John J. McCarthy Observatory

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Hi!

Here's a self-image at "John Kline" drill site in Gale Crater, where I've been probing for signs of ancient water. You can see more of what I've been up to at the next Second Saturday Stars program on April 13 at JJMO.

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It is through their efforts that the McCarthy Observatory has established itself as a significant educational and recreational resource within the western Connecticut community.

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"Out the Window on Your Left"

T'S BEEN OVER 40 YEARS since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the con quest of new frontiers, we appear to have lost our will to lead as a space-faring nation. But, what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).



The view this month is a small, but attention-grabbing area bounded by Mare Serenitatis (the Sea of Serenity) to the north and Mare Vaporum (the Sea of Vapors) to the west. The area was battered by ejecta from the impact that created the Imbrium basin 3.85 billion years ago.

The area is notable for the numerous rilles that crisscross the lava plain. The term "rille" (or the Latinized version: rima) is used to describe a long, narrow depression. On the Moon, rilles generally fall into one of three categories: sinuous rilles, arcuate rilles or straight rilles. Sinuous rilles that meander like ancient river beds are thought to be volcanic features, possibly created from ancient lava flows. Arcuate or concentrate rilles appear near the outer edges of impact basins and are theorized to have been created when the weight of the mare lava near the center caused fracturing near the edges. Straight rilles can be grabens, formed when the terrain drops between parallel faults or fractures due to pressure from subsurface magma chambers.

The rilles east and north of the 26 km diameter crater Triesnecker are not easily characterized. They don't appear to be associated with any volcanic features — they have straight runs, as well as some tight curves — and several are radial to the Imbrium basin while others are not. The crisscrossing pattern indicates that the rilles formed over time rather than in response to a singular event.

To the north of the Triesnecker crater and rille complex is the diminutive crater Hyginus. At only 9 km in diameter, Hyginus is unusual in that it may not be an impact feature, but a volcanic caldera. The rille radiating from either side of Hyginus is composed of rimless pits, possibly formed from the collapse of an underlying lava tube.

Sinus Medii, a small patch of lava southwest of Triesnecker, is unremarkable except that it represents the center of the Moon for Earthbound observers. It was the landing site of Surveyor 6, the fourth of the Surveyor spacecraft to successfully land on the Moon (on November 10, 1967). It returned almost 30,000 images and confirmed that the surface was primarily basaltic in composition and able to support manned landings.



A straight rille was photographed by the Apollo 10 crew in 1969 during their historic approach to only 14-kilometers above the lunar surface.



Curiosity Update

In a first on Mars, the Mars Science Laboratory, Curiosity, drilled a hole into the bedrock at the base of Mount Sharp in Gale Crater, collecting gray tailings from inside the rock for analysis. Drilling occurred near an ancient streambed that the rover had discovered earlier in its survey of the surrounding area.

Curiosity's onboard chemistry and mineralogy instruments detected the presence of clay within the sample, indicative of the reaction of fresh water with igneous (volcanic) minerals. Elements, e.g., calcium sulfate, found along with the clay suggest that the water that ran through the site was relatively neutral, unlike at other Martian landing sites where conditions were found to be too acidic or salty. Additional elements detected in the sample included sulfur, nitrogen, hydrogen, oxygen, phosphorus and carbon. Encouraged by the analysis, NASA investigators believe that the Curiosity has provided the first direct evidence that ancient conditions on Mars were once suitable for life.



Image credit: NASA/JPL-Caltech/Cornell/MSSS

14,000 Feet Below the Atlantic

The Saturn V rocket, as tall as a football field is long, was the workhorse of the Apollo program. Weighing over 6 million pounds at liftoff, the large payload capacity of the rocket made travel to the Moon possible. The first stage, 33 feet in diameter and 138 feet long, was powered by five F-1 engines, producing a total of 7,500,000 million pounds of thrust. The engines burned the entire contents of the first stage's fuel tanks (203,000 gallons of kerosene and 331,000 gallons of liquid oxygen) in just 2½ minutes. In that short time, the five F-1 engines carried the Saturn V to an altitude of approximately 38 miles. With tanks emptied, the 300,000 pound first stage was cast off, falling back to Earth and impacting the Atlantic Ocean at approximately 5,000 miles per hour before settling in more than 14,000 feet of water.

