Teacher's Guide for Evening Star Parties

Evening Star Parties are informal events that usually begin at dusk and last an hour and a half to two hours. Northern Stars will be setting up several telescopes at your dark location.

This guide is designed to help you better prepare your students for their upcoming evening star party hosted by *Northern Stars Planetarium.* This presentation is given to a variety of grade levels, so be aware that not everything in this guide may be appropriate for your students, some portions may seem too old or too young. Please use only what you feel is useful and appropriate to you and your students.

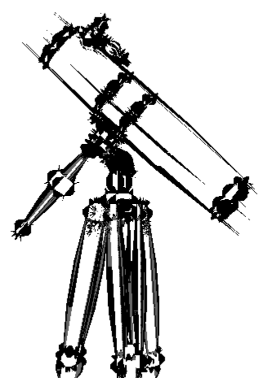
Preparation for the Event

• Be sure that your students arrive **dressed appropriately.** Standing around a telescope after dark can be a cold event. During the late fall or winter it can be very cold. Winter coats, warm boots, mittens, and hats are hightly suggested (even for autumn events).

• Inform your students that **telescopes are delicate and expensive intruments**. There will be telscopes that they can use themselves, but they are not toys and need to be used appropriately.

•**Do <u>not</u> have your students bring flashlights**. To see well through a telescope your eyes need to be dark adapted. Once adapted, in an open dark area everyone should be able to safely move about without flashlights. Any leader lights should have red filters.

The Scale of Space



The Earth is about 8,000 miles in diameter, Jupiter is about 85,000 miles in diameter, and the Sun is just under 1,000,000 miles in diameter. Distance-wise, Earth is 93 million miles from the Sun, while Jupiter is approximately 600 million miles from the Sun.

To put this in a more realistic perspective, set up the following model for your students: Using a grain of sand to represent the size of the Sun, at this scale, the Earth would be about 3.5 inches away and would be about a quarter as big as the smallest speck of dust you can find (barely visible at all). The entire orbit of the Moon would be less than half the size of a single grain of sand. Jupiter would be 12 feet away and also nearly microscopic at this scale. The next closest star would be another grain of sand 15 miles away! Our galaxy, the Milky Way, has by some estimates just under one trillion stars. Now imagine taking a trillion grains of sand and spread them out into a giant disk with an average of 15 miles between each and every grain. This Scale Model of our galaxy, having each star represented by a grain of sand, would fill the entire orbit of the Moon!

Vocabulary

Aperature: The diameter of the objective or primary lens or mirror of a telescope. This determines the light gathering ability of a given telescope. The larger the aperature, the more light a telescope can gather, and therefore the brighter an object will appear.

Binary Star: Two stars that revolve around each other. Half of all the stars we see in the night sky are actually double or multiple star systems, but their distance from us makes them look like one star to the unaided eye. A telescope is often needed to seperate binaries.

Catadioptric Telescopes: Telescopes that use both lenses and mirrors together to bend light.

Constellations: Imaginary, dot-to-dot pictures drawn using the stars as the dots. These are used to map the nighttime sky. There are 88 constellations all together.

Deep Space Objects: These distant objects can only be seen with a telescope. They include: galaxies, nebulae, planetary nebulae, star clusters, binary stars, and supernova remnants.

Diffuse Nebula: A huge cloud of hydrogen gas floating in space, usually many light years across in size. These hydrogen nebulae are slowly contracting and forming into new stars.

Focal Point: The point at which light converges after passing through a lens or reflecting off a parabolic mirror.

Lens: A spherical shaped piece of glass or crystal that bends light together to a single point at a set distance from where the light enters the lens. A magnifying glass is a single lens. Refracting telescopes often use multiple lenses.

Light Gathering: This term refers to the ability of a telescope to gather faint light and concentrate it together and therefore make faint objects appear brighter. The larger the aperature of a telescope the greater the light gathering capabilities it has.

Light Year: A light year is the distance that a beam of light will travel in one years time. Light travels at 186,000 miles per second! Astronomers use this unit to measure great distances in space. One light year equals about 6 trillion miles. For example, the closest star to the Sun is Alpha Centauri, which is 4.3 light years away or 25,278,000,000,000 miles away!

Magnification: The amount that the image of a distant object is made larger using optics. To calculate magnification divide the focal length of the objective lens or mirror by the focal length of the eyepiece. (Remember to use the same units, don't divide millimeters by centimeters!)

