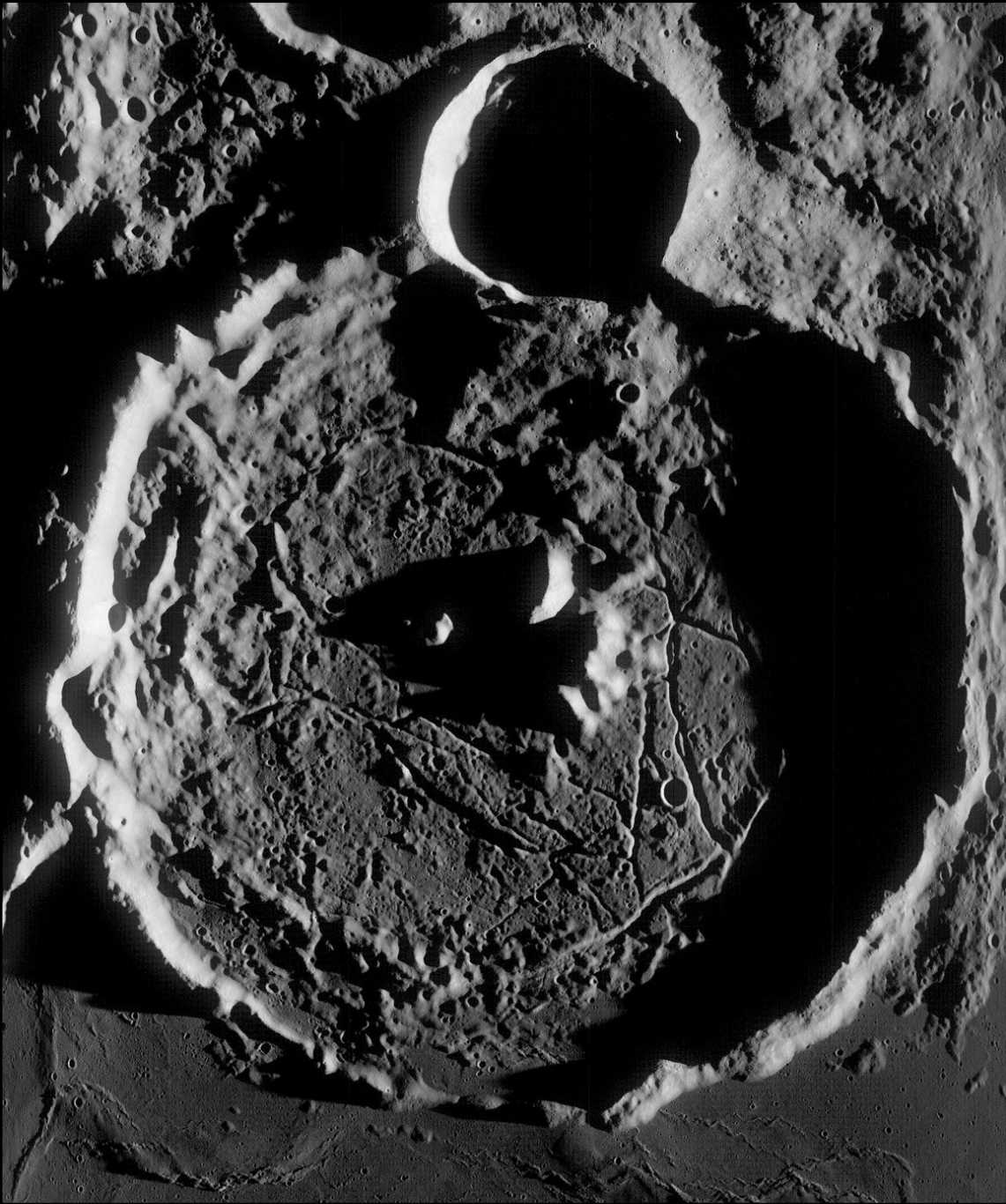


# *Galactic Observer*

*John J. McCarthy Observatory*

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Floor-Fractured Crater Gassendi on the edge of Mare Humorum  
Credit: LRO/WAC/GSFC/ASU

## October Astronomy Calendar and Space Exploration Almanac



International Observe the Moon Night - October 16, 2021  
10 Day Old Moon Mosaic with 4-Inch Antique Refractor: Bill Cloutier

## In This Issue

	<u>Page</u>
🌐 International Observe the Moon Night .....	3
🌐 InOMN Highlight, Mare Humorum.....	4
🌐 Lucy in the Sky .....	5
🌐 BepiColombo, First Mercury Flyby.....	6
🌐 Carolyn Shoemaker (1929-2021).....	7
🌐 First Sample .....	8
🌐 Ready for Launch.....	10
🌐 Hurricane Ida .....	11
🌐 Red Mars.....	14
🌐 Saturn .....	15
🌐 Jupiter.....	15
🌐 Jovian Moon Transits.....	15
🌐 Great Red Spot Transits .....	15
🌐 Space Race History .....	16
🌐 October Nights .....	17
🌐 Sunrise and Sunset .....	17
🌐 Astronomical and Historical Events .....	17
🌐 Commonly Use Terms .....	22
🌐 Lagrange Points .....	22
🌐 References on Distances .....	23
🌐 International Space Station and Artificial Satellites .....	23
🌐 Solar Activity .....	23
🌐 NASA’s Global Climate Change Resource .....	23
🌐 Mars – Mission Websites.....	23
🌐 Contact Information .....	24

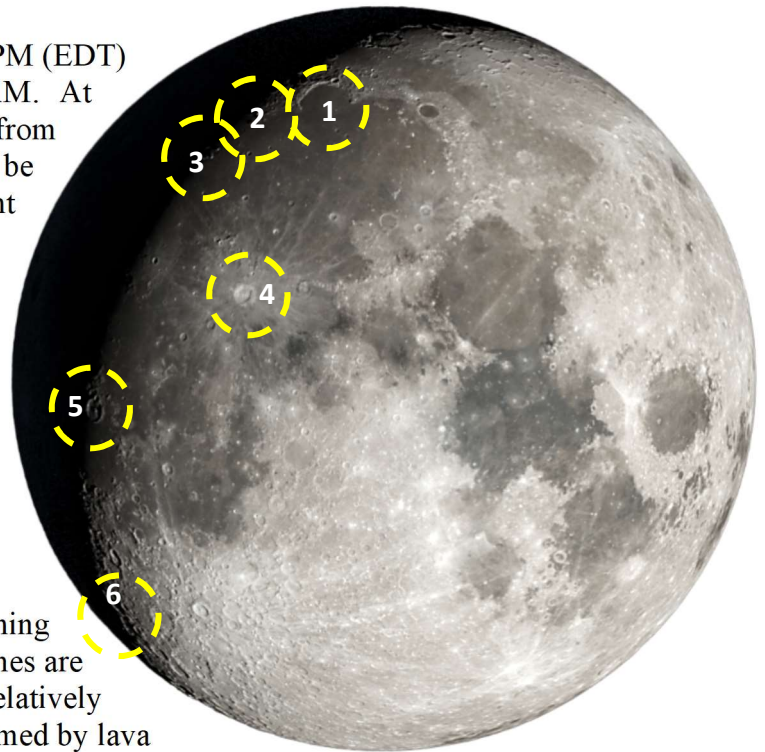


## International Observe the Moon Night

October 16<sup>th</sup> is International Observe the Moon Night (InOMN). The event was first inspired by public outreach activities held in August 2009 by the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) educational teams at the Goddard Space Flight Center in Greenbelt, Maryland and at the Ames Research Center in Moffett Field, California, respectively. In 2010, the Lunar and Planetary Institute and Marshall Space Flight Center joined Goddard and Ames in a world-wide event to raise public awareness of lunar science and exploration.

On the 16<sup>th</sup>, the Moon will rise just before 5 PM (EDT) and set the next morning around 3:48 AM. At approximately 239,000 miles (385,000 km) from Earth, 87% of the near-side surface will be illuminated as the Sun sets and twilight deepens. With clear skies, the following lunar features will be visible:

1. Sinus Iridum (Bay of Rainbows): a segment of a 161-mile-wide (260 km) crater along the northwest rim of Mare Imbrium that forms a natural bay after being flooded with lava. The crater's north and west rims form the Jura Mountains.
2. Gruithuisen Domes: volcanic domes reaching about a mile (1,600 m) in height. The domes are unusual for Moon in their elevation and relatively steep gradient as they must have been formed by lava that was particularly viscous.
3. Harbinger Mountains: a small range about 59 miles (95 km) long, with heights up to 1.2 miles (2 km). Best seen just after sunrise.
4. Copernicus: a relatively young (about 800 million years old), 57-mile-diameter (93 km) classic complex crater, with terraced walls, a flat floor, and a group of central peaks towering almost a mile (1,200 m) above the floor. The crater is over 2.2 miles (3,700 m) deep.
5. Gassendi: This 68-mile-diameter (110 km) floor-fractured crater lies on the northern rim of Mare Humorum. Floor-fractured craters are created when magma rising from beneath the surface pushes up the floor of the crater, creating a network of fractures across the crater's floor. Gassendi was under consideration for Apollo 17, but the rough terrain posed too much risk for the final mission.
6. Schiller: an elongated crater near the limb, measuring 111 x 43 miles (180 x 70 km) - likely formed by a grazing impact of an asteroid.

