



Galileoscope Observing Guide 2018

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Galileoscope Activity Guide

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Introduction to Observing with the Galileoscope

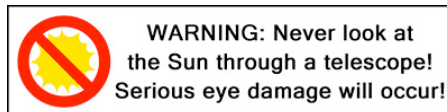
The Galileoscope provides exceptional optical quality for its price. You can explore the night sky and see craters on the Moon, Saturn's rings, Jupiter's moons, star clusters, double stars, and an endless variety of fascinating astronomical objects.



As with any endeavor, you will get better at astronomical observing the more you practice. You will get better at finding objects in the night sky, and you will learn to find objects that are not visible to the naked eye. As you become a more experienced observer, you will notice more detail in the objects you observe. Using the telescope will become second nature!

This guide will lead you through how to observe with the Galileoscope. We will highlight observing the Moon, the phases of Venus, the four Galilean moons of Jupiter, and the rings of Saturn. These are four of the objects that Galileo observed 400 years ago and that led to a revolution in our understanding of the Universe.

One object not to observe is the Sun:



THE GALILEOSCOPE IS NOT A SOLAR TELESCOPE AND SHOULD NEVER BE POINTED AT THE SUN!



Observing Tips and Tricks

The Galileoscope is designed for ease of use. Once the telescope is put together, the only moving part is the focuser. However, you will find your observing experience much more enjoyable if you know a few observing basics before heading out under the night sky. In fact, start using the Galileoscope in the daytime, to familiarize yourself with how to use it.

The View Is Upside Down!

The first thing you will notice about the Galileoscope is the view through the eyepiece is upside down and right and left are reversed. This point of view does not matter for astronomical objects — whether Jupiter is upside down is not a concern. To make the image become upright requires more lenses — and each lens absorbs more light, dimming the image. Therefore astronomers have chosen not to add these lenses, wanting to preserve the maximum amount of light when looking at dim objects.

The Galileoscope Needs a Stable Mount

Because it has high magnification, it needs a tripod to steady the image. The telescope has a special camera thread so it can attach to any photo tripod made anywhere in the world. Without a tripod or an improvised way of holding it steady, the Galileoscope cannot give its maximum performance, except in the frustration department. Even a small table-top tripod is a big improvement over just holding the telescope. Find a tripod! Buy a tripod! This is *so* important!

If a photographic-type tripod is unavailable, the Galileoscope may be steadied against a wall or a post for brief views of the Moon or planets. However, it will perform much better when attached securely to even a crude tripod.

You can attach the Galileoscope to a broom handle or fence post using a bolt put through the handle or post and then attached to the tripod nut on the bottom of the Galileoscope.

A crude, but useful tripod can be constructed from a cardboard box using a method developed by Alan Gould of the Lawrence Hall of Science. The illustration shows how a telescope tube (this picture is of a different type of telescope) would be attached to a box using a bolt going into the box. The box can be put on a table and rotated in azimuth (like a tank turret) by moving the whole box. The telescope can also be pointed at different altitudes or angles above the horizon by rotating the telescope tube around the bolt where it attaches to the box. Looking straight up is never easy though but can be done by placing the box near the edge of a table.



Be Sure to Achieve a Good Focus

If the telescope is not properly focused, it will not produce good images. The Galileoscope can be focused by sliding the eyepiece tube (which holds the eyepiece) in and out of the main tube. Take care not to pull the eyepiece from the focusing tube. For closer objects the focusing tube is extended and pulled out. For objects that are far away the eyepiece tube should be pushed in. Take care not to put your fingerprints on the eyepiece outer lens.

For closer objects, the telescope may not come to a focus. It has been designed to work the best when looking at objects that are very far away — like planets! To play with the focus first aim the telescope at an object that is far away using the sights on the top of the telescope tube.

When you achieve a good focus, stars should appear as sharp points of light. Simply slide the focuser slowly back and forth to find the best focus possible. If you move the focuser too quickly, you may miss the focus point. You can rotate the focus tube while drawing it in and out if that helps make the motion smoother.

The telescope is designed to be used while wearing prescription glasses. (Take off your sunglasses, though.) Most people should leave their glasses on when using the Galileoscope. If you prefer to remove your glasses, that is fine as well. You need to remember that the focus point may be different for different people, especially if they remove their glasses. If someone is slightly nearsighted or farsighted, they may need to adjust the focus.

Start Using Low Magnification

The Galileoscope has a magnification of 25 times (25x) in its default configuration. You can increase the magnification to 50x using the supplied Barlow lens, which fits into the focusing tube, with the eyepiece inserted into the Barlow lens.

Objects are easier to find if you use 25x. The field of view of the telescope is 1.5 degrees with a magnification of 25x. This large field of view makes it easier to find objects in the sky. When you increase the magnification to 50x, the diameter of the field of view is 0.75 degree. This smaller field of view means you are looking at an area of sky only $\frac{1}{4}$ as large in area! When you look at a smaller portion of the sky, it is more difficult to find the object you are looking for.

