A Collection of Curricula for the STARLAB® Deep Sky Objects Cylinder & Slide Set Transcript

Including:

A Look at the Deep Sky Objects Cylinder by Talcott Mountain Science Center

Deep Sky Objects: Activity 1 by Gary D. Kratzer

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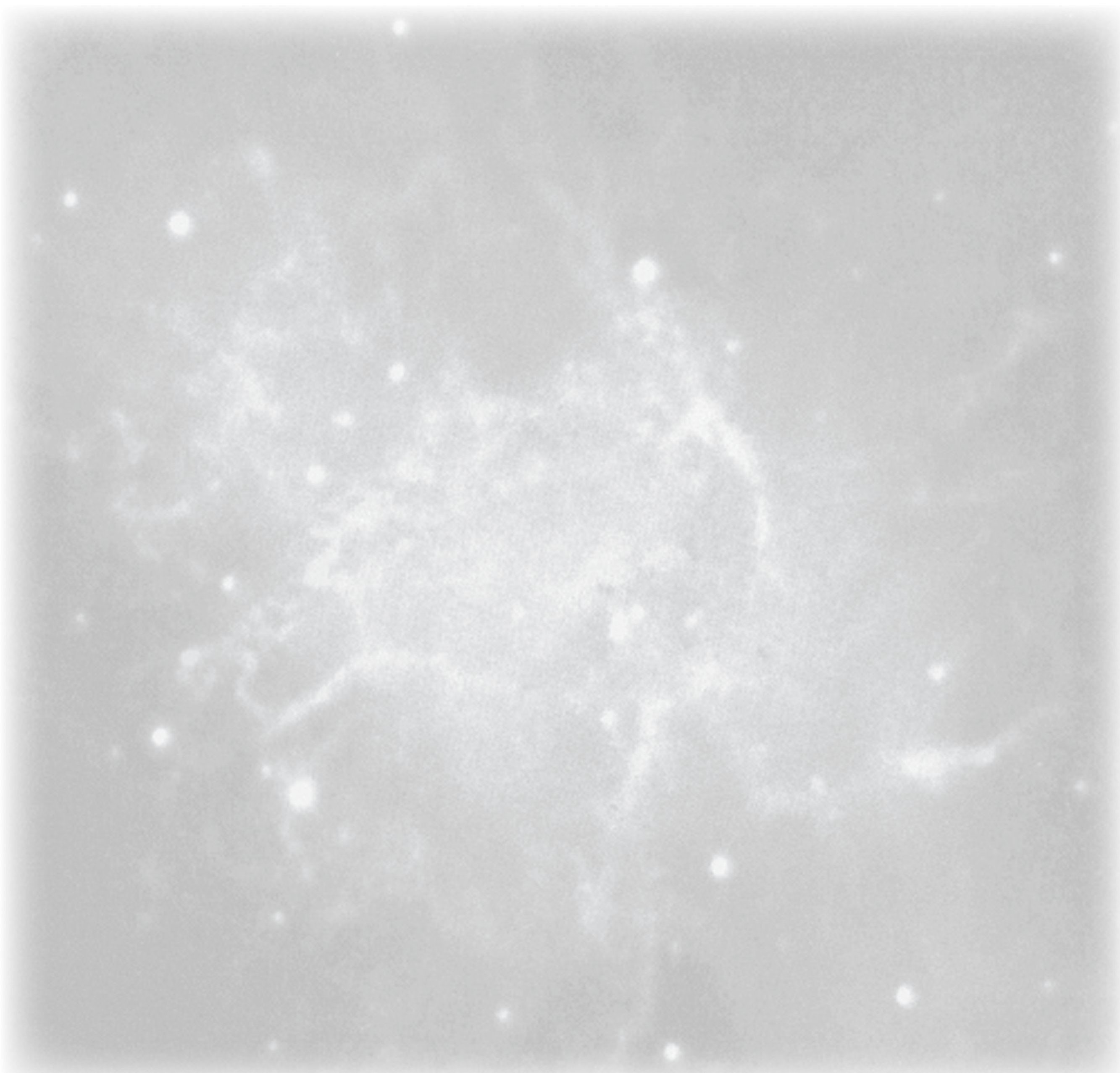
Plus: Transcript for the Slide Set of the Planets, Stars, and Galaxies

