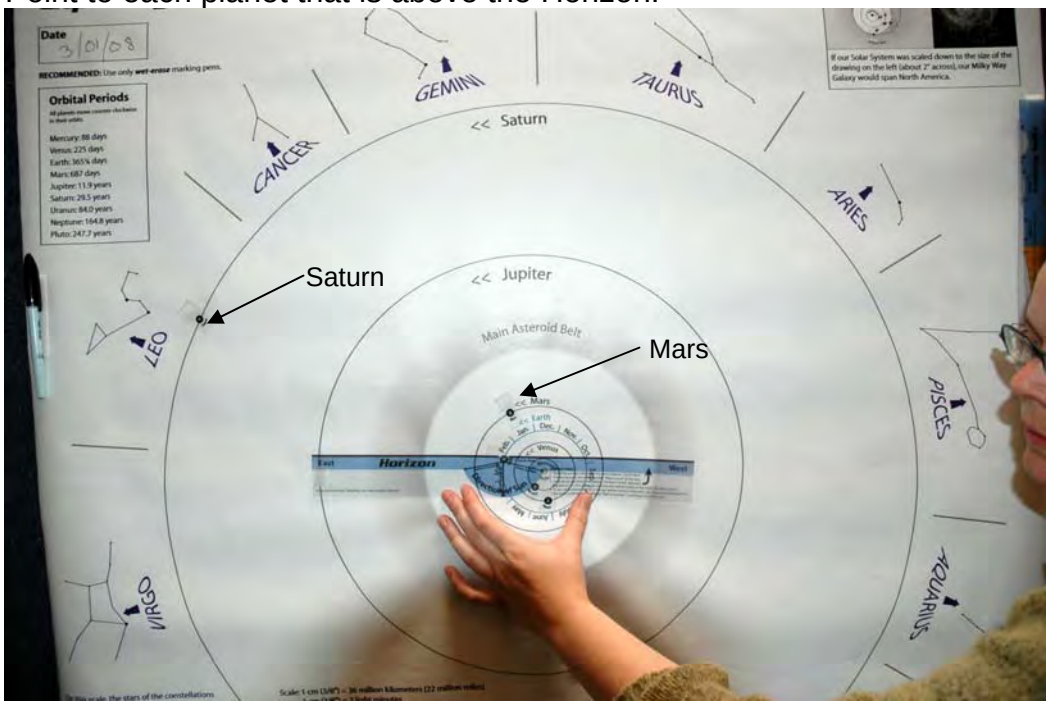
Leader's Role	Participants' Role (Anticipated)
To Do: Just showing your visitors the banner with the planets placed helps to dispel the perception many people have that the planets are in a line. *To Say:* Here are the orbits of the planets in our Solar System, from Mercury through Saturn. These are the planets we can see with just our eyes. These stickers show where the planets are right now in their orbits. Who can find Venus?  Do you think we'll see it tonight in the sky?	I didn't know we could see any planets without a telescope! Here it is! Hope so.