You should always find the object with low magnification first. Once you have found the object, carefully insert the Barlow lens without moving the telescope. If you accidentally move the telescope while inserting the Barlow, the object may not be in your field of view anymore and you should start over at low power.

Where to Observe

When choosing an observing site always keep safety in mind. Do not use private



property without permission and if you use a public park, be sure to observe park hours and rules.

You will want to find a place that is as dark as possible. At the very least be sure there are no street lights shining directly on you or creating glare. You may contact your local astronomy club for recommendations; they frequently have dark sites for observing or can make recommendations. Often the best site is the most convenient one: your backyard or balcony. As you progress you will want to find observing sites where you do not look over heated buildings, if possible. The hot air rising from buildings may cause the image to shimmer. You will notice if this is a problem because the image will become unsteady. Objects closer to the horizon also suffer from this same effect. Try to be patient and let the object get at least 30 to 45 degrees above the horizon for the best view.

Another important consideration is your view of the horizon. You do not want lots of tall trees or buildings nearby as they restrict your view. You do not want to miss seeing some of the best sights in the sky if a tree or building is in the way!

You also want fairly level ground. A tripod can be adjusted to make up for small bumps, but you want to avoid the side of a steep hill.

Again, your safety is the primary consideration.

Universal Time

Since people observe at different locations all around the world, we need a common time system. This system is called Universal Time (UT) and is based on the time at the Prime Meridian. You need to know your time zone and add or subtract an appropriate number of hours from UT. You may need to adjust for daylight savings time as well.

For the United States, you subtract a certain number of hours from UT depending on which time zone you live in. The chart below shows how many hours to subtract for time zones in the continental U.S.

Time Zone	Standard Time Subtract	Daylight Savings Time Subtract
Eastern	5 hours	4 hours
Central	6 hours	5 hours
Mountain	7 hours	6 hours
Pacific	8 hours	7 hours

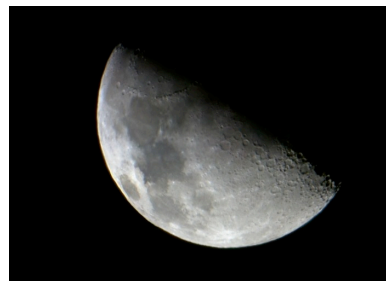
All times for events are given in UT. You might notice that sometimes the full Moon occurs on a different day than listed in the chart. Remember the date of the full Moon is given in UT which may be a day ahead or behind your time!



Observing the Moon

Introduction

The Moon is a natural observing target. It is large, bright, easy to find, and has lots of interesting details to explore. You can see a wide variety of details including craters, the so-called seas (dark areas called maria), rays, and mountains.



The Moon as seen through the Galileoscope.
(courtesy A. Jaunsen, Norway)

Many people think the best time to observe the Moon is when it is full. When the Moon is full, the Sun is high in the sky on the surface of the Moon. Therefore, the shadows cast by craters and mountains are small and details are hard to see. The Moon is considered best to observe near first quarter or last quarter. At first quarter the Moon rises near noon and is high in the sky at sunset — a convenient time to observe. The Moon can also be observed in the daytime at certain phases. However, the Moon is better observed at night or at sunrise or sunset.

Most major newspapers list the phase of the Moon as well as when it rises and sets each day. Online sources include *Sky & Telescope* magazine (www.skyandtelescope.com) or *Astronomy* magazine (www.astronomy.com). You can run a free planetarium program on your computer called *Stellarium* (www.stellarium.org) that will give you the Moon's rise and set times for any day.

Moon Phases For 2018

The following chart gives the dates for New Moon, First Quarter Moon, Full Moon, and Third Quarter Moon for 2018 (all dates are in Universal Time).

Month	New Moon	First Quarter	Full Moon	Third Quarter
January	17	24	2,31	8
February	15	23	NA	7
March	17	24	1, 31	9
April	16	22	30	8
May	15	21	29	7
June	13	20	27	6
July	12	19	27	6
August	11	18	26	4
September	9	16	24	2
October	8	16	24	2
November	7	15	22	29



December	7	15	22	29
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Moon Conjunctions

The Moon frequently has nice encounters with planets which can be very pretty visually as well as photographically. However, it is very rare that the Moon is close enough in the sky to a planet to see them both in the field of view of the Galileoscope.

Timing is important when viewing conjunctions with the Moon. The Moon moves about one half degree per hour (about the same as the Moon's diameter). For example, if you view a conjunction eight hours after the time listed below, the Moon will have moved four degrees in that time. Some of the better conjunctions for 2018 are listed below.