STARLAB

Curriculum Guide Contents



A Look at the Deep Sky Objects Cylinder

from the Talcott Mountain Science Center

Overview

- This guide is designed to assist the teacher using the Deep Sky Objects Cylinder with the STARLAB Portable Planetarium System. It has been divided into several sections, each describing a different class of deep sky objects such as galaxies, double stars and nebulae. Each section has been designed to provide the teacher with the background information necessary to create an exciting and informative unit in astronomy.
- The first step in interesting students in astronomy is for the teacher to encourage every student to learn the constellations and locate some of the brighter stars and planets. The following STARLAB star and constellation cylinders can be used for this purpose:
    - Starfield Cylinder
    - Urban Starfield Cylinder
    - Constellation Cylinder
    - Celestial Coordinates Cylinder
    - Any of the STARLAB mythology cylinders such as: Greek, African, Native American, and Ancient Chinese mythology
- Suitable star maps may be obtained at nominal cost from Project STAR (see resource list at the end of this curriculum). These maps make excellent complementary materials for STARLAB. Or, a subscription to *Sky & Telescope* or *Science and Children* magazines will provide you with star maps for every month of the year.
- Once some of the constellations are known, it is easy to begin identifying some deep sky objects. Some can be seen with the unaided eye, most can be found using ordinary binoculars. STARLAB's Deep Sky Objects Cylinder graphically depicts the locations of the brightest and most interesting objects.
- The STARLAB *Slide Set of Planets, Stars, and Galaxies* (see the transcript at the end of this Cylinder Guide) is an invaluable aid in helping students to differentiate between these objects. Encyclopedias and astronomy books print full color photos with descriptions for any student pursuing projects studying deep sky objects.
- The Deep Sky Objects Location Chart near the end of this section will help you locate the objects on the STARLAB Deep Sky Objects Cylinder.

Deep Sky Terms

Nebula

Nebula is the Latin word for cloud. The astronomer uses this term to describe any cloud of dust and gas that is found in this galaxy or others. Nebulae are composed mostly of hydrogen and helium, the two simplest and most abundant elements in the universe. Lesser amounts of other gases and dust are found in most nebulae. STARLAB slides 60 through 67 show some very good photographs of nebulae taken by large telescopes.

Deep Sky Objects Cylinder Key

Nebula = ☆

Double Stars = △

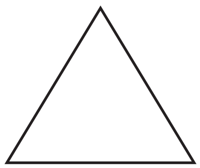
Clusters = □

Variable Stars = ◇

Galaxies = ▭

Nebulae absorb light from nearby stars and radiate it back into space. Most nebulae glow red, the color of hydrogen gas. The brightest nebula is the Orion Nebula (see slide #60) which can be seen with the unaided eye in a dark sky.

Nebulae are very important in astronomy because they are the key to understanding the birth of stars. All stars, including the sun, formed from nebulae like the Orion Nebula. Astronomers have also found, however, that certain types of nebulae mark the death of stars (see slides #62 and 63). In old age, some stars blow off a shell of gas (planetary nebula) or even explode (supernova) on the way to becoming a black hole. The Deep Sky Objects Cylinder will aid students in locating these objects, some of which are visible through binoculars or a small telescope.

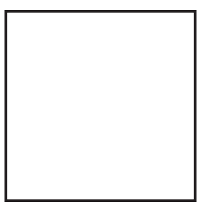


Double Stars

Amazing as it may seem, more than half of the stars in our galaxy are probably part of double star systems. Our sun, therefore, as a single star, may actually be in the minority. Double stars are stars that revolve around each other, or more accurately, around a common center of mass. These stars travel through the galaxy together sometimes eclipsing each other as seen from the Earth. In other words, stars of double star systems orbit each other much in the same way that planets orbit our sun.

One of the best known and easiest double stars to locate in the sky is Mizar. Mizar and its faint companion Alcor make up the second star in the handle of the Big Dipper. Both stars may be seen with the unaided eye.

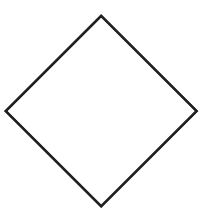
Double stars are important because they provide astronomers with the only direct method of finding the mass weight of stars. Our understanding of the evolution of stars has increased dramatically since we have been able to measure the masses of stars in double systems.



Clusters

Stars seldom form individually but most often in groups, associations or clusters. Gravity is the determining factor in all clusters. If the forces between stars are weak, then the cluster will begin to drift apart and lose its identity. The Big Dipper is an association of stars that is slowly drifting apart.

Basically there are two types of star clusters: open or galactic clusters (slides #56 and 57), and globular clusters (slide #68). Open clusters contain stars that have formed recently on the cosmic scale. These stars are bright, hot and formed in groups ranging from 20 to perhaps 1000 stars. Globular clusters represent the oldest objects in the galaxy. They formed at the very beginning of the Milky Way's history. Globular clusters contain hundreds of thousands of stars tightly bound by gravity. Scientists believe that many old dead stars including black holes, may exist at the center of these clusters.



Variable Stars

Though most stars in the heavens give off a constant or nearly constant amount of light, a relatively small number vary their brightness noticeably. Such stars are known as variable stars. While some variable stars change brightness because of mutual eclipses, most vary because the star itself is changing size and temperature. Variable stars of this type are poorly understood, but they seem to be a result of a star growing old and exhausting its fuel reserves.

As our sun ages, it may become a variable star, changing so drastically that life as we know it could not exist on Earth. The best prediction scientists can make is that our sun will begin to change billions of years from now. Studying variable stars helps astronomers to predict what changes may occur in the sun's future.

Galaxies

All the stars, clusters and nebulae seen in the night sky with the unaided eye are part of the Milky Way Galaxy. (Slides #58 and 59 show photographs of the Milky Way.) The Milky Way is one of many millions (perhaps billions) of galaxies that are part of our universe. Though there are several types of galaxies, many contain all the objects described in this guide. A galaxy is bound together by its gravitational forces and it moves through the universe usually as part of a cluster of galaxies.

