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SPECIAL VENUS TRANSIT ISSUE!

The black drop effect is observed in this image of the 2004 Venus transit taken from Mauritius by Michael Batchelor. Long thought to be evidence of Venus' atmosphere, the black drop effect is now considered to be a combination of limb darkening on the Sun, atmospheric effects on Earth, and optical imperfections although it can be observed even from space. The last opportunity to observe a Venus transit for 105 1/2 years will be visible on June 5, starting at 3:06 pm PDT from the greater Los Angeles area. Don't miss it!

OCA CLUB MEETING

The free and open club meeting will be held June 8 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month, Peter Swan will speak on Space Elevator Survivability and the Debris Threat

NEXT MEETINGS: July 13, August 10

STAR PARTIES

The Black Star Canyon site will be open on June 23. The Anza site will be open on June 16. Members are encouraged to check the website calendar for the latest updates on star parties and other events.

Please check the website calendar for the outreach events this month! Volunteers are always welcome!

You are also reminded to check the web site frequently for updates to the calendar of events and other club news.

COMING UP

The next session of the Beginners Class will be held on Friday, June 1 at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana. The next two sessions will be on August 3rd and September 7th.

GOTO SIG: TBA
Astro-Imagers SIG: June 19, July 17
Remote Telescopes: TBA
Astrophysics SIG: June 15, July 20
Dark Sky Group: TBA

The Transit of Venus - 2012

By Joel K. Harris

Last month, I wrote about a relatively rare celestial phenomenon --- an annular, or ring, type of central solar eclipse, which took place on Sunday, May the 20th, across the Southwestern U.S.

This month, yet another sun-related astronomical event will occur --- one even rarer than an annular, or even a total, solar eclipse. That event is a transit of the planet Venus across the fiery disc of the Sun.

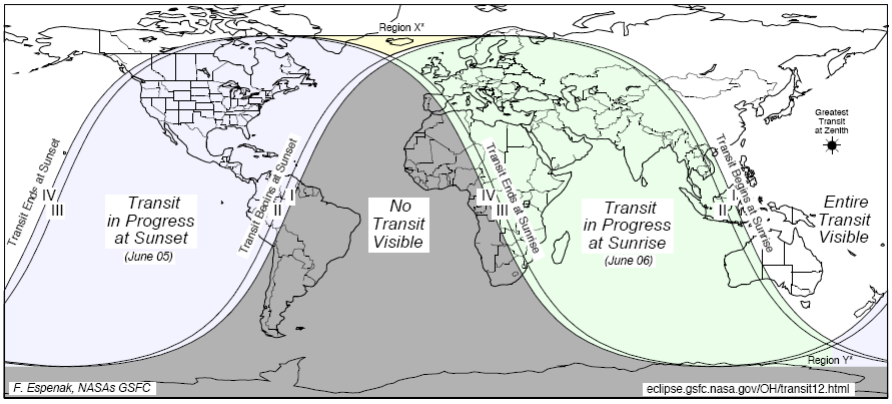
Unlike a solar eclipse (or at least a significantly "deep" partial one), if you didn't know that a Venusian transit was taking place, you'd never know about it, and you'd never notice anything different that day about the Sun or its illumination of the Earth.

That's because unlike our Moon (which while only 1/400th the diameter of the Sun is also 400 times closer to the Earth than we are to the Sun), Venus only subtends a scant 66 seconds (just over an arcminute) of arc at its maximum, versus the Moon, which can --- of course --- completely cover the Sun's disc, during a total solar eclipse. Indeed, at just over an arcminute across, Venus cannot significantly affect the amount of ambient solar illumination during a transit.

But **how rare** are Transits of Venus (TOV), anyhow? Well, these events typically are spaced approximately 121.5 or 105.5 years apart, depending upon which part of the Earth/Venus commensurabilities the two bodies are at, at the time….

Currently, for the June 5/6 transit occurring this year, this translates to the simple fact that the next TOV will not occur until the year 2117 ---- certainly after just about everyone alive today has passed on to their "final destination".

