



## Galileoscope Observing Guide 2017

**Stephen M. Pompea and Robert T. Sparks**  
National Optical Astronomy Observatory  
Tucson, Arizona USA  
Version 1.0



NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation





# Galileoscope Activity Guide

## Table of Contents

### Table of Contents

<b>INTRODUCTION TO OBSERVING WITH THE GALILEOSCOPE</b>	<b>4</b>
<b>THE GALILEOSCOPE IS NOT A SOLAR TELESCOPE AND SHOULD NEVER BE POINTED AT THE SUN!</b>	<b>4</b>
<b>OBSERVING TIPS AND TRICKS</b>	<b>5</b>
<b>OBSERVING THE MOON</b>	<b>8</b>
<b>SOLAR ECLIPSES</b>	<b>14</b>
<b>OBSERVING VENUS</b>	<b>15</b>
<b>OBSERVING JUPITER</b>	<b>16</b>
<b>OBSERVING SATURN</b>	<b>18</b>
<b>OTHER PLANETS</b>	<b>20</b>
<b>CONJUNCTIONS AND OTHER SKY EVENTS</b>	<b>22</b>
<b>OTHER OBJECTS</b>	<b>23</b>
<b>RECORDING YOUR OBSERVATIONS</b>	<b>24</b>
<b>OBSERVING LOG</b>	<b>25</b>
<b>OBSERVING NOTES AND COMMENTS</b>	<b>25</b>
<b>OBSERVING RESOURCES</b>	<b>26</b>



This work was supported by a grant from the National Science Foundation to the American Astronomical Society for coordination of the International Year of Astronomy 2009.

NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation.

For Suggestions and Comments Please Contact:

Dr. S. Pompea

Manager of Science Education

U.S. Project Director, International Year of Astronomy 2009

NOAO, 950 N. Cherry Avenue, Tucson AZ 85719 USA

[spompea@noao.edu](mailto:spompea@noao.edu)



# Introduction to Observing with the Galileoscope

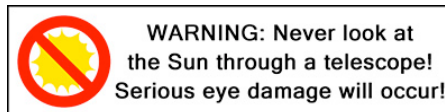
The Galileoscope provides exceptional optical quality for its price. You can explore the night sky and see craters on the Moon, Saturn's rings, Jupiter's moons, star clusters, double stars, and an endless variety of fascinating astronomical objects.



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.

<b>Time Zone</b>	<b>Standard Time Subtract</b>	<b>Daylight Savings Time Subtract</b>
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](http://www.skyandtelescope.com)) or *Astronomy* magazine ([www.astronomy.com](http://www.astronomy.com)). You can run a free planetarium program on your computer called *Stellarium* ([www.stellarium.org](http://www.stellarium.org)) that will give you the Moon's rise and set times for any day.

## Moon Phases For 2017

The following chart gives the dates for New Moon, First Quarter Moon, Full Moon, and Third Quarter Moon for 2017 (all dates are in Universal Time).

Month	New Moon	First Quarter	Full Moon	Third Quarter
January	28	5	12	19
February	26	3	10	18
March	27	5	12	20
April	26	3	10	19
May	25	2	10	18
June	23	1,30	9	17
July	23	30	8	16
August	21	29	7	14
September	19	27	6	12
October	19	27	5	12
November	18	26	3	10