Slides #71 through 78 show typical galaxies. The faint band of light seen on dark clear nights is actually the inside view of our own galaxy, the Milky Way. The study of galaxies is an important part of the work done by astrophysicists as they formulate theories describing the beginning of the universe. Astronomers already utilize telescopes in orbit about the Earth. These instruments see objects three or four times farther away than our earth-based telescopes. These "space telescopes" also photograph the most distant galaxies and another class of objects called quasars (slide #79). Quasars seem to be very old, very distant and very bright galaxies. These mysterious objects hold the key to unlocking the door to our far distant past.

Deep Sky Objects Cylinder Key

Nebula = ☆

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MATERIALS

- STARLAB Portable Planetarium
- Starfield Cylinder
- Constellation Cylinder
- Deep Sky Objects Cylinder
- star maps
- Slide Set of Stars, Planets & Galaxies

Deep Sky Objects: Activity 1

by Gary D. Kratzer

Objectives

1. Students will identify 5 constellations and 5 bright stars (in STARLAB and in the night sky).
2. Students will show the locations of 5 deep sky objects and explain the differences between the various types (in the STARLAB).
3. (Optional) Students will observe 5 deep sky objects using binoculars or a small telescope.

Preparation

Conduct a study of constellations, stars and deep sky objects. Discuss the differences between an asterism and a constellation. An asterism is a group of stars that appear as a shape or object to the observer. An asterism is usually a part of a constellation or constellations (example: The Big Dipper, Square of Pegasus, Summer Triangle). A constellation is a group of stars that appears as a common object or shape. Constellations contain bright stars that are categorized by their brightness and the letters of the Greek alphabet. The brightest star in a constellation is called "alpha." The dimmest star is called "omega." Constellations have boundaries in which deep sky objects are located.

> **Note**
>
> *Remind your students that the stars and deep sky objects found in the boundaries of a constellation are not necessarily all the same distance from the Earth.*

Discuss the differences between the various types of deep sky objects. Show slides of the various objects in the classroom or in STARLAB (this slide set is included with the Deluxe and Super Deluxe STARLAB systems, not the Basic system). Practice using seasonal star maps in the classroom before entering STARLAB. Go over the list of objects that the students will be looking for in STARLAB according to the season you are viewing.

Procedure

1. Once all the students are seated in the planetarium, place the Starfield Cylinder on the projection platform, adjust the projector to your latitude and slowly turn down the side lamps and increase the brightness of the stars. Have the students notice that the stars are not all the same brightness.
2. Practice finding constellations of a particular season.
3. After the students have located several constellations for that season, turn down the projection lamp and switch to the Deep Sky Objects Cylinder. Project the starfield onto the dome. Explain that the star-shaped objects represent nebulae, diamond-shaped objects represent variable stars, triangle-shaped objects represent double stars, rectangle-shaped objects represent galaxies, and the square-shaped objects represent clusters.
4. Have the students locate the constellations of a particular season. Using the list provided below, identify some of the deep sky objects in various constellations

(example, the star-shaped object in Orion is M-42, a nebula where many stars have and will form). Other objects are listed in the list entitled Deep Sky Objects Locations.

5. Upon completion of this lesson, challenge your students to go out on a clear, dark night and try to find the locations of some of the objects found in STARLAB. If available, binoculars or a telescope would greatly enhance the student's ability to locate these objects.

Note

Remind the students that deep sky objects such as nebulae, clusters and galaxies often appear as small fuzzy "snowball-like" objects. Textbook pictures of these objects were taken through the world's largest telescopes with very sophisticated cameras attached.

Here are some of the brightest deep sky objects in each category:

Object	***Number***	***Constellation***	***Season***
Orion Nebula	*M-42*	*Orion*	*winter, spring*
Andromeda Galaxy	*M-31*	*Andromeda*	*fall, winter*
Lagoon Nebula	*M-8*	*Sagittarius*	*summer*
Globular Cluster	*M-13*	*Hercules*	*spring, summer*
Mizar/Alcor	*Zeta*	*Big Dipper (asterism)*	*all year*
Double Cluster (open)	*h & chi*	*Perseus*	*summer, fall, winter*
Algol (eclipsing variable)	*Beta*	*Perseus*	*summer, fall, winter*
Pleiades (open cluster)	*M-45*	*Taurus*	*fall, winter*

Note

All of the above objects can be seen with the unaided eye in very dark viewing conditions although binoculars are helpful.

Nebulae and Light: Activity 2

by Gary D. Kratzer

Materials

- STARLAB Portable Planetarium
- Deep Sky Objects Cylinder
- Starfield Cylinder
- Holographic diffraction grating or spectroscopes (available from Project STAR, see references)
- various light sources (e.g. light bulb, candle, neon light, fluorescent, etc.) used in STARLAB
- red and blue paper-covered flashlights

Optional

- gas tubes (such as hydrogen, helium, mercury. etc.) A power source is required

Objectives

1. Students will describe several different processes that produce light (e.g. chemical process such as in a flashlight battery; mechanical process such as friction; electric discharge such as lightning, etc.).
2. Students will explain how light produced from an incandescent light bulb differs from that produced by a "neon" or fluorescent light.
3. Students explain the difference between light produced from stars and light produced in nebulae.