Global Visibility of the Transit of Venus of 2012 June 05/06

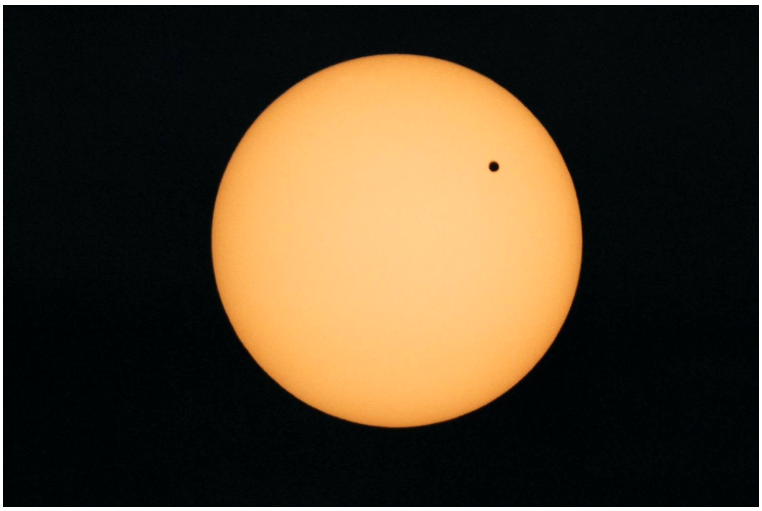


As evidenced by the graphic above, the TOV on 5/6 June will be visible to just about anyone on the daytime side of the Earth, provided it is during the time that the transit is occurring. This stands in stark contrast to the relatively narrow corridor that the annular solar eclipse traversed in late May, forcing would-be observers to expend some effort to place themselves in the path of annularity.

Visually, a transit is actually pretty underwhelming to the naked eye. Again, seeing a 1 arcminute black dot cross the Sun over the course of ~ 7 hours is not going to make David Letterman's "Top Ten" list any time soon. Rather, it's the simple fact of being alive to observe this very rare astronomical event, which makes it notable at all.

Personally, this upcoming transit takes me back to the previous member of this pair of transits (TOVs always come in pairs, separated by 8 years), in June of 2004. I and a small band of enthusiastic occultation fanatics --- including OCA member David Kodama and his wife Jean --- traveled all the way to Zambia, Africa in order to see the entire transit from start to finish. We chose the same observing venue as we used during the total solar eclipse of 21 June 2001, north of the Zambian capital city of Lusaka, near the town of Chisamba. The specific site was at Frangilla Farm, a working dairy farm owned by two long time settlers in Zambia, the Davises.

The transit began early in the morning of June 8th, just after local sunrise in Zambia. The conditions that day were nearly ideal, with virtually no interference from clouds until the very last few minutes of the event, in the mid afternoon. An image I captured of that event appears below.



Transit of Venus – 8 June 2004 © Joel K. Harris/Twilight Tours Inc.

Accompanying our small troupe of 13 transit aficionados was my one-time boss at Griffith Observatory in LA, Dr. Edwin C. Krupp --- the long standing Director of that esteemed facility. Ed was attended by a group of observatory docents/supporters, all of whom were most eager to take in this very unusual celestial event. As an added bonus, Ed was gracious enough to render a couple of his always entertaining and linguistically vibrant talks, focusing on the history and lore surrounding prior TOV events.

Another point of contrast to a central solar eclipse (either annular or total) is that owing to the very long duration of TOVs, there is no particular urgency to either observe every single minute of the event, or even a strong sense of "meteorological anxiety" that typically accompanies eclipses. Even IF the weather is suboptimal at the start of the transit, there is a huge amount of time in which conditions can improve and permit observers to see some of the transit!!

A rather humorous anecdote to that transit was the fact that about an hour or so after the ingress of Venus onto the solar disc, many of the group who were on the trip elected to take a breakfast break and sit down for a leisurely hour+ meal in the lodge dining room. I dare say that you wouldn't find anyone doing something of that nature during a total solar eclipse anytime soon!

As a final note, in a similar vein to the annular eclipse of late May, the same precautions apply to the upcoming TOV on June 5/6. Since only an extremely tiny portion of the bright solar disk will be covered by Venus as it moves across it over the course of the event, at **NO TIME** should one look directly at the sun with the naked eye, in an attempt to see the transit…

In a manner similar to a partial eclipse (or annular eclipse, or the initial or latter phases of a total eclipse), one **must** use proper solar filtering materials or devices to protect one's eyesight during the entire transit. There is NO point in the event when it is safe to look directly at the Sun, without using any intervening filter device or media.

In case you are either unsure about or in need of a source for proper solar filter material or devices, please consult any experienced OCA member, or contact a reliable telescope or filter dealer such as OPT in Oceanside, CA, Rainbow Symphony (online), or Meade Instruments Inc. (also online).