January 11, 6UT: Jupiter is 4 degrees south of the Moon

January 11, 10UT: Mars is 5 degrees south of the Moon

January 15, 2UT: Saturn is 3 degrees south of the Moon

January 15, 7UT: Mercury is 3 degrees south of the Moon

February 7, 16UT: Jupiter is 4 degrees south of the Moon

February 9, 5UT: Mars is 4 degrees south of the Moon

February 11, 15UT: Saturn is 2 degrees south of the Moon

March 7, 7UT: Jupiter is 4 degrees south of the Moon

March 10, 1UT: Mars is 4 degrees south of the Moon

March 11, 2UT: Saturn is 2 degrees south of the Moon

March 18, 19UT: Venus is 4 degrees north of the Moon

April 3, 14UT: Jupiter is 4 degrees south of the Moon

April 7, 13UT: Saturn is 1.9 degrees south of the Moon

April 7, 18UT: Mars is 3 degrees south of the Moon

April 14, 9UT: Mercury is 4 degrees north of the Moon

April 17, 19UT: Venus is five degrees north of the Moon



April 30, 17UT: Jupiter is 4 degrees south of the Moon
May 4, 20UT: Saturn is 1.7 degrees south of the Moon
May 6, 7UT: Mars is 3 degrees south of the Moon
May 13, 7UT: Mercury is 2 degrees north of the Moon
May 17, 18UT: Venus is 5 degrees north of the Moon
May 27, 18UT: Jupiter is 4 degrees south of the Moon
June 1, 1UT: Saturn is 1.6 degrees south of the Moon
June 3, 12UT: mars is 3 degrees south of the Moon
June 16, 13UT: Venus is 2 degrees north of the Moon
June 23, 19UT: Jupiter is 4 degrees south of the Moon
June 28, 4UT: Saturn is 1.8 degrees south of the Moon
July 1, 2UT: Mars is 5 degrees south of the Moon
July 14, 22UT: Mercury is 2 degrees south of the Moon
July 16, 4UT: Venus is 1.6 degrees south of the Moon
July 21, 0UT: Jupiter is 4 degrees south of the Moon
July 25, 6UT: Saturn is 2 degrees south of the Moon
August 14, 14UT: Venus is 6 degrees south of the Moon
August 17, 11UT: Jupiter is 5 degrees south of the Moon
August 21, 10UT: Saturn is 2 degrees south of the Moon
September 14, 2UT: Jupiter is 4 degrees south of the Moon
September 17, 16UT: Saturn is 2 degrees south of the Moon
September 20, 7UT: Mars is 5 degrees south of the Moon
October 11, 21UT: Jupiter is 4 degrees south of the Moon



October 15, 3UT: Saturn is 1.8 degrees south of the Moon

October 18, 3UT: Mars is 1.9 degrees south of the Moon

November 11, 16UT: Saturn is 1.5 degrees north of the Moon

November 16, 4UT: Mars is 1 degrees north of the Moon

December 3, 19UT: Venus is 4 degrees south of the Moon

December 5, 21UT: Mercury is 1.9 degrees south of the Moon

December 9, 5UT: Saturn is 1.1 degrees south of the Moon

December 14, 23UT: mars is 4 degrees north of the Moon

Lunar Eclipses

After only partial lunar eclipses in 2017, 2018 features two total lunar eclipses. You can watch the Moon turn a deep shade of orange or red during totality. Given the spacing of the two eclipses on the Earth, almost everyone on Earth will be able to enjoy at least one of the two total lunar eclipses this year!

The first total lunar eclipse of the year occurs on January 31. The penumbral phase begins at 10:51UT. The partial eclipse starts at 11:48UT with totality beginning at 12:51UT. Totality lasts until 14:07UT, the partial phases end at 15:11UT and the penumbral eclipse ends at 16:08UT. The eclipse occurs early in the morning at Moonset for most of North America. The entire eclipse will be visible from very northwestern Canada and Alaska, the Pacific, New Zealand, most of Australia, most of China and Russia. The eclipse will be visible at Moonrise eastern Europe and eastern Africa. Look for the Beehive Cluster about three degrees north of the Moon during this eclipse!

The second total lunar eclipse of 2018 occurs on July 27. The penumbral eclipse starts at 17:14UT followed by the partial eclipse at 18:24UT. Totality lasts from 19:30UT until 20:13UT. After totality, the partial phases last until 22:19UT and the penumbral eclipse until 23:28UT. This eclipse is centered over the Indian Ocean. Australia, China, the Pacific islands, China and most of Russia see the eclipse at Moonset. India, eastern Europe and eastern Africa see the entire eclipse. Western Europe, western Africa and most of South America see the eclipse at Moonrise. This eclipse is not visible in North America.

Surface Features

Craters

Most people notice craters when they look at the Moon. The largest craters are hundreds



of miles across. Craters have raised walls. Craters on the Moon are formed by meteoroid impacts. Since the Moon has no erosion processes, craters can last for billions of years. Very large craters frequently have what is called a central peak. When a large meteoroid strikes the Moon, it compresses the surface. The surface rebounds and forms a peak in the middle of the crater. When a crater is near the terminator (the dividing line between the dark and light areas of the Moon, where the Sun is either rising or setting), you can sometimes see a lighted central peak while the floor of the crater is dark. Using simple geometry and the length of shadows allows the height of these central peaks to be calculated.