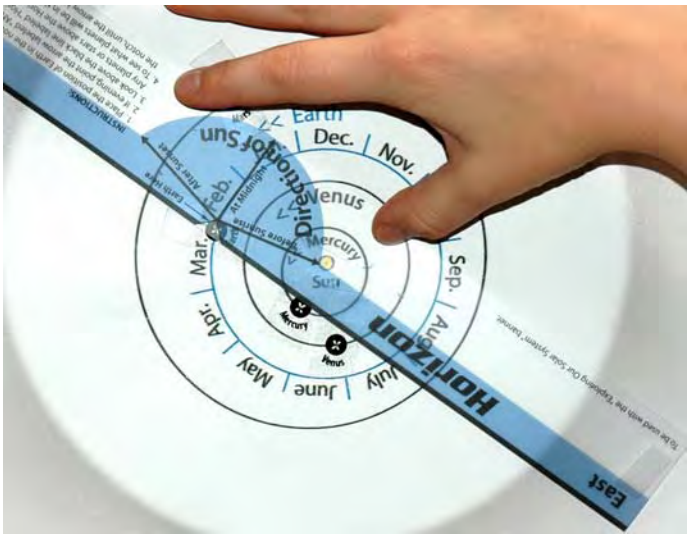
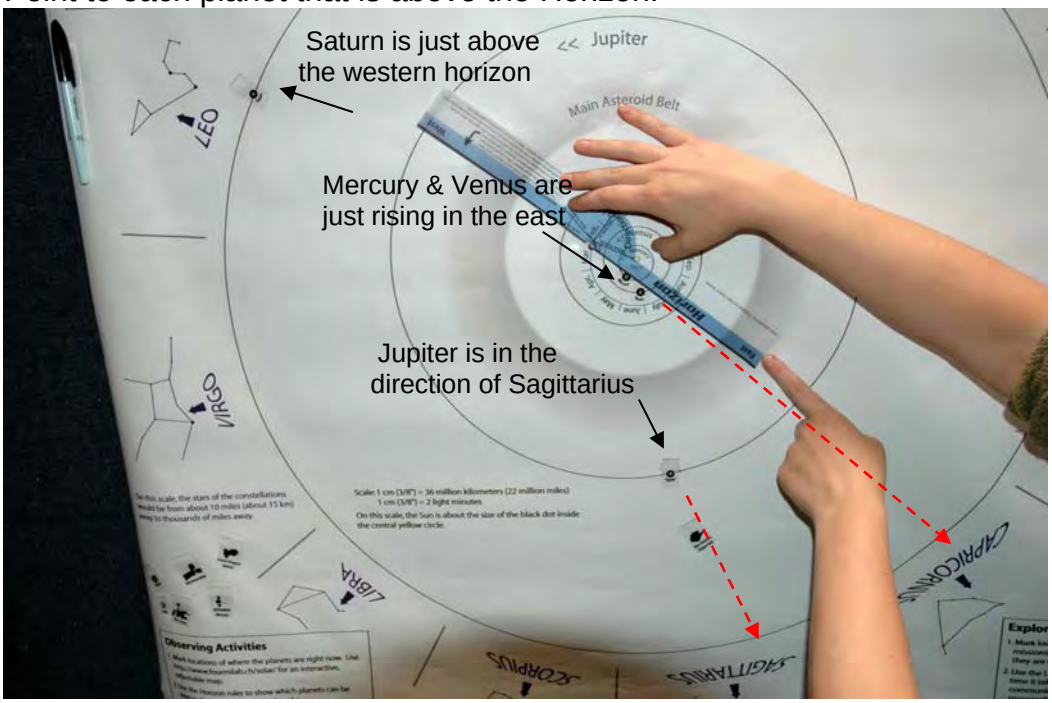
Leader's Role	Participants' Role (Anticipated)
To Do: Point to the constellations around the edge of the poster. *To Say:* These are the constellations of the ecliptic. The ecliptic is the apparent path the Sun and planets take across the sky, among the constellations. What do you notice about the names of these constellations? Right, the planets and the Moon are always seen in the area of the sky where these constellations are. That's why these constellations were special to ancient people. Now this is important, the stars of these constellations are not in our Solar System, but if our Solar System was scaled down to the size of this diagram, these stars would be many miles away. The constellations are on the banner to show that we'll see the planets in the direction of certain constellations.	Signs of the Zodiac. Astrology signs.
To Do: Pick a planet visible in the evening sky. Trace with your finger a straight line on the banner from Earth to the planet, then beyond to the constellation.  *To Say:* For example, from Earth, Mars looks like it is in this direction, toward Taurus on this date. (See photo at left – the finger is pointing to Earth. The red arrow draws a line-of-sight from Earth to Mars to the constellation Mars is in front of on March 1, 2008). So Mars will appear to be in Taurus.	
To Do: Pass out "Where are the Planets" star maps for the current month.	Takes map.