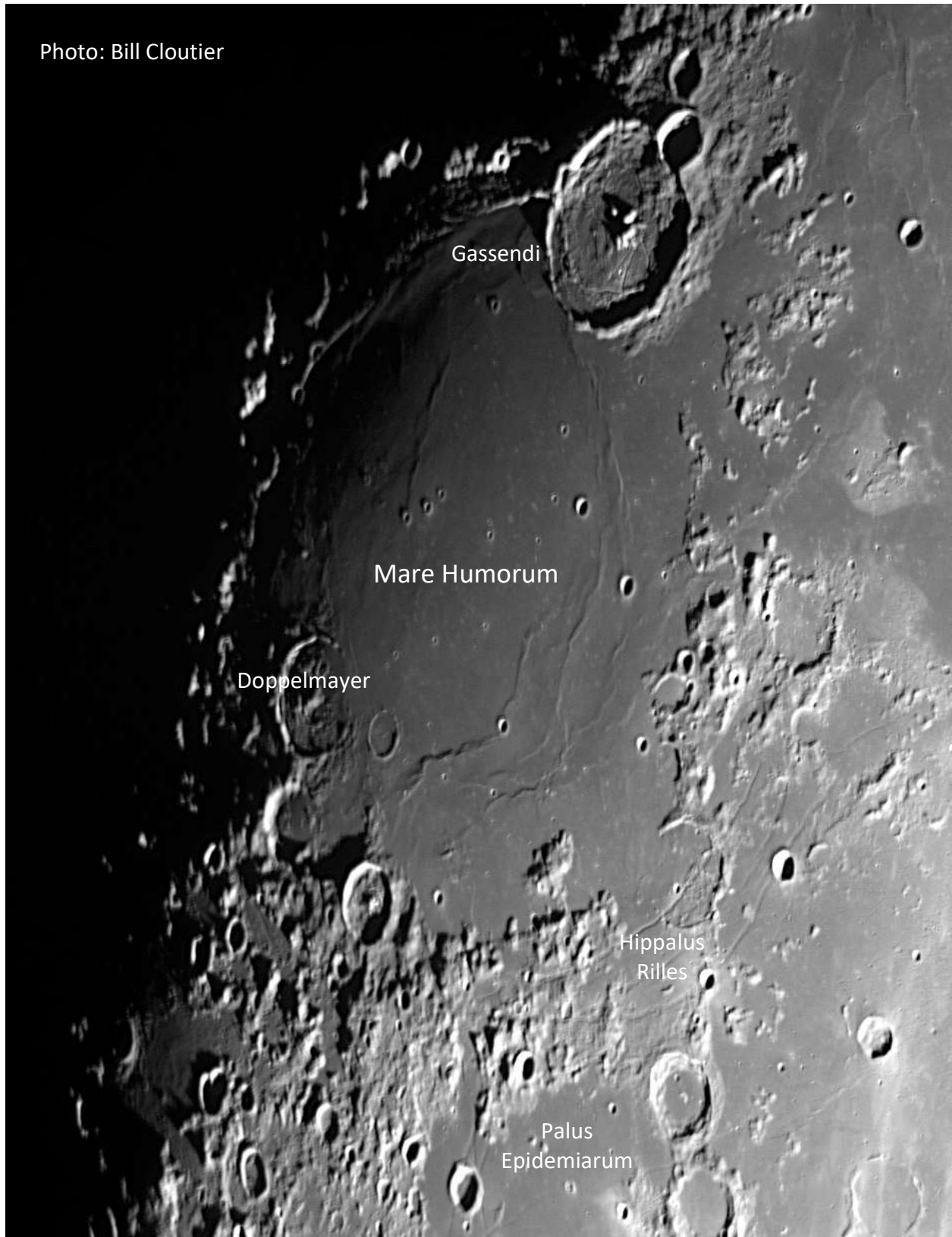


The Moon on the night of October 16  
Credit: NASA's Scientific Visualization Studio

Information on InOMN events is available at: <https://moon.nasa.gov/observe-the-moon-night/>

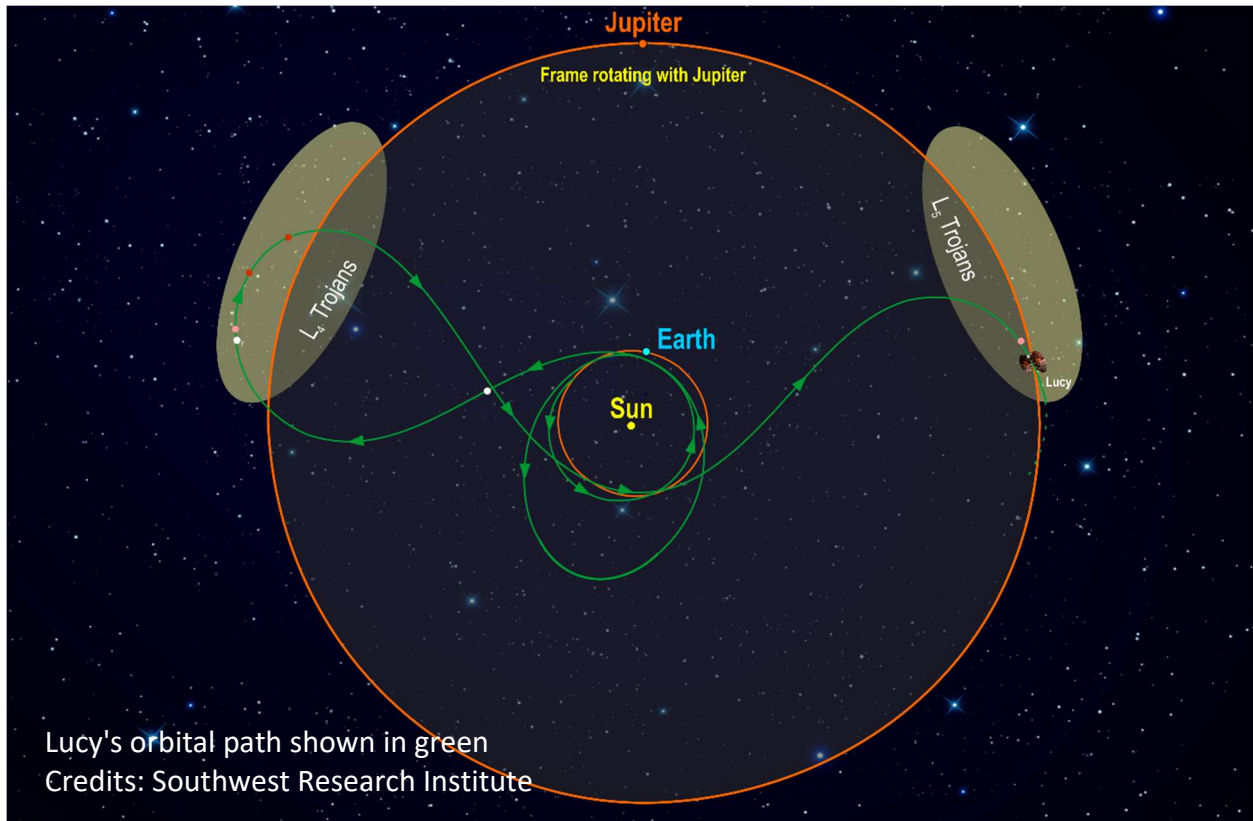
InOMN Highlight  
Mare Humorum

Photo: Bill Cloutier



## Lucy in the Sky

The launch window for NASA's Lucy mission opens on October 16<sup>th</sup>. It will be a twelve-year mission that will visit eight asteroids – one main belt asteroid and seven Jupiter Trojan asteroids located at the L4 and L5 Lagrange points along the gas giant's orbit (roughly 60° in front and behind the planet). Astronomers believe that the Trojan asteroids are relics from a time over 4 billion years ago when the first protoplanets were accreting from within the solar nebula and, as such, are time capsules that may provide insight into the planet-building process.



Lagrange points are areas of gravitation stability, first identified by the 18<sup>th</sup> century mathematician Joseph Louis Lagrange. They are utilized to park spacecraft and telescopes for long-term stays/observations, as little energy is required to maintain position. Jupiter's L4 and L5 points form an equilateral triangle with the Sun and the gas giant.