Planetary Nebula: A circular nebula, composed of many types of gases, that is expanding into space. Its the result of the death of an average star (like the Sun). The nebulosity you see is the outer layers of the star that have been blown out into space. They're called planetary because of their appearance only, which led early astronomers to mistake them for undiscovered planets.

Refractor: A telescope that uses lenses to bend light.

Reflector: A telescope that uses mirrors to bend light.

Resolution: The ability of a telescope to seperate fine detail.

Telescope: An instrument that is used to help us see distant objects more clearly, brighter, bigger and with more detail.

What Does A Telescope Do?

Telescopes do three things: 1. **Magnify**, 2. **Resolve**, and 3. **Gather Light**.

Magnification is by far the best known of these three functions, but it really is the least important. Most objects in space are so far away that no matter how much you magnify them, they still look pretty much the same, the only difference is they get dimmer.

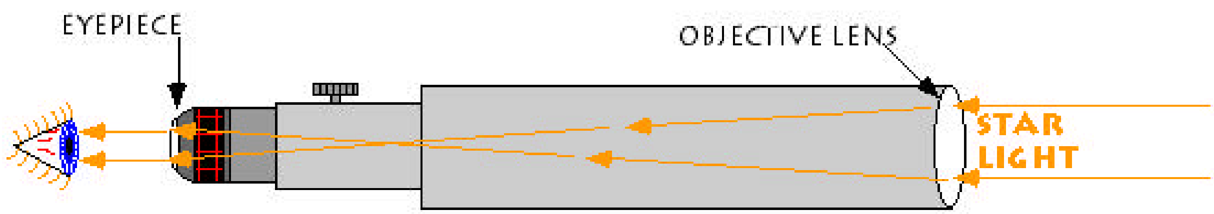
What really allows you to see more distant objects better is to make them brighter, this is done by **light gathering**. The larger the lens or mirror in diameter, the more light it's able to capture and the brighter the object appears. This enables you to see much more than you can by just magnifying. Any good telescope can change it's magnification by simply changing the eyepiece. The easiest way to understand light gathering is to think about the pupil in your eye. On a sunny day it gets small. In the dark it gets big. The larger pupil that lets more light into your eye so that you can see better in faint light, but your eyes can only get so big. When you use a telescope with an aperture of, say, 8 inches, it essentially makes your pupil 8 inches in diameter! This will allow you to see very faint objects.

Dilated Pupil
See faint objects in the dark.

Constricted Pupil
Limits how much light enters the eye in bright light.

Resolution is perhaps the most difficult to understand. At first it may seem to be the same as magnification, but it's not. Resolution is the ability to see fine detail. A telescope's resolution is determined by its aperture, not its magnifying power. For example when you view a double or binary star with an 8 inch telescope you can clearly see it is two stars at say 50 X, but if you look at the same star system with a 4 inch telescope at 50 X again, you may not be able to split the pair of stars, even though it's the same magnification. It requires more light to be able to split those close binary star systems. The larger the aperture the better the resolution and the finer the detail that you will be able to see.

Refracting Telescopes:



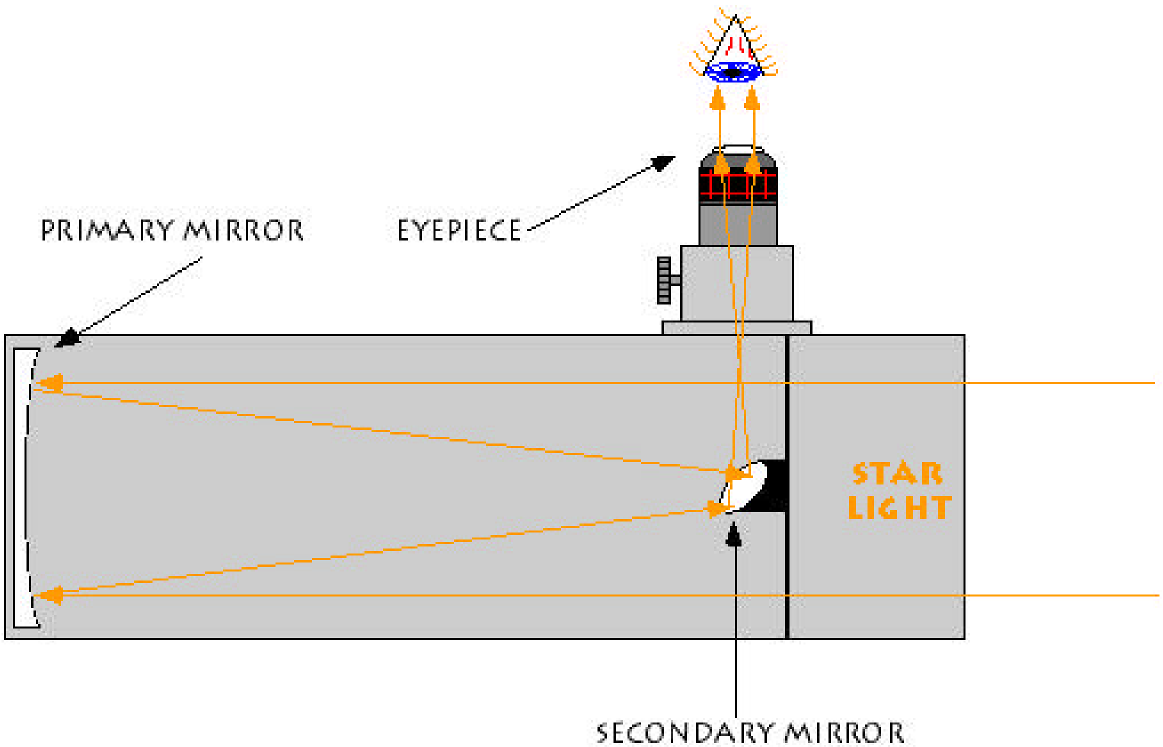
LIGHT PATH FOR A REFRACTING TELESCOPE

Refracting Telescopes use a lens to gather light and bring the image to the eyepiece. These are the type of instruments that most people think of when they think of a telescope. Galileo used a refractor when he first viewed the craters of the Moon and Jupiter's four largest moons. Refractors are fairly maintenance free and generally provide superb images of the moon, planets, star clusters and general sky gazing. They tend to be smaller in aperture than other types so they are not as good for viewing fainter sky objects such as galaxies and nebulae. Good quality refractors tend to be expensive. Beware of cheap refractors!

Strengths: Great for viewing planets, the moon, star clusters, and splitting binary and multiple star systems. They have the classic telescope appearance.

Weaknesses: Because of their small aperture they are less well adapted for viewing very faint objects such as galaxies and nebulae. They are also expensive to get one with good optics and reasonable aperture.

Reflecting Telescopes:



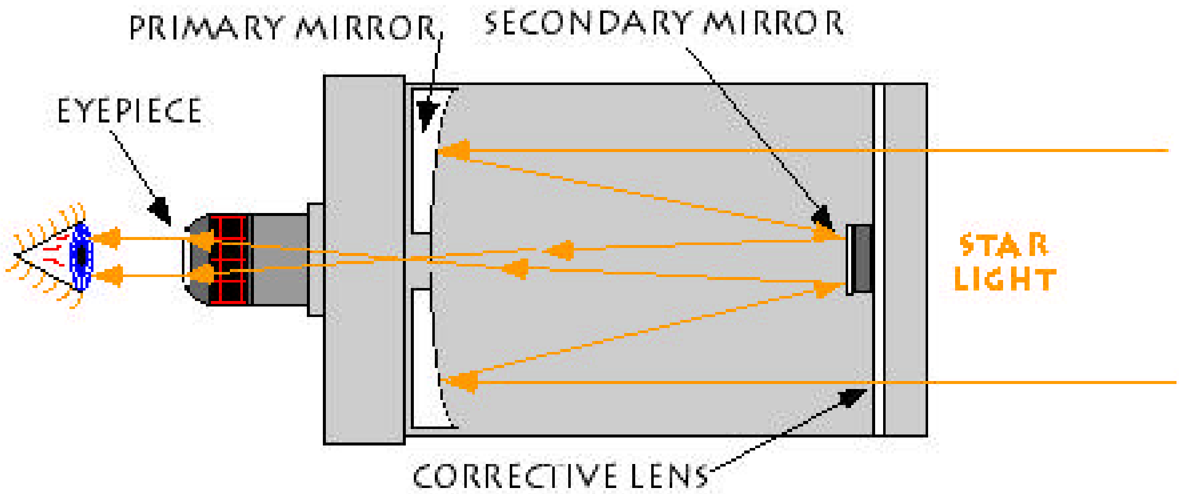
LIGHT PATH FOR A REFLECTING TELESCOPE

Reflecting Telescopes use a mirror to gather light and bring the image to the eyepiece. These telescopes are often referred to as "Newtonians" because they were first conceived of by Isaac Newton. Reflectors utilize a parabolic mirror that reflects the image to a focal point. Since the mirror reflects the image back towards the source, a small secondary mirror set at an angle reflects the light perpendicular to the tube so that the eyepiece is attached to the side of the telescope, rather than the end. Reflectors provide good views of all types of sky objects such as planets, the moon, star clusters, galaxies, nebulae, and multiple star systems. They require some minor maintenance to keep the mirrors in proper alignment. They are the least expensive telescopes and provide the most light-gathering abilities for the dollar. A favorite choice of amateur astronomers everywhere.

