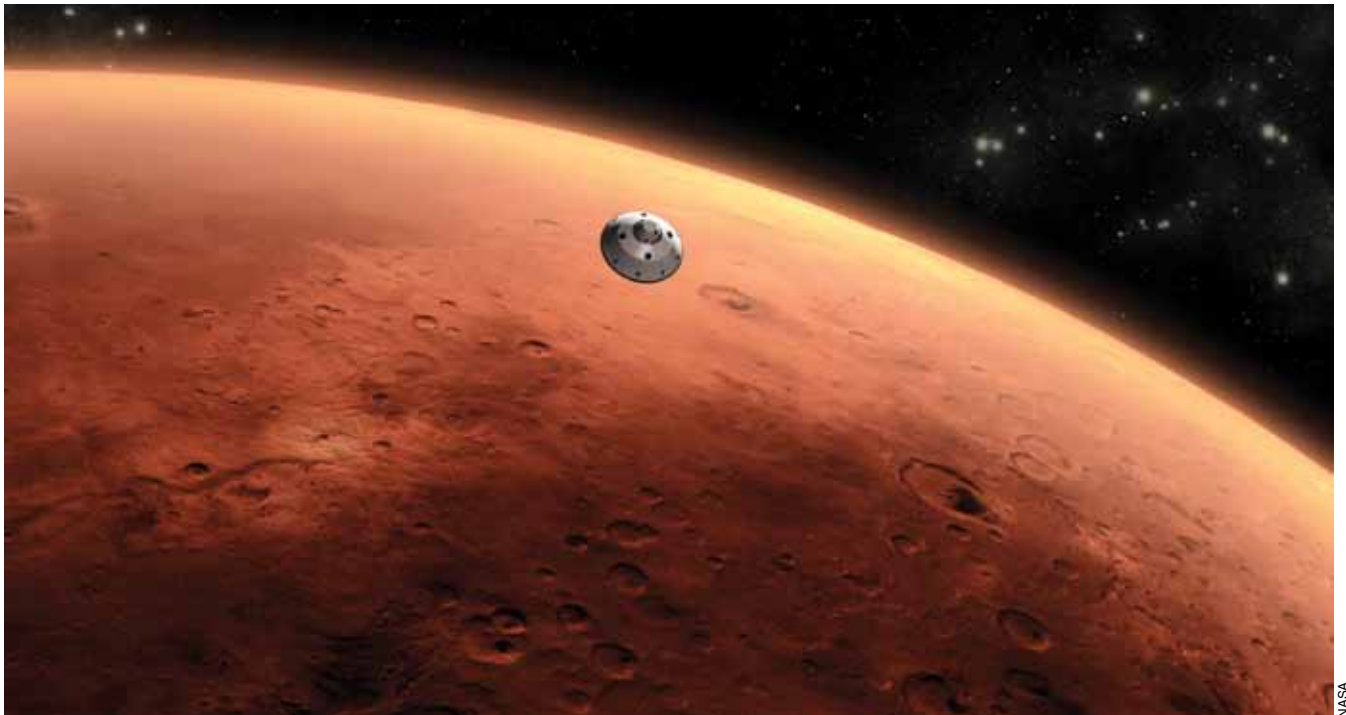


Summer space missions

by Bob Riddle



The end of cruise phase starts entry, descent, and landing for *Curiosity*.

This summer, while we prepare for the next school year, the Mars Science Laboratory (MSL), *Curiosity*, will be in its final few months of interplanetary travel to Mars. Scheduled for landing on August 6, the spacecraft will be traveling at a speed of around 12,000 km/h (7,500 mph) and will be nearing the conclusion of the cruise phase of the mission. Toward the end of June, 45 days prior to arrival at Mars, and at a distance of around 13,000,000 km (8,077,825 miles), the approach phase will begin as mission controllers prepare the spacecraft for atmosphere entry and landing. By August 6, the spacecraft will be 0 km from Mars and will have slowed from interplanetary speeds to 0 following a successful landing in Gale Crater on Mars.

During these final months of space flight, the progress of the MSL can be followed with the use of online solar system simulators. NASA's Eyes on the Solar System, a 3-D solar system simulation, shows an interactive display of the solar system and several spacecraft at their respective locations. You can zoom in to closer views of planets and many moons and even lock onto an object and follow it along its orbital path. The relative speeds of objects and even distances between objects can be determined with some of the program's tools. The relative positions of Earth, Mars, and the MSL spacecraft can be modeled, and dragging the screen display around will allow for views of the spacecraft and other objects in the solar system. Adjusting the date setting can animate the entire flight from Earth to Mars.

