

Laboratory 4 - Observing the Planets in the Night Sky

Materials Used: Star and Planet locator, Star Charts, Cartes du Ciel software.

Objectives: To investigate the night sky as it will appear this evening and to predict when conditions will be favorable for viewing planets in the future.

Discussion: Our solar system consists of the Sun, eight planets and a number of smaller observable objects: comets, meteoroids, etc. All of the planets revolve about the Sun in the same direction and are arrayed a plane, known as the *ecliptic plane*, except Mercury - whose orbit is inclined about 7° relative to the ecliptic plane. Since the Sun and planets lie in the same plane they all appear to move across our sky along a common path known as the *ecliptic*.

Determining Visibility

Seldom is any celestial object except the sun visible in the daytime sky. Because the sun is very bright (the visual magnitude of the sun is -26.73 , the full moon -12.6 and Jupiter -2.9), and because Earth's atmosphere scatters light from the sun (especially blue light), everything in the daytime sky is washed out by sunlight. Any planet we wish to view in our own solar system from earth must be viewed between sunset and sunrise.

On the moon, where there is no atmosphere, stars and planets (including Earth) are easily visible during daytime. Why is this so?

To determine when planets are visible in the night sky one must take into account a planet's brilliance. Brilliance or brightness is a function of size, distance, reflectivity and other factors. The more brilliant a planet, the easier it is to see - especially during twilight. The following may be considered a rough guide to how dark the sky must be in order for a planet to be easily visible:

- | | | |
|-----------|--|---|
| • Mercury | first appears 45 minutes after sunset | disappears 45 minutes before sunrise |
| • Venus | first appears 20 minutes after sunset | disappears 20 minutes before sunrise |
| • Mars | first appears 30 minutes after sunset | disappears 30 minutes before sunrise |
| • Jupiter | first appears 30 minutes after sunset | disappears 30 minutes before sunrise |
| • Saturn | first appears 30 minutes after sunset | disappears 30 minutes before sunrise |

Note: these times represent only how long after sunset and how long before sunrise the sky is dark enough for the planet to be seen. Mercury and Venus are never visible throughout the course of the night.

All planets rise in the east and set in the west. The inner or *inferior* planets, Mercury and Venus, always appear close to the sun in the sky due to their low *elongation* (angular separation from the sun as viewed from earth). Neither ever appears very far from the sun and consequently never far above the horizon (except Venus at maximum elongation). Mercury and Venus can only appear in the west in the evening and in the east in the morning and only for a short amount of time.