Thirteen Saturn V rockets were launched from the Kennedy Space Center between 1967 and 1973. Until recently, the relics from those launches remained in perpetual darkness on the deep ocean floor, unseen for over 40 years, until recently discovered by stateof-the-art deep sea sonar on an expedition privately funded by Jeff Bezos. Mr. Bezos is the founder of Amazon and Blue Origin, a startup rocket company.

Using a remotely operated vehicle, the expedition recovered components from two F-1 engines during a three week effort. On March 21st, the engines returned to the Kennedy Space Center after more than 40 years. While still the property of NASA, the components will be stabilized to prevent further corrosion and prepared for public display.



F-1 Thrust Chamber (above) and Saturn V's First Stage (S-IC) Skeletal Remains (below). Photos Credit: Bezos Expeditions



Weather Report from Saturn

Scientists have been using the Cassini spacecraft to monitor atmospheric conditions on Saturn since the spacecraft arrived in 2004. Diligence was rewarded when a large storm began to take shape in December 2010. For the next seven months, the storm grew in size and intensity, eventually wrapping itself around the planet. As impressive as the view was in the visible wavelength, the real surprise was recorded by Cassini's infrared spectrometer. The instrumentation detected large releases of energy by the storm, creating temperature spikes in the atmosphere 150 degrees above normal. Coincident with the energy discharges was the appearance of a large amount of ethylene gas, a gas not typically observed on Saturn. While this is the first storm on Saturn to be observed in the infrared, there is no explanation for the sudden appearance of ethylene.



True color view of Saturn, planet engulfing storm, and second largest moon, Rhea Image Credit: NASA/JPL-Caltech/Space Science Institute

Missed Opportunity

Less than six months after Neil Armstrong took the first step onto the lunar surface, NASA began the difficult task of canceling future flights to the Moon. While most of the hardware had been built, and the incremental costs of flying the last three missions was relatively small, political and public support for the Moon program was already waning before Armstrong and his crew returned to Earth.

Had we stayed the course, the final three flights (Apollo 18, 19 and 20) would have been the most ambitious undertakings of the Apollo program. Although mission plans continued to evolve with each new flight, the areas of Moon targeted for exploration in late 1969 = particularly after Apollo 12 demonstrated the ability to make precision landings - included the craters Copernicus and Tycho, and the Marius Hills.

While crews were not officially assigned to the last three missions, the standard rotation of backup crews would have placed Richard Gordon (Gemini 11, Apollo 12) in command of the Apollo 18 mission, with test pilot Vance Brand as the Command Module Pilot and geologist Harrison Schmitt as the Lunar Module Pilot. The mission was originally scheduled for February of 1972.

Schmitt, the only scientist (geologist) to walk on the Moon, would later be reassigned to Apollo 17 after the cancellation of Apollo 18 in September 1970.

Fred Haise (Apollo 13) would have likely commanded Apollo 19 with test pilot William Pogue as the Command Module Pilot and Gerald Carr as the Lunar Module Pilot. Charles "Pete" Conrad (Apollo 12) would have been in line to command Apollo 20, with test pilot Paul Weitz as the Command Module Pilot and Jack Lousma as the Lunar Module Pilot.

Copernicus was listed as either a prime or alternative landing site at the meetings of the Apollo Site Selection Board or the Group for Lunar Exploration Planning in 1969, despite the rough terrain and operational challenges. Unfortunately, with the cancellation of three missions and the failure of Apollo 13 to complete its objectives, this magnificent crater (as well as the volcanic domes of the Marius Hills) did not make the final cut. Tycho, possibly the most science-rich target, was the most difficult to reach and was also dropped from consideration.

The view from inside Copernicus would have been breathtaking. Terraced walls reach more than two miles above the floor, low-lying hummocks of rebounded rock huddle around its center, and the deep shadows that hide from the Sun create visual voids in the moonscape.





Lunar Resources

NASA's Goddard Space Flight Center has released a new tool to assist in planning your lunar observations, and several new educational videos on the Moon. The planning tool (shown on the right) provides the user with



the phase and libration of the Moon at hourly intervals for any date in 2013. The animation was developed from data gathered by the Lunar Reconnaissance Orbiter (LRO). While the same side of the Moon faces the Earth, we can actually see (over time) more than 50% of its surface. This is a result of the Moon's elliptical orbit, tilt of its axis and inclination of its orbit around the Earth, and our vantage point over the course of a night. The interaction produces an apparent rocking or oscillating motion in the Moon's appearance, if charted over an extended period of time. The effect, called libration, allows Earth-dwellers to catch periodic glimpses of the lunar terrain past the limbs and over the poles. The application can be found at *http://svs.gsfc.nasa.gov/vis/ a000000/a004000/a004000/*.