December	17	26	3	10
----------	----	----	---	----

### **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 2017 are listed below.

January 2, 9UT: Evnus is 1.9 degrees south of the Moon

Jauary 3, 4UT: Neptune is 0.4 degrees south of the Moon

January 3: 7UT: Mars is 0.2 degrees south of the Moon

January 9, 15UT: Aldebaran is 0.4 degrees south of the Moon

January 19, 5T: Jupiter is 3 degrees south of the Moon

January 24, 10UT: Saturn is 4 degrees south of the Moon

Jnauary 26, 1UT: Mercury is 4 degrees south of the Moon

January 30, 11UT: Neptune is 0.2 degrees south of the Moon

January 31,15UT: Venus is 4 degrees north of the Moon

February 1, 1UT: Mars is 2 degrees north of the Moon

Ferbruary 5, 22UT: Aldebaran is 0.2 degrees south of the Moon

February 15, 15UT: Jupiter is 3 degrees south of the Moon

February 20, 23UT: Saturn is 4 degrees south of the Moon

March 1, 19UT: Mars is 4 degrees north of the Moon

March 5, 3UT: Adlebaran is 0.2 degree south of the Moon

March 14, 20UT: Jupiter is 2 degrees south of the Moon



March 20, 10UT: Saturn is 3 degrees south of the Moon  
March 26, 8UT: Neptuen is 0.005 degrees north of the Moon  
April 1, 9UT: Aldebaran is 0.3 degrees south of the Moon  
April 10, 21UT: Jupiter is 2 degrees south of the Moon  
April 16, 18UT: Saturn is 3 degrees south of the Moon  
April 22, 20UT: Neptune is 0.2 degrees north of the Moon  
April 23, 16UT: Venus is 0.8 degrees south of the Moon  
April 28, 18UT: Aldebaran is 0.5 degrees south of the Moon  
May 7, 21UT: Jupiter is 2 degree south of the Moon  
May 13, 23UT: Saturn is 3 degrees south of the Moon  
May 20, 6UT: Neptuen is 0.5 degrees North of the Moon  
May 22, 13UT: Venus is 2 degrees North of the Moon  
June 4, 0UT: Jupiter is 2 degrees south of the Moon  
June 10, 1UT: Saturn is 3 degrees south of the Moon  
June 16, 14UT: Neptune is 0.7 degrees north of the Moon  
June 20, 21UT: Venus is 2 degrees north of the Moon  
June 22, 15UT: Aldebaran is 0.5 degrees south of the Moon  
July 1, 7UT Jupiter is 3 degrees south of the Moon  
July 7, 3UT: Saturn is 3 degrees south of the Moon  
July 20, 11UT: Venus is 3 degrees north of the Moon  
July 25, 9UT: Mercury is 0.9 degrees south of the Moon  
August 3, 7UT: Saturn is 3 degrees south of the Moon  
August 19, 5UT: Venus is 2 degrees north of the Moon



August 25, 13UT: Jupiter is 3 degrees south of the Moon  
August 30, 14UT: Saturn is 4 degrees south of the Moon  
September 18, 1UT: Venus is 0.5 degrees north of the Moon  
September 18, 20UT: Mars is 0.1 degrees south of the Moon  
September 18, 23UT: Mercury is 0.03 degrees north of the Moon  
September 22, 8UT: Jupiter is 4 degrees south of the Moon  
September 27, 0UT: Saturn is 3 degrees south of the Moon  
October 17, 10UT: Mars is 1.8 degrees south of the Moon  
October 18, 0UT: Venus is 2.0 degrees south of the Moon  
October 24, 12UT: Saturn is 3 degrees south of the Moon  
November 15, 1UT: Mars is 3 degrees south of the Moon  
November 16, 21UT: Jupiter is 4 degrees south of the Moon  
November 17, 6UT: Venus is 4 degrees south of the Moon  
November 20, 9UT: Mercury is 7 degrees south of the Moon  
November 21, 0UT: Saturn is 3 degrees south of the Moon  
December 13, 16UT: Mars is 4 degrees south of the Moon  
December 14, 14UT: Jupiter is 4 degrees south of the Moon  
December 14, 19UT: Venus is 0.2 degrees north of the Moon

### **Lunar Eclipses**

There are not total lunar eclipses in 2017 but there is a penumbral lunar eclipse on February 11 and a partial lunar eclipse on August 7. In a penumbral eclipse, the Moon never passes through the darkest part (umbra) of Earth's shadow. The Moon may appear slightly dimmed and become slightly more yellow during a penumbral eclipse. The effect is subtle and many people will not notice a penumbral eclipse unless they are watching carefully. In a partial lunar eclipse, only a portion of the Moon is covered by the dark



umbra of Earth's shadow. It is easily observed with the naked eye or telescope.

The February 11<sup>th</sup> penumbral eclipse starts at 22:23UT with greatest eclipse at 00:43UT and 2:53UT. The entire eclipse is visible from Africa, Europe, western Asia and far eastern South America and far eastern Canada. The eclipse is in progress at sunrise for most of North America and South America and at sunset for most of Asia. The eclipse is not visible from Australia and the south Pacific.