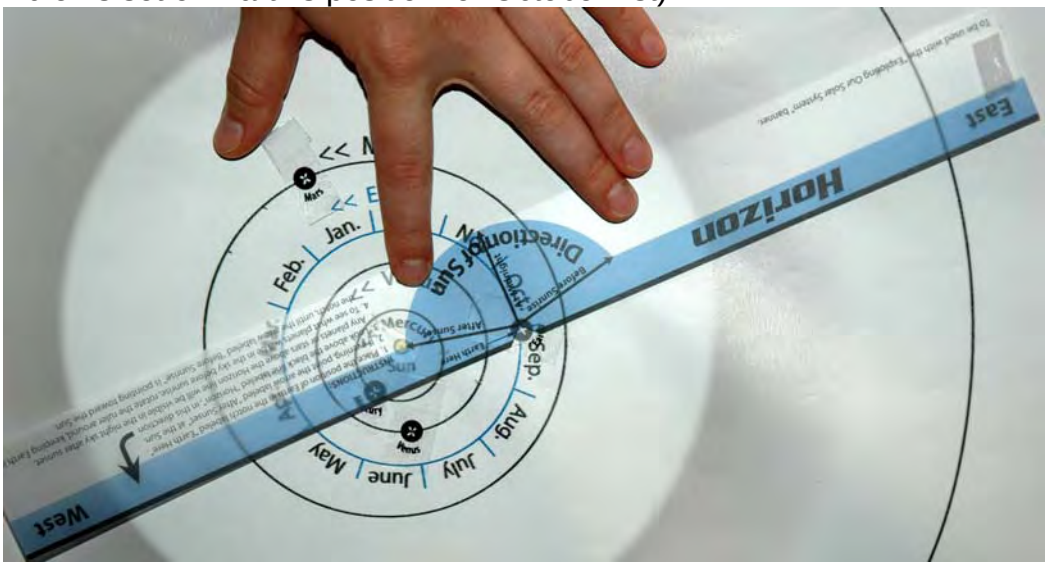
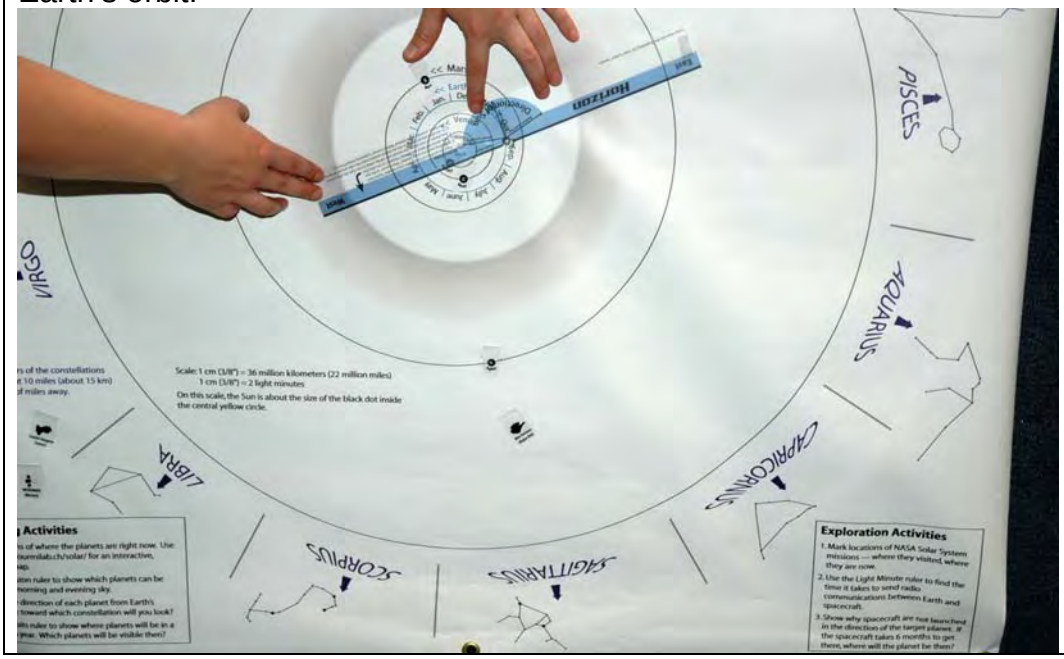
Leader's Role	Participants' Role (Anticipated)
To Say: Who can find [name the constellation (in this case, Taurus)] on this star map?  	Here it is!
We'll see [the planet (in this case, Mars)] in the direction of that constellation tonight.	Cool.