Goddard Multimedia has also assembled several animations based upon LRO data. The general tour of the Moon (*http://svs.gsfc.nasa.gov/vis/a010000/ a010900/a010929/*) visits the immense impact basins, bright young craters, winding chasms carved by ancient lava flows, the dark and cold polar regions, as well as the battered far side of the Moon.

The Evolution of the Moon animation (http://svs.gsfc.nasa.gov/vis/a010000/a010900/a010930/) pro-

vides an overview of the events that shaped the Moon over the past 4.5 billion years.

Twenty-Three Years in Space

The Hubble Space Telescope is one of the four "Great Observatories" along with the Compton Gamma-Ray, Chandra X-Ray and Spitzer (infrared) telescopes. However, it is the only space telescope that can be serviced by astronauts. Over the past twentythree years, the five servicing missions have given the



telescope a new lease on life, replacing and repairing many of the telescope's original components and extending its capabilities many times over. The Hubble Space Telescope in orbit today is a far superior instrument to the one originally launched.

The image (above) shows the telescope during its original deployment from the cargo bay of the space shuttle Discovery (STS-31) on April 29, 1990. This was followed by five servicing missions:

Servicing Mission 1 (December 1993) S p a c e shuttle Endeavour (STS-61) delivered/ installed corrective optics, replaced/installed a new Wide-Field and Planetary Camera, solar arrays and gyroscopes

Servicing Mission 2 (February 1997) Replaced original spectrograph with the Near-Infrared Camera and Multi-Object Spectrometer (NICMOS), repaired insulation and upgraded instrumentation

Servicing Mission 3A (December 1999) Replaced/ installed all six gyroscopes, a fine guidance system, main computer and thermal insulation blankets

Servicing Mission 3B (March 2002) Installed the Advanced Camera for Surveys, revived the dormant NICMOS and replaced the solar arrays

Servicing Mission 4 (May 2009) Replaced batteries, gyroscopes, a fine guidance system, installed a new Wide-Field and Planetary Camera, Cosmic Origins Spectrograph and repaired failed electronics in two instruments

Hubble Trivia

The pilot of the space shuttle Discovery (STS-31) that deployed the Hubble Space Telescope was Charles F. Bolden. In 2009, Mr. Bolden was appointed NASA's twelfth Administrator.



Our Mysterious Moon

The Earth's moon does not give up its secrets easily. After six manned missions, several sample return attempts and extensive surveys from orbiting satellites, there is still so much that we don't know about our mysterious neighbor. One of those mysteries involves the formation of the area around the crater Descartes. The early Apollo missions targeted the relatively smooth maria (lunar seas). The maria are remnants of spectacular impacts at the time when the Moon's crust was relatively thin and its interior molten. The impacts fractured the crust, allowing the molten magma to flood the impact sites. Although they cover less than 20 percent of the lunar surface, the maria offered more appealing (and safer) landing sites. However, for the Apollo 16 mission, geologists convinced NASA to visit the lunar highlands. Unlike on Earth, the lunar highlands did not form through some geologic process - for example, plate tectonics. The highlands represent the Moon's original crust, pushed

upward by the tremendous energy from the impacts that created the maria. Scientists hoped that by analyzing samples of the original crust, answers might be found to many of the questions related to the Moon's origin and formation.

Descartes is a broken and battered crater. Its wall is breached to the north and topped by a small crater to the south. Spilling out of the crater is some rather unusual furrowed material, unlike any found elsewhere on the Moon. Scientists originally theorized that the material was from lunar volcanoes that had piled up around the vents rather than flowing away. To test their hypothesis, a landing site for Apollo 16 was selected just north of *Descartes* where a smooth plain met the furrowed or hilly material. The site was 7,400 feet higher than the Apollo 11 site just to the north. Unfortunately, the crew of Apollo 16 (John Young and Charles Duke) never got as far as Descartes in their travels, and all the samples brought back were of the lunar crust, not dark lavas which would be produced from volcanic activity. So, the mystery of the Descartes formation remains.