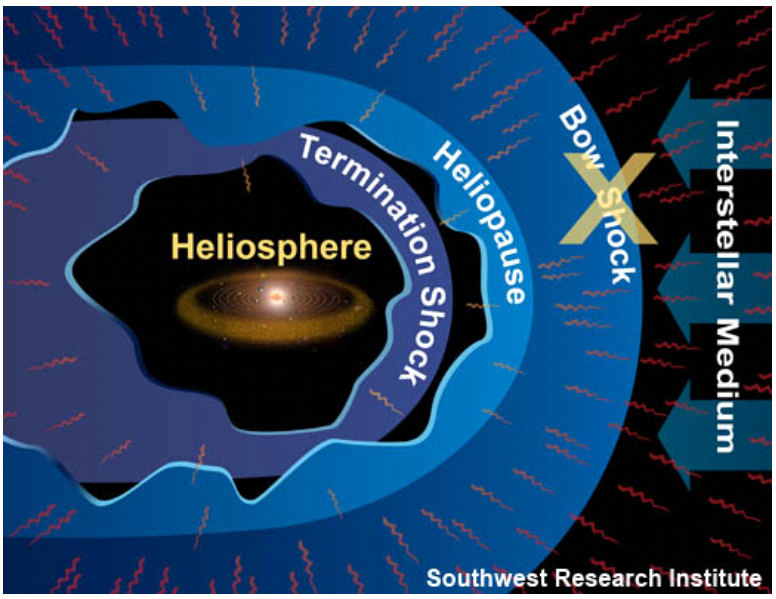
Good luck on June 5/6, and as always, clear skies to everyone!!

AstroSpace Update

June 2012

Gathered by Don Lynn from NASA and other sources

IBEX (particle space telescope) has revealed that the bow shock long assumed to exist outside the heliosphere does not in fact exist.



The heliosphere is the volume about the solar system affected by the Sun's magnetic field and wind. IBEX showed that the motion of the heliosphere through interstellar wind is slower than thought, and the interstellar magnetic field is stronger than thought. The combination of these means that the motion of our solar system is insufficient to create a shock, but instead creates only a wave ahead of the heliosphere. IBEX measures uncharged particles, which are not deflected by magnetic fields, to image conditions near the edge of the heliosphere. Bow shocks have been observed in front of other stars moving through the interstellar wind, but the Sun does not have one. Our solar system's speed through the interstellar medium was measured to be 52,000 mph (84,000 kph) rather than the previously estimated 59,000 mph (95,000 kph). The new measurements affect scientists' understanding of how cosmic rays enter the heliosphere.

Cosmic rays, very high-energy particles from space, have been known for over a century, but their origin is still not settled. One leading theory for higher energy cosmic rays has been ruled out by observations made by the IceCube, a neutrino detector buried in a cubic kilometer (1/4 cu mile) of Antarctic ice. The theory that gamma-ray bursts produce cosmic rays should produce enough neutrinos to be detected by IceCube. But no neutrinos have been detected at the times of gamma-rays detected (by gamma-ray space telescope) from bursts.

Dark matter – If the dark matter that has been detected gravitationally surrounding our Milky Way galaxy is roughly evenly distributed, then there should be detectable amounts of dark matter in our corner of the galaxy. A new study using a telescope in Chile measured the motions of more than 400 stars in a volume of up to 13,000 light-years from the Sun. From the motions, they calculated the mass that must exist in that volume. Because of dark matter, the mass should have been several times larger than the mass seen in stars, dust and gas, but was about the same as the mass seen. The most likely explanation is that dark matter is not distributed evenly throughout the Milky Way and its halo, but no cause is known for that. It is unlikely that this disproves the existence of dark matter because it has been measured gravitationally in many other places. Theorists need to do some more work to explain this observation.

Herschel (infrared space telescope) has shown that there is a limit to how much material can fall into a supermassive black hole before it shuts off star formation in its galaxy. This study involved 65 galaxies so far that we are seeing them as they were 8 to 12 billion years ago. This is the time when star formation was most vigorous, under much different conditions than today. Previous evidence for this star-formation shutdown has been from much nearer galaxies. The amount of star formation was measured by Herschel using far infrared observations, and material falling into black holes was measured by separate X-ray observations, and correlations were made. At smaller black hole activity levels, more material falling in resulted in more star formation. But then a threshold is reached where star formation turns off. This implies that material falling into a galaxy feeds both the central supermassive black hole and star formation. But material falling into a black hole heats to millions of degrees and gives off huge amounts of radiation before it disappears into the black hole. A threshold exists in radiation level beyond which it blows away the material that should form new stars.