As the MSL spacecraft closes in on Mars, what do you suppose the red planet would look like from that perspective, as if one were a passenger onboard? Another NASA website, the Solar System Simulator, is designed to show a variety of views, including Mars as seen from the spacecraft. On this website, the images are accurate graphic depictions of the object and are static, not animated. You may choose the object from which you wish to view, as well as what to view, and can see anything from above or below views of the solar system to how planets or moons appear from each other, as well as the view from selected spacecraft. The last can extend out as far as the *Voyager* spacecraft on the fringes of the solar system to the MSL currently between Earth and Mars.

Once the objects have been selected and the date and time set, the field of view is then established. This determines how much space to show and ranges from a wide angle of 120° to an extremely narrow 0.0001° . The image is then displayed and includes information showing the distance to the object and its apparent size. When the program starts, select “Show me Mars as seen from Mars Science Laboratory” from the drop-down menus and a date for the simulator. Set the field of view and percentage width of the picture to determine how large the image will appear after clicking on the “Run Simulator” button. To see how the view changes, adjust the date a few days at a time until reaching August 6 to see how Mars slowly but steadily increases in size.

Unfortunately, while both of these websites can take you to Mars, neither one shows you its surface. The solution is to view a NASA animation depicting the exciting final minutes of the space flight from when the spacecraft enters the Martian atmosphere to its successful landing and deployment on the surface. This part of the mission is known as entry, descent, and landing (see Figure 1), and the video *Next Mars Rover in Action* is available on the MSL mission website (see Resources).

Be sure to set the date in your planner —August 6—when we once again land on another planet.

Dawn

This summer, while the MSL spacecraft is scheduled to arrive at Mars, there is another spacecraft scheduled to depart for another planet. This is the *Dawn* spacecraft, which is currently in low orbit around

the asteroid Vesta. Having spent this past year in the first stop of a two-world tour, the spacecraft will leave Vesta and set its course for the largest object in the asteroid belt, dwarf planet Ceres. Arriving at Ceres in February 2015, the *Dawn* spacecraft will enter orbit and begin that part of its mission.

The *Dawn* spacecraft is solar powered and uses some of that power to provide the energy for its ion-propulsion system. *Ion propulsion* is a method where xenon gas is ionized, and then the ions are streamed out to provide the thrust for the spacecraft. The ion thruster does not provide a lot of thrust, but over a period of time it increases the speed of the spacecraft so that each passing day sees the spacecraft going faster and faster. The ion thruster is also used to slow the spacecraft and place it in orbit around the asteroid. To follow the *Dawn* spacecraft as it journeys across the asteroid belt and to learn more about this area of our solar system, be sure to visit the mission website or use the Solar System Simulator (see Resources).

Dragon

The *Dragon* is a maneuverable and reusable spacecraft designed and built by SpaceX for future use by NASA to deliver cargo and crew to the International Space Station (ISS), or as a science lab for low-Earth-orbit experiments. The *Dragon* spacecraft is carried into space on top of the Falcon 9, a heavy lift rocket also developed by SpaceX. After successfully demonstrating the capabilities of the Falcon 9 and *Dragon* in docking with the ISS, SpaceX has been contracted by NASA for additional flights to the ISS this summer. In July, the *Dragon* spacecraft will deliver cargo, and the following month a *Dragon* lab will launch into orbit. Another flight by SpaceX will include the release of the CUSat, a satellite developed by Cornell University to demonstrate GPS-based technologies for monitoring the condition of other satellites.

Cassini at Saturn

July 1 marks the seventh anniversary of the *Cassini* mission to Saturn. The *Cassini* orbiter has been living up to its name as an orbiter as it has looped over, under, and around the Saturn system of rings and at least 62 satellites. *Cassini* completed its original four-year mission in 2008 and then received the go-ahead for an extended mission of two years. This extended

mission, the Equinox Mission, ended in 2010, and the spacecraft is now on a second extended mission, the Solstice Mission, which is scheduled to end in September of 2017. In the meantime, the orbiter continues to send back remarkable images and new data. You can follow the orbits of *Cassini* on the mission website (see Resources).

Summer sky events

This summer, all of the visible planets will be above the horizon and visible as either morning or evening planets. At various times, the planets, bright stars, and the Moon will group together in interesting arrangements known as *conjunctions*. In August, the annual Perseids meteors peaks with the waning crescent Moon but should still be a good display of shooting stars. Be sure to check the calendar for specific dates for these and other sky events this summer.