Preparation

Conduct a study of light. Explain that light is produced in a number of ways. Chemical energy is produced in a flashlight which in turn illuminates a filament in a bulb. Mechanical processes such as friction can produce light (example: metal shaped on a grinding machine). Electrical discharges such as those in lightning also produce light. Stars produce light as a result of the intense heat generated from within their core as hydrogen is converted to helium. This differs from a light bulb which emits light from a glowing wire. Neon and fluorescent lights glow as a result of an electrical charge being passed through a gas in the bulb. This is very much like a nebula. Nebulae glow as a result of light from stars within which cause the gas to fluoresce, or by distant starlight being reflected from the dust particles within.

Gather up a variety of light sources for students to analyze either in the classroom or STARLAB. Have diffraction grating or spectroscopes ready for the students to study the various light sources. Explain that diffraction grating is a special material that breaks light up into its "rainbow" colors. By studying light, scientists have been able to determine what stars are made of, how hot they are, and how far away they are from us.

Procedure

1. If in STARLAB, place the Starfield Cylinder on the projection platform and adjust it for your latitude. Almost any seasonal setting will do. After the students are seated and ready, slowly dim down the side lamps and increase the brightness of the starfield. Begin a discussion of why we see things. (Some students may say because we have eyes, while others will say because of light.) Explain that without light we would not be able to see anything. Reinforce this idea by slowly fading the brightness of the starfield until it is totally dark. Increase the brightness of the starfield once again.
2. Discuss how stars make their own light. Use a red and blue covered flashlight to demonstrate that a star make its own light because of the reaction within its core.
3. Turn down the brightness of the Starfield Cylinder and increase the brightness of the side lamps. Turn on a regular clear incandescent light bulb then turn down the brightness of the side lamps once again. Pass out the diffraction grating or spectroscopes. Have the students examine the spectrum produced from the light when seen through the spectroscopes. Discuss the colors seen with particular attention given to the order. Explain that this spectrum is produced as a result of a very hot wire emitting light. This is very different from that of a star.
4. Now turn on a small fluorescent lamp. Have the students examine the spectrum

of the lamp. Discuss how it appears different from that of the light bulb. The students will notice brightly-colored lines in the spectrum. This is called a "bright-line spectrum." This is the result of gases being excited by an electrical charge. The resulting glow is similar to that which occurs in a nebula.

5. If gas tubes are available, study the spectra of various gases. They too will display bright-line spectra much like those seen in the spectra of stars.
6. Conclude the lesson by placing the Deep Sky Objects Cylinder onto the cylinder platform and increase the brightness of the stars while decreasing the brightness of the side lamps. Point out the locations of various nebulae and stars which produce their light by either fluorescing, or from reactions within. (Examples: M-42 glows due to the abundance of hot blue-white stars embedded within. Sirius shines brightly due to the reactions occurring in the core.)
7. Reinforce the concept that by studying light, scientists have been able to understand the physical nature of objects in the universe.

Notes

When students look through diffraction grating at any light source, they will see an array of colors that help identify the source. The spectrum produced by the light bulb is similar to that of a star, while that produced by a neon sign compares well to that of a nebula excited to glow by nearby stars. The instrument used by astronomers to analyze light is called a spectroscope.

This activity is most effective when done in STARLAB thus eliminating outside light. See the next page for deep sky objects that can be found on the Deep Sky Objects Cylinder.