Strengths: Great for viewing faint objects such as galaxies and nebulae, reflectors also provide good general viewing of clusters, planets, the moon and binaries. Affordable.

Weaknesses: They tend to be more bulky to move about and store. They also require periodic maintenance to keep the optics properly aligned.

Catadioptric Telescopes:



LIGHT PATH FOR A CATADIOPTRIC TELESCOPES

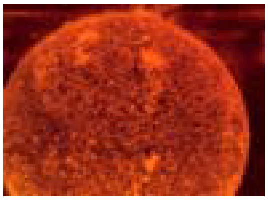
Catadioptric Telescopes use a combination of both lenses and mirrors. The most common variety of "cats" would probably be the Schmidt-Cassegrains. They come in many sizes, but the 8" variety is by far the most popular. They give good views of all night sky objects. They have a vast array of accessories available. They are fairly compact and easy to use. The downside is that they are more expensive than reflectors.

Strengths: Great for viewing all objects in the sky. They provide good aperture and magnification. They are compact and relatively easy to move about. Abundant peripherals make it easy to dabble in astrophotography or computerization. Low maintenance.

Weaknesses: Relatively expensive.

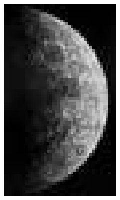
Planet Facts & Figures

The Solar System's Only Star:



SUN Rotates: 26 days. Surface Temp: 12,000°F (6000°C) Core Temp: 27 Million°F (15 Million°C) Diameter: 865,000 mi. (1,395,161 km) A middle aged (4.5 Billion yrs. old), average sized star. It's outer atmosphere "the heliosphere" extends beyond Pluto.

The Inner Planets:



MERCURY Rotates: 58 days 16 hrs. Revolves: 88 days. High Temp: 700°F (350°C) Low Temp: -270° F (-170° C). Diameter: 3,031 mi. (4,878 km.) Gravity: 0.38 X Earth's. No moons, rings or atmosphere. Dominanted by craters. Visited by the Mariner and Mercury Messenger space probes.

VENUS Rotates: 243 days. Revolves: 224.7 days. Average Temp: 900°F (480°C) Diameter: 7,541 mi. (12,104 km.) Gravity: 0.9 X Earth's. Thick Carbon Dioxide (CO_2) atmosphere. No Moons or rings. Visited by Pioneer Venus, Venera, Magellan, Galileo, and several other space probes.

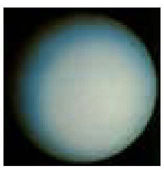
EARTH Rotates: 23 hrs. 56 min. Revolves: 365.25 days. High Temp: 130°F (58°C) Low Temp: -126°F (-88°C). Gravity: 1 X Earth's. Diameter: 7,927 mi. (12,756 km.) Nitrogen & Oxygen atmosphere. 1 moon, no rings. The Earth's surface is 75% covered with water.

MARS Rotates: 24 hrs. 37 min. Revolves: 1.88 yrs. High Temp: 80°F (27°C). Low Temp: -190°F (-123°C). Diameter: 4,197 mi. (6,794 km). Gravity: 0.38 X Earth's. Thin Carbon Dioxide atmosphere. 2 moons, no rings. In 1996 scientist found evidence of fossilized bacteria in a meteorite believed to have originated on Mars--perhaps long ago Mars had life! Visited by Viking 1 & 2, Pathfinder, Sojourner, Mars Global Surveyor, Spirit & Opporttunity Rovers, Phoenix, Mars Reconaissance, and others.

The Outer Planets:

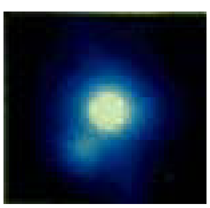
JUPITER Rotates: 9 hrs. 48 min. Revolves: 11.86 yrs. Cloud top Temp: -140°F (-95°C) Diameter: 88,733 mi. (142,796 km.). Gravity: 3 X Earth's. Composition: Mostly Hydrogen, Helium. 63 moons, 1 small ring. Visited by Pioneers 10 & 11, Voyagers 1 & 2, and Galileo space probes.