Maria

Maria are also called seas. Maria appear as large dark areas on the Moon. They were originally thought to be oceans but are now known to be ancient lava flows. Maria are younger than other parts of the Moon's surface and have few craters. The near side of the Moon has several large maria that you can see labeled on the map on the next page.



Solar Eclipses

After the Great American Eclipse of 2017, 2018 features three partial solar eclipses (the next total solar eclipse in 2019 will be visible from the south Pacific, Chile and Argentina).

The first partial solar eclipse of 2018 takes place on February 15th. This solar eclipse is only visible from the southern oceans, southern South America and much of Antarctica. The point of greatest eclipse is on Antarctica where about 60% of the Sun will be covered.

The second partial eclipse of 2018 takes place on July 13th. This eclipse will also be difficult to observe as it is mostly visible from the southern ocean between Australia and Antarctica. People in very southern Australia and the coast of Antarctica will see a very small partial eclipse.

The final partial eclipse of 2018 takes place on August 11. This eclipse is visible from northern Europe, Greenland, northeastern Canada, and northern and eastern Russia. Up to 73% of the Sun will be covered by the Sun with maximum eclipse just off the coast of Russia in the Arctic Ocean.

Solar eclipses are not safe to view with the naked eye during their partial phases. Be sure you are using eclipse glasses or a full aperture solar filter if you are using a telescope or binoculars. The plastic eyepiece makes the Galileoscope unsuitable for solar projection. However, you can build a Sun Funnel for the Galileoscope. For instructions on how to build a Sun Funnel, see <http://transitofvenus.org/june2012/eye-safety/293-build-a-sun-funnel-for-group-viewing-with-a-telescope> (the Sun Funnel is also useful for observing the Transit of Venus in June so this is a great year to build one!) The Sun Funnel can be used on any telescope that accepts a 1.25" eyepiece.



NASA has an interactive map you can use to find the extent of the eclipse and times at <http://eclipse.gsfc.nasa.gov/eclipse.html>



Observing Venus

Introduction

Venus is the second brightest object in the night sky. Since it orbits closer to the Sun than the Earth, Venus is always visible either before sunrise or after sunset, except for short periods of time when it is in the same direction as the Sun.

Venus orbits about 67 million miles from the Sun (compared to Earth's 93 million mile orbit) and is very close to the same size as Earth. The similarities end there. Venus has a very thick atmosphere with a pressure 90 times that of the surface of the Earth. Clouds hide its surface from our view. Its temperature rises to almost 900 degrees Fahrenheit due to a runaway greenhouse effect. Venus is very inhospitable to life.

Observing Venus

Although surface features are not visible due to the cloud cover, Galileo made an important observation of Venus. He observed that Venus goes through phases just like our Moon. Galileo also noticed substantial differences in the size of the disk of Venus through his telescope at different times in its orbit. These two pieces of information led him to the conclusion that Venus and the Earth orbited the Sun.

You will need to observe Venus over the course of several weeks to see the changes take place. If Venus is in the evening sky, you will notice its disk goes from full, to half lit, to a slender crescent. During this time you will notice Venus increases in size as it approaches Earth. Then it appears very close to the Sun and is lost in the glare.



The phases of Venus. Image credit Stasis Kalyvas.

In the morning sky, the process is reversed. Venus will start off as a large crescent and shrink to a half lit disk and shrink further as it becomes full and gets closer to the Sun in direction. Then as it gets to the full phases it passes behind the Sun and becomes invisible. Venus is moving away from us when we see it in the morning sky.

Make sketches of Venus over time. Be sure to sketch its size relative to the field of view of your telescope so you can see the changes in size as well as the phases.



Venus in 2018

Venus is always very bright and easy to identify when it is visible in the sky. Since it orbits closer to the Sun, it is always visible either after sunset or before sunrise. In fact due to the orbit of Venus inside the orbit of the Earth Venus is restricted to being within 47 degrees of the Sun. So a bright object farther than this in its angle to the Sun is not Venus.

Venus starts 2018 on the far side of the Sun and passes through superior conjunction on January 9. Later in January, Venus will appear very low in the evening sky after sunset getting a little higher each evening. See how soon you can spot it! Venus will dominate the western sky after sunset for much of the year and have nice monthly pairings with the Moon (see the Moon section for a table listing these). On March 29th Venus and Uranus pass very close together and will be visible in the Galileoscope at the same time!

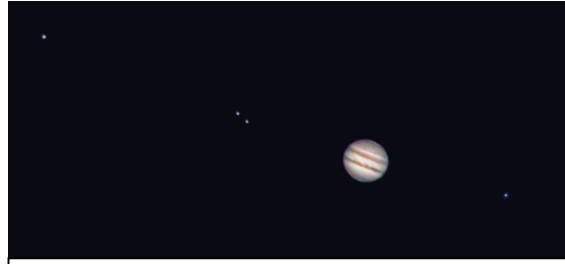
Venus will sink back toward the Sun in September and October until it passes through inferior conjunction on October 26. In the following weeks, Venus will reappear in the morning sky where it closes out 2018.



