And now there are five

This month opens with four of the five brightest planets (Venus, Mars, Saturn, and Jupiter) very visible as they line up across the evening skies after sunset, stretching from the western horizon to the southeastern horizon. The month closes with the addition of the fifth bright planet, Mercury, joining the others in the evening skies. As spectacular as this planetary vista may be, it is also dynamic in that the other planets, as well as the Earth, are moving eastward along their orbits. In fact, as you are reading this, the Earth is moving through space around the Sun at the rate of approximately one degree per day. Or to put it differently, the Earth will complete a 360-degree revolution around the Sun in 365.25 days. Alternatively, the Sun, in its apparent motion along the *ecliptic* (due to the Earth's real orbital motion around it) moves eastward relative to the stars at the rate of approximately one degree per day. The ecliptic is the Earth's orbit, but since we are on the Earth, it is the apparent eastward path we observe the Sun to follow through the year.

While this may be a different way to think about the Earth's motion, it allows for an interesting comparison with the other planets using either the Earth or Sun as a reference point. For example an inner planet, Mercury or Venus, would complete a revolution around the Sun in less time than the Earth. On the other hand, outer planets take longer to orbit the Sun and, therefore, will move less than the Earth's rate of about one degree per day. To illustrate the relationship between orbital period and orbital motion, students should calculate the degrees per day that the other planets travel and then graph them as a function of orbital time (see Figure 1).

Follow the planets—Explore revolution

To put this idea into motion, start observing Venus at the same time each evening when possible this month. You will see that each day Venus is higher in the sky, further east from the Sun, and moving closer to the Pleiades. You should also observe that the Pleiades are getting closer to the horizon each evening. What is taking place is a very regular celestial event involving a combination of real and apparent motions coming together. The Earth's orbital motion around the Sun gives the appearance of the stars and their host constellations slowly but steadily shifting westward at the rate of approximately one degree per day. Put these apparent motions together with the faster real motions of Venus and, relative to the sky's apparent westward motion, the fastest moving planets are moving eastward at a rate that is very noticeable compared to the stars in the background.

For comparison, observe Mars at the same time. Located just above and to the left of Venus, and below and to the right from the Pleiades, Mars is also moving eastward relative to the stars in the background. However, as an outer planet, it will not cover as much celestial territory as Venus will during the same amount of time. How many degrees will Mars move during March? Venus? The Sun?

Celestial events

The March equinox occurs this month (1:49 A.M. EST on the 20th) as the Sun reaches the celestial coordinates of 0 degrees, 0 hours (within the boundaries of the constellation Pisces). This is the astronomical, or actual, position of the Sun relative to the stars in the background, while according to the astrology column in most newspapers, the Sun would be within the boundaries of the constellation Aries. This is the beginning of northern hemisphere spring and southern hemisphere autumn.

Visible planets

- Four of the brightest visible planets are stretched across the sky at sunset from the western horizon to the eastern horizon.
- Mercury becomes visible over the western horizon at sunset during the last week of the month.
- Venus is visible over the western horizon at sunset and sets about four hours later.
- Mars is visible over the western horizon at sunset and sets before midnight.

FIGURE 1 **How many degrees does each planet move per day?**

Planet	Orbital period (Earth days)	Orbital period (Earth years)	How many degrees per day?
Mercury	89.97 days	0.24	
Venus	224.7 days	0.61	
Earth	365.25 days	1.00	0.98
Mars	686.98 days	1.88	
Jupiter	4,332.7 days	11.86	
Saturn	10,760 days	29.45	
Uranus	30,685 days	84.01	
Neptune	60,082 days	164.79	
Pluto	90,767 days	248.50	

Bob Riddle *is a science educator living in western Missouri. You can reach him via e-mail at* starwalk@currentsky.com *or visit his website at* www.currentsky.com.

- Jupiter is over the southeastern horizon at sunset and is visible most of the night.
- Saturn is visible over the southwestern horizon at sunset and sets after midnight.