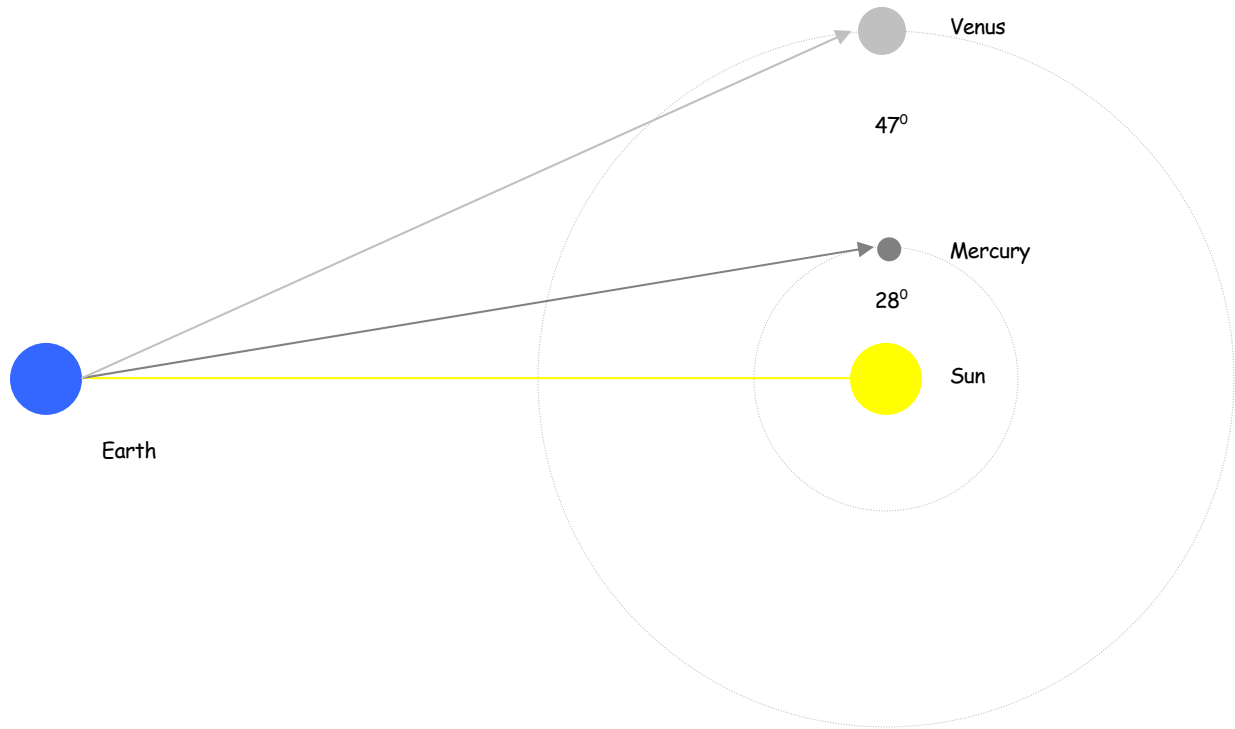


Figure 1. Inferior Planet Elongation.

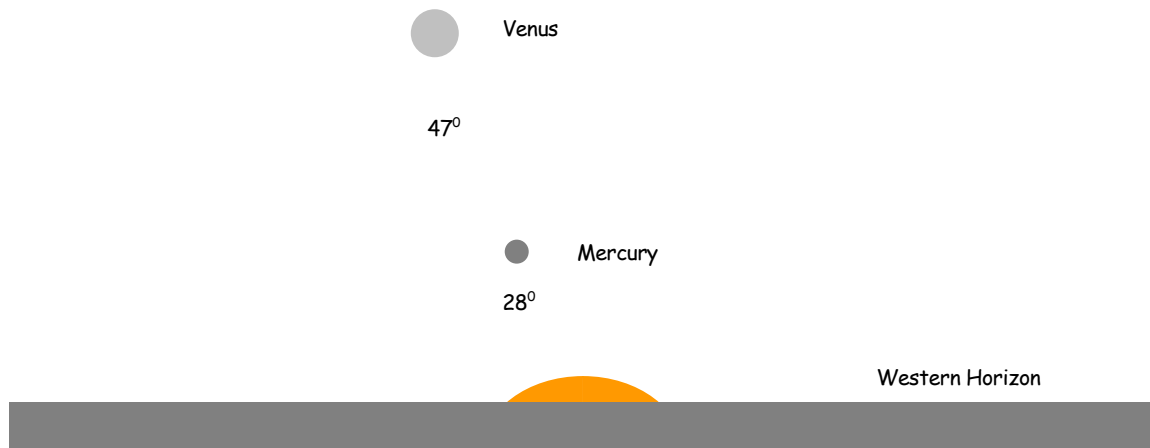


Figure 2. Mercury and Venus set shortly after the sun because of their low elongation.

An object *transits* when it crosses the meridian - the imaginary line that divides the sky into east and west halves that we studied in the first lab. This means that an object that is transiting is moving from the east half to the west half of the sky. The visible outer planets (Mars, Jupiter, and Saturn) are ideally placed for evening observation if they transit around the end of evening twilight because they are high in the sky at prime time for observing.

Why, exactly, are planets in an ideal spot for observation if they transit as the sky is getting completely dark?