Observing Jupiter

Introduction

Jupiter is the largest of the planets and always appears very bright in the sky when it is visible. Jupiter is one of the most impressive sites in a small telescope and shows a variety of details to the patient observer.



Jupiter and the Galilean Moons. Image Credit Don Waid.

Jupiter is about 88,000 miles in diameter and orbits almost 500 million miles from the Sun. It is a gas giant that does not have a solid surface. Jupiter's atmosphere has distinctive cloud bands and the Great Red Spot, a storm over twice the diameter of the Earth that has been raging for over 300 years.

Observing

Jupiter is easy to find as it is one of the brightest objects in the sky. You can find its position from various sources (see the Observing Resources section). Jupiter is easily visible to the naked eye.

The first thing that people notice through a telescope are the four Galilean Moons. You may only see three (or even two on rare occasions) if one or more of the Moons is either directly in front of or directly behind the planet. The Moons all orbit in the same plane so they usually lie very close to a straight line.

The four Galilean Moons are, in order from nearest to farthest from Jupiter, Io, Europa, Ganymede, and Callisto. Io orbits the fastest of the Moons taking a little under 2 days to orbit the planet. Callisto takes almost two weeks to complete one orbit. You can watch the Moons change position in as little as a couple of hours over the course of a night.

Sometimes you can see one of the Moons cast a shadow on Jupiter. The shadow will move across the face of Jupiter as the Moon orbits. Predictions for when you can see shadows transit Jupiter are available online (see the *Observing Resources* section).

Look closely at the disk of Jupiter. Most people quickly notice the bands across the equator of the planet. These are Jupiter's equatorial bands. If you look carefully and the air is steady (the "seeing" is good), you may see other bands as well.

The Great Red Spot is difficult to see with the Galileoscope, but is worth pursuing. The Great Red Spot is a large storm on the surface of Jupiter that has been raging for at least 300 years. The diameter of the Great Red Spot is over twice the diameter of Earth! Use your favorite observing program to be sure the Great Red Spot is visible and not on the other side of the planet. You may want to use a Barlow lens or higher magnification



eyepiece when you attempt to find the Great Red Spot. The Great Red Spot changes color and is currently rather pale, more salmon colored than red. Check observing reports on the internet as it may change back to a deeper red at any time!

You may notice that Jupiter does not appear perfectly round but rather has a squished appearance. Jupiter rotates on its axis very quickly (under 10 hours at the equator). Its rapid rotation causes a bulge at the equator that is visible in small telescopes. Can you see the elongated shape of Jupiter?

Jupiter in 2018

Jupiter begins the year in the morning sky. Be sure to check out its close encounter with Mars before sunrise on January 6th! Jupiter spends most of the year in Libra. It will rise earlier each night as Earth catches up to Jupiter in their orbits around the Sun. Jupiter reaches opposition on May 9th when it will be closest to Earth for the year. Jupiter will be relatively low in the southern sky during this opposition so try to observe when Jupiter is at its highest. On this date, Jupiter will rise at sunset and be visible all night long. Jupiter remains a fine evening target for observing for several months after opposition.

By fall Jupiter will be getting progressively lower in the southwest at sunset so look before it passes behind the Sun! Jupiter will be lost to view sometime in late October and pass behind the Sun on November 26th. Late in December you may catch Jupiter rising shortly before the Sun in the morning sky.

Observing Saturn

Introduction

Saturn is one of the most beautiful sites in a small telescope. Its rings never cease to captivate even seasoned observers. Although the rings appear impressive, they are made up of rocks and ice. The rings are only a few hundred meters thick, but they are made of very reflective material so they appear bright.

Saturn has a bright satellite called Titan which is also easily visible. Titan is the second largest satellite in the solar system and the only moon known to have a thick atmosphere. The pressure at the surface of Titan is 50% greater than Earth's atmospheric pressure!

Observing

Saturn is typically fairly bright and easy to pick out with the naked eye even when it is far from Earth. Consult the *Observing Resources* section for various computer programs and web sites that will provide you with Saturn's location on a given day.

Once you have a well-focused image of Saturn, look for its rings. They should be just visible at 25x in the Galileoscope. If you have the Barlow lens, use it to increase the magnification (or you can use any standard 1.25" telescope eyepiece). At higher



magnification, you may see the Cassini Division in the rings. The Cassini Division is a gap in the rings and will show up as a dark band. Surface details on Saturn are usually difficult to detect through a small telescope. The bands and zones are very pale and have low contrast.

Saturn's largest Moon, Titan, is an easy observing target. Titan orbits Saturn once about every 16 days. You can find Titan's position by consulting the Observing Resources section. Unlike Jupiter's Moons, Titan's shadow is rarely visible on Saturn due to the presence of the rings. Only when the rings are nearly edge on (as they were in 2009) can you hope to see Titan's shadow on Saturn.