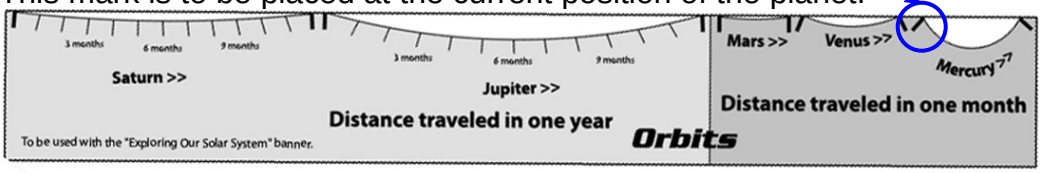
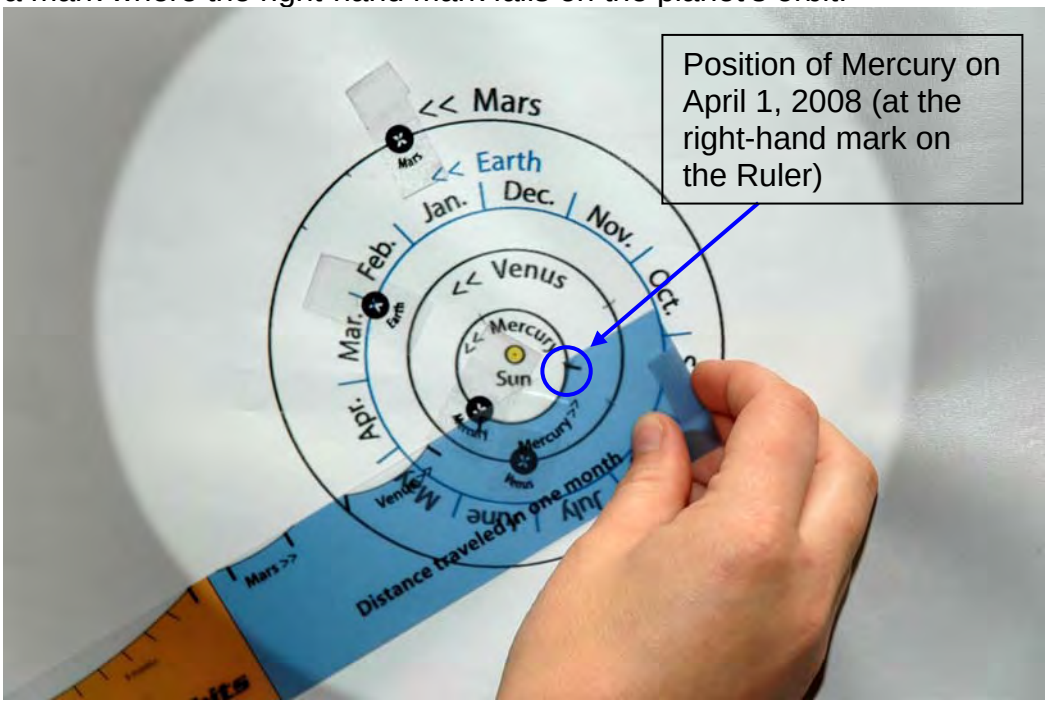
Leader's Role	Participants' Role (Anticipated)
HORIZON	
To Do: **Show the Horizon Ruler** and place Earth's position on the banner in the notch. Rotate the "Direction of Sun" so that the "After Sunset" arrow is lined up with the center of the Sun (see photo below).  The banner in this photo is set for March 1, 2008. ***IMPORTANT:*** This example shows a date of **March 1, 2008.** You will be using the date of your presentation to set the locations of the planets.	

Leader's Role	Participants' Role (Anticipated)
To Say: This ruler is used to show where our Horizon is from our perspective here on Earth. We'll use this to figure out which planets and constellations we'll see tonight and where in the sky they will be.  The banner in this photo is set for March 1, 2008. *To Say:* When you look to the west, as it starts getting dark, which constellations will we see toward the west? *To Do:* Point to the constellations near the western horizon (above the "West" end of the Ruler). *To Say:* And in the east? *To Do:* Point to the constellations near the eastern horizon (above the "East" end of the Ruler).	Calls out names of constellations (in this case, Aries and Pisces). Calls out names of constellations (in this case, Leo).