Lucy will execute three flybys of Earth, using our planet to adjust its course and velocity (gravitational assists). The second flyby in 2024 will send the spacecraft out through the main asteroid belt where it will fly by the asteroid (52246) Donaldjohanson in April of the following year. In 2027, Lucy will reach the L4 group of asteroids where it will first encounter (3548) Eurybates and its satellite. Over the following year, several more Trojan asteroids (including three different types) will be visited before the spacecraft loops back toward Earth for its third flyby, which will send it back towards Jupiter and the trailing L5 group. While the 2033 encounter with the binary pair (617) Patroclus-Menoetius at L5 will officially conclude the mission, Lucy's orbit will continue to cycle the spacecraft between the L4 and L5 points every six years for the foreseeable future. Lucy is named after the 2.4-million-year-old humanoid fossil found in Ethiopia in 1974 by Donald Johanson and Tom Gray, which in turn was named after the Beatles tune "Lucy in the Sky with Diamonds" by an expedition team member.

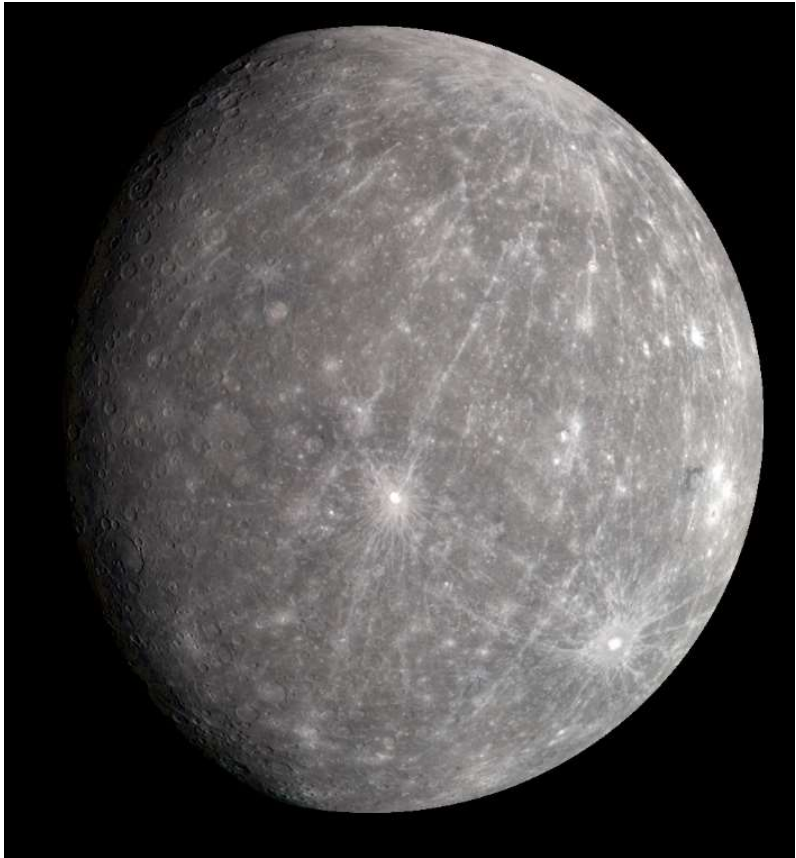
## BepiColombo - First Mercury Flyby

A joint mission (BepiColombo) to the planet Mercury, between the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA), was launched in October 2018. The spacecraft executed a successful flyby of Earth and two flybys of Venus (gravity assists), using the planets to reduce its distance to Mercury and lower its relative velocity. On October 2, 2021 the spacecraft will conduct its first of six flybys of Mercury before being captured by the gravity of the inner-most planet in late 2025.

The BepiColombo spacecraft is comprised of two orbiters, which will separate once in orbit around Mercury – JAXA’s Mercury Magnetospheric Orbiter (MMO) and ESA’s Mercury Planetary Orbiter (MPO). MPO will study the planet’s surface and internal composition from an elongated orbit of 300 by 900 miles (480 by 1,500 km) - completing an orbit every 2.3 hours. MMO will study the planet’s magnetosphere, the area around the planet that is influenced by Mercury’s weak magnetic field, from an orbit of 370 by 7,200 miles (590 by 11,640 km) - completing an orbit every 9.3 hours. Both spacecraft will be inserted into polar orbits. The mission has a one-year nominal timeframe, with a possible one-year extension.

BepiColombo is only be the third mission to visit the planet Mercury. The first spacecraft was NASA’s Mariner 10, which imaged about half the planet during three flybys between 1974 and 1975. Mariner 10 was also the first spacecraft to use a gravity assist (from Venus) to modify its trajectory.

NASA’s MESSENGER spacecraft conducted three flybys of Mercury between 2008 and 2009, before settling into orbit in 2011, nearly seven years after launch. The spacecraft spent the next four years studying the planet - getting as close as 15.5 miles (25 kilometers) above the surface in its final orbit. MESSENGER transmitted more than 250,000 images of Mercury before running out of fuel and crashing into the planet in April 2015.



Mercury, as photographed by NASA’s MESSENGER spacecraft in 2008  
Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Arizona State University/Carnegie Institution of Washington

Carolyn Shoemaker (1929-2021)



Pictured above (from left to right): John Dobson, David Levy, Kyle Cloutier, Carolyn Shoemaker, and Wendee Levy at the 2002 Stellafane Convention in Springfield, Vermont  
Credit: Bill Cloutier

Comet hunter Carolyn Shoemaker has died at the age of 92. She is credited with the discovery of more than 800 asteroids and 32 comets (holding the record for the most comet discoveries) in an age when photographic plates or films were examined with a stereoscope for moving objects.

In 1993, Carolyn co-discovered, with husband Eugene, and David Levy, their ninth short-period comet, using the 0.4-meter Schmidt telescope on Palomar Mountain in California. It would be formally designated P/Shoemaker-Levy 9 and, at the time of discovery, had already been torn apart by Jupiter's gravity into more than 20 pieces (likely as a result of a close approach to the gas giant in 1992). The "string of pearls" subsequently collided with Jupiter in 1994, capturing world-wide attention, and creating short-lived, dark blemishes on the planet's cloud tops.

Born in Gallup, New Mexico, Carolyn didn't develop an interest in the night sky and asteroid hunting until late in life (after she and her husband had raised their family). She was a keen observer and charter member of the Planetary Society (underwriter of the Shoemaker NEO Grant program). The Hildian asteroid 4446 Carolyn (in orbital resonance with Jupiter) was named in her honor.

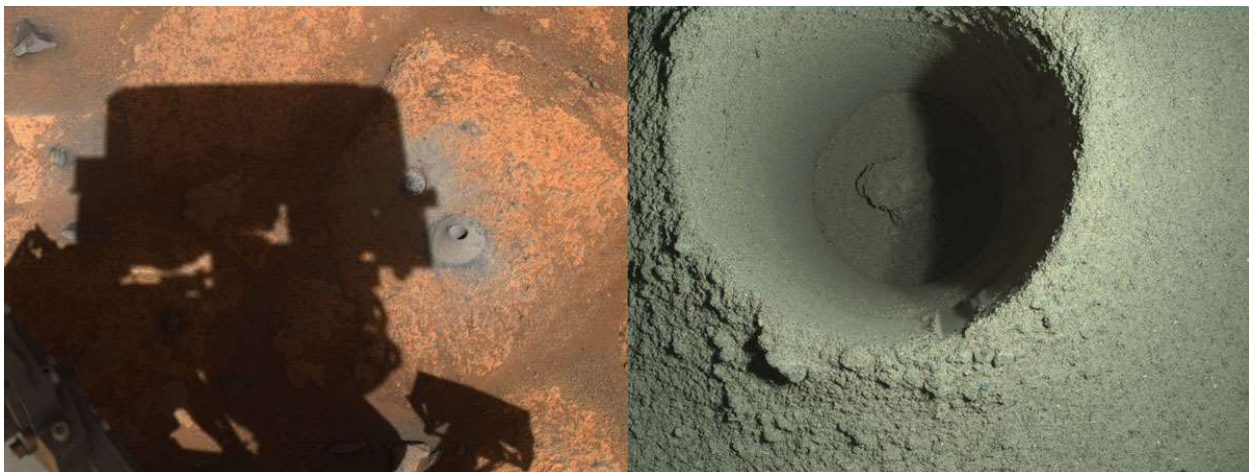


## First Sample

The mission of NASA's Perseverance rover includes the collection and caching of samples for eventual return to Earth. On the rover's first attempt, the drilling and caching system appeared to work flawlessly, but the results were not as anticipated or desired. On August 6<sup>th</sup>, the rover used its rotary-percussive drill and a hollow coring bit in an attempt to extract a pencil-sized sample from a field of flat rocks dubbed "paver stones." While the drill reached its intended depth, no sample was collected. The project team at the Jet Propulsion Laboratory (JPL) believe that the interior of the rock was too powdery or crumbly to maintain cohesion.