Saturn in 2018

Saturn starts 2018 low in the eastern sky before sunrise in Sagittarius. Last year we passed the maximum ring opening (when the rings are most prominent) but they are still very good in 2018. Look for a close conjunction with Mercury on the morning of January 13th before sunrise. Saturn comes to opposition on June 27th when it is closest to Earth for the year and visible from sunrise to sunset. Saturn is fairly low in the southern sky during this opposition so try to observe when it is highest in the sky.

Saturn will be getting difficult to observe late in October as it will be very low in the southwest after sunset. Saturn will pass on the other side of the Sun on New Year's Day, 2019.

Saturn's brightest Moon, Titan, is frequently visible through the Galileoscope. You can use a program such as Stellarium (www.stellarium.org) to find its position relative to Saturn to be sure you are seeing this large Moon. In very dark sites, I have spotted three other moons of Saturn with the Galileoscope: Rhea, Tethys and Dione. However, these are challenging and require excellent observing conditions.



Other Planets

Mercury

Mercury undergoes phases like Venus. However, Mercury is much smaller and farther away from the Earth so they are more difficult to observe. Mercury never gets more than 28 degrees in angle from the Sun. This means that it is always close to the western horizon after sunset in the evening sky or close to the eastern horizon before sunrise. Like Venus, Mercury is brightest and most interesting when it is in a crescent phases. The best time to see it is just after sunset or just before sunrise. You will never see Mercury in the middle of the night or even a few hours after sunset.

Consult the *Observing Resources* section for information on how to find Mercury.

Mercury is always close to the Sun either in the morning or evening. To find Mercury, go out near the night (or morning) of greatest elongation. You can usually only see Mercury well a few days before or after these dates.

Evening Appearances in 2018: March 15, July 12, November 6

Morning Appearances in 2018: January 1, April 29, August 26, Decembr 15

Not all appearances of Mercury are created equal. Mercury has an elliptical orbit so it is farther from the Sun during some appearances than others. You also have to take into account the angle the ecliptic makes with the horizon to see how high Mercury will be in the sky. The ecliptic is steep to the horizon in the evening in the spring for the northern hemisphere. The April 1st evening appearances is well positioned for northern hemisphere observers. The September 12th appearance will mark the best chance to see Mercury in the morning sky for northern hemisphere observers.

There is a story that Copernicus never saw Mercury and expressed this regret on this deathbed. Don't let this happen to you!

Mars

Mars captures the public imagination. When it shines brightly in the sky, it has a distinctive reddish color that stands out in the night sky.

Mars is only half the diameter of the Earth, however. Even when it gets close to Earth (as it does about once every two years when it is at opposition) it is still a small planet (compared to Jupiter, for example) appears small in a telescope. You can tell that Mars (or any planet) is at opposition as this always occurs when Mars rises near sunset (Investigation for you: Why?)

Mars will have a very favorable opposition in 2018. Mars has an elliptical orbit so it



distance from Earth at opposition can vary greatly. In 2018, Mars will have its best opposition since 2003 as it is near perihelion (it's closest point to the Sun) and hence will be significantly closer to Earth than average so it will appear brighter in the night sky and larger through telescopes.

Mars begins 2018 in the morning sky and will have a close encounter with Jupiter on the morning of January 6th although they will still be close on the 7th as well. Mars begins the year in Libra and then passes through Scorpius, Ophiuchus and Sagittarius on its way to opposition in Capricorn on July 27th. The best time to observe Mars is about a month before and after opposition when its size will be above 20 arc seconds. Mars is still small in a telescope and you may want to practice using the Galileoscope with the Barlow lens to achieve a magnification of 50x.

Uranus and Neptune

Uranus and Neptune are not visible to the naked eye but you can see them with the Galileoscope. The difficult part is pointing the telescope at the right part of the sky.

You will not see any surface detail on these distant planets as they appear small even through relatively large amateur telescopes. Consult the *Observing Resource* section for information on how to find Uranus and Neptune on where to find detailed finder charts.

Uranus and Neptune move very slowly relative to the background stars due to their great distances. Their brightnesses and relative sizes vary significantly less than those of the inner planets as the distance between Earth and the planet changes. Therefore, you can pretty much try to observe them whenever they are easily visible in the sky and you do not have to wait for opposition to get the best view. However, near opposition is still a convenient time to observe since Uranus and Neptune are visible all night long.

Uranus starts the year in Pisces and is well positioned for evening observing. Be sure to check out Uranus on March 29th when it passes very close to Uranus and they will both be visible in the Galileoscope at the same time! Shortly after this conjunction, Uranus will be lost in the Sun's glare as it passes on the far side of the Sun on April 18 and returns to the morning sky a few weeks later. Uranus comes to opposition on October 23rd in Aries when it will be visible all night.

