Milestones in space exploration

BY BOB RIDDLE

On July 29, 1958, President Eisenhower signed into law the National Aeronautics and Space Act (see Resources). On October 1, 1958, NASA officially opened its doors. To mark its 60th anniversary, this month we will be reviewing some of the highlights achieved by NASA over the past 60 years, as well as those of Russia's Space Program (Roscosmos) and China's National Space Administration (CNSA).

Launched in 2004, NASA's *MESSENGER* mission (***ME**rcury **S**urface, **S**pace **EN**vironment, **GE**ochemistry, and **R**anging*) first encountered Venus in 2006 and then Mercury in 2008 on the spacecraft's way to an orbital rendezvous with Mercury in 2011. As the spacecraft embarked on its difficult route to Mercury, the innermost planet in the solar system, it headed toward the Sun and at times worked with or against the Sun's gravitational attraction. A *gravity assist*, the flyby of another planet or moon, helps move a spacecraft from Earth's orbit to the orbit of a different solar system object. This flyby technique allows for course adjustments and provides an adjustment to the spacecraft's velocity. (See Resources for additional information about a gravity assist and the *MESSENGER* mission.)

An interesting milestone was made by NASA's space telescope, known as the IRAS (Infrared Astronomical Satellite). Launched in 1983 on a mission that lasted only 11 months, the IRAS satellite mapped and identified approximately 350,000 infrared sources in the Milky Way in addition to what was known prior to its launch. Infrared sources in our galaxy are objects that are either a heat source or a reflected source. The heat from many of these objects are interfered with (e.g., blocked and absorbed by dust and gases or glowing at temperatures with a spectrum outside the visible wavelengths). With the use of infrared equipment such as the IRAS satellite, these objects become visible at infrared wavelengths. For example, the IRAS satellite has discovered warm dust clouds surrounding stars, galaxies, and comets. The IRAS's infrared capabilities were able to show the structure of the core of our galaxy. Interestingly, the IRAS discovered the first asteroid via its telescope in October of 1983. The asteroid, named 3200 Phaethon is a member of the Apollo group of asteroids, which orbit the Earth. 3200 Phaethon is an unusual member of the Apollo group in that its orbit not only crosses the orbits of Mars, Earth, Venus, and Mercury but this asteroid has the smallest perihelion, coming closer to the Sun than any other known asteroid.

The Russian space program has led about 40 missions to Venus, using a variety of orbiters and landers to reveal the first views of the planet's surface and data about its atmosphere. Both the Venera (Russian for Venus) 15 and 16 were twin orbiters using radar altimetry to map the surface of Venus. Sending a signal to the surface and then timing its return provided the data necessary to convert into altitudes for map making. The orbiters were placed in a polar orbit and mapped a swath of the surface approximately 120 km (75 mi.) wide and 7,500 km (4,600 mi.) long. Mapping of the surface of Venus by radar was also done with NASA's *Magellan at Venus* mission. (See Resources for the NASA website of archived Venus images and a link to a video showing the surface of Venus made using radar data.)

In October 2003, the Chinese space program successfully launched into orbit its first Chinese astronaut, known as a "taikonaut." Flying aboard the Shenzhou-5 spacecraft, the astronaut Yang Liwei orbited the Earth 14 times during his 21-hour orbital flight. During his mission, Liwei ate a specially prepared "take out" meal of traditional Chinese foods, took a three-hour nap, and conducted other preplanned activities. October also marks the birthday for China's first female astronaut, Liu Yang. Her historic flight took place during June of 2012 when she flew aboard the Shenzhou-9 with two male astronauts on a flight to orbit and then dock on the Tiangong-1 space laboratory.

Martian winter solstice

This month also marks a change of seasons on Mars as it transitions from fall to winter. Seasons on Mars are based on the planet's longitudinal location along its 684-Earth-day orbit around the Sun. Each seasonal starting/ending point is 90° apart, but because of Mars's elliptical-shaped orbit, each Martian season varies in length. At 90° longitude, Mars is at its *aphelion*, the greatest distance from the Sun, and experiences the Martian summer solstice. Mars reaches its *perihelion*, its closest distance to the Sun, at 270° longitude and experiences the Martian winter solstice. Figure 1 shows the dates and heliocentric longitudes for the current and following Martian years. While the Martian day is based on its 24-hour, 39-second rotation rate referred to as a *Sol*, the Martian year is based on its 684-Earth-day (688 Sols) orbit around the Sun.

Mars has an orbital shape that is more eccentric than the Earth's. *Eccentricity* is a measure of the shape of the orbit ranging from 0 for a perfect circle to 1, which technically would be a straight line, as the shape becomes increasingly elliptical from 0 to 1. Mars has an eccentricity of 0.0934 compared

FIGURE 1: Martian seasons calendar

Year 34		
May 5, 2017	0°	Spring equinox
November 20, 2017	90°	Summer solstice
May 22, 2018	180°	Fall equinox
October 16, 2018	270°	Winter solstice
Year 35		
March 23, 2019	0°	Spring equinox
October 8, 2019	90°	Summer solstice
April 8, 2020	180°	Fall equinox
September 2, 2020	270°	Winter solstice

Visible planets

Mercury will be visible but low over the western horizon for most of this month.

Venus will be visible over the western horizon near Mercury; however, Venus, like Mercury, will be low over the horizon and will only be visible for the first week of October.