The penumbral phase of the August 7<sup>th</sup> lunar eclipse begins at 15:50UT while the partial phase begins at 17:22UT. Maximum eclipse occurs at 18:20UT, the partial phase ends at 19:18UT and the penumbral phase ends at 20:51UT. About 25% of the Moon will be covered by Earth's shadow at maximum eclipse. The entire eclipse is visible from most of Asia and eastern Africa and Australia. The eclipse occurs at moonrise for Europe and most of Africa.

## **Surface Features**

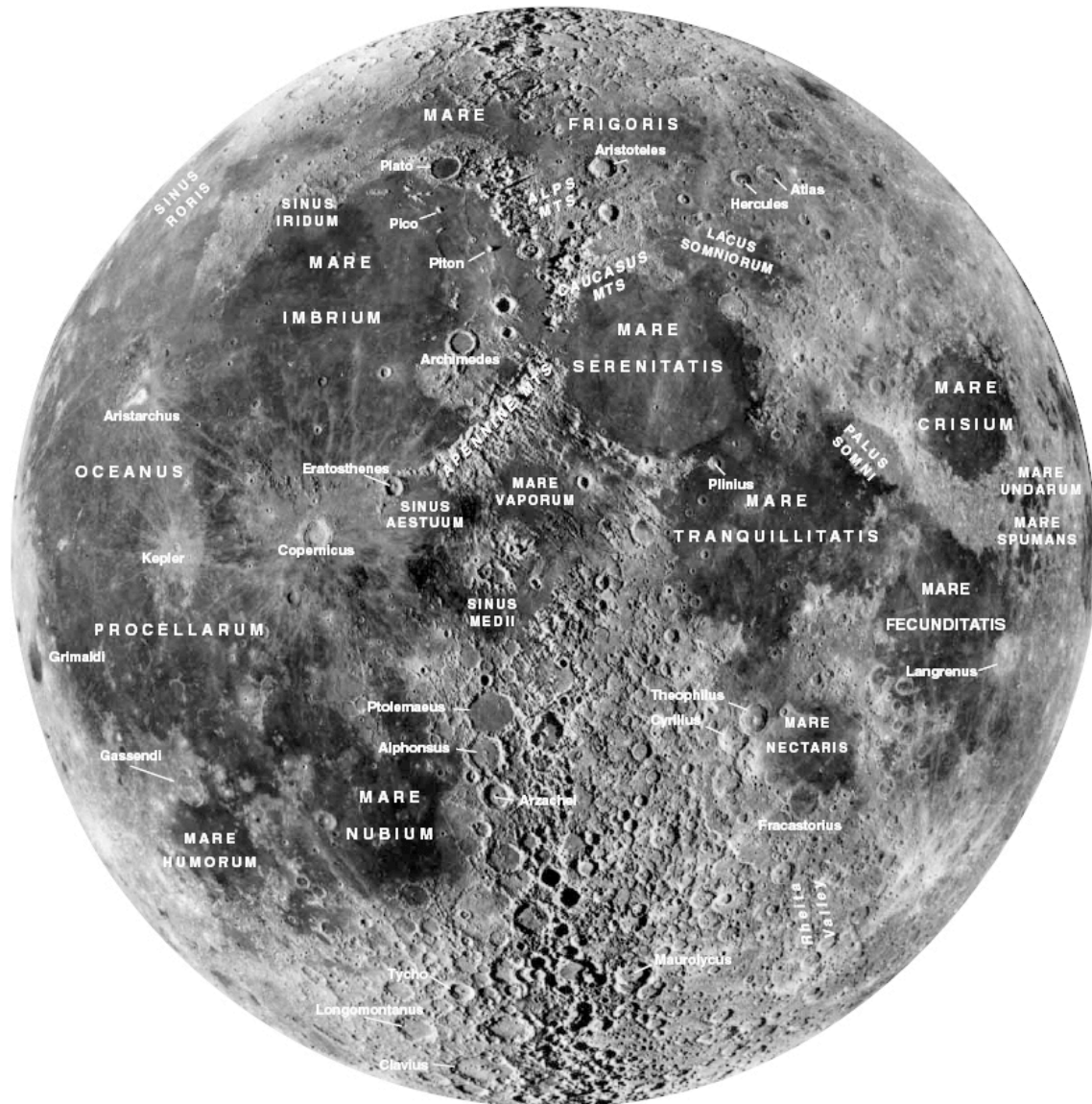
### **Craters**

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.