SATURN Rotates: 10 hrs. 39 min. Revolves: 29.46 yrs. Cloud top Temp: -292°F (-180°C) Diameter: 74,600 mi. (120,000 km.). Gravity: 1.32 X Earth's. Composition: Mostly Hydrogen, Helium. 60 moons. It has a large ring system. Visited by Pioneers 10 & 11, Voyager 1 & 2, and coming soon the Cassini Space Probe.



URANUS Rotates: 16 hrs. 48 min. Revolves: 84 yrs. Cloud top Temp: -346°F (-210°C). Diameter: 31,600 mi. ((50,800 km.). Gravity: 0.93 X Earth's. Composition: Mostly Hydrogen, Helium, some Ammonia, and Methane. 27 moons, about a dozen thin rings. Uranus is tipped on its side. Visited by Voyager 2 in 1986.

NEPTUNE Rotates: 16 hrs 3 min. Revolves: 164.8 yrs. Cloud top Temp: -364°F (-220°C). Diameter: 30,200 mi. (48,600 km.). Gravity: 1.23 X Earth's. Composition: Mostly Hydrogen, Helium, some Methane and Ammonia. 13 moons, 3 thin rings, 2 broad rings. Visited by Voyager 2 in 1989.



PLUTO Rotates: 6 days, 9 hrs. Revolves: 248 yrs. Temp: -400°F (-238°C). Diameter: 1900 mi. (3,000 km.). Gravity: 0.03 X Earth's. Has a very thin atmosphere. 3 moons, no rings. The largest moon, Charon, is half the size of Pluto. Pluto's orbit is very elliptical and tilted; it actually crosses inside Neptune's orbit from 1979-1999. Will be explored in the early 21st century by the space probe named "New Horizons." Pluto is no longer classified as a planet, instead it is classified as a "Dwarf Planet".

Night Vision

An important principle for viewing the night sky properly is giving your eyes a chance to get dark adapted. This process takes five to ten minutes. To illustrate this phenomenon, take your class to a room without windows (if one is available). Perhaps there is such a room in the basement. Have everyone sit on the floor or in a chair so that no one will fall in the dark. Then turn out the lights. What can your students see? Right after turning the lights out, they shouldn't be able to see hardly anything. Have them sit in the dark for five to ten minutes and have them notice how their sight improves after a couple of minutes. Can they begin to see other objects in the room? At the end of the exercise, have them make a special note about how their eyes feel when you turn the lights back on. The light should seem very bright and make them squint. Now their eyes must adjust to the light!

True or False

1. Half of all the stars we see in the night sky are binaries. (True)

2. All the stars we see in the night sky with our eyes alone are part of the Milky Way galaxy. (True)

3. It's impossible to see artificial satellites in the night sky. (False)

4. There are only 5 of the 9 planets in our Solar System that we can see in the night sky without a telescope. (True: Mercury, Venus, Mars, Jupiter and Saturn)

5. Open star clusters contain between 500,000 and 1,000,000 stars each. (False: Globular clusters have this many stars. Open clusters have only 200-600 stars on average.)

6. Night vision is obtainable after approximately 3 minutes. (False: 10 minutes is a more reasonable amount of time.)

7. Galileo invented the telescope. (False: He was the first to point it towards space, but it was invented by Jan Lippershey of Holland.)

8. The first planet to be discovered with a telescope was Uranus. (True: Uranus was discovered with a telescope by William Hershel in 1781, and he named it George, after the King of England!)

9. Telescopes make objects look brighter. (True)

10. Telescopes help us see very tiny objects like germs and bacteria. (False: That's a microscope.)

11. A pair of binoculars are simply two small telescopes attached together, one for each eye. (True)

12. With binoculars you can see more than twice as many stars as you can see with just your eyes. (True)

Study Questions

(some answers in italics!)