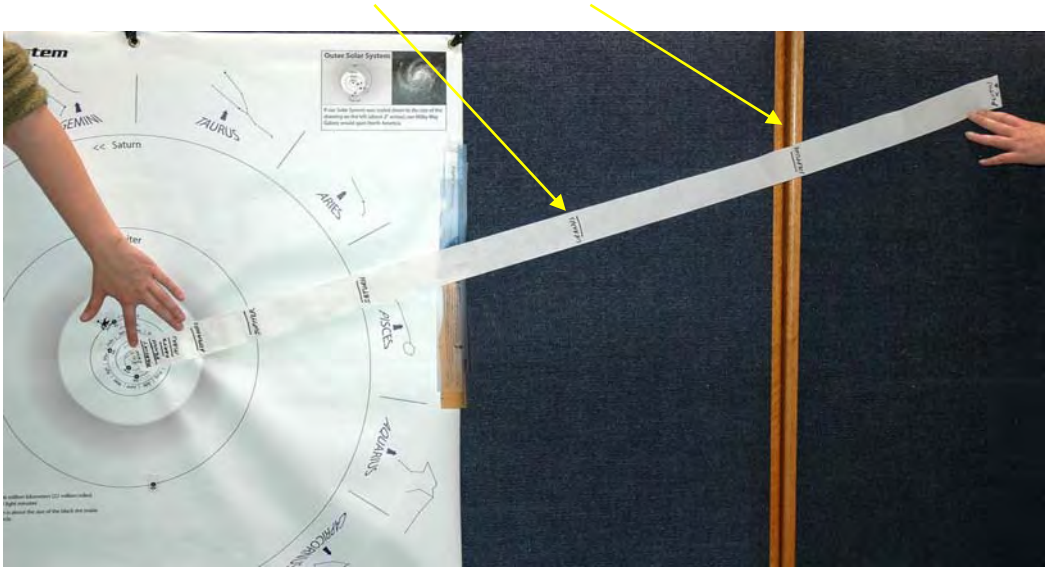
Leader's Role	Participants' Role (Anticipated)
To Say: Which planets will we see in the sky this evening? *To Do:* Point to each planet that is above the Horizon.  The banner in this photo is set for March 1, 2008.	Calls out names of planets (in this case, Mars and Saturn).
To Say: [This planet (in this case, Saturn)] is in the direction of which constellation?	Calls out name of constellation (in this case, Leo).

Leader's Role	Participants' Role (Anticipated)
To Do: Rotate the Horizon Ruler until the "Before Sunrise" arrow is lined up with the center of the Sun.  The banner in this photo is set for March 1, 2008. **Note that in the morning, Mercury and Venus are visible. Both are just above the eastern horizon.** <PHOTO> *To Say:* If you get up before sunrise, which planets will you see in the morning sky? *To Do:* Point to each planet that is above the Horizon.  	Calls out names of planets

Leader's Role	Participants' Role (Anticipated)
To Say: How many know that we see different constellations in the evening at different times of year? Let's see why. *To Do:* Line up the Horizon Ruler at different places on Earth's orbit, with the "After Sunset" arrow pointing to the Sun (see photo below – the Horizon Ruler is set on Earth's position for October 1st).  *To Say:* As Earth orbits the Sun, the constellations we see change every month. *To Do:* Point to the constellations visible in the evening at each location around Earth's orbit.  	Hands raise. In October, after sunset, Libra is in the west and Pisces is in the east.

Leader's Role	Participants' Role (Anticipated)
ORBITS	
To Do: **Show the Orbits Ruler.** Left mark of Mercury's orbit is here This mark is to be placed at the current position of the planet.  *To Say:* Where will the planets be next month? This ruler is used to help us find out. *To Do:* Pick a planet and place the left mark of the planet's orbit at the current position of the planet on the banner. Line up the curve of the orbit on the Ruler with the orbit line on the banner. Move the planet's sticker or place a mark where the right-hand mark falls on the planet's orbit.  The banner shown in the photo above is set for March 1, 2008. The Orbits Ruler is set to be ready to mark the position of Mercury on April 1, 2008.	

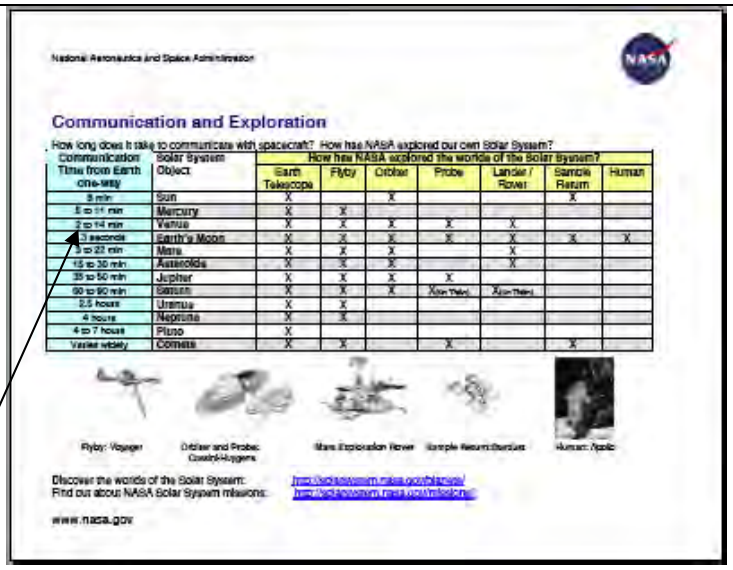
Leader's Role	Participants' Role (Anticipated)
To Say: That's where the planet will be in a month. Who wants to mark where [another planet] will be?	Visitor uses Orbits ruler to mark location of another planet.
What about Earth – where will it be? *To Do:* Mark (or have your visitors mark) the rest of the planets.	Visitor points to the place on Earth's orbit.
To Say: The distance the planet moves in a month is related to the length of its year – how long it takes to orbit the Sun. *To Do:* Point to the "Orbital Periods" box on the banner. *To Say:* (There are a number of discussion topics, such as:) Which planet moves the farthest in a month? Will we see any of these planets in the evening in a month? (Use the Horizon Ruler to check) Where will this planet be next year at this same time? Will we see the same planets in the evening sky? In the direction of which constellations will we see each of the planets? **More Topics:** Venus as morning and evening "star." Mercury is always very close to the horizon.	