Deep Sky Locations

#	Object	Star Number	Location	Right Ascension	Declination
1.	Spiral Galaxy	NGC-224	in Andromeda	0h 40m	+41°00′
2.	Spiral Galaxy	NGC-253	south of Cetus	0:451m	-25°34′
3.	Spiral Galaxy	NGC-598	between Andromeda and Pisces	1:31.1m	+30°24′
4.	Planetary Nebulae	NGC-650-1	between Andromeda and Cassiopeia	1 :38.8m	+51°19′
5.	Open Cluster	NGC-1039	between Perseus and Andromeda	2:38.8m	+42°34′
6.	Open Cluster	Pleides	in Taurus	3:43.9m	+23°58′
7.	Open Cluster	Hyades	in Taurus	4:16.7m	+15°31′
8.	Diffuse Nebula	IC 434	on Orion's belt	5:38.6m	-2°26′
9.	Supernova Remnant	NGC-1952	between Auriga and Orion	5:31.5	+21°59′
10.	Diffuse Nebula	NGC 1976-82	between Orion's belt and Rigel	5:33.0	-5 22′
11.	Open Cluster	NGC-2099	between Auriga and Taurus	5:49	+32°33′
12.	Open Cluster	NGC-2168	between Open Cluster #11 and Orion	6:05.7	+24°20′
13.	Diffuse Nebula	NGC 2237-44	between Orion and Canis Minor	6:29.7	+4°54′
14.	Planetary Nebula	NGC-2392	in Gemini	7:26.2	+21°01′
15.	Open Cluster	NGC-2422	in Canis Major	7:34.3	-14°22′
16.	Planetary Nebula	NGC-2438	in Canis Major	7:39.6	-14°36′
17.	Planetary Nebula	NGC-2440	south of the Planetary Nebula in Canis Major	7:39.9	-18°05′
18	Open Cluster	NGC-2632	in Cancer	8:37.5	+19°52′
19.	Spiral Galaxy	NGC-3031	between North Pole Star (Polaris) and the Big Dipper pointer stars, it is south of #20	9:51.5	+69°18′
20.	Irregular Galaxy	NGC-3034	between the North Pole Star (Polaris) and the Big Dipper's pointer stars, north of #19	9:51.9	+69°56′
21.	Spiral Galaxy	NGC-3227	in Leo	10:20.7	+20°07′
22.	Planetary Nebula	NGC-3242	in Hydra between Spica and Sirius	10:22.4	-18°23′
23.	Planetary Nebula	NGC-3587	in the cup of the Big Dipper	11:12.0	+55°18′
24.	Spiral Galaxy	NGC-4258	between Ursa Major and Canis Venatici	12:16.5	+47°35′
25.	Spiral Galaxy	NGC-4565	between Canis Venatici and Leo, north of #27	12:33.9	+26°16′
26.	Spiral Galaxy	NGC-4594	in Virgo by Spica	12:37.3	-11°21′
27.	Spiral Galaxy	NGC-4826	between Canis Venatici and Leo, south of #25	12:54.3	+21°57′
28.	Globular Cluster	NGC-5139	in Centaurus	13:23.8	-47°13′
29.	Spiral Galaxy	NGC-5194-5	in Ursa Major adjacent to the handle of the Big Dipper	13:27.8	+47°27′
30.	Globular Cluster	NGC-5272	between Canis Venatici and Bootes (by Arcturus)	13:39.9	+28°38′
31.	Globular Cluster	NGC-5904	between Virgo and Libra	15:16.0	+2°16′
32.	Spiral Galaxy	NGC-5907	in Draco	15:14.6	+56°31′

#	Object	Star Number	Location	Right Ascension	Declination
33.	Globular Cluster	NGC 6121	in Scorpius by Antares	16:20.6	-26°24′
34.	Globular Cluster	NGC 6205	in Hercules	16:39.9	+36°33′
35.	Globular Cluster	NGC 6254	in Ophiuchus (the serpent holder)	16:54.5	-4 02′
36.	Diffuse Nebula	NGC 6523	in Sagittarius south of #39	18:01.6	-24°20′
37.	Planetary Nebula	NGC 6543	between Ursa Minor and Draco	17:58.8	+66°38′
38.	Planetary Nebula	NGC 6572	between Ophiuchus and Aquila	18:09.7	+6°50′
39.	Diffuse Nebula	NGC 6618	in Sagittarius north of #36	18:17.9	-16°12′
40.	Open Cluster	NGC 6705	between Aquila and Sagittarius	18:48.4	-6°20′
41.	Planetary Nebula	NGC 6720	in Lyra	18:51.7	+32°58′
42.	Open Cluster	COL 399	in Sagitta (the Arrow)	19:23.2	+20°05′
43.	Globular Cluster	NGC 6809	in Sagittarius	19:36.9	-31°03′
44.	Planetary Nebula	NGC 6818	between Capricornus and Sagittarius	19:41.1	-14°17′
45.	Irregular Galaxy	NGC 6822	between Capricornus and Sagittarius	19:42.1	-14°53′
46.	Planetary Nebula	NGC 6853	in Sagitta (the Arrow)	19:57.4	+22°35′
47.	Supernova	NGC 6960-2	between Sagitta and Cygnus	20:49.0	+31°00′
48.	Remnant Planetary	NGC 7009	between Capricornus and Aquarius	21:01.4	-11°34′
49.	Nebula Globular	NGC 7078	between Pegasus and Delphinus	21:27.6	+11°57′
50.	Cluster Globular	NGC 7089	in Aquarius	21:30.9	-1 03′
51.	Double Star	ζ Mizar & Alcor	in the handle of the Big Dipper	13:21.9	+55°11′
52.	Double Star	ε Epsilon Lyrae	adjacent to Vega in Lyra	18:42.7	+39°37′
53.	Double Star	β Albireo	(Beta Cygni) in the head of Cygnus	19:28.7	+27°51′
54.	Double Star	ζ	in Hercules (Zeta Herculis)	16:39.4	+31°42′
55.	Double Star	α Ras Algethi	in Hercules (Alpha Herculis)	17:12.4	+14°27′
56.	Double Star	γ Algieba	in Leo's mane (Gamma Leonis)	10:17.2	+20°06′
57.	Double Star	γ Mesarthim	in Aries (Gamma Arietis)	1:50.8	+19°03′
58.	Double Star	θ Alya	in Serpent's Tall (the serpent of the Serpent Holder) (Theta Serpentis)	18:53.8	+4°08′
59.	Double Star	α Castor	in Gemini (Alpha Geminarum)	7:31.4	+32°00′
60.	Double Star	γ	in the sail (Velorum) of Puppis (south of Double Star #61) (Gamma Velorum)	8:07.9	-47°12′
61.	Double Star	δ	in the sail (Velorum) of Puppis, (north of Double Star #60) (Delta Velorum)	8:43.3	-54°31′
62.	Double Star	θ	in the middle of Eridanus (Theta Eridani)	2:56.4	-40°30′
63.	Double Star	α A Crux	in the Crux (Southern Cross-Alpha Crucis)	12:23.8	-62°49′
64.	Double Star	α Toliman	in the Centaurus adjacent to the Crux (Alpha Centauri)	14:36.2	-60°38′
65.	Double Star	β	in Tucanae (Beta Tucanae)	22:41.1	-81°39′
66.	Double Star	α	in Capricornius (Alpha Capricorni)	20:14.9	-12°40′
67.	Double Star	θ	near the belt of Orion (Theta Orionis)	5:32.8	-5 25′
68.	Double Star	γ Arich, Porrima	in Virgo (Gamma Virginis)	12:39.1	-1 11′

