



## 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



### 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.

<b>Leader's Role</b>	<b>Participant's Role</b>
<p><b>Introduction:</b> 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 <i>does</i> 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.</p> <p>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").</p>	<p>At each telescope, participants can mark their Passport with the object they saw.</p>



<b>Leader's Role</b>	<b>Participant's Role</b>
<p><b>If you'd like to expand on the story of time machines, try this line of presentation and questioning:</b>            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.)</p> <p>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.</p>	<p>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)?</p>
<p>This Passport can be used to guide your journey.</p> <p>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.</p> <p><u>To do:</u>  <i>(Pick an object that is visible now, say the moon.)</i></p> <p><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.</p> <p>For objects within the Milky Way it is much longer. Not just days, but years, perhaps tens of thousands of years.</p> <p><u>To Do:</u>  <i>Pick a nearby star, for example, Sirius.</i></p> <p><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.</p>	<p><i>Individuals should call out answers</i></p>



## Helpful Hints

Distances in astronomy are so vast, that it is often difficult to put them in 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!

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## Passport Through Time

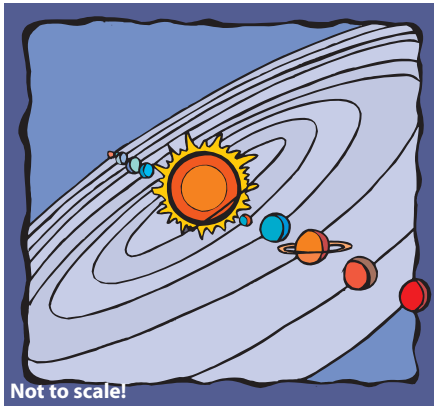


Looking through a telescope is like jumping into a time machine.

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.**



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

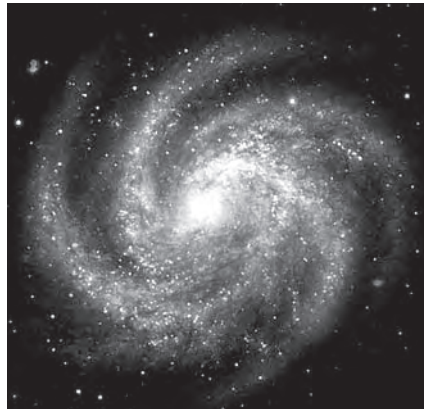


Image Credit: NASA

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



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.**



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: \_\_\_\_\_