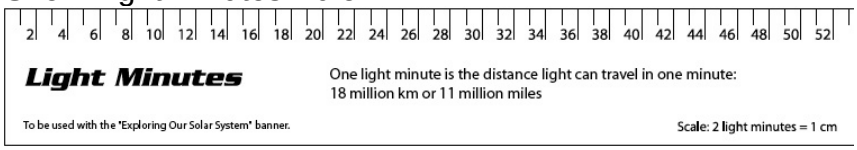
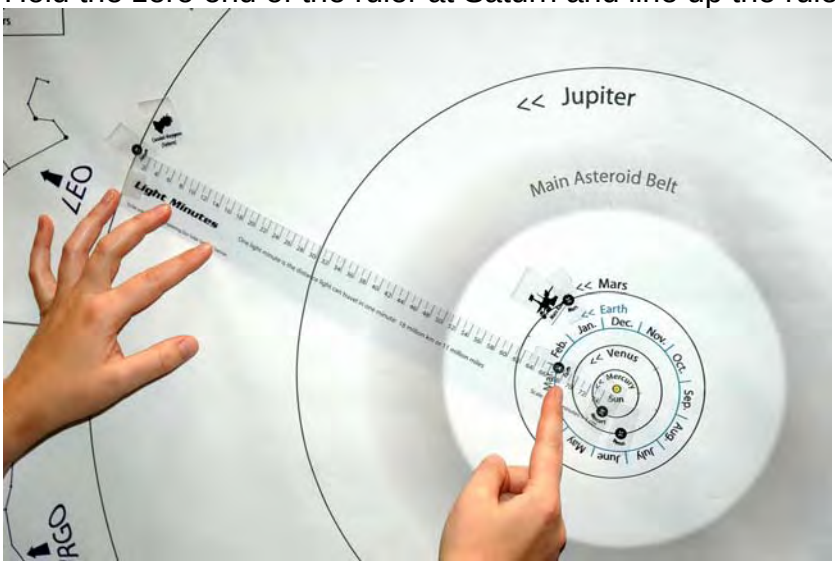
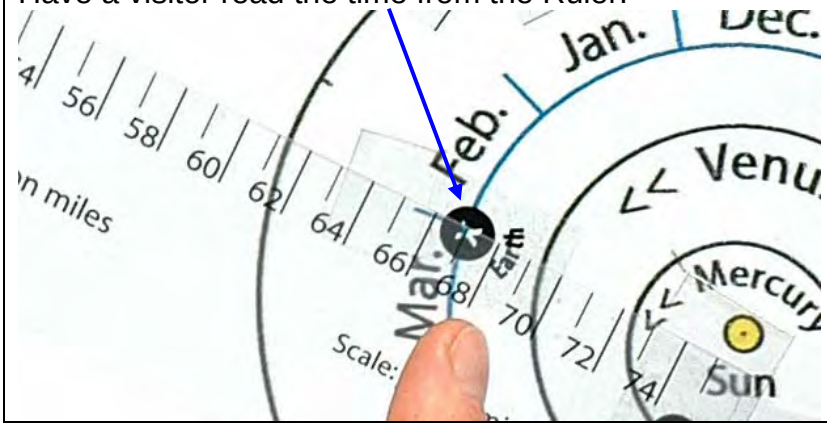
Leader's Role	Participants' Role (Anticipated)
LOCATIONS OF ORBITS OF URANUS AND NEPTUNE	
To Do: If you made a five-foot Pocket Solar System, hand the Sun end to a visitor and have them hold it against the banner at the Sun's position. *To Say:* Let's see how far away the orbits of Uranus and Neptune will be from the Sun. *To Do:* Stretch out the Pocket Solar System, lining up Jupiter's and Saturn's orbit. Point out where Uranus and Neptune's orbits would be.	Visitor holds Sun end.
 *To Say:* Remember that the stars on the banner just represent the direction of the stars. On this scale, the stars are about ten miles to thousands of miles away. Are there are stars between the orbits of Saturn and Uranus? How many stars are in the Solar System? And what do we call it?	No! ONE! The Sun!
To Do: Point to the diagram that includes the orbits of Neptune, Uranus, and Pluto in the upper right of the banner. *To Say:* This is on an even smaller scale than the diagram. If our Solar System was shrunk even farther down to be this size, the Galaxy we live in – the Milky Way would span North America.	
Presentation Tip: If you have the Our Galaxy, Our Universe ToolKit, you can use the presentations in that ToolKit to discuss the Galaxy in relation to the Solar System.	