The best time to view the *Descartes* region is when it is near the terminator (the line that separates the sunlit portion of the Moon from the darkened portion). Sunrise occurs a day or two before First Quarter. Try looking for this area on the evening of April 17th. Sunset occurs a few days prior to Last Quarter, around the morning of April 1st. The *Descartes* region can best be found by starting at the three large craters (*Theophilus*, *Cyrillus* and *Catharina*) located on the western shore of the *Sea* of Nectar. West of Cyrillus is the crater Abulfeda. Look for a string of craterlets trailing from its southern rim. *Descartes* is located just to the north of Abulfeda. The furrowed material breaches the north wall of the crater and *Descartes A* is the small crater on the southern rim.

The Apollo 16 landing site is near a bright spot on the edge of the smooth *Cayley Plains*, just to the north of *Descartes* and west of the *Sea of Nectar*. For scale, the craters *Abulfeda* and *Descartes A* are approximately 39 miles and 9 miles in diameter, respectively.

Swirls are bright features that resemble splashes on the dark lunar surface. They are typically associated with strong magnetic anomalies. Reiner Gamma, located near the western shore of the Ocean of Storms, is the most familiar swirl on the Moon. However, in a low pass over the *Descartes* Mountains in 1999, the Lunar Prospector spacecraft detected the strongest magnetic anomaly yet on the rim of the *Descartes* crater. The discovery raises even more questions on how these anomalies form (e.g., are they surface phenomena or do they extend deep into the lunar crust; did the rocks become magnetized by an impact or from a volcanic eruption; and why is the anomaly so localized). Hopefully, future missions to the Moon will provide some clues to the formation of these unusual features and whether these areas that divert the solar wind could someday be useful (e.g., as a refuge for colonists during a solar storm).

Life without the Moon

You might wonder why you should direct your gaze upon this desolate world when so many other celestial treasures await in the night sky. The Moon is more extraordinary than you might first think. No other planet (except for the dwarf planet Pluto) has a larger moon (compared to the size of the planet around which it revolves). Many believe that life on Earth would have been much different without the Moon.

The tidal forces of the Moon act as a brake to slow down the Earth's rotation. Without the Moon, the Earth would spin much faster. The faster rotation could lead to higher winds and stronger storms, similar to conditions on Jupiter. Gale force winds would have altered how life would eventually evolve. It might have created conditions under which some life forms could not have existed. The Moon also stabilizes the Earth's axis of rotation. A stable axis is necessary for long-term climates to develop and ecologies to take hold. Most important, the Moon has shielded the Earth from swarms of cosmic debris. The battered lunar surface provides a visual record of the vast number of objects that could have impacted the Earth, had the Moon not been present.

April History

Apollo 16 wasn't the only lunar mission launched in the month of April. Two years earlier, on April 11, 1970, Apollo 13 lifted off from Cape Canaveral in what was intended to be the third manned mission to the Moon. The crew of James Lovell, Fred Haise and Jack Swigert never got their chance.

Two days later and almost 200,000 miles from Earth, the No. 2 oxygen tank exploded, cracking the feed pipe to the No. 1 oxygen tank and crippling the fuel cells providing the electrical power to the Command Module. The next four days would become the greatest human drama in space history.

With failing power and a cloud of debris surrounding the space craft, the three astronauts shut down the Command Module and moved into the Lunar Module (LM). The LM was designed to support two astronauts for a maximum of 45 hours. The LM needed to support the three astronauts for 75 to 100 hours for a safe return to Earth. To conserve supplies, almost all the spacecraft's systems were turned off. The temperature dropped to just above freezing, water condensed on all the internal surfaces and instruments and the level of carbon monoxide increased to life-threatening levels. Fluids and gases being expelled from the crippled Command Module acted like small rockets, continually pushing the spacecraft off course. The debris cloud prevented anything more than rudimentary navigation. The astronauts became dehydrated (fuel cells also provide water) and the conditions inside the spacecraft became increasingly unsanitary when the crew, through a misunderstanding, began to accumulate human waste inside the spacecraft (instead of discharging it).