Star consumed – Astronomers have gathered the most direct evidence yet of a supermassive black hole shredding a star that wandered too close. It was 1st seen by GALEX (ultraviolet space telescope) and the Pan-STARRS1 telescope in Hawaii. A spectrum showed that the victim was mostly helium. Even stars with high helium content have a shell of unfused hydrogen about the helium. The spectrum implies that the hydrogen shell must have been previously stripped before the helium core fell into the black hole. The astronomers involved believe that the black hole stripped the shell on a previous close approach. The black hole is in the center of a galaxy

2.7 billion light-years away. Stars falling into black holes are believed to be rare events. This one was found only because the astronomers were monitoring hundreds of thousands of galaxies for the ultraviolet signature of such an event. The 1st indications happened in June 2010, and it continued to brighten for a month, then fade for a year. Though the brightness was comparable to a supernova, the rise and fade time was too long to be a supernova.

Rogue stars – It takes a huge kick to throw a star out of a galaxy, because the escape velocity of a galaxy is fairly large. The best theory on how this occurs is that a binary star wanders too close to a supermassive black hole, and one star falls in while the other is flung out. The math for this event comes up with enough speed. 16 of these rogue stars (also called hypervelocity stars) have been discovered with sufficient speed to eventually leave our Milky Way. A new study found a way to locate lots of these rogue stars. The astronomers looked for stars in the halo of our Milky Way that showed up bright in red filtered images. These are known to be (usually) red giant stars with high content of heavier (than helium) elements. This is relevant because stars that form in the halo have low heavy element content, so the stars found this way came from somewhere else. The Sloan Digital Sky Survey has imaged a large fraction of the sky in various filters. So that data was searched for such stars. 675 of them were found. The astronomers still have to weed out nearby brown dwarfs, since they also show up bright in these filter images, but it is expected many of the 675 will be shown to be rogue stars thrown out by the supermassive black hole in our Milky Way.

Yellow supergiants – A study of 2 nearby galaxies, the Large Magellanic Cloud and M33, has identified hundreds of yellow supergiant stars and more even red supergiants. Stars go through their yellow supergiant phase in only a few thousand years, very short in cosmic times, and so are rarely caught in this phase. The astronomers compared the numbers found with the newest computer simulations of the yellow supergiant phase and found good agreement. This implies these simulations are predicting correct lifetimes for this phase. Previous simulations had predicted lengthier lives in this phase that do not agree with the new study.

Chandra (X-ray space telescope) has discovered an ultraluminous X-ray source (ULX) in the galaxy M83 that was not there a few years ago. This is one of the largest changes in X-ray brightness ever seen. A leading theory of ULX's is that the X-rays are given off by huge amounts of material falling into a black hole. Generally a young bright companion star is found that appears to be losing the material that falls into the black hole. Since binary stars almost always were formed at the same time, this implies the black hole is also young. However archived visible light images taken before the brightening show no bright blue star, in fact no detectable star, at the location of the new ULX. Therefore it must be a dim red companion star giving off the material. A dim red star would most likely be old, probably at least 500 million years old, and therefore its black hole companion would be old also. There is now a bright blue object seen in visible light, but it must be material falling into the black hole, not a bright blue star. The astronomers involved suggest that past observations may have been fooled by this blue light, and that ULX's are not necessarily a binary with a bright blue star. Certainly this ULX is not. Only one other ULX, one in the Andromeda Galaxy, has been shown to contain an old red star. There may be 2 kinds of ULX's: one with a bright blue young star, and one with an old red star.

Type Ia supernovas – There are 2 theories of how Type Ia supernovas occur: 1) a white dwarf star gravitationally pulls matter off a close companion star until it becomes too massive and explodes, or 2) two white dwarf stars merge and explode. Previous observations have implied that both theories are right, sometimes one, sometimes the other. A new study of 23 such supernovas looked for gas surrounding each one, which should indicate a companion was losing gas before the explosion, and therefore theory 1 was occurring. The study found that a gassy supernova tends to be more powerful. The astronomers involved suggest that when using Type Ia supernovas as "standard candles" to determine cosmic distances, the gassy and non-gassy cases should be treated separately. But the study did show that the difference is not great, which raises the question of how the 2 different causes can result in such similar results.

Colliding exoplanets – Astrophysicists have found that 4 white dwarf stars are surrounded by dust from shattered planetary bodies with composition similar to Earth. The Hubble Space Telescope was used for the biggest survey yet of the chemical composition of the atmospheres of white dwarf stars. 4 stars were found to have much oxygen, magnesium, iron and silicon in their dust. These elements make up roughly 93 percent of Earth. They also had low proportions of carbon, which is characteristic of Earth and its neighboring rocky planets. In fact these were the lowest proportions of carbon ever found in white dwarf atmospheres. White dwarfs normally have only hydrogen and helium in their atmospheres, as other elements generally sink into the star within days. So when other elements are found, they are probably being continuously deposited there from recent incidents.