Neptune is in Aquarius and positioned for early to mid-evening observations at the start of 2018 but look quick because it quickly gets lower in the sky each evening and comes to solar conjunction on March 4th. Several weeks later, you can catch Neptune low in the morning sky and it will get higher each day and become easier to see in early summer. Mars comes to opposition on September 7th. On December 7th, Mars and Neptune have a very close encounter and will be visible in the Galileoscope at the same time!

Pluto is too faint to be seen with the Galileoscope.



Conjunctions and Other Sky Events

Since all the planets orbit the Sun fairly close to the same plane, you can frequently see planets pass fairly close to each other and/or the Moon in the night sky. These events are called conjunctions. Conjunctions can be very rewarding to observe as you watch the planets move relative to each other through the night sky. Frequently no telescope is required to see these celestial events.

Here are some of the more notable between two or more planets in 2018 (for events involving the Moon, see the Moon section).

January 7, 4UT: Mars is 0.2 degrees south of Jupiter

January 13, 7UT: Mercury is 0.6 degrees south of Saturn

March 5, 18UT: Mercury is 1.4 degrees north of Venus

March 29, 0UT: Venus is 0.07 degrees south of Uranus

April 2, 12 UT: Mars is 1.3 degrees south of Saturn

May 12, 21UT: Mercury is 2 degrees south of Uranus

October 30, 4UT: Mercury is 3 degrees south of Jupiter

December 7, 15 UT: Mars is 0.04 degrees north of Neptune

December 21, 15UT: Mercury is 0.9 degrees north of Jupiter



Other Objects

The Pleiades

Galileo observed the Pleiades star cluster, and it is a lovely sight. Your Galileoscope was designed to give you a view of nearly this entire group of stars, which is also known as the Seven Sisters.

The Pleiades are visible to the naked eye even with moderate light pollution. They are best viewed from late fall to early spring. Many people mistake the Pleiades for the Little Dipper. The Pleiades do have a shape similar to a small dipper, but they are not near the North Star and are much smaller than the Little Dipper.

Observing the Pleiades through the Galileoscope will reveal many more stars than you can see visually. Use 25x when observing the Pleiades with the Galileoscope for the best view. The larger field of view allows you to see most of the cluster at one time and will be much more impressive than if you use higher magnification.

The Pleiades are an open cluster. They are young hot stars that were all born about the same time from the same cloud of gas and dust.

The Orion Nebula

Galileo looked at the Orion Nebula, and you can too. The nebula is easily found in the sword of Orion. Orion is best viewed during the winter months from late November through late March.

Note the color of the nebula (gray, perhaps with a slight greenish tinge) and the small pattern of stars in the center. At 50x, you may be able to see the four stars at the center called the Trapezium (look closely!). Take your time and look at the intricate patterns present in the gas cloud.

Orion is a stellar nursery — astronomers have observed new stars being born here from this giant cloud of gas and dust. It is relatively nearby...about 1,200 light-years away. As the nearest large star-forming region, the Orion Nebula is a subject of intensive study by professional astronomers.

The Milky Way

The Milky Way is best observed from a dark site. In the summer, you can see the Milky Way starting in the south and stretching high into the sky. You are looking toward the center of our galaxy and see the band of light formed by countless distant stars.

The Galileoscope will reveal many of these stars. Simply scan up and down the Milky Way slowly. You will find many star clusters as well as nebula (star forming regions). You can consult the *Observing Resources* section for information on specific objects



visible in the Milky Way.

Recording Your Observations

You may wish to keep track of your observations. It can be gratifying to see the list of object you have found and observed grow. Recording details of your observations let you see how your observing skills grow and improve over time.

Many observing logs have a place to make a sketch of your object. A circle represents the field of view of your eyepiece. Try to sketch your object to scale. If it covers half of your eyepiece field of view, it should cover half the circle in your observing log.

The next page has a sample observing log you can print out and use to record your observations.



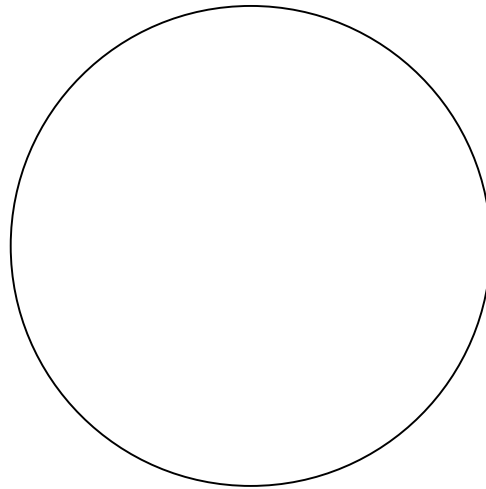
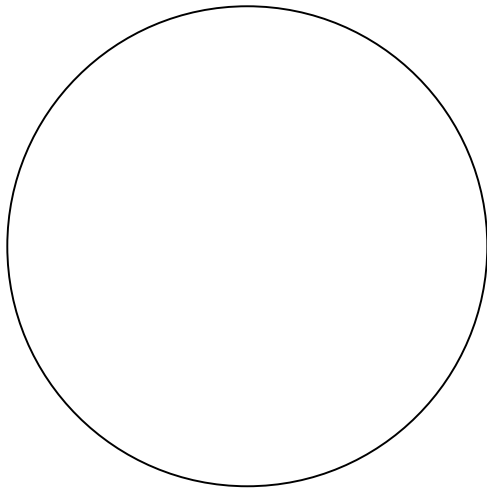
Observing Log