1. What are the three main functions of a telescope? *(the three main functions listed in order of importance are 1. light gathering 2. resolution 3. magnification)*

2. What are some uses for a telescope?

3. Why does a stick appear to bend when it is placed partially in water? *(refraction)* Does it really bend? *(no)* **What is bending?** *(the light)* **How does this relate to what a lens does in a telescope?**

4. Why does a lens bend light? *(whenever light passes through a substance it is bent and different substances bend light in different amounts)*

5. Why do objects appear upsidedown in a telescope?

6. Why does the pupil in your eye change sizes? *(to either restrict the amount of light that enters the eye, or to allow more light into the eyes)* **Which way helps us see better in the dark, when the pupil is big or small?** *(big)* **Therefore, which telescope will allow you to see fainter objects in space, an 8 inch diameter telescope or a 4 inch diameter telescope?** *(8")*

7. What is the difference between a refracting telescope and a reflecting telescope? *(refractors use lenses to bend the light, reflectors use mirrors)*

8. What is the Milky Way? *(our galaxy) Are we part of the Milky Way? (yes)*

9. Why do the stars appear to move across the sky from east to west? *(because Earth is rotating or spinning). Are the stars really moving? (no) What causes day and night? (the rotation of the Earth)*

10. Why is the North Star (Polaris) so famous? *(Because it is directly above the north pole of Earth and thus helps us find the direction north. It is not the brightest star.)*

11. What is a light year? *(A light year is a way astronomers measure great distances in space. Its based on the speed of light: 186,000 miles per second. One light year is the distance that light can travel at that speed in one years time. A light year equals about 6 trillion miles. For example, the star Alpha Centauri is 4.3 light years away or 25,278,000,000,000 miles!)*

12. What is a star? *(A large ball of mostly hydrogen gas that has sufficient internal pressures to cause nuclear fusion within its core.)* **Why do stars twinkle?** *(Stars don't really twinkle. The twinkling effect is caused by the Earth's atmosphere.)*

13. All are stars white? *(No. Stars actually are many different colors: Red, Orange, Yellow, Blue, Violet and White.)* **Why can't we generally see the different colors of the stars?** *(Because the part of our eye that we use to see faint objects, such as stars, is color-blind.)*

14. What do the different colors of stars tell us about the stars? *(The temperature of the stars. Red stars are cool: 6,000-8,000 degrees F, Yellow stars are hotter: 12,000-14,000 degrees F, while Blue and White stars are the hottest: 16,000-30,000 degrees F.)*