Mars will rise during mid-afternoon and will be visible over the southern horizon at sunset. It is also that time of year on Mars when seasons will change, and this month marks the Martian Winter Solstice.

Jupiter will be over the western horizon at sunset and will set a couple of hours later.

Saturn will be visible over the southern horizon at sunset and will be visible for the remainder of the night hours.

For students

1. Use the NASA resources listed at the end of this column to research a space mission and learn of its history, technology used, mission objectives or accomplishments, and discoveries.
2. Many of the NASA missions are acronyms in which the letters stand for mission objectives. The use of acronyms by NASA to name missions is creative and requires much brainstorming. Have students come up with an idea for a space mission, objectives for the mission, and an acronym for the mission that states some of the mission objectives.
3. Get some ideas about hosting your own International Observe Moon Night with family and friends. Download the Moon Viewing guide from the activity page at the IOMN website (see Resources).
4. What are the dates and time, season on Mars, and its heliocentric longitude position on October 16th or on your birthday? Use the Earth Date to Martian Solar Longitude Conversion website to find out (see Resources).

with Earth's 0.0167. Because of the rounder shape of Earth's orbit, it is the Earth's axial tilt (23.5o), rather than its distance from the Sun, that accounts for the northern hemisphere having the opposite season of the southern hemisphere. Even though Mars has a similar axial tilt (25o), it is the distance from the Sun that has the greatest influence on seasons. Near its aphelion, for instance, Mars is moving more

October

1 NASA's 60th anniversary (1958)
Japan Aerospace Exploration Agency's (JAXA) 15th anniversary (2003)
2 Last quarter Moon
4 Moon at ascending node
Waning crescent Moon near Beehive Star Cluster
World Space Week (October 4–10)
5 Waning crescent Moon near Regulus
Moon at perigee: 366,396 km (227,668 mi.)
6 10th anniversary of *MESSENGER* making second Mercury flyby
9 New Moon
10 35th anniversary of *Venera 15* Venus orbital insertion
11 Waxing crescent Moon near Jupiter
35th anniversary of the discovery of asteroid 3200 Phaethon
35th anniversary of *Venera 16* Venus orbital insertion
50th anniversary of the launch of Apollo 7
14 15th anniversary of the launch of the first Chinese-crewed mission
15 Waxing crescent Moon near Saturn
16 Waxing crescent Moon near Mercury
First quarter Moon
Mars winter solstice
17 Moon at descending node
Moon at apogee: 404,227 km (251,175 mi.)
18 Waxing gibbous Moon near Mars
19 10th anniversary launch of *Interstellar Boundary Explorer*
20 International Observe the Moon Night
21 Orionid meteor shower
24 Uranus at opposition
Full Moon
12th anniversary of *MESSENGER* making first Venus flyby
26 Venus at inferior conjunction
27 Aldebaran 1.6°S of Moon
28 European summer time ends
29 Mercury 3.1° of Jupiter
20th anniversary of STS-95 launch
31 Moon at ascending node
Waning gibbous Moon near Beehive Star Cluster
Last quarter Moon
Moon at perigee: 370,201 km (230,032 mi.)

slowly than it would at its perihelion. When Mars approaches 90°, it experiences summer in the northern hemisphere solstice and winter in the southern hemisphere. What this means is there will be more summer days in the northern hemisphere and colder days in the southern hemisphere. ●

RESOURCES

A Gravity Assist Primer—*solarsystem.nasa.gov/basics/primer*

Apollo 7—*nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1968-089A*

China National Space Administration—*www.cnsa.gov.cn/n6443408/index.html*

Earth Time to Martian Time—*www-mars.lmd.jussieu.fr/mars/time/martian_time.html*

ESA—*www.esa.int/ESA*

Flying by a Venus Volcano—*www.jpl.nasa.gov/video/details.php?id=900*

IBEX—*nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=2008-051A*

International Observe the Moon Night—*www.lpi.usra.edu/observe_the_moon_night/past-future-events*

IRAS—*www.jpl.nasa.gov/missions/infrared-astronomical-satellite-iras*

JAXA—*global.jaxa.jp*

Liu Yang—*https://bit.ly/2vR2gQ6*

List of Space agencies (Click on Export link to download spreadsheet)—*www.wmo-sat.info/oscar/spaceagencies*

Mars Winter Solstice—*www.planetary.org/explore/space-topics/mars/mars-calendar.html*

MESSENGER—*messenger.jhuapl.edu*

NASA—*www.nasa.gov*

NASA History Program Office—*history.nasa.gov/publications.html*

NASA Space Science Data Coordinated Archive—*nssdc.gsfc.nasa.gov*

National Aeronautics and Space Act—*history.nasa.gov/spaceact.html*

Planet Mercury—*solarsystem.nasa.gov/planets/mercury/overview*

Rosecosmos—*en.roscosmos.ru*

Space Calendar—*www2.jpl.nasa.gov/calendar/calendar.html*

STS-95—*nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1998-064A*

Shenzhou 5—*nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=2003-045A*

Venera 15—*nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1983-053A*

Venus Images—*nssdc.gsfc.nasa.gov/photo_gallery/photogallery-venus.html*

Women in Space—*history.nasa.gov/women.html*

World Space Week—*www.worldspaceweek.org*

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