Moon map courtesy UCO/Lick Observatory and *Sky & Telescope* magazine.

## Rays

Fresh impact craters have rays emanating from their center. Rays are material that was ejected from the crater during the impact of the meteorite. Rays tend to fade over time as they are exposed to sunlight. Bright rays indicate a very young crater. The rays on the Moon can best be seen at a full Moon. At this time the rays are very prominent and impressive, even though the shadows on the lunar surface disappear.



# Solar Eclipses

2017 features an annular eclipse on February 21<sup>st</sup> followed by a total solar eclipse on August 21<sup>st</sup>.

The annular eclipse of February 21<sup>st</sup> is mostly visible south of the equator. The path of annularity passes over southern Chile and Argentina before heading across the Atlantic Ocean to Africa where it passes over Angola, Zambia and the Democratic Republic of the Congo. Most of South America and much of Africa can see a partial eclipse.

The total solar eclipse of August 21<sup>st</sup> is being billed as the Great American Eclipse. The path of totality passes over the United States from Oregon to South Carolina along a path about 70 miles wide. Almost all of North America sees a partial eclipse and even northern South America and much of the Caribbean can observe partial phases. This promises to be one of the most widely observed total solar eclipses in history so make plans to get to the path of totality!

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 2017

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 the year dominating the evening sky high in the southwest at sunset. It reaches greatest distance from the Sun in our sky on January 12<sup>th</sup> at which time it is also very close to Neptune which will be visible in the same binocular field as Venus (and the same Galileoscope field!) Venus starts a gradual trek back toward the Sun and really picks up the pace in early March when it plunges lower in the sky each evening until it passes the Sun on March 25<sup>th</sup> and emerges into the morning sky.

Venus spends the rest of 2017 as a morning object. It has a great conjunction with the Moon on May 22 and Uranus on June 3 (use binoculars or the Galileoscope to catch Uranus!) Venus and Mars will have a very close conjunction on October 5<sup>th</sup>. Venus and Jupiter will have a close conjunction on November 13 but they will be low in the pre-dawn sky so you will need a clear eastern horizon to catch them. Venus exits the morning sky in December as it passes around the far side of the Sun in January.

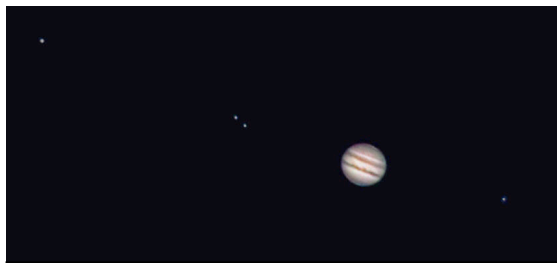




# Observing Jupiter

## 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 2017**

Jupiter starts the year near Spica in Virgo. You will need to get up early as the best views will be before morning twilight begins. Jupiter rises earlier each night until its opposition on April 7<sup>th</sup> when it rises at sunset and visible all night long. Jupiter has moved to Pisces by April. Jupiter stays well positioned for observing for several months until it gets too low in the west in the fall. Jupiter passes behind the Sun on October 26.

Remember Jupiter and Venus have a close conjunction on November 13!

# **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 2017**

Saturn starts the year in Sagittarius before crossing into Scorpius on May 18. That means Saturn will be an early morning object at the beginning of the year and rise a little earlier each day until it reaches opposition on June 15<sup>th</sup> when it will rise at sunset and be visible all night long. Saturn will be near the heart of the summer Milky Way and fairly low in the sky for northern hemisphere observers. Southern hemisphere observers will see a glorious view of Saturn high in the sky.

Saturn's rings are tipped to the maximum extent Earth this year making them exceptionally large and bright to observe.

Saturn stays well positioned in the night sky for a few months after opposition but will get low in the sky later in the year before passing on the far side of the Sun on December 21. Saturn will emerge into the morning sky in early 2018.

Saturn's brightest Moon, Titan, is frequently visible through the Galileoscope. You can use a program such as Stellarium ([www.stellarium.org](http://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, Rhea, Tethys and Dione. However, these are challenging and require excellent observing conditions.