Mercury will be visible in the evening sky during June and the first half of July, and then will reappear in the morning skies after moving into inferior conjunction in July.

Venus will move into the morning skies during the summer months following inferior conjunction and transit of the Sun, and will steadily move east away from the Sun, becoming increasingly visible as the bright morning star.

Mars will remain visible after sunset over the south to southwest horizon, but will be getting noticeably dimmer as the distance between the Earth and Mars increases.

Jupiter will join Venus as a morning star and slowly become more visible, rising earlier each morning during the summer.

Saturn will be visible all night this summer, shining brightly near the blue-white star Spica in Virgo.

June

- 3 Moon at perigee: 358,484 km (222,752 mi.)
- 4 Partial lunar eclipse
Full Moon
- 5 Venus inferior conjunction/transit
Neptune begins retrograde motion
- 7 *Cassini* Titan flyby
- 8 Mars at east quadrature
- 11 Jupiter near the Pleiades
Last quarter Moon

- 15 Moon at apogee: 405,800 km (252,152 mi.)
- 17 Waning crescent Moon close to Jupiter
- 19 New Moon
- 20 Summer solstice 7:07 p.m. EDT
- 21 Thin waxing crescent Moon and Mercury near Gemini Twins
- 25 Waxing crescent Moon near Mars
- 26 First quarter Moon
Saturn ends retrograde motion
- 27 Waxing gibbous Moon near Spica and Saturn
Venus ends retrograde motion
- 29 Dwarf planet Pluto at opposition
Uranus at western quadrature
- 30 Waxing gibbous Moon near Antares

July

- 1 Happy birthday Kennedy Space Center
Moon at perigee: 362,400 km (225,185 mi.)
Mercury at eastern elongation
- 2 Mercury near the Beehive Cluster
- 3 Full Moon
- 4 Earth at aphelion 152,092,425 km (94,505,856 mi.)
- 7 *Dragon* spacecraft launch to ISS
- 8 Venus and Jupiter near Aldebaran
- 10 Last quarter Moon
- 13 Moon at apogee: 404,800 km (251,531 mi.)
- 15 Waning gibbous Moon near Jupiter and Venus
- 18 New Moon
- 24 Waxing crescent Moon near Mars
Cassini Titan flyby
- 25 First quarter Moon
Moon near Saturn
- 27 *Dawn* leaves Vesta
- 28 Waxing gibbous Moon near Antares
Mercury inferior conjunction
- 29 Moon at perigee: 367,300 km (228,230 mi.)
- 30 Jupiter near Aldebaran
- 31 Saturn near Spica

August

- 2 Full Moon
- 6 *Curiosity* lands on Mars
- 9 Last quarter Moon
- 10 Moon at apogee: 404,100 km (251,096 mi.)
Waning crescent Moon near the Pleiades
- 11 Waning crescent Moon near Jupiter
- 12 Perseids meteor shower peak
- 13 Waning crescent Moon near Venus

- Mars and Saturn near Spica
- 15 Venus at western elongation
- 17 New Moon
- 21 Waxing crescent Moon near Spica, Mars, and Saturn
- 23 Moon at perigee: 369,700 km (229,721 mi.)
- 24 Neptune at opposition
- First quarter Moon
- Moon near Antares
- 31 Full Moon

Resources

Cassini at Saturn—<http://saturn.jpl.nasa.gov>
 CUSat satellite project—<http://cusat.cornell.edu>
 Dawn mission—<http://dawn.jpl.nasa.gov>
 Eyes on the solar system—<http://solarsystem.nasa.gov/eyes>
 Kennedy Space Center—www.nasa.gov/centers/kennedy/about/history

Mars Science Lab—<http://marsprogram.jpl.nasa.gov/msl>
 Next Mars rover in action—<http://marsprogram.jpl.nasa.gov/msl/multimedia/videoarchive/?n=2011>
 Partial lunar eclipse—<http://eclipse.gsfc.nasa.gov/OH/OH2012.html#LE2012Jun15T>
 Perseid meteor shower—<http://meteorshowersonline.com/perseids.html>
 Safe solar viewing—<http://sunearthday.nasa.gov/2012/transit/viewing.php>
 Solar system simulator—<http://space.jpl.nasa.gov>
 SpaceX Dragon spacecraft—www.spacex.com/dragon.php
 Transit of Venus—www.transitofvenus.org
 Where is Dawn now?—http://dawn.jpl.nasa.gov/mission/live_shots.asp#

Bob Riddle (bob-riddle@currentsky.com) is a science educator in Lee's Summit, Missouri. Visit his astronomy website at www.currentsky.com.