Planets a go-go

by Bob Riddle

The school year kicks off with a great parade of planets in the evening skies, as four of the six visible planets will make an appearance during the evening hours following sunset. For the first half of September, students will have a great opportunity for viewing and comparing the relative orbital speeds of planets and the effect of Earth's revolution. Simply look toward the west at sunset for a trio of planets a couple of hand widths above the horizon. The brightest member of the trio will be Venus, greatly outshining nearby Mercury and Mars.

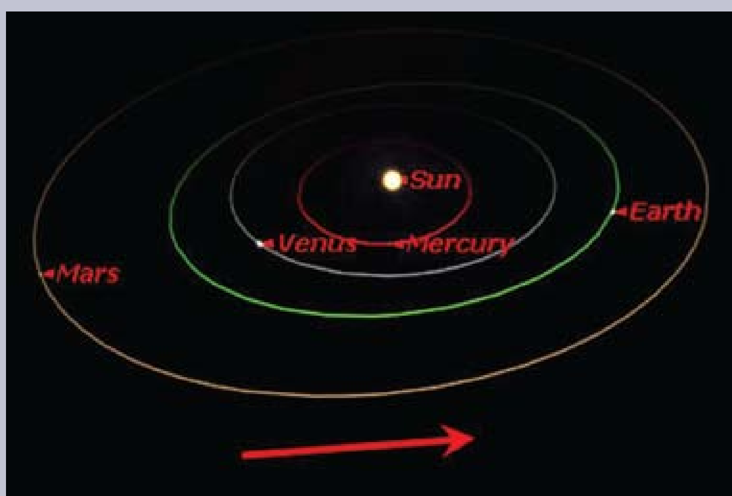
Each of the three planets has a similar but distinct motion relative to the Sun, the horizon, and nearby planets. In general, the planets all share the same orbital direction as they orbit the Sun toward the east, as seen from Earth. However, there are times when some planets appear to go backward or toward the west, while other planets actually do go westward. This is called *retrograde motion* and it occurs every time the Earth moves past an outer planet, giving us the illusion that the outer planet has slowed its regular direct, or eastward, motion, and then reversed its direction to the west for a time before returning to eastward motion. Mars underwent its retrograde motion in 2007 and is now steadily moving eastward until the next time Earth passes Mars (toward the end of 2009), triggering another cycle of retrograde motion.

The two inner planets, Mercury and Venus, actually do change directions as they orbit the Sun, at least as we view them from Earth. We know planets orbit the Sun in the same direction and in near circular orbits, as shown in Figure 1 (also see Solar System Live website in Resources). However, from our perspective, we see them move from one side to the other side of the Sun throughout each orbital period, as shown in Figure 2. When the inner planets are at their maximum distance from the Sun, they are at a position known as *elongation* (X marks the spot in Figure 2). This month, both Venus and Mercury will be moving eastward, or to the left, away from the Sun. Mercury will reach eastern elongation, meaning that it will be on the east side of the Sun, or visible in the evening sky. Once the inner planet reaches an elongation, it appears to stop and reverse motion, moving in the other direction. Mercury, for example, will end its eastward motion on September 11, and then start moving westward back toward the Sun and eventually be on the other side of the Sun at western elongation.

In addition to the real motions of the planets, there is the apparent daily eastward motion of the Sun caused by the Earth revolving around the Sun. Each day the Earth revolves nearly 1° around the Sun, while the Sun will have appeared to have moved eastward by the same amount the Earth has actually moved. So what does this mean with respect to the motions of the three planets over the western horizon at sunset?

Look at Figure 3. This is a view set for 9:45 p.m. CDT on September 1. At this setting, the Sun is just below the horizon and the three planets are visible just above the horizon. Notice how the orbits of the two inner planets curve back toward the Sun, while the orbit of Mars keeps going to the left, or east. Each day, the Sun, in its apparent motion eastward, will follow a path very similar to that for Mars. All outer planets moving eastward will eventually be overtaken by the faster apparent speed of the Sun, and will be lost from our view for awhile as the Sun moves between us and the outer planet. What we see is that each evening an outer planet will be a little closer to the Sun, will set closer to the time of sunset, and will be lower over the horizon, eventually becoming too close to the Sun to be seen.