#	Object	Star Number	Location	Right Ascension	Declination
69.	Variable Star	δ	in Cepheus (Delta Cephei)	22:27.3	+58°10′
70.	Variable Star	β Sheiiak	in Lyra (Beta Lyrae) (Eclipsing Binary)	18:48.2	+33°18′
71.	Variable Star	α Betelgeuse	in Orion (Alpha Orionis)	5:52.5	+7°24′
72.	Variable Star	υ	in Orion north of Betelgeuse (U Orionis)	5:52.9	+20°10′
73.	Variable Star	χ	in Cygnus (Chi Cygni)	19:48.6	+32°47′
74.	Variable Star	η	in Aquila south of Altair (Eta Aquilar)	19:49.9	+0°53
75.	Variable Star	ρ	between Aquila and Sagittarius (R Scuti)	18:44.8	-5 46′
76.	Variable Star	ρ	in Leo next to Cancer (R Leonis)	9:44.9	+11°40′
77.	Variable Star	β Algol	in Perseus adjacent to Aries, (Beta Persei)	3:04.9	+40°46′
78.	Variable Star	ο Mira	in Cetus next to Pisces (Mira Ceti)	2:16.8	-3°12′
79.	Variable Star	Κ	in Pavo (Kappa Pavonis)	18:51.8	-67°18′
80.	Variable Star	ρ	in Lepus south of Rigel (R Leporis)	7:17.2	-16°18′
81.	Variable Star	λ^2	in Puppis (L2 Puppis)	7:12.0	-44°31′
82.	Variable Star	η	in Carina (Eta Carinae)	10:43.1	-59°25′
83.	Variable Star	β	in Dorado south of Canopus (Beta Doradus)	5:33.2	-62°31′
84.	Variable Star	ζ	in Phoenix next to Achernar in Eridanus (Zeta Phoenicis)	1:06.3	-55°31′
85.	Variable Star	ρ	in Centaurus which is close to the pointer stars to the Crux Australis (R Centauri)	14:12.9	-59°41′
86.	Globular Cluster	NGC 104	next to the Small Magellanic Cloud	0:21.9	-72°21′
87.	Globular Cluster	NGC 6397	in Ara	17:36.8	-53°39′
88.	Globular Cluster	NGC 6752	in Pavo	19:06.4	-60°04′
89.	Galactic Cluster	NGC 6405	in the tail of Scorpius	17:36.8	-32°11′
90.	Galactic Cluster	NGC 6475	adjacent to Galactic Cluster #89 in Scorpius	17:50.7	-34°48′
91.	Galactic Cluster	NGC 3532	in Carina	11:03.4	-58°24′
92.	Galactic Cluster	NGC 4755	next to the Crux (Southern Cross)	12:50.6	-60°05′
93.	Diffuse Nebula	NGC 2070	in the Large Magellanic Cloud which is in the Dorado	5:38.7	-69°06′
94.	Diffuse Nebula	NGC 3372	in Carina	10:43.1	-59°25′
95.	Galaxy	Small Magellanic Cloud	labeled on cylinder as SMC southern celestial hemisphere	0:50.0	-73°
96.	Galaxy	Large Magellanic Cloud	labeled on cylinder as LMC southern celestial hemisphere	5:26	-69°

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Planets, Stars and Galaxies: Transcript

Note

This accompanies the SL-611 Slide Set of Planets, Stars, and Galaxies consisting of 79 slides gathered from satellite transmissions and large telescopes around the world.

1. A photograph of the sun showing various sun spots on the surface.
2. A photograph of a close-up of the sun showing various sun spots on the surface of the sun. It is taken in hydrogen alpha light so it shows a great deal of detail.
3. A full photograph of the sun in hydrogen alpha light. This photograph is taken with a special filter that shows only a particular spectral frequency of red light. This shows considerable detail of the sun's surface.
4. Similar to the last, this photo depicts several spectroheliographs and shows the sun in various colors of light — the upper left being hydrogen alpha. This essentially shows the detail of various elements on the surface of the sun.
5. A huge solar flare (much larger than the Earth). Solar flares disturb radio communication on the Earth.
6. A solar prominence, which is another type of solar activity.
7. Moving further away from the sun, the first planet we reach is Mercury. Although it looks quite a bit like the moon because of the cratering, it is indeed a planet. It often appears as a crescent and in the sky it's always found very close to the sun. It's very difficult to find.
8. A photograph of Venus from Earth. You can see that Venus has crescent shapes similar to the moon. Venus is constantly covered with clouds.
9. This is also Venus. It shows the cloud cover in more detail. This picture was taken from a space craft very close to the surface of Venus.
10. The next planet on our trip from the sun is the Earth. You can see clouds, land and ocean on the surface. We'll descend to the surface of the Earth in several steps.
11. The first shows the Mediterranean Sea.
12. Getting even closer to the surface, we can see the Gulf of Mexico.
13. Shown here is the east coast of the United States around New York.
14. The Mississippi River in Louisiana.
15. The Sinai Peninsula between Egypt and Israel.
16. The Florida Peninsula, with the Gulf of Mexico on the left. All these pictures have been taken by satellites which maintain a constant surveillance over the surface of the Earth. Such pictures of course were impossible to take before satellites became available.
17. Certain special satellites are used for monitoring various activities on the surface of the Earth. This slide shows an unusual cloud cover and several storms in the northern hemisphere.
18. This is a view of a hurricane. You can see the eye of the hurricane in the center