3. Banner: Exploration Activities

Leader's Role	**Participants' Role (Anticipated)**
Materials: Banner, stickers, copies of "Communication and Exploration" handout, wet-erase marking pen, sponge. Light Minutes Ruler Orbits Ruler **For locations of spacecraft** that are en route use NASA's Solar System Simulator: http://space.jpl.nasa.gov/. See "Helpful Hints" for settings.	
Objective: • Provide a clearer understanding of where NASA missions are - connect to viewing planets in the sky • Introduce communication lag time • Provide understanding why we can't send a spacecraft toward where the planet is right now.	
NASA MISSIONS EXPLORING THE SOLAR SYSTEM	
To Do: For the planets visible that evening, place a few of the NASA Mission stickers next to the planets the spacecraft are studying, near, or will be studying. Examples: Saturn: Cassini-Huygens Mars: Mars Exploration Rover  Place the DSN (Deep Space Network) stickers around Earth. These radio telescopes are on Earth and facilitate communications with spacecraft.	

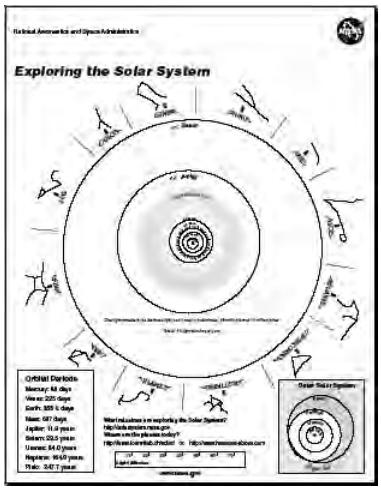
Leader's Role	Participants' Role (Anticipated)
To Say: For some of the planets we'll be viewing in the telescopes tonight, NASA has spacecraft exploring them. Who has heard we have rovers exploring the surface of Mars? Who knows what mission is exploring Saturn right now? We won't see the spacecraft in the telescopes, but you can imagine them at the planet. [Pick a couple of missions to talk about – See "Background Information"]	 Hands up. Cassini
ACTIVITY: WALK LIKE A RADIO WAVE	
To Say: How do we communicate with these missions? Can we call them up or control them with a joystick? We are going to pretend to transform each of you into energy. You will become a radio wave sending communications between Earth and spacecraft in the Solar System. Radio energy is a kind of light energy, just with long wavelengths instead of short wavelengths. Radio energy travels at the same speed as visible light. How far does light travel in a second – anyone? Look at your foot. The length of your foot will represent 186,000 miles. So how far can you travel from heel to toe? And if we pretend you're traveling at the speed of light, how long will it take you to go 186,000 miles or one foot length? Let's spread out and try walking like a radio wave for 10 seconds, heel-to-toe and counting the seconds. (clap for each second as you demonstrate radio-wave-walking. Go to 10 seconds) Stop. How far did we travel in 10 seconds with your foot length representing 186,000 miles? That's 10 light seconds.	 No! 186,000 miles (300,000 km) 186,000 miles 1 second. 1,860,000 miles.