Use *Cartes du Ciel*, the visibility data page 26, and an estimate of the time of sunset to describe when and where you would see each of the five planets listed below tonight (hint: check scroll through tonight's chart on *Cartes du Ciel* in 1 hour increments).

1. Mercury: Visible between _____ and _____.
Where? _____ (direction and angle above horizon)
Transit time _____

2. Venus: Visible between _____ and _____.
Where? _____
Transit time _____

3. Mars: Visible between _____ and _____.
Where? _____
Transits time _____

4. Jupiter: Visible between _____ and _____.
Where? _____
Transit time _____

5. Saturn: Visible between _____ and _____.

Where? _____

Transit time _____

6. What is the phase of the moon on tonight's date (right click on the Moon in Cartes du Ciel)?

Predicting Sunrise and Sunset Times

It is very useful to be able to estimate the amount of daylight or darkness that will occur on a given day in order to predict observing conditions. A Star and Planet Locator may be used to predict the approximate times of sunrise and sunset.

In order to find the approximate time of sunrise with a Star and Planet Locator one must locate the position of the sun. Since the sun is not on the Star and Planet locator its location must be determined with respect to a star that is near its position in the sky. This is accomplished by finding a prominent star that is near the sun on the desired date. The curved line across your equatorial star chart is the ecliptic. The dates along the ecliptic indicate the sun's position in the sky on those dates.

Are the stars along the ecliptic on the Equatorial Star Chart actually close to the sun? Why or why not?

Example: Let's predict the times of sunrise and sunset on August 20th. According to the Star Chart the sun is near the star Regulus on August 20th. Move the disk on the Star and Planet Locator until the time 12:00 noon lines up with the date August 20th. Observe that Regulus lies on (or very close to) the meridian. Now rotate the disk of the Star and Planet Locator clockwise (east) until Regulus is on the eastern horizon of the sky oval. Observe now that August 20th now lines up with the time 5:30 am.

Recall that when we used the Star and Planet Locator to find objects we subtracted time for longitude and Daylight Savings Time corrections. When using the Star and Planet Locator to predict sunrise or sunset times one reverses the procedure and adds the appropriate amount of time. In this case you will add 90 minutes to the time to find that the sun rises at approximately 7 a.m.

Why did you begin by moving the Star and Planet locator to *noon* on August 20?

Why did you shift the time estimate by *90* minutes from that on the Star and Planet Locator?

At approximately what time does the sunset occur on August 20th?

On March 21st, about what time does the rise and set?

How many hours of daylight and darkness are there on March 21st?

What time does the sun rise and set today?

What is the total amount of time from sunset to sunrise today?

Is the amount of dark time increasing or decreasing from night to night this week?

The *middle of darkness* is, literally, the middle of the night - the midpoint between sunset and sunrise.

Tonight will the middle of darkness come:

On August 21st the middle of darkness will come:

On March 21st the middle of darkness will come:

Predicting Viewing Times for the Planets

The inner planets are often difficult to observe during the course of a given night due to their low elongation. Refer to the data on page 26 for assistance with the next three questions.

The later Mercury sets after sunset the easier it is to see because it is at maximum elongation. Use *Cartes du Ciel* to predict two dates, at least two months apart (both after today) when Mercury might be easiest to see in the evening sky.

The earlier Mercury rises before sunrise the easier it is to see in the morning. Use *Cartes du Ciel* to predict two dates, at least two months apart (both after today) when Mercury might be easiest to see in the morning sky.

Predict when Venus might be easiest to see in the evening and morning skies.

The outer planets can usually be seen sometime during the night but are especially well placed for observation in the evening sky if they rise around the end of evening twilight.

Find the next dates when Mars, Jupiter and Saturn rise at the end of evening twilight. These dates are also near the planets *opposition* dates (when the planets are opposite the sun in the sky).

The outer planets are even better placed for evening observation if they transit around the end of evening twilight.

Find the next dates when Mars, Jupiter and Saturn transit at the end of evening twilight.

In which direction would you look to find each of these planets (with respect to the meridian, zenith and horizon)?