Only through the ingenuity of the engineers back in mission control, the backup crew and hundreds of contractors involved in the assembly and operation of the spacecraft, was the crew returned safely to Earth. The crew and the spacecraft reentered the Earth's atmosphere not knowing whether the heat shield had been damaged in the explosion or whether the parachutes would still deploy after four days of extreme cold. While Houston lost contact with the spacecraft for a minute longer than expected, Apollo 13 splashed down right on target. The cause of the accident was eventually traced to damage the oxygen tank had sustained during its removal from Apollo 10. Due to a defective drain, internal heaters were used to empty the tank. Unfortunately the pad power supply was not compatible with the spacecraft's power systems. The higher voltage melted the insulation leaving bare metal exposed to the pure oxygen environment. When Jack Swigert turned on the tank fan, the contents exploded. The story of Apollo 13 is detailed in astronaut Jim Lovell's book *Lost Moon*, former Flight Director Gene Kranz's book *Failure is Not an Option*, and recreated in the Ron Howard/Tom Hanks film *Apollo 13*.

April Showers

The Lyrid meteor shower is expected to peak just before dawn on April 22nd. The dust producing the shooting stars is from *Comet Thatcher*. Expect to see 10 to 20 meteors per hour. As with all meteor showers, the Lyrids are named for the constellation (Lyra) from which they appear to radiate.

Sunrise and Sunset

<u>Sun</u>	<u>Sunrise</u>	<u>Sunset</u>
April 1 st (EDT)	06:36 am	7:19 pm
April 15 th	06:13 am	7:34 pm
April 30 th	05:52 am	7:51 pm

April Nights

Saturn reaches opposition on April 28th, as the magnificent ringed world rises in the eastern sky as

the Sun sets in the west. Saturn will reach maximum altitude, with the best viewing, around midnight. You can find Saturn (and its largest moon *Titan*) in the constellation Virgo. *Titan* (larger than the planet Mercury) can



be identified by its orange hue.

The 2011 Astronomy Picture of the Day for March 15th combines images taken by the Cassini spacecraft to create flyby videos of Saturn, its rings and several moons as they would appear to the space traveler. The video can be found at http://apod.nasa.gov/apod/ap110315.html.

Comet History

In the photo (below), *Comet Hale-Bopp* graces the evening sky on April 2, 1997, one day after perihelion (closest approach to the Sun). The comet was brighter than the brightest stars in the sky, with a dust tail that stretched almost 45 degrees across the sky. The photo shows the brighter, yellow dust tail and the dimmer, blue ion (gas) tail.

The orbital period of *Hale-Bopp* as it entered the inner solar system was 4,206 years. A close encounter with Jupiter in April of 1996 modified its orbit, short-ening its orbital period to 2,380 years as it returned to the outer solar system.



http://www.mccarthyobservatory.org

Astronomical and Historical Events

- 1st History: launch of the first weather satellite, Tiros 1 (1960)
- 2nd History: launch of Zond 1, Soviet Venus flyby mission (1964)
- 2nd History: selection of the Mercury 7 astronauts (1959)
- 3rd Last Quarter Moon
- 3rd History: Soviet spacecraft Luna 10 becomes the first artificial satellite to orbit the Moon (1966)
- 4th History: launch of Apollo 6, last test flight of the Saturn V rocket (1968)
- 5th Flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
- 5th History: launch of the Compton Gamma Ray Observatory (1991)
- 5th History: launch of the first Pegasus rocket (1990)
- 5th History: launch of Pioneer 11, Jupiter and Saturn flyby mission (1973)
- 6th History: launch of Intelsat 1, first commercial communications satellite (1965)
- 7th History: launch of Luna 14, Soviet Moon orbiter mission designed to test radio transmission stability, measure the lunar gravity field, solar wind and cosmic rays (1968)
- 8th History: discovery of Saturn moon's *Telesto* by the Voyager 1 spacecraft (1980)
- 8th History: launch of the unmanned Gemini 1 (1964)
- 8th History: Project Ozma, the search for extraterrestrial intelligence, begins as Frank D. Drake, an astronomer at the National Radio Astronomy Observatory in Green Bank, West Virginia, turns the 85-foot Howard Tatel telescope toward the star Tau Ceti (1960)
- 9th Kuiper Belt Object and Dwarf Planet 136108 *Haumea* at Opposition (49.956 AU)