Moon phases

Full Moon	3/06
Last quarter	3/13
New Moon	3/20
First quarter	3/28

Internet resources

SFA Star Charts—*observe.phy.sfasu.edu*
Equinox—*www.equinox-and-solstice.com/html/vernal_equinox.html*

Tracking our Sun

Sun distance

March 12th—Distance: 0.9958 AU, Apparent diameter: 32'

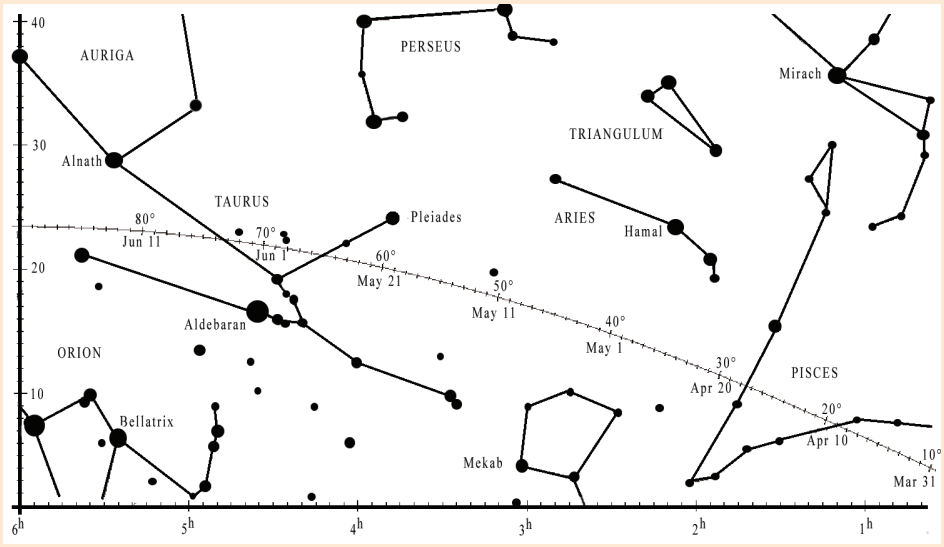
Along the Ecliptic

March 19th—Constellation: Pisces, Declination: -0 degrees 12.5', Right ascension: 23^{h} 58^{min}

Ephemeris generator—*ssd.jpl.nasa.gov/cgi-bin/eph*
Cassini-Huygens Mission to Saturn and Titan—*saturn.jpl.nasa.gov/index.cfm*
Saturn Observation Campaign—*soc.jpl.nasa.gov/index.cfm*
Solar System Educator Program—*www.ssep.org*

Charting the planets

The star chart shows a piece of the sky in the area around the constellations of Aries and Taurus. The curving line with calendar dates along it is the ecliptic, the apparent path the Sun follows eastward. Each marker on the ecliptic represents the date and location of the Sun at mid-day each day.



Outdoor observation: Use a copy of a star chart for plotting the positions of the two planets as they are observed in the evening at a specified time. It is important to use the same time each evening throughout the observation. When outdoors, face the southwestern horizon. Hold and rotate the star chart so that the brighter stars on the chart match the same stars in the sky. Use the bright reddish star, Aldebaran, and the star cluster, the Pleiades, for reference. Once the star chart is matched with the sky, observe the position of Venus and Mars. Draw a dot on the star chart showing the location of each. The date should be written next to each dot. Continue this throughout the month.

Computer-assisted astronomy: With a second copy of the star chart, plot the changing locations of the two planets using the celestial coordinates of *declination* and *right ascension*. These coordinates are essentially an extension of the Earth's surface-based grid system. Declination is like latitude and measures degrees north and south of the celestial equator. Right ascension is somewhat like longitude, except that it is measured in hours, minutes, and seconds (from 0 to 23 hours) and is only measured eastward. The vertical line on the chart is used for measuring declination, and the hours and minutes for right ascension are shown along the bottom. (To obtain coordinate information for these two planets or any others, see Internet resources above for an online *ephemeris* for generating planet coordinates. An ephemeris is a table of positions for celestial objects. It can show coordinate positions, rising/setting times, transits, and so on.)