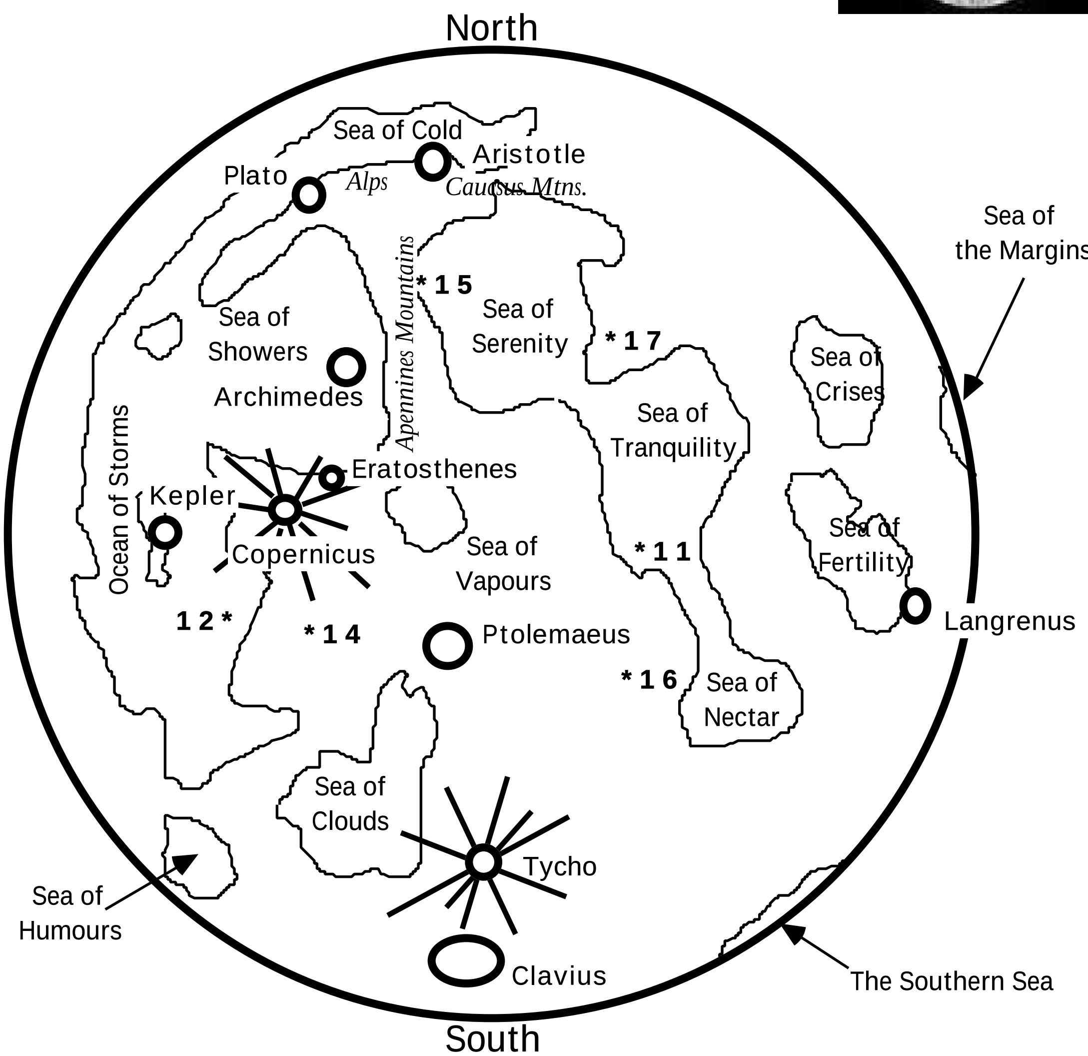
Telescope Word Search

Try to find the vocabulary words listed on the bottom of this page hidden within this puzzle. Words can be written either horizontally, vertically or diagonally.

S	U	L	B	I	G	D	I	P	P	E	R	J	U	P	V	X
L	K	T	T	W	B	I	N	A	R	Y	G	Q	M	O	O	N
O	S	Y	S	P	E	A	T	M	O	S	P	H	E	R	E	R
H	P	C	T	N	C	S	U	N	S	E	T	O	T	M	S	E
I	L	I	A	O	O	N	T	F	P	D	F	T	E	J	H	D
D	A	R	R	M	N	R	B	G	L	K	L	O	O	M	S	S
G	N	C	S	E	S	I	T	E	A	U	R	O	R	A	T	U
H	E	U	K	R	T	J	G	H	N	L	I	B	F	R	A	P
O	T	M	X	C	E	U	K	H	E	E	A	S	T	S	R	E
R	A	P	N	U	L	P	R	I	T	K	B	X	G	P	C	R
I	R	O	B	R	L	I	Z	E	B	A	P	U	Y	O	L	G
Z	I	L	O	Y	A	T	S	O	L	J	V	S	L	L	U	I
O	U	A	S	A	T	E	L	L	I	T	E	A	T	A	S	A
N	M	R	I	S	I	R	E	G	S	O	U	T	H	R	T	N
F	A	H	Z	F	O	S	W	T	O	J	H	U	Q	I	E	T
S	O	J	V	E	N	U	S	E	D	H	T	R	U	S	R	I
M	H	N	I	G	H	T	V	I	S	I	O	N	E	F	O	J

Atmosphere	Aurora	Big Dipper
Binary	Circumpolar	Constellation
East	Galaxy	Horizon
Jupiter	Mars	Mercury
Meteor	Moon	Nebula
Night Vision	North	Planet
Planetarium	Polaris	Red Supergiant
Satellite	Saturn	Sky Tonight
South	Star Cluster	Stars
Sunset	Venus	West

The Moon



Maria or Seas:

Mare Australe.........................The Southern Sea
Mare Crisium...........................The Sea of Crises
Mare Fecunditatis................The Sea of Fertility
Mare Frigoris...........................The Sea of Cold
Mare Humorum......................The Sea of Humors
Mare Imbrium..........................The Sea of Showers
Mare Marginis..........................The Sea of Margins
Mare Nectaris...........................The Sea of Nectar
Mare Nubium...........................The Sea of Cloud
Oceanus Procellarum.........The Ocean of Storms
Mare Serenitatis....................The Sea of Serenity
Mare Tranquillitatis............The Sea of Tranquility
Mare Vaporum........................The Sea of Vapours

Craters:

Archimede
Aristotle
Clavius
Copernicus
Eratosthenes
Kepler
Langrenus
Plato
Ptolemaeus

***** Apollo Landing Sites

Mountains Ranges:

Alps
Apennines
Caucasus

Astronomy Web Sites

Northern Stars Planetarium: http://www.northern-stars.com

Astronomy Magazine: http://www.kalmbach.com/Astro/Astronomy.html

Astronomical Society of the Pacific: http://maxwell.sfsu.edu/asp/asp.html

Comet Hale-Bopp: http://newproducts.jpl.nasa.gov/comet/

Extra Solar Planets: http://www.obspm.fr/departement/darc/planets/encycl.html

International Dark Sky Society: http://www.darksky.org/~ida/index.html

International Space Station Alpha: http://issa-www.jsc.nasa.gov/

***Jet Propulsion Lab (info on Space Probes):** http://www.jpl.nasa.gov/

Lick Observatory: http://www.ucolick.org/

Life on Mars? http://cu-ames.arc.nasa.gov/marslife/

Mars Pathfinder Mission: http://mpfwww.jpl.nasa.gov/mpf/fact_sheet.html

The Nine Planets: (an excellent resource on solar system information)
http://seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html

The NASA Homepage: http://www.nasa.gov/

Project Galileo: http://www.jpl.nasa.gov/galileo/

Sky and Telescope: http://www.skypub.com

Sky Watcher's Diary: http://www.pa.msu.edu/abrams/diary.html

Space Shuttle Archives: http://shuttle.nasa.gov/

Space Telescope Info: http://www.stsci.edu/top.html

Weather Net: http://cirrus.sprl.umich.edu/wxnet/

Bibliography

Younger Students:

Branley, Franklyn M., *The Planets in our Solar System,* New York: Harper and Row, Harper Junior Books, 1987.

-------------------------- *The Sky is Full of Stars,* New York: Harper and Row, Harper Junior Books, 1981.

Cole, Joanna, *The Magic School Bus, Lost in the Solar System,* New York: Scholastic, Inc., 1990.

Fradin, Dennis B., *Comets, Asteroids, and Meteors,* Chicago: Children's Press, New True Books, 1984.

Rey, H.A.., *The Stars, A New Way to See Them,* Boston: Houghton Mifflin Co., 1976. (This is probably the best book for learning constellations for any age level.)

Ride, Sally & Okie, Susan, *To Space and Back,* New York: Lothrop, Lee & Shepard Books, 1986.

Older Students:

Beatty & Chaikin, *The New Solar System, 2nd Ed.* Cambridge: Cambridge University Press, 1990. (High school to college age level)

Couper & Henbest, *New Worlds, In Search of the Planets,* Reading, MA: Addison-Wesley, 1986.

Gallant, Roy, *Our Universe, 2nd Ed.,* Washington D.C.: National Geographic Society, 1986.

Miller & Hartmann, *The Grand Tour: A Traveller's Guide to the Solar System,* New York: Workman Publishing, 1981.

Moeschl, Richard, *Exploring the Sky, 100 Projects for Beginning Astronomers,* Chicago: Chicago Review Press, 1989. (Contains lots of project ideas for both teachers and older students.)

Pogue, William, *How Do You Go To The Bathroom in Space?* New York: Tom Doherty Associates, 1985. (Younger Readers may also enjoy this Q & A book about space flight.)

For Teachers:

Braus, Judy, Editor, *NatureScope: Astronomy Adventures,* Washington, D.C.: National Wildlife Federation, 1986.

Universe in the Classroom, Astronomical Society of the Pacific, Teacher's Newsletter, Dept. N. 390 Ashton Ave., San Francisco, CA 94112 (free to all teachers, request on school letterhead.)

Planetarium Program Evaluation

After the Northern Stars Planetarium has visited your class, please take a moment to fill out this evaluation. Your suggestions are very valuable to us!

Mail the completed evaluation to :......................Northern Stars Planetarium
15 Western Ave.
Fairfield, Maine 04937
Or Email To :...info@northern-stars.com

1. Show Name: ____

2. Group grade/age level:____

3. Was the material presented at an appropriate level for your class? ______________________

____

4. Was the amount of material discussed: Enough Overwhelming Not Enough

5. Should any parts of the presentation be developed further? ______________. If so, which parts?

6. Was there sufficient time for questions and answers? Yes No

7. Were you studying astronomy or another related subject at the time of the planetarium's visit?

Yes No

If so, was the planetarium visit helpful?
____

8. Was the Teacher's Guide helpful in preparing your class for the planetarium visit? Yes No

Which parts were most helpful?
____

Which parts were least helpful?
____

9. Did the presenter present the material in a clear and understandable fashion? _____________

10. How would you rate the overall program given to your class in the planetarium? _________

____

11. (Optional) Your name & school:____

Thank you for your time! Your Comments Make a Difference!