10th New Moon

- 10th History: Japanese lunar probe Hiten impacts Moon; first non-U.S. or Soviet lunar probe, also first to visit the Lagrangian Points L4 and L5 during its three year mission (1993)
- 11th History: ESA spacecraft Venus Express enters orbit around the planet Venus (2006)
- 11th History: launch of Apollo 13 with astronauts James Lovell, Fred Haise and Jack Swigert; mission aborted when oxygen tank explodes and cripples the Command Module (1970)
- 12th Distant flyby of Saturn's moon Titan and Polydeuces by the Cassini spacecraft
- 12th History: launch of the first space shuttle (Columbia) with astronauts John Young and Robert Crippen (1981)
- 12th History: launch of Vostok 1 with cosmonaut Yuri Gagarin, first person to orbit the Earth (1961)
- 12th History: Edward Maunder born; studied solar cycle and sunspots. Analyzed period between 1645 and 1715 when almost no sunspots where recorded - known as the "Maunder minimum" or "Little Ice Age" because of the severe winters (1851)
- 12th History: discovery of Asteroid 10 *Hygiea* by Annibale de Gasparis (1849)

13th Second Saturday Stars - Open House at McCarthy Observatory

- 13th History: launch of Transit 1B, first experimental navigation satellite (1960)
- 14th History: Christiaan Huygens born, Dutch scientist and discoverer of Saturn's rings and largest moon *Titan* (1629)
- 15th Moon at apogee (furthest distance from Earth)
- 16th History: launch of Apollo 16 with astronauts John Young, Ken Mattingly and Charles Duke, the only mission to the lunar highlands (1972)
- 16th History: Leonardo Da Vinci born, first to correctly explain Earthshine (1452)
- 17th History: closest flyby of the Sun by a spacecraft, Helios 2 (1976)
- 17th History: launch of Surveyor 3, Moon lander, first to experience a lunar eclipse from the Moon's surface during which the temperature fell 250° F; Apollo 12 would later land near Surveyor 3 in 1969, retrieving pieces of the lander for return to Earth and analysis of the effects of the harsh lunar environment (1967)
- 18th First Quarter Moon
- 19th History: launch of the last Soviet Salyut space station, Salyut 7 (1982)
- 19th History: launch of the Soviet spacecraft Salyut 1, first space station (1971)

Astronomical and Historical Events (continued)

- 20th Northeast Astronomy Forum and Telescope Show (NEAF), Rockland Community College, Suffern, NY (20th and 21st)
- 22nd Lyrids Meteor Shower peak
- 22nd History: launch of the Air Force's X-37B prototype space plane from Cape Canaveral, Florida; first orbital mission (2010)
- 23rd Kuiper Belt Object 2010 EK139 at Opposition (37.227 AU)
- 24th Scheduled launch of a cargo-carrying Progress spacecraft from the Baikonur Cosmodrome in Kazakhstan to the International Space Station
- 24th History: launch of space shuttle Discovery (STS-31) and deployment of the Hubble Space Telescope (1990)
- 24th History: launch of Mao 1, first Chinese satellite (1970)
- 24th History: cosmonaut Vladimir Komarov dies during re-entry of a prototype Soviet lunar spacecraft (Soyuz 1) when parachute lines become entangled (1967)
- 25th Full Moon (Full Pink Moon)
- 26th History: flyby of Venus (gravitational assist) by the Cassini spacecraft (1998)
- 26th History: launch of Sputnik 14 (Cosmos 4), first successful Soviet reconnaissance satellite designed to study upper layers of atmosphere and monitor U.S. nuclear tests (1962)
- 26th History: discovery of Asteroid 9 Metis by Andrew Graham (1848)
- 27th Moon at perigee (closest distance from Earth)
- 28th Saturn at Opposition
- 28th History: launch of the Cloudsat/Calipso cloud imaging and profiling satellites (2006)
- 28th History: Isaac Newton publishes his Principia, describing universal gravitation and the three laws of motion (1686)
- 30th Moon Occults Pluto

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°); three fingers span approximately five degrees (5°)

• One astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station/Space Shuttle/Iridium Satellites

Visit *www.heavens-above.com* for the times of visibility and detailed star charts for viewing the International Space Station, the Space Shuttle (when in orbit) and the bright flares from Iridium satellites.

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*.

Image Credits

Front page design and graphic calendars: Allan Ostergren

Page 1: Curiosity Rover's Self Portrait at 'John Klein' Drilling Site, Cropped. This rectangular version combines dozens of exposures taken by the rover's Mars Hand Lens Imager (MAHLI) during the 177th Martian day, or sol, of Curiosity's work on Mars (Feb. 3, 2013). Image Credit: NASA/JPL-Caltech/MSSS

Page 3: On April 17, 2012, the space shuttle Discovery was delivered to its new home: the National Air and Space Museum's Steven F. Udvar-Hazy Center near Washington Dulles International Airport. Photo by Bill Cloutier.

Second Saturday Stars poster: Sean Ross, Ross Designs



Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
	1960: First successful weather observation satellite, TIROS I (Television Infra-Red Observation Satellite), launched by NASA; operated for 78 days. (1960)	Launch of Zond 1, Soviet Venus flyby mission (1964)	Soviet spacecraft Luna 10 first artificial satellite to orbit moon (1966)	Launch of Apollo 6, last test flight of the Saturn V rocket 1968	Launch of Pioneer 11, Jupiter and Saturn Ryby mission 1973 Launch of Compton Garma Ray Observatory 1991 Launch of the first Pegasus rocket (1990)	Launch of Intelsat 1, first commercial communica- tions satellite (1965)
7	8	9	10	11	Shuttle, 12	13
Launch of Luna 14, Soviet Moon orbiter mission (1968)	Launch of umanned Gemini I 1964 I Project OZMA, search for extraterrestrial life (1960) Discovery of Saturn's moon Telesto by Voyager 1 (1980)	NASA introduces Project Mercury astronauts: Scott Carpenter, L. Gordon Cooper Jr., John H. Glenn Jr., Virgil "Gus" Grissom, Walter Schirra Jr., Alan Shepard Jr., and Donald Slayton (1959)	Japanese lunar probe Hiten impacts Moon's surface (1993)	ESA spacecraft Venus (2006) Apollo 13 launch on ill-fated moon mission (1970)	Columba, with John Young and Robert Crippen 1981 Yuri Gagarin first man in space on Vostok I 1961 Edward Maunder born, studied solar cycle and sunspots. 1851 Juri Gagarin first man in space on Vostok I 1961	Launch of Transit IB, first experimental navigation satellite (1960)
14	Moon at apogee	16	17	18	19	20 Harold Graham performs
Christiaan Huygens, discoverer of Saturn's rings and moon Titan born (1629)	from earth)	Apollo 16 launch to lunar highlands (1972) Leonardo da Vinci born (1452)	Launch of Surveyor 3 Moon lander (1967)	Albert Einstein dies in Princeton, NJ (1955)	Launch of Salyut 1 (1971) and Salyut 7 (1982), first and last Soviet space stations	1.2-meter, 13- second free flight of a rocket pack, designed at Bell Aerosystems. (1961)
21	22	23	Launch of 24	25 The 20th Annual Great	26	27
Apollo 16 on the Moon (Young, Mattingly and Duke) - fifth manned mission and first to land in the lunar highlands (1972)	Lyrids meteor shower peak launch of the Air Force's X-37B prototype space plane from Cape Canaveral, Florida; first orbital mission (2010)	Ranger 4 Lunar probe launched - failed its mission, but became first U.S. craft to impact the Moon (1962)	Discovery with Hubble (1990) Cosmonaut Valery Komarov dies on re-entry on lunar spaceraft Soyuz 1 (1967) Launch of 1 ^e Chinese Mao 1 (aka "the East is Red") satellite, (1970)	Nikolai Semenovich Kardashev born, astrophysicist and deputy director of the Russian Space Research Institute, pioneered search for extraterrestrials (1932)	Cassini spacecraft gets gravitational assist from Venus on way to Saturn 1998	Karl Jansky, a Bell Labs physicist and radio engineer, announces discovery of radio from Milky Way (1932)
28	29	30				
Air Force's X- 37B prototype space plane from Cape Canaveral, Florida, first orbital mission (2010) Isaac Newton publishes <i>Principia</i> , describing gravitation and 3 laws of motion (1686)	Cornelis de Jager, Dutch astronomer born; worked on predicting solar variation, to assess the Sun's impact on future climate (1921)	Plinius' Eclipse, described by Pliny the Elder, Roman naturalist in Campagnia, Italy : "Then the sun was suddenly darkened and the fourteen districts of the city were struck by lightning" (59 AD)	Apr 3	Phases of Apr 10	the Moon	Apr 25

FREE EVENT

Every Month at the John J. McCarthy Observatory Behind the New Milford High School 860.946.0312 www.mccarthyobservatory.org

April 13th 8:00 - 10:00 pm

Refreshments Family Entertainment Activity Center Stars & Planets Rain or shine

S.Ross

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