# Other Planets

## Mercury

Mercury undergoes phases like Venus and can be a satisfying telescopic object. However 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 2017: April 1, July 30, November 24

Morning Appearances in 2017: January 19, May 17, September 12

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 1<sup>st</sup> evening appearances is well positioned for northern hemisphere observers. The September 12<sup>th</sup> appearance will mark the best chance to see Mercury in the morning sky for northern hemisphere observers.

Mercury undergoes phases like Venus. However, Mercury is much smaller and farther away from the Earth so they are more difficult to observe.

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 starts 2017 low in the southwest at sunset and will be a little lower each night. Mars



starts the year right next to much dimmer Neptune which you can see with binoculars or a Galileoscope. Mars is far from Earth and appears very small so you will not see any surface detail on Mars. Mars has a close conjunction with Uranus on February 26<sup>th</sup> but be sure to catch them before they set!

Mars finally comes into conjunction with the Sun on June 26<sup>th</sup> and will return to the morning sky. You will probably have a hard time spotting Mars before September. Mars spends the rest of the year in the morning sky but don't despair: Mars will have a very close opposition in 2018 when it will be the closest to Earth since 2003!

### **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 in the southern sky at sunset. The best time to observe Uranus at this time is early in the evening as it will be at its highest point in the sky. Uranus sets a little earlier each night and passes the far side of the Sun on April 14<sup>th</sup>. It returns to the morning sky several weeks later still in Pisces and reaches opposition on October 19<sup>th</sup> when it will be visible all night long.

Neptune starts the year in the southwestern sky in a conjunction with Mars on January 1<sup>st</sup>. Find Mars in a telescope or binoculars and there will be Neptune as well! Venus and Neptune pass close to each other on January 12<sup>th</sup>, another easy night to catch Neptune. Catch Neptune quickly in early 2017 since it will rapidly sink in the western sky and is in conjunction with the Sun March 2 and will emerge into the morning sky a few weeks later. Neptune comes to opposition on September 5<sup>th</sup> when it is visible all night long. Neptune will be in Aquarius all year.

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 2017 (for events involving the Moon, see the Moon section).

January 1, 7UT: Mars is 0.02 degrees south of Neptune

February 27, 8UT: Mars is 0.6 degrees north of Uranus

March 27, 6UT: Mercury is 2 degrees north of Uranus

May 7, 23UT: Mercury is 2 degrees south of Uranus

June 2, 14UT: Venus is 1.8 degrees south of Uranus

October 5, 13UT: Venus is 0.2 degrees north of Mars

November 13, 6UT: Venus is 0.3 degrees north of Jupiter

November 28, 9UT: Mercury is 3 degrees south of Saturn



# 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

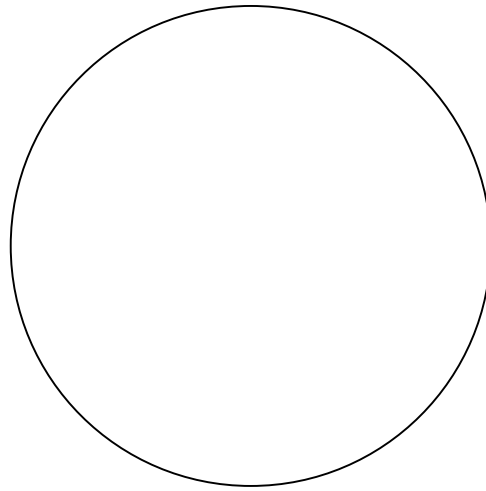
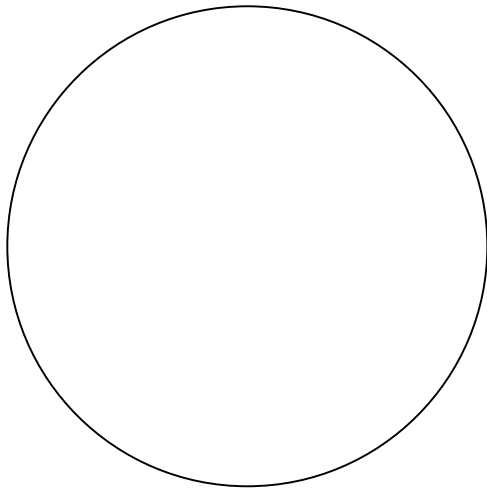
Observer	_____	Object	_____
Date	_____	Constellation	_____
Time	_____	Telescope	_____
Location	_____	Magnification(s)	_____

---

## 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.