Leader's Role	Participants' Role (Anticipated)
To Do: Hand out "Communication and Exploration" sheet. *To Say:* Here's a chart that shows how long light takes to travel from Earth to various places in the Solar System. Look at the column on the left called "Communication Time from Earth – one-way."  National Aeronautics and Space Administration **Communication and Exploration** How long does it take to communicate with spacecraft? How has NASA explored our own Solar System? Communication Time from Earth one-way / Solar System Object / How has NASA explored the worlds of the Solar System? (Earth Telescope, Flyby, Orbiter, Probe, Lander / Rover, Sample Return, Human) 8 min — Sun — X — X — X 5 to 11 min — Mercury — X — X 2 to 14 min — Venus — X — X — X — X 1.3 seconds — Earth's Moon — X — X — X — X — X — X — X 3 to 22 min — Mars — X — X — X — X 15 to 30 min — Asteroids — X — X — X — X 35 to 50 min — Jupiter — X — X — X — X 60 to 90 min — Saturn — X — X — X — Xion Tiles — Xion Tiles 2.5 hours — Uranus — X — X 4 hours — Neptune — X — X 4 to 7 hours — Pluto — X Varies widely — Comets — X — X — X — X Flyby: Voyager — Orbiter and Probe: Cassini-Huygens — Mars Exploration Rover — Sample Return Mission — Human: Apollo Discover the worlds of the Solar System: Find out about NASA Solar System missions: www.nasa.gov	
How long does the chart say it takes radio waves to get from Earth to Moon?	1.3 seconds.
How many foot-lengths is that?	One plus a little bit.
So is the Moon farther than 186,000 miles or closer?	Farther!
When Earth and Mars are closest, how long will it take to send a communication?	3 minutes.
Yes, that's 180 seconds. So is it farther than 186,000 miles away?	A lot farther!
I'll let you use your calculators to figure out how far.	
So if the distance light travels in one second is called a light second, what do we call the distance light can travel in a minute?	A light minute.
And the distance light can travel in a year?	A light year!

Leader's Role	Participants' Role (Anticipated)
LIGHT MINUTES RULER: COMMUNICATIONS	
To Do: Show Light Minutes Ruler.  *To Say:* All the distances to the planets in the Solar System can be measured in light minutes. We can use this to measure on the banner how long it takes to communicate with spacecraft at other planets. This is marked in light minutes. One light minute is the distance light can travel in a …? Let's measure how long it takes for a photo of Saturn radioed by Cassini to reach Earth. *To Do:* Hold the zero end of the ruler at Saturn and line up the ruler with Earth.  Have a visitor read the time from the Ruler.  	Minute! 67 minutes (or whatever it is in your own example).

Leader's Role	**Participants' Role (Anticipated)**
To Say: What time is it right now? What time will it be when that radio message Cassini is sending right now reaches Earth?	Visitor looks at watch & gives time. Time+67 minutes.
To Say: Remember that spacecraft traveling to the planets take a lot longer to get there than radio communications do. How long did the handout say it takes to send a message to the Moon? Can we travel to the Moon that fast? That's right. It can take a few days to get there. But the other planets, it can take a few months or years to get there. Many people think that the best time to send a spacecraft is when the planet is closest to Earth. *To Do:* Place the Mars sticker on the orbit of Mars across from where Earth is. Pick up the Orbits Ruler. *To Say:* If we aim the spacecraft in that direction and if it takes six or seven months, say, to travel from Earth to Mars, where would Mars be six months later? *To Do:* Use the Orbits Ruler to mark the location of Mars in six months. *To Say:* Would the spacecraft reach Mars? Right, we need to aim the spacecraft where the planet WILL be, like where a quarterback has to throw a football to reach his receiver. Ready to see the planets in the telescopes?	1.3 seconds. No. No! Yeah!

4. Handout: Exploring Our Solar System

Leader's Role	**Participants' Role (Anticipated)**
Materials: Handout for banner: Exploring the Solar System *Optional*: Pencils. *Optional*: You may want to copy your club information on the back of the handout.	
Objective: • Provide visitors with a handout that reinforces some of the messages of the banner • Provide visitors with websites to get more information about NASA missions exploring the Solar System and about the planets.	
To Do: After your presentation, pass around copies of the banner handout. *Optional*: Pass out pencils. *To Say:* Here is a copy of the banner with some websites to find out more about NASA missions exploring the Solar System. Let's mark the locations of the planets on your handouts.  	Takes handouts. Visitors mark the locations of planets from the locations shown on the banner.