of the slide. Satellites can also be used to monitor differences in temperature on the surface of the Earth.

19. Here you can see pollutants emanating from a lake. The pollutants are at a different temperature from the rest of the lake.
20. A photograph of a meteor. Meteors are particles or rocks that enter the Earth's atmosphere and can only be seen from the Earth.
21. They can sometimes break into pieces and fall to the Earth as meteorites.
22. The closest astronomical companion to the Earth is, of course, the moon. Here is a photograph of the moon — of the side of the moon that we never see from the Earth—the back side of the moon. You can see a very large crater at the bottom of the photograph which we can tell developed fairly recently in the history of the moon because the rays emanating from the crater can still clearly be seen.
23. We will close up on the surface of the moon. You can see the thousands of craters that dot the surface. This photograph is a mosaic assembled from several photographs of the moon. You can see patterns of light and dark and lines demarking the sections.
24. This was taken by Apollo 17 and shows in detail a large crater on the surface of the moon.
25. Apollo 17 landed three men on the surface of the moon and allowed, for the first time, men to walk on the surface. You can see the dune buggy on the left and an astronaut walking next to a boulder.
26. A dune buggy riding around on the surface of the moon.
27. On rare occasions from the Earth, one can see a lunar eclipse where the moon slowly disappears and reappears as it moves in and out of the Earth's shadow. In taking photographs of objects in space, we on Earth are severely limited by the turbulence and thickness of the Earth's atmosphere.
28. The whitish areas on the top and bottom of the planet Mars are called the Martian Icecaps.
29. Here you can see the seasonal changes that take place during the different seasons of the Martian year. The icecaps slowly shrink and grow at different times of the year. Still there is very little detail of the planet itself. Martian probes first circled and then landed on Mars to take the pictures that we usually see in the newspaper and magazines.
30. A picture of Mars taken by Viking I. You can see a tremendous amount more detail including some coloration and cratering on the surface.
31. A much closer photograph of the Martian surface. You can see what appears to be a sinuous channel — the remains of a river on the Martian surface.
32. A close-up of that channel and what looks like minor streams off of that channel. This is thought to be evidence of water once having flowed freely on the Martian surface.
33. The largest known volcano in the solar system — Olympus Mons or Mount Olympus is now completely inactive.
34. Viking II landed on the surface of Mars and tested the soil for life and chemical action. You can see the arms of the Viking Explorer on the surface, collecting the soil.
35. The rock-strewn surface of Mars and the red dust-like soil. It looks like parts of the Earth's desert.
36. A Martian sunset. There is very little air surrounding Mars so we don't get the same coloration as we do on Earth. Also the sun seems a little smaller and a little

dimmer than on the surface of the Earth.

37. Moving away from Mars, we encounter one of the Martian moons. Cratered heavily because of its lack of atmosphere, Phobos is thought to be a captured asteroid, since Mars lies close to the asteroid belt.
38. If we pass through the asteroid belt, even further away from the sun, we approach the largest planet in the solar system, Jupiter. Photographed by the Voyager spacecraft, here we have more detail of Jupiter than previously possible using earth-based telescopes.
39. As we close in on Jupiter, we can see to the left the giant red spot of Jupiter, many different bands and coloration on the planet's surface and also two moons of Jupiter suspended over the giant planet.
40. From only 2.7 million miles away we can see great detail in the surface of Jupiter. We can see clouds swirling about and the giant red spot to the lower right. The spot is thought to be a continuous storm on the surface of Jupiter. There are many theories that try to explain its significance and origin.
41. Passing Jupiter again, we can see tremendous detail on the surface of the planet. Many stars are thought to have planets as large as Jupiter. Many astronomers think that Jupiter is a star which never started its nuclear burning. Its mass was just too small to ignite. It is even surrounded by several moons which are very similar in size and composition to the planets which revolve around the sun.
42. Ganymede, one of Jupiter's moons, and a large crater on its surface.
43. Callisto, another of Jupiter's moons, pockmarked with craters.
44. Europa. Dark lines are apparent on the surface of the moon and are thought to be volcanic in origin. Indeed these moons are very volcanic. Quite a bit of volcanic activity was seen on the Voyager flyby.
45. A close-up of one of the volcanic regions on one of these moons.
46. One of Jupiter's moons, Io, is the most volcanic of Jupiter's moons.
47. A close-up of one volcanic region on Io.
48. Moving further away from the planet Jupiter, we can see the planet Saturn and its well-known rings. Saturn is very similar to Jupiter in structure. In fact, rings have been found around Jupiter and Uranus as well.
49. The rings are actually very thin. Viewed sideways, as in this slide, they disappear.
50. The planet Uranus and its five moons.
51. The planet Neptune. The "spikes" emanating from the planet are artifacts from the telescope that was used to photograph the planet. Usually, Neptune looks perfectly round.
52. The furthest planet from the sun is Pluto. Seen through a 200-inch telescope at the Hale observatory, this slide shows a good view of the planet Pluto.
53. Planets, sun, and moons are not the only members of our solar system. In fact, there are others, including comets. Comets have orbits that go out much further than any of the planets and cyclically return close to the sun after many years.
54. Comets can only be seen easily when they approach the sun and develop tails. This can clearly be seen in this photograph. Comets are thought to be the oldest original members of our solar system and several chemical compounds have been found by spectroscopic methods. For instance, comets contain water and several compounds which are similar to organic compounds here on Earth. It is postulated that perhaps life was formed on Earth after a collision with a comet.