Lighter colored "paver stones," in the lower left-hand corner of the image, were the target of the rover's first sampling attempt  
Credit: NASA/JPL-Caltech/ASU/MSSS



Paver stone drill hole (adjacent to the shadow cast by Perseverance's mast) on the left and interior of the hole, surrounded by the cuttings pile on the right  
Credit: NASA/JPL-Caltech/MSSS

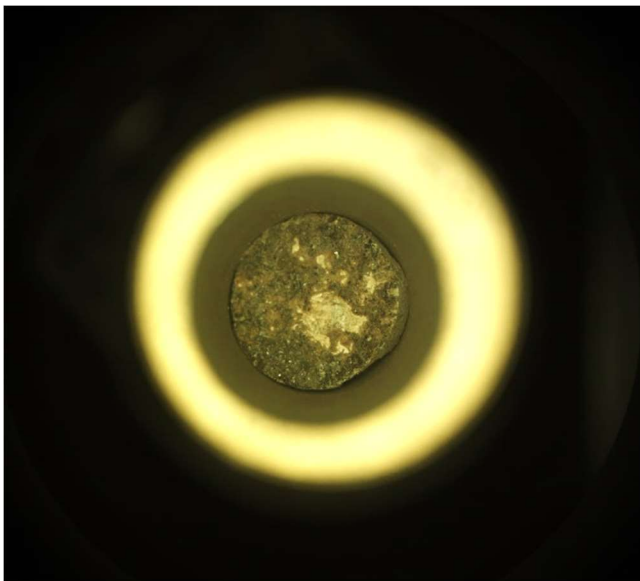
Not to be deterred, a second, more substantive rock (named Rochette) was targeted for a second (and third) sampling effort. On September 1<sup>st</sup>, the rover successfully collected its first rock core. While Perseverance's sample and caching system is completely automated, engineers interrupted the process to verify (visually) that the sample tube contained a core, prior to the tube being sealed.



The brief-case-sized rock named Rochette after the first successful sampling campaign  
Credits: NASA/JPL-Caltech

The coring process begins by abrading the surface of the rock to expose its original features (the rover's drill has a suite of interchangeable drill bits, including those that are used to reveal a fresh patch of rock about 2 inches in diameter). NASA used the rover's PIXL (Planetary Instrument for X-ray Lithochemistry) instrument to analyze the abrasion targets – revealing salt minerals that could include trapped bubbles of ancient water.

Left: image acquired by the onboard Sample Caching System Camera located inside the rover - looking down the sample tube and at the top of the sampled material Right: the final product - a sealed airtight titanium sample tube, which is then stored inside the rover  
Image Credit: NASA/JPL-Caltech



## Ready for Launch

Engineers at Northrop Grumman have completed the comprehensive and integrated testing of NASA's next generation telescope. The James Webb Space Telescope (Webb) is now being prepared for shipment to the launch site in Kourou, French Guiana, on the northeastern coast of South America, with a tentative launch date of December 18.



Credits: NASA/Chris Gunn

The telescope was developed as a joint venture between NASA, the European Space Agency, and the Canadian Space Agency, with contributions from more than 14 countries. As the largest space telescope ever built; it has a deployable mirror measuring 21.3 feet (6.5 meters) in diameter. Designed to observe the universe in the infrared, the Webb will be able to look back to a time when the first galaxies were materializing, as well as inside dust clouds where stars and planets are forming today.

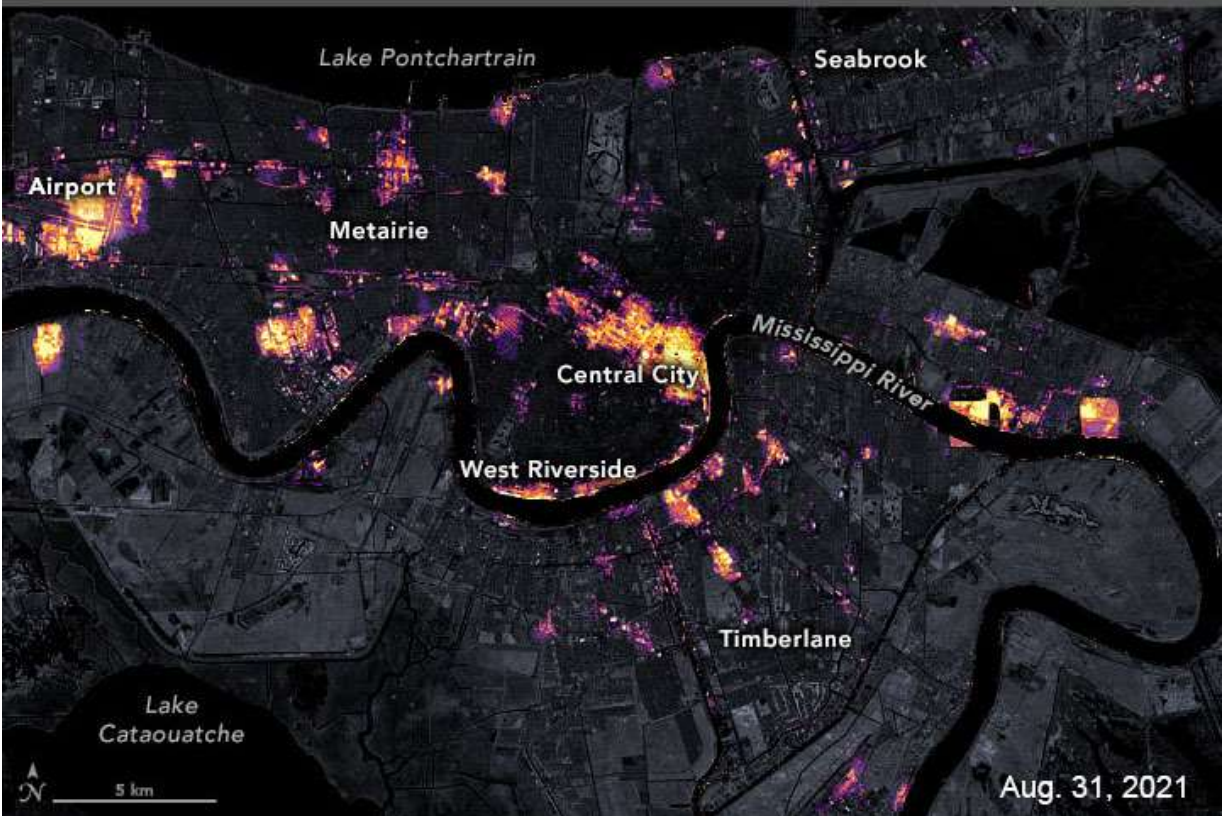
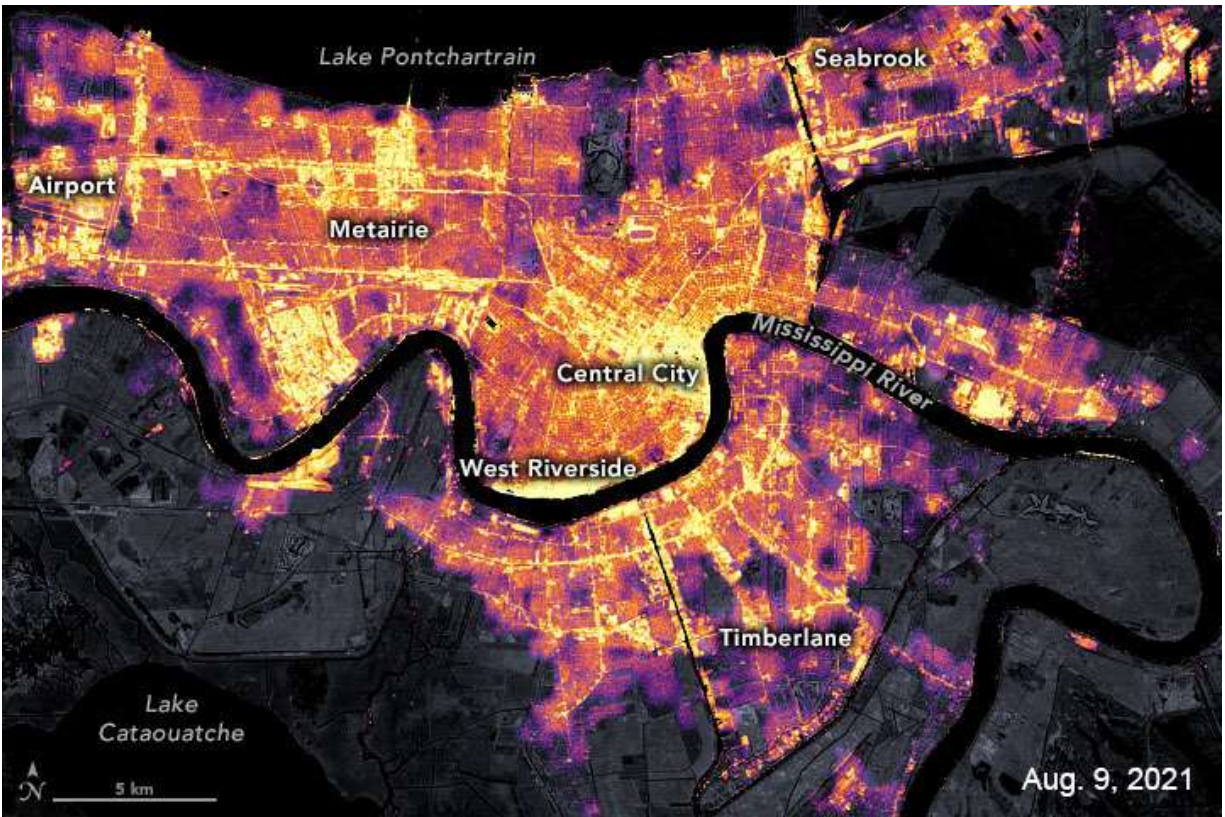
A Lockheed C5 Galaxy cargo plane could have flown the telescope to an airport in French Guiana; however, the bridges along the overland portion of the route to the launch pad could not accommodate the load. Consequently, the decision by made to send the telescope by sea – from California through the Panama Canal and eventually up the Kourou river, to a location about an hour’s drive from the launch site.

No sooner than December 18, an Ariane 5 rocket will carry the telescope into orbit and send it along its way to its permanent observing location at the L2 point (Lagrange), approximately 1 million miles (1.5 million km) behind the Earth, as seen from the Sun. It will take about a month for the Webb to reach its observing location - the remoteness necessary to be able to cool the telescope to just 50° above absolute zero. The tennis-court-size sunshield will be the first component to deploy – just days after launch. As the telescope cools down, the mission team will initiate the unfolding of the secondary mirror tripod and primary mirror, followed by powering up of the telescope’s instruments. After reaching the L2 point, the telescope and its instrument will be aligned and calibrated, with scientific observations expected to commence about six months after launch.

### Hurricane Ida



Hurricane Ida as captured by the VIIRS instrument onboard the NASA/NOAA Suomi-NPP satellite early the morning of Aug. 30, 2021  
Credit: NASA



New Orleans' nighttime lights data acquired by the Suomi NPP satellite with base maps from Landsat 8 satellite data

Credits: NASA Earth Observatory images by Joshua Stevens, using Black Marble data courtesy of Ranjay Shrestha/GSFC and Landsat data from the USGS



Hurricane Ida, a Category 4 storm, captured on August 29, 2021 from the International Space Station as it nears the southeast Louisiana coast  
Image Credit: NASA

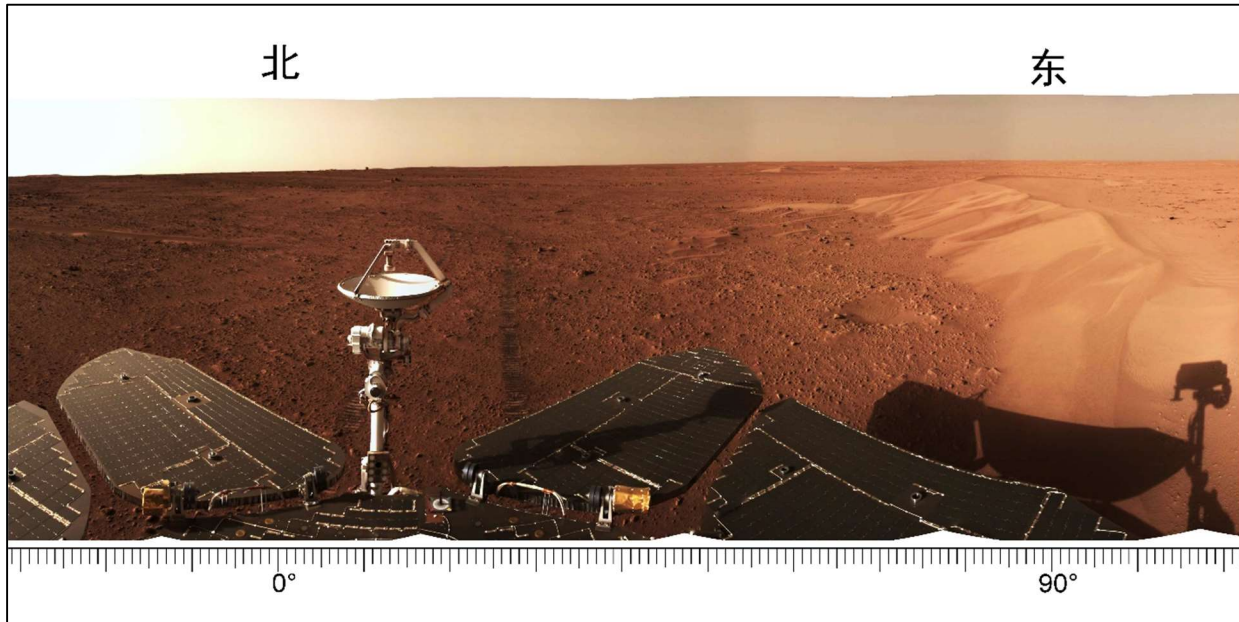
Sixteen years after Hurricane Katrina made landfall in 2005, southern Louisiana and the city of New Orleans were struck by a powerful Category 4 storm called Ida. The hurricane delivered a destructive storm surge, high winds, and heavy rainfall, leaving over 1 million customers without power in the region, including the entire city.

With its fleet of Earth-monitoring satellites, collectively known as the Earth Observing System (EOS), NASA is in a unique position to assess storm damage and aid in recovery efforts. The Visible Infrared Imaging Radiometer Suite (VIIRS), onboard the Suomi National Polar-Orbiting Partnership (Suomi NPP) spacecraft, is capable of providing data in 22 imaging and radiometric bands, covering both visible and infrared wavelengths. The data is used to monitor clouds, sea surface temperature, ocean color, polar wind, aerosols, fire, snow and ice, vegetation, as well as for other applications. For example, the day/night-band imagery can assess the change in nighttime light, that in the aftermath of a storm can be an indicator of wide spread power outages.

The Suomi NPP spacecraft is a weather satellite operated by the National Oceanic and Atmospheric Administration (NOAA). It was launched in 2011 into a polar orbit 512 miles (825 km) above Earth's surface and circles the planet 14 times a day. It was intended as a bridge between the older EOS satellites and a series of new Joint Polar Satellite System (JPSS) satellites – the first of which (JPSS-1 or NOAA-20) was launched in November 2017. JPSS-1 circles the Earth in the same orbit as Suomi NPP – with the two separated by 50 minutes. The second of NOAA's next generation of polar-orbiting satellites (JPSS-2) is scheduled for launch in 2022.

## Red Mars

China's Mars rover Zhurong is planning to suspend operations for several weeks (as are NASA's rovers) with the approach of Solar Conjunction – when Mars is on the opposite side of the Sun from the Earth and communications can be easily disrupted (the Sun is a strong radio source). In celebration of 100 days on Mars, the rover captured a new panorama of its surroundings on Utopia Planitia.



A segment of the full panorama, including the rover's solar panels and communications equipment – a dune can be seen on the right  
Image credit: CNSA/PEC

The six-wheeled, solar-powered rover (similar in appearance to NASA's Mars Exploration Rovers) has traveled 3,491 feet (1,064 meters) since rolling off its landing platform in May. Zhurong is equipped with ground penetrating radar, which will be used to determine the soil profile around the landing area and the presence of any subsurface water or ice.

## Saturn

Saturn reached Opposition in early August when the ringed-world was closest to Earth. Since that time, the distance between the Earth and Saturn has been steadily increasing with Earth's higher orbital velocity. Saturn is still well placed in evening sky, just to the west of Jupiter in the constellation Capricornus and east of the Milky Way. The planet's north pole is tilted towards the Earth and its rings inclined at an angle of  $18^\circ$  to our line of sight (less than their maximum inclination in 2017, but still a nice presentation).



Image: Marc Polansky

## Jupiter

Jupiter was also closest to the Earth in August. In October, Jupiter shines brightly in the southern sky after sunset (more than 18 times brighter than Saturn). The largest planet in the solar system is also in the constellation Capricornus and just to east of Saturn.

	Rise and Transit Times (EDT)			
	October 1		October 31	
Planet	Rise	Transit*	Rise	Transit*
Saturn	4:00 pm	8:50 pm	2:03 pm	6:50 pm
Jupiter	4:46 pm	9:54 pm	2:48 pm	7:51 pm



\* The celestial meridian is an imaginary the line that connects the north and south points of the horizon with the observer's zenith (point directly overhead). A planet is highest in the sky when it crosses or transits the meridian.

## Jovian Moon Transits

On nights of good visibility, the shadow(s) of Jupiter's moon(s) can be seen on the cloud tops as they cross (transit) the planet's disk. Only events that start or end between 8 pm and midnight are included. A more complete listing can be found in *Sky & Telescope's* monthly magazine.

Date	Moon	Transit Begins	Transit Ends
4 <sup>th</sup>	Io	10:20 pm	12:38 am (5 <sup>th</sup> )
7 <sup>th</sup>	Europa	6:42 pm	9:30 pm
11 <sup>th</sup>	Ganymede	6:54 pm	10:29 pm
13 <sup>th</sup>	Io	6:45 pm	9:02 pm
14 <sup>th</sup>	Europa	9:18 pm	12:06 am (15 <sup>th</sup> )
18 <sup>th</sup>	Ganymede	10:56 pm	2:30 am (19 <sup>th</sup> )
20 <sup>th</sup>	Io	8:41 pm	10:58 pm
21 <sup>st</sup>	Europa	11:54 pm	2:42 am (22 <sup>nd</sup> )
27 <sup>th</sup>	Io	10:37 pm	12:53 am (28 <sup>th</sup> )

## Great Red Spot Transits

The Great Red Spot is a large, long-lived cyclone in the upper Jovian atmosphere. The Earth-size storm will cross the center line of the planetary disk on the following evenings during the hours between 8 pm to midnight local time.



## Great Red Spot Transit Times

Date	Transit Time	Date	Transit Time
1 <sup>st</sup>	9:54 pm	18 <sup>th</sup>	8:58 pm
3 <sup>rd</sup>	11:32 pm	20 <sup>th</sup>	10:37 pm
6 <sup>th</sup>	9:02 pm	23 <sup>rd</sup>	8:07 pm
8 <sup>th</sup>	10:41 pm	25 <sup>th</sup>	9:46 pm
11 <sup>th</sup>	8:11 pm	27 <sup>th</sup>	11:24 pm
13 <sup>th</sup>	9:49 pm	30 <sup>th</sup>	8:55 pm
15 <sup>th</sup>	11:28 pm		

## Space Race History

On October 11, 1968, a Saturn 1-B rocket carried Apollo 7, the first manned Apollo command and service module, into low-Earth orbit. The test flight would last almost 11 days and complete 163 orbits of the Earth. Walter Schirra (5<sup>th</sup> American in space when he flew the Mercury-Atlas 8 mission on October 3, 1962), commanded the crew along with command module pilot Donn Eisele and lunar module pilot Walter Cunningham.

The Block II command module was a redesigned and much improved version of the Block I model that was involved in the Apollo 1 accident. The two-piece, inward opening and bolted hatch on the Block I model was replaced with a one-piece, outward opening, quick release hatch on the Block II module. The 100% oxygen atmosphere used in the Block I module was also replaced with a less flammable 60% oxygen and 40% nitrogen mixture at launch. The air in the Block II module was purged and converted to 100% oxygen as the flight progressed.



Apollo 7 did not carry a lunar lander; however, a simulated docking with the third stage was planned (the lunar lander would be carried within the third stage in future flights). Schirra canceled the docking maneuvers when one of the adapter panels on the third stage did not fully deploy (the panels were jettisoned with explosive charges on future flights to avoid such a reoccurrence since access to the lunar module was vital to a lunar mission).

There were relatively few problems with the spacecraft and most were resolved before Apollo 8 made its historic trip to the Moon in the following December. The service module's main engine, required to enter into and leave lunar orbit performed flawlessly, restarting eight times during the mission. The overall performance of the Apollo 7 command and service module was a significant factor in NASA's decision to send Apollo 8 to the Moon after only one low-Earth test flight.

### October Nights

As the nights grow longer and cooler our view of the night sky begins to change. Summer evenings showcase our own galaxy, the Milky Way. The center of our spiral galaxy is in the direction of the constellation Sagittarius, which appears in the southern sky throughout the summer. In the autumn, as Sagittarius disappears into the west, the stars forming the Great Square of Pegasus rise in the east. Following Pegasus is the Andromeda Galaxy, one of the most distant objects that can be seen with the unaided eye at approximately 2.5 million light years (14.7 million trillion miles). With the rising of Andromeda, we begin to look outward to the outer arms of our own galaxy and to other galaxies far, far away.

### Sunrise and Sunset (from New Milford, CT)

<u>Sun</u>	<u>Sunrise</u>	<u>Sunset</u>
October 1 <sup>st</sup> (EDT)	06:50	18:33
October 15 <sup>th</sup>	07:05	18:10
October 31 <sup>st</sup>	07:23	17:47

### Astronomical and Historical Events

- 1<sup>st</sup> History: launch of Chang'e 2 – China's Moon Orbiter (2010)
- 1<sup>st</sup> History: NASA created by the National Aeronautics and Space Act (1958)
- 2<sup>nd</sup> BepiColombo, 1<sup>st</sup> Mercury flyby
- 2<sup>nd</sup> Apollo Asteroid 2201 *Oljato* closest approach to Earth (1.467 AU)
- 2<sup>nd</sup> History: opening of the Hayden Planetarium (1935)
- 3<sup>rd</sup> Atira Asteroid 2012 VE46 closest approach to Earth (0.335 AU)
- 3<sup>rd</sup> Plutino 469372 (2001 QF298) at Opposition (42.595 AU)
- 3<sup>rd</sup> History: first successful test launch of the German A-4 rocket (V-2) (1942)
- 3<sup>rd</sup> History: launch of the fifth Mercury flight, piloted by astronaut Walter Schirra (1962)
- 3<sup>rd</sup> History: fall of the Zagami Martian meteorite in Katsina Province, Nigeria; the meteorite is classified as a Shergottite and is the largest single individual Mars meteorite ever found at 40 pounds (1962)
- 3<sup>rd</sup> History: fall of the Chassigny Martian meteorite in Haute-Marne province, France; the meteorite is distinctly different from other Martian meteorites (shergottites and nakhlites) and is classified as its own subgroup – "chassignites" (1815)

## Astronomical and Historical Events

- 4<sup>th</sup> Amor Asteroid *5751 Zao* closest approach to Earth (1.670 AU)
- 4<sup>th</sup> Kuiper Belt Object 523794 (2015 RR245) at Opposition (60.537 AU)
- 4<sup>th</sup> Kuiper Belt Object *541132 Leleakuhonua* at Opposition (76.504 AU)
- 4<sup>th</sup> History: Japanese lunar probe “Selenological and Engineering Explorer” (SELENE) enters lunar orbit; also known as Kaguya, the spacecraft was designed to study the geologic evolution of the Moon (2007)
- 4<sup>th</sup> History: SpaceShipOne rockets to an altitude of almost 70 miles to win the \$10 million Ansari X Prize (2004)
- 4<sup>th</sup> History: launch of Luna 3; Soviet spacecraft was first to photograph the far side of the Moon (1959)
- 4<sup>th</sup> History: launch of Sputnik 1, world’s first artificial satellite (1957)
- 5<sup>th</sup> Schedule launch of cosmonaut Anton Shkaplerov, film director Klim Shipenko, and actress Yulia Peresild. Shkaplerov to the International Space Station aboard a Russian Soyuz rocket from the Baikonur Cosmodrome, Kazakhstan
- 5<sup>th</sup> Amor Asteroid *2608 Seneca* closest approach to Earth (2.046 AU)
- 5<sup>th</sup> History: Edwin Hubble's discovery of Cepheid Variable Star V1, a special class of variables that can be used measure large cosmic distances (1923)
- 5<sup>th</sup> History: launch of the space shuttle Challenger (STS-41-G), crew included astronaut Kathryn Sullivan, first American women to walk in space (1984)
- 5<sup>th</sup> History: Robert Goddard born, founding father of modern rocketry (1882)
- 6<sup>th</sup> New Moon
- 6<sup>th</sup> Aten Asteroid 1998 SD9 near-Earth flyby (0.027 AU)
- 6<sup>th</sup> History: Asteroid 2008 TC3 discovered by astronomers on Mt. Lemmon less than 24 hours before exploding over the Sudan. The McCarthy Observatory submitted one of the last accepted observations. Meteorites from the fall were eventually recovered. (2008)
- 6<sup>th</sup> History: launch of the space shuttle Discovery and the solar polar orbiter spacecraft Ulysses (1990)
- 7<sup>th</sup> Apollo Asteroid 2015 TQ21 near-Earth flyby (0.020 AU)
- 8<sup>th</sup> Moon at apogee (furthest distance from Earth in its orbit)
- 8<sup>th</sup> Kuiper Belt Object 308933 (2006 SQ372) at Opposition (29.536 AU)
- 9<sup>th</sup> **Second Saturday Stars at the McCarthy Observatory** (starting at 7:00 PM)
- 9<sup>th</sup> Draconids Meteor Shower peak (produced by debris from Comet Giacobini-Zinner)
- 9<sup>th</sup> History: LCROSS impacts crater Cabeus near the Moon’s south pole in search of water (2009)
- 9<sup>th</sup> History: Peekskill meteorite fall; 27-pound meteorite hits a 1980 Chevy Malibu sitting in its driveway in Peekskill, NY (1992)
- 9<sup>th</sup> History: discovery of Supernova 1604 (Kepler's Nova) (1604)
- 10<sup>th</sup> Kuiper Belt Object 528381 (2008 ST291) at Opposition (61.343 AU)
- 10<sup>th</sup> History: inauguration of the Very Large Array, one of the world's premier astronomical radio observatories; located west of Socorro, New Mexico (1980)
- 10<sup>th</sup> History: enactment of the Outer Space Treaty: 1) prohibited placement of nuclear and other weapons of mass destruction in orbit, on the Moon or other celestial body and 2) limited the use of the Moon and other celestial bodies to peaceful purposes (1967)
- 10<sup>th</sup> History: discovery of Neptune’s moon *Triton* by William Lassell (1846)
- 11<sup>th</sup> Apollo Asteroid 2019 SE5 near-Earth flyby (0.042 AU)
- 11<sup>th</sup> Apollo Asteroid *66391 Moshup* closest approach to Earth (0.780 AU)

## Astronomical and Historical Events (continued)

- 11<sup>th</sup> Amor Asteroid 3352 *McAuliffe* closest approach to Earth (0.982 AU)
- 11<sup>th</sup> Amor Asteroid 13553 *Masaakikoyama* closest approach to Earth (1.421 AU)
- 11<sup>th</sup> History: NASA's historic 100<sup>th</sup> space shuttle flight as Discovery carries the Z1 Truss (first piece of the ISS structural backbone) into space (2000)
- 11<sup>th</sup> History: Magellan spacecraft burns up in the Venusian atmosphere after completing its mission to map the planet with its imaging radar (1994)
- 11<sup>th</sup> History: launch of first manned Apollo mission (Apollo 7) with astronauts Schirra, Eisele and Cunningham (1968)
- 11<sup>th</sup> History: launch of WAC Corporal, first man-made object (16-foot rocket) to escape Earth's atmosphere (1945)
- 12<sup>th</sup> History: launch of Voskhod 1; Soviet spacecraft was first to carry multiple (3) cosmonauts (a pilot, scientist and physician) into space. Due to the cramped conditions the crew flew without spacesuits, ejection seats, or an escape tower (1964)
- 12<sup>th</sup> History: first Symposium on Space Flight held at the Hayden Planetarium in New York City; participants included Wernher von Braun, Willy Ley, and Fred L. Whipple; topics included an orbiting astronomical observatory, survival in space, circumlunar flight, a manned orbiting space station, and the question of sovereignty in outer space (1951)
- 13<sup>th</sup> First Quarter Moon
- 13<sup>th</sup> Aten Asteroid 3362 *Khufu* closest approach to Earth (1.469 AU)
- 13<sup>th</sup> History: launch of Shenzhou 6, China's second manned spacecraft (2005)
- 13<sup>th</sup> History: launch of Explorer 7; spacecraft measured solar X-rays, energetic particles, and cosmic rays (1959)
- 13<sup>th</sup> History: formation of the British Interplanetary Society by Phillip Cleator in Liverpool (1933)
- 14<sup>th</sup> Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.700 AU)
- 14<sup>th</sup> History: three main belt asteroids discovered by the McCarthy Observatory while searching for NEOs. 2003 TG10 (its provisional name) was subsequently named after Monty Robson (115449 Robson), the founder and director of the observatory (2003)
- 14<sup>th</sup> History: launch of Shenzhou 5, first Chinese manned spacecraft (2003)
- 14<sup>th</sup> History: Air Force Captain Chuck Yeager breaks the sound barrier in the Bell X-1 rocket plane (called "Glamorous Glennis" as a tribute to his wife). The plane reached a speed of 700 miles per hour after being launched from the bomb bay of a Boeing B-29 (1947)
- 15<sup>th</sup> History: launch of the Cassini spacecraft to the planet Saturn (1997)
- 16<sup>th</sup> International Observe The Moon Night
- 16<sup>th</sup> Scheduled launch of the Lucy spacecraft aboard an Atlas 5 rocket from the Cape Canaveral Space Force Station, Florida on a flyby of seven Trojan asteroids that orbit the Sun in front of and behind Jupiter
- 16<sup>th</sup> Parker Solar Probe, 5<sup>th</sup> Venus flyby
- 16<sup>th</sup> Kuiper Belt Object 303775 (2005 QU182) at Opposition (53.439 AU)
- 16<sup>th</sup> History: launch of GOES 1, first weather satellite placed in geosynchronous orbit (1975)
- 17<sup>th</sup> Apollo Asteroid 469219 *Kamo`oalewa* closest approach to Earth (0.142 AU)
- 17<sup>th</sup> Amor Asteroid 96189 *Pygmalion* closest approach to Earth (1.404 AU)
- 17<sup>th</sup> Kuiper Belt Object 19308 (1996 TO66) at Opposition (46.640 AU)
- 18<sup>th</sup> Dwarf Planet 136199 *Eris* at Opposition (94.899 AU)
- 18<sup>th</sup> History: launch of the space shuttle Atlantis (STS-34) and Galileo spacecraft to Jupiter (1989)

## Astronomical and Historical Events (continued)

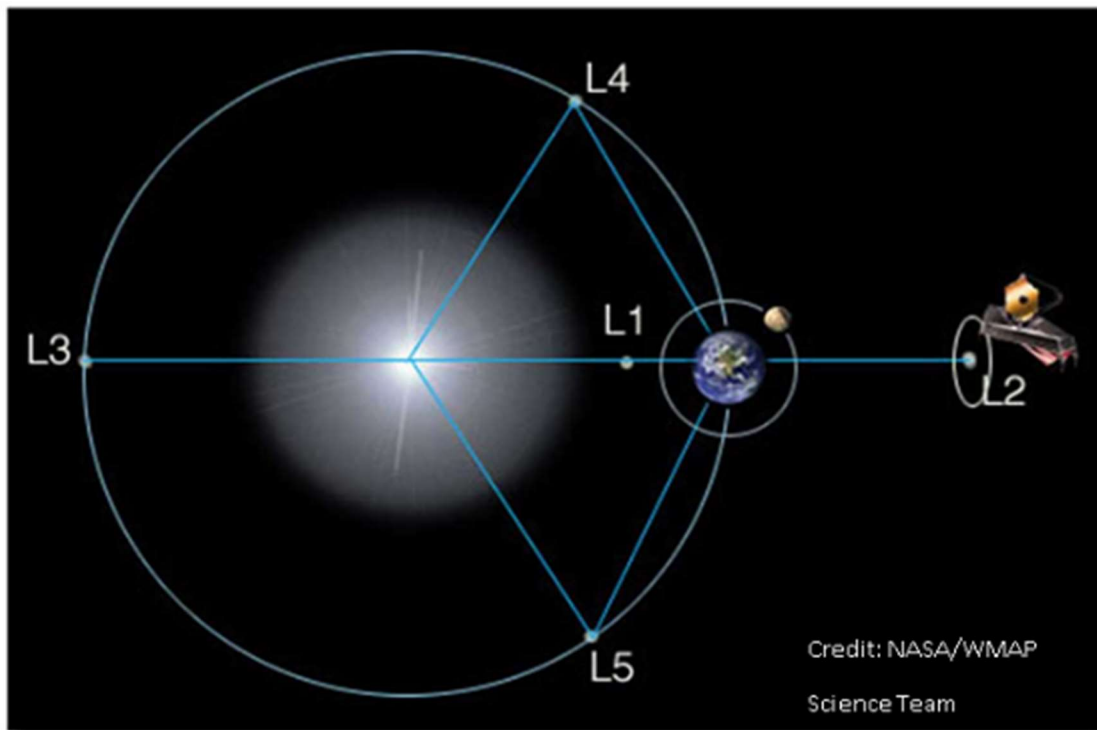
- 18<sup>th</sup> History: discovery of *Chiron* by Charles Kowal; *Chiron* has the characteristics of both a comet and an asteroid. These types of objects are called Centaurs after a mythological being that are half human/half horse (1977)
- 18<sup>th</sup> History: Soviet spacecraft Venera 4 enters the atmosphere of Venus; first probe to analyze the environment (in-situ) of another planet (1967)
- 18<sup>th</sup> History: discovery of Asteroid 8 *Flora* by John Hind (1847)
- 19<sup>th</sup> History: launch of the BepiColombo spacecraft (Mercury orbiters) from the Kourou launch facility in French Guiana. BepiColombo is on a seven-year journey to Mercury carrying orbiters from the European Space Agency and the Japan Aerospace Exploration Agency (2018)
- 19<sup>th</sup> History: launch of the IBEX (Interstellar Boundary Explorer) (2008)
- 19<sup>th</sup> History: flyby of the planet Venus by the Mariner 5 spacecraft (1967)
- 19<sup>th</sup> History: Subrahmanyan Chandrasekhar born; awarded Nobel Prize in Physics (1983) for studies of the structure and evolution of stars; NASA named its premier X-ray observatory the Chandra X-ray telescope in his honor (1910)
- 20<sup>th</sup> Full Moon (Full Harvest Moon)
- 20<sup>th</sup> Apollo Asteroid 1996 VB3 near-Earth flyby (0.022 AU)
- 20<sup>th</sup> History: launch of the Soviet spacecraft Zond 8; moon flyby mission (1970)
- 20<sup>th</sup> History: discovery of asteroid 577 *Rhea* by Max Wolf (1905)
- 21<sup>st</sup> Orionids Meteor Shower peak (produced by debris from Comet Halley)
- 21<sup>st</sup> History: NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft successfully entered orbit around Mars - first spacecraft dedicated to studying the Martian atmosphere and its connection to the Red Planet's climate (2014)
- 21<sup>st</sup> History: dedication of the Yerkes Observatory in Williams Bay, Wisconsin; home of the world's largest refractor with its 40-inch objective lens ground and polished by Alvan Clark and Sons (1897)
- 22<sup>nd</sup> Kuiper Belt Object 202421 (2005 UQ513) at Opposition (46.894 AU)
- 22<sup>nd</sup> History: launch of Chandrayaan-1, India's first mission to the Moon (2008)
- 22<sup>nd</sup> History: Soviet spacecraft Venera 9 touches down on Venus and transmits first pictures (black and white) of its surface (1975)
- 22<sup>nd</sup> History: launch of the Soviet Moon orbiter Luna 12 to take high-resolution photos of the Moon's surface from lunar orbit (1966)
- 23<sup>rd</sup> History: India's Mars Orbiter Mission (MOM) entered orbit around Mars (2014)
- 23<sup>rd</sup> History: first time female commanders led orbital missions at the same time: Pamela Melroy commanded space shuttle Discovery (STS-120) to the ISS while Peggy Whitson led the Expedition 16 team aboard the ISS in the installation of a new orbital node (2007)
- 24<sup>th</sup> Moon at apogee (furthest distance from Earth in its orbit)
- 24<sup>th</sup> History: launch of Chang'e-1, Chinese lunar orbiter, from the Xichang Satellite Launch Center in the southwestern province of Sichuan (2007)
- 24<sup>th</sup> History: Mars Odyssey enters orbit around Mars (2001); science goals included mapping the elemental composition of the surface
- 24<sup>th</sup> History: launch of Deep Space 1; first of a series of technology demonstration probes developed by NASA's New Millennium Program; propulsion was provided by a xenon ion engine that operated for a total of 16,265 hours (1998)
- 24<sup>th</sup> History: discovery of Saturn's moon Prometheus by Stewart Collins in photos taken by the Voyager 1 probe (1980)

## Astronomical and Historical Events (continued)

- 24<sup>th</sup> History: Over 100 people killed in a launch pad explosion when Air Marshal Mitrofan Nedelin, commander of the USSR's Strategic Rocket Forces, orders workers back to the pad to repair a defective R-16 missile without first unloading the unstable fuel (1960)
- 24<sup>th</sup> History: discovery of Uranus' moons *Umbriel* and *Ariel* by William Lassell (1851)
- 25<sup>th</sup> Mercury at its Greatest Western Elongation (18°) – greatest apparent distance from the Sun in the eastern sky before sunrise
- 25<sup>th</sup> Apollo Asteroid 2017 SJ20 near-Earth flyby (0.048 AU)
- 25<sup>th</sup> Centaur Object 20461 *Dioretsa* at Opposition (31.876 AU)
- 25<sup>th</sup> History: launch of the twin Solar Terrestrial Relations Observatories (STEREO A and B); 3-D studies of the Sun and coronal mass ejections (2006)
- 25<sup>th</sup> History: Soviet spacecraft Venera 10 touches down on Venus 2,200 km from its twin Venera 9; lands on a flat boulder that was determined to be similar in composition to basalt on Earth (1975)
- 25<sup>th</sup> History: discovery of Saturn's moon *Iapetus* by Giovanni Cassini (1671)
- 26<sup>th</sup> Apollo Asteroid 2019 UW6 near-Earth flyby (0.020 AU)
- 26<sup>th</sup> Aten Asteroid 3753 *Cruithne* closest approach to Earth (0.590 AU)
- 26<sup>th</sup> Amor Asteroid 11284 *Belenus* closest approach to Earth (0.706 AU)
- 27<sup>th</sup> Amor Asteroid 1580 *Betulia* closest approach to Earth (2.053 AU)
- 27<sup>th</sup> Kuiper Belt Object 308379 (2005 RS43) at Opposition (43.291 AU)
- 27<sup>th</sup> History: first test flight of the Saturn I rocket (1961)
- 28<sup>th</sup> Last Quarter Moon
- 28<sup>th</sup> Scheduled launch of a Russian Progress cargo-carrying spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station
- 28<sup>th</sup> History: first (and last) test flight of the Ares I-X rocket; a two-minute powered suborbital flight (2009)
- 28<sup>th</sup> History: launch of Prospero spacecraft, Great Britain's first space launch (1971)
- 29<sup>th</sup> Venus at its Greatest Eastern Elongation (47°) – greatest apparent distance from the Sun in the western sky after sunset
- 29<sup>th</sup> History: launch of the space shuttle Discovery (STS-95) with astronaut and then U.S. Senator, John Glenn (1998)
- 29<sup>th</sup> History: flyby of asteroid *Gaspra* by the Galileo spacecraft on mission to Jupiter (1991)
- 30<sup>th</sup> History: discovery of the Los Angeles (Mars) Meteorite (1999)
- 30<sup>th</sup> History: launch of Venera 13, Soviet Venus lander; lander survived for 127 minutes on the surface where the temperature was recorded at 855 °F (1981)
- 30<sup>th</sup> History: Mercury Theatre broadcasts Orson Welles' adaptation of H.G. Wells "War of the Worlds" (1938)
- 31<sup>st</sup> Scheduled launch of a Crew Dragon (Crew 3), with four astronauts, aboard a SpaceX Falcon 9 rocket from the Kennedy Space Center, Florida to the International Space Station
- 31<sup>st</sup> Kuiper Belt Object 55636 (2002 TX300) at Opposition (42.059 AU)
- 31<sup>st</sup> History: Walter Baade's discovery of the first Centaur Object, 944 Hidalgo (1920)
- 31<sup>st</sup> History: birthday of Apollo 11 Command Module pilot Michael Collins (1930)
- 31<sup>st</sup> History: first rocket engine tests by three young rocketeers that would be the beginning of what would become the Jet Propulsion Laboratory (1936)

## Commonly Used Terms

- Apollo: a group of near-Earth asteroids whose orbits also cross Earth's orbit; Apollo asteroids spend most of their time outside Earth orbit.
- Aten: a group of near-Earth asteroids whose orbits also cross Earth's orbit, but unlike Apollos, Atens spend most of their time inside Earth orbit.
- Atira: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit
- Centaur: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4<sup>th</sup> and 5<sup>th</sup> Lagrange points (leading and trailing) of major planets in the Solar System



## Lagrange Points

Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point

(and future location of the James Webb telescope) is located 1.5 million kilometers beyond the Earth (as viewed from the Sun).

### References on Distances

- the apparent width of the Moon (and Sun) is approximately one-half a degree ( $\frac{1}{2}^\circ$ ), less than the width of your little finger at arm's length which covers approximately one degree ( $1^\circ$ ); three fingers span approximately five degrees ( $5^\circ$ )
- 1 astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

### International Space Station and Artificial Satellites

Visit [www.heavens-above.com](http://www.heavens-above.com) for the times of visibility and detailed star charts for viewing the International Space Station and other man-made objects in low-Earth orbit.

### Solar Activity

For the latest on what's happening on the Sun and the current forecast for flares and aurora, check out [www.spaceweather.com](http://www.spaceweather.com).

### NASA's Global Climate Change Resource

Vital Signs of the Planet: <https://climate.nasa.gov/>

### Mars – Mission Websites

Mars 2020 (Perseverance rover): <https://mars.nasa.gov/mars2020/>

Mars Helicopter (Ingenuity): <https://mars.nasa.gov/technology/helicopter/>

Mars Science Laboratory (Curiosity rover): <https://mars.nasa.gov/msl/home/>

Mars InSight (lander): <https://mars.nasa.gov/insight/>



## Contact Information

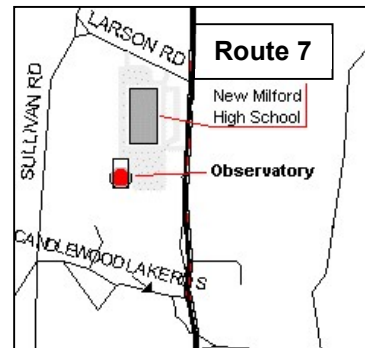
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