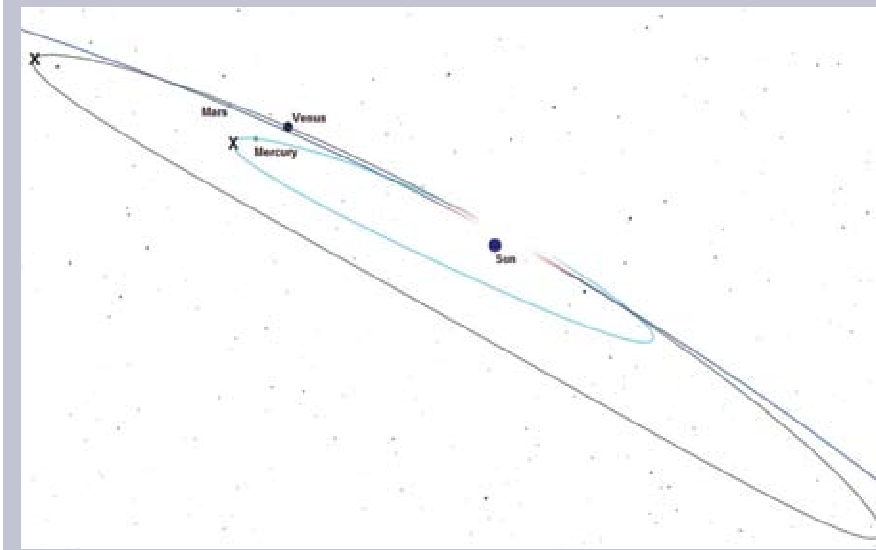
FIGURE 1 Inner solar system from above



Inner planets, on the other hand, are closer to the Sun than Earth, so their orbital motion relative to the Sun's apparent motion is faster. Both inner planets easily outrun the Sun toward the east. At sunset, as they move toward their respective eastern elongation, the two inner planets will appear higher over the horizon each evening. Mercury, however, will reach eastern elongation this month. From September 11 on, it will appear lower over the horizon at sunset until it has moved between the Sun and the Earth, and for a while is not visible.

For the evening planets now visible—Mercury, Venus, Mars, and Jupiter—it is only a matter of time before the Sun catches up and blocks them from view.

FIGURE 2 Orbits as seen from the Earth



Visible planets

Mercury will be visible but relatively dim, and low over the western horizon at sunset for about the first two weeks of the month.

Venus will be very bright and visible low over the western horizon at sunset.

Mars will be slightly dimmer than Mercury and will be located above Mercury and Venus over the western horizon at sunset.

Jupiter will be very bright and will be located over the southern horizon at sunset.

Celestial events

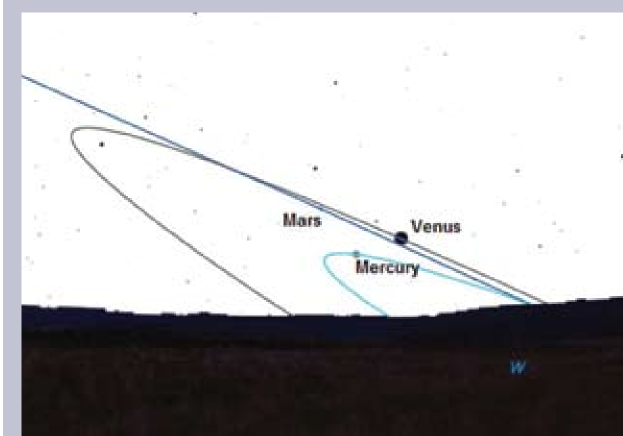
September

4 Saturn–Sun conjunction
6 Moon near Antares (p.m.)
7 First quarter Moon
Moon at apogee: 404,209 km
8 Jupiter ends retrograde motion
9 Jupiter near Moon (p.m.)
11 Mercury at greatest east elongation
13 Uranus at opposition
15 Full Moon
20 Moon at perigee: 368,888 km
Moon near Pleiades (a.m.)
22 Last quarter Moon
22 September equinox (11:45 EDT)
23 Moon near Twins (a.m.)
27 Saturn near Moon (a.m.)
29 New Moon

Questions for students

1. What is meant by a visible planet? (*A visible planet is one close enough so that its reflected sunlight is bright enough to be seen with the unaided eye.*)
2. What are the names of the visible planets in our solar system? (*There are six visible planets in our solar system. They are Mercury, Venus, Mars, Jupiter, and Saturn, and of course the Earth.*)

FIGURE 3 Trio of planets at sunset local time on September 1



3. Explain how it is that we see the planets appearing to go from one side to the other side of the Sun, rather than going around the Sun in circles. (*All planets orbit the Sun relative to the Sun's equator and therefore lay very nearly in the same plane or level. This is referred to as the* plane of the ecliptic, *and is based on the Earth's orbit or what we view as the Sun's apparent path—the ecliptic. Because the planets are all close to the ecliptic or on the same level, we see them edge-on or from the side, as Figures 2 and 3 illustrate.*)
4. The Earth moves approximately 1° each day as it orbits the Sun. Determine how much the other planets move each (Earth) day. (*Divide 360° by the orbital period to see how much that planet moves in one Earth day; see Figure 4.*)

Resources

Complete sun and moon data—*http://aa.usno.navy.mil/data/docs/RS_OneDay.php*
Lunar perigee and apogee calculator—*www.fourmilab.ch/earthview/pacalc.html*
SFA star charts—*www.midnightkite.com/starcharts.html*
Solar System Live—*www.fourmilab.ch/cgi-bin/Solar*
The nine planets—*www.nineplanets.org*

FIGURE 4

Name	Orbital period in Earth days	Distance traveled in one Earth day
Sun	-----	(apparent)
Mercury	87.97	
Venus	224.70	
Earth	365.25	
Mars	686.98	
Jupiter	4332.71	
Saturn	10759.50	
Uranus	30685.00	
Neptune	60190.00	
Pluto	90550.00	

Bob Riddle *(briddle@kcmsd.net)* is the planetarium director for the Kansas City, Missouri, school district. Visit his astronomy website at *www.currentsky.com.*