

Naked Eye Astronomy, Day 6: Observing the Planets

1. Review

- (a) Please ask questions at ANY TIME.
- (b) Web page with resources for the course: <https://osp.berry.edu/SeniorScholars>.
- (c) Recall our observations of the stars, Sun, and Moon.
 - i. The stars appear as though they are stuck to a celestial sphere that rotates around an axis through the Earth once every 23 hours 56 minutes.
 - ii. The Sun generally moves along with this daily rotation but also drifts eastward relative to the stars along a circular path called the Ecliptic (which is tilted by 23.5 degrees relative to the celestial equator), completing its motion in 365.25 days.
 - iii. The Moon moves roughly along the ecliptic, always eastward relative to the stars, but completes its motion in one sidereal month of 27.3 days.
- (d) Now we will observe the five other objects that are visible in the night sky: the planets Mercury, Venus, Mars, Jupiter, and Saturn.

2. The Inferior Planets: Mercury and Venus

- (a) Turn off atmosphere and ground. Find Venus and center it. Note the day and a star that is near Venus. Advance time by day and watch how Venus moves relative to the stars. Motion is generally eastward, roughly along the ecliptic, but then it stops and goes westward for a bit! This is retrograde motion. Continue to track Venus until it gets back to its starting star. Note the date, roughly one year after we started.
- (b) This time is the tropical period of the planet's motion and if we average over many cycles the value is exactly one year.
- (c) We can also measure the time from one retrograde to the next. Find when Venus is in the middle of its retrograde. Note that it is very near the Sun (in CONJUNCTION). Note the date. Advance time until Venus is in conjunction again, but note that this is a prograde conjunction. Keep advancing until the next retrograde conjunction. Note date. This time period is Venus' synodic period, about 584 days.
- (d) We see that Venus is ALWAYS in conjunction when it is in the middle of its retrograde.
- (e) Show that Venus never gets very far from the Sun. Maximum angle from Sun (elongation) is about 47 degrees.
- (f) Now let's look at Mercury. Find Mercury and center it. Note the date and a star near Mercury. Follow Mercury around, see it move eastward, then retrograde westward across the Sun, and keep going until it gets back to the starting star. The tropical period of Mercury is also a year (if we average over many cycles).
- (g) Now measure the synodic period of Mercury. Get it into retrograde conjunction, note date, follow until it is back in retrograde conjunction. Synodic period of Mercury is 116 days.
- (h) We see that Mercury is also ALWAYS in conjunction when it is in the middle of its retrograde.
- (i) Mercury stays even closer to the Sun than Venus, with maximum elongation of only 28 degrees.

- (j) Note how the planets seem linked to the Sun: they stay close to it, they have the same tropical period (no coincidence), and they are always in conjunction in the middle of retrograde.

3. Superior Planets: Mars, Jupiter, Saturn

- (a) Turn off atmosphere and ground. Find Mars and center it. Note the day and a star that is near Mars. Advance time by day and watch how Mars moves relative to the stars. Motion is generally eastward, roughly along the ecliptic, but then Mars retrogrades (but where is the Sun?). Continue to track Mars until it gets back to its starting star. Note the date. Tropical period of Mars is 687 days.
- (b) Get Mars into conjunction. Note date. Advance time until Mars is in middle of retrograde. Note that Sun is nowhere near, in fact it is in opposite part of sky (Mars is in opposition). Continue advancing until Mars is in conjunction again. Synodic period of Mars is 780 days.
- (c) We see that Mars is ALWAYS in opposition when it is in the middle of its retrograde.
- (d) Note how Mars is lapped by the Sun. So it doesn't stay close to the Sun like the inferior planets, but can be at any elongation.
- (e) Also note how the brightness of Mars changes. When is it brightest? It is brightest in retrograde/opposition.
- (f) Now let's look at Jupiter. Find Jupiter and center it. Note the date and a star near Jupiter. Follow Jupiter around (advance by week), see it move eastward, then retrograde westward in opposition, and keep going until it gets back to the starting star. The tropical period of Jupiter is 4333 days.
- (g) Now measure the synodic period of Jupiter. Get it into conjunction, note date, follow until it is back in conjunction. Synodic period of Jupiter is 399 days.
- (h) We see that Jupiter is also ALWAYS in opposition when it is in the middle of its retrograde.
- (i) Jupiter can have any elongation. It is slightly brighter when in opposition. Note that Jupiter's retrogrades are smaller than Mars'.
- (j) Repeat for Saturn which has tropical period of 10,759 days and synodic period of 378 days. Saturn's retrograde motion is even smaller than Jupiter's. It can be at any elongation and always retrogrades in opposition. It's brightness doesn't change much.
- (k) So the superior planets don't stay near the Sun, yet they are linked to it since they always retrograde when in opposition.

4. Next time we will look at theories to explain why the planets move the way they do.

5. Questions and conversation