55. This slide demonstrates what you would see if you pointed a camera into space and left the shutter open for several hours. Stars appear as long streaks called polar star trails. The camera that took this photo was pointed at the North Star, which is slightly blurry in the center of the slide.

56. Moving out of our solar system we first encounter individual stars and small groups of stars. This is the Pleiades in the constellation Taurus. This is a group of seven stars visible to the naked eye and several others which can only be resolved by a telescope or binoculars. Several of these individual stars seem surrounded by clouds of dust.

57. In other parts of the sky, one can easily make out star clusters like this one in Perseus.

58. This slide shows a part of the sky in Sagittarius with a very dense distribution of stars. These densely populated areas are parts of arms of our Milky Way Galaxy. All of the stars that we see in the night sky are in the Milky Way Galaxy.

59. The Milky Way in Sagittarius and Scorpio. This is another very dense grouping of stars. In various parts of our galaxy we can see large dense clouds of gas which seem to be lit up as giant incandescent blobs. These clouds of gas actually surround a star or stars and are lit up by the light from that star which is invisible to us.

60. This slide is of the great Orion Nebula, which makes up a bright spot in the sword of Orion. Over the course of time, pieces of this cloud will contract and form new stars which start their solar burning. We have detected several of these in the Orion Nebula.

61. The famous Horsehead Nebula in Orion which is seen very close to Orion's belt. The Horse Head Nebula is a combination of an incandescent gas cloud and dark opaque clouds of gas.

62. In other parts of the sky, we can see remnants of dying or dead stars. In this slide we can see the remnants of an exploded star called the Veil Nebula.

63. Here we can see another remnant of an explosion called the Ring Nebula. There is a very dim star in the center which exploded forming a gaseous ring. Throughout the sky, we see thousands of these nebulae either marking the birth or death of stars.

64. Nebula NGC3312.

65. Nebula In Serpens, M16.

66. The Trifid Nebula in Sagittarius.

67. Another Nebula in Auriga.

68. On the outskirts of our Milky Way Galaxy are several globular clusters of stars which aren't galaxies themselves but are large populous groupings of stars. Here is one called Omega Centauri. If we move farther from the Milky Way, we reach two smaller companion galaxies, the large and small Magellanic Clouds.

69. Here is the Large Magellanic Cloud which can only be seen from the southern hemisphere.

70. Here is the Great Andromeda Galaxy often termed our companion galaxy. It's very similar in size and shape to our Milky Way Galaxy and it is actually very close to us on a galactic scale. Andromedae is only several galactic diameters away from the Milky Way.

71. Here is the central region of Andromeda, also known as M31. The stars we can see in this photograph are all located within the Milky Way Galaxy.

72. Moving even further from our local group of galaxies, we reach galaxies with

very interesting structures that seem to dot the sky. This slide is of a spiral galaxy NGC6946.

73. Galaxies may be of spiral shape, elliptical shape, circular shape, or very irregular shape such as in this slide.
74. This irregular galaxy has very strong radio waves emanating from it which can be picked up by radio telescopes. It is not known what causes the strong signal. Optically, however, there seems to be quite a violent disturbance in the center of this galaxy.
75. This is Galaxy M104 which is seen from all locations edge on. You can see a dark band running around the galaxy. This dark band is a cloud of opaque gas.
76. Galaxies are often found grounded together. This slide shows the whirlpool galaxy and a companion to its left. These two galaxies are thought to have collided causing a trail of stars to stretch out between them.
77. Here is another spiral galaxy with a great deal of detail in it.
78. Shown here are two galaxies which seem to have collided, and a bright streamer of stars that stretches between them. Mathematical models have been made of these galaxies colliding and seem to bear out the theory that they have passed very close to each other and each has disturbed the other's structure.
79. This is a photograph of one of the most distant objects ever seen in our universe. It is a quasar, a very bright quasi-stellar object that is so far away it has taken almost the entire lifetime of our universe to reach us.