Observer	_____	Object	_____
Date	_____	Constellation	_____
Time	_____	Telescope	_____
Location	_____	Magnification(s)	_____

Field Drawing

LOW-POWER VIEW

HIGH-POWER VIEW



OBSERVING NOTES AND COMMENTS



Observing Resources

There are many good observing resources available online. Here are some of the best free web sites and programs.

Sellarium: <http://www.stellarium.org/>

Stellarium is a free open source planetarium program. It is available for Windows, Mac OS X, and Linux. Stellarium allows you to input your location, date and time and see what objects are visible in the night sky.

WorldWide Telescope: <http://www.worldwidetelescope.org/Home.aspx>

Microsoft's WorldWide Telescope is a powerful program that allows you to explore the night sky. It can function as a traditional planetarium program but allows you to call up astronomical images from a variety of sources and create you own tours of the night sky. It is currently only available for Windows, but a web-based version is coming soon.

Google Sky: <http://www.google.com/sky/>

Google Sky is an extension of Google Earth that will function as a planetarium program in addition to allowing you to access images and data on astronomical objects. Clicking on any object brings up information on the object and links to images. You can see the night sky as it appears from anywhere on Earth.

Virtual Moon Atlas: <http://www.ap-i.net/avl/en/start>

The Virtual Moon Atlas is a free computer program that shows that allows you to make highly detailed maps of the Moon to assist in observations. You can find the phase of the Moon as well as rise and set times. You can find features by name and determine the best time to observe different features on the Moon. Available for Windows and OS X.

Sky Charts: <http://www.stargazing.net/astrovc/index.html>

Sky Charts is a free planetarium program available for Windows. Once you enter your location and time, you can see what is visible in the night sky to help you plan your observations.

Uncle Al's Sky Wheel: <http://www.lhs.berkeley.edu/starclock/skywheel.html>

Uncle Al's Sky Wheel is a free printable planisphere. Once assembled, this sky chart can be set to help you find the constellations at any time of night for any night of the year. Sky Wheels are very useful if you are you are observing and do not have access to a computer at your observing site.

Heavens Above: <http://www.heavens-above.com/>

Heavens Above is best known for its predictions of visible satellite passes. This site also has information on visible comets, the Moon and the planets to help you determine what is visible in the night sky. You can find rise and set times as well as locations for all the major planets and bright comets.



Spaceweather.com: <http://www.spaceweather.com/>

Spaceweather focuses on the Sun, sunspots, and northern lights. Spaceweather posts information on planetary conjunctions and posts pictures from amateur and professional astronomers around the world. They frequently highlight upcoming conjunctions in the night sky.

Sky & Telescope: <http://www.skyandtelescope.com/>

Sky & Telescope magazine's website is a good repository for news as well as observing information. They have sky charts, observing tips and tricks as well as a wealth of astronomy news.

Astronomy: <http://www.astronomy.com/>

Astronomy magazine covers astronomy news as well as provides observing information. You can access sky charts, product reviews, breaking news, sky charts and a wide variety of observing tips.

Astronomy Cast: <http://www.astronomycast.com/>

One of the most popular and well produced astronomy podcasts on the web intended for a general audience. Topics cover all areas of astronomy and you can search the catalog of podcasts by topic. The popular question shows allow listeners to send in their own questions to be answered.

Juplet: <http://www.shallowsky.com/jupiter.html>

The "Juplet" will plot the positions of Jupiter's four Galilean Moons for a given date and time. This applet is extremely easy to use. You can identify which of the Moons will be visible and their precise location.

Jupiter's Moons Javascript Utility:

<http://www.skyandtelescope.com/observing/objects/javascript/3307071.html#>

This more powerful applet will also predict when you can see satellite shadows cross the face of Jupiter. In addition to a map of the positions of the Moon, it provides a narrative of major events such as show transits and eclipses with start and end times.

Saturn's Moons Javascript Utility:

<http://www.skyandtelescope.com/observing/objects/planets/3308506.html>

This online tool allows you to find the position of Saturn's moons on any given night and time. The applet will match the view as seen through your telescope, reversing and inverting the image as appropriate for your optical system.

You Are Galileo:

<http://www-irc.mtk.nao.ac.jp/~webadm/Galileo-E/index.php>

You are Galileo, developed by the National Observatory of Japan, focuses on students recreating Galileo's historic observations. It includes observing guides and logs for several objects. Students can make observations and send them in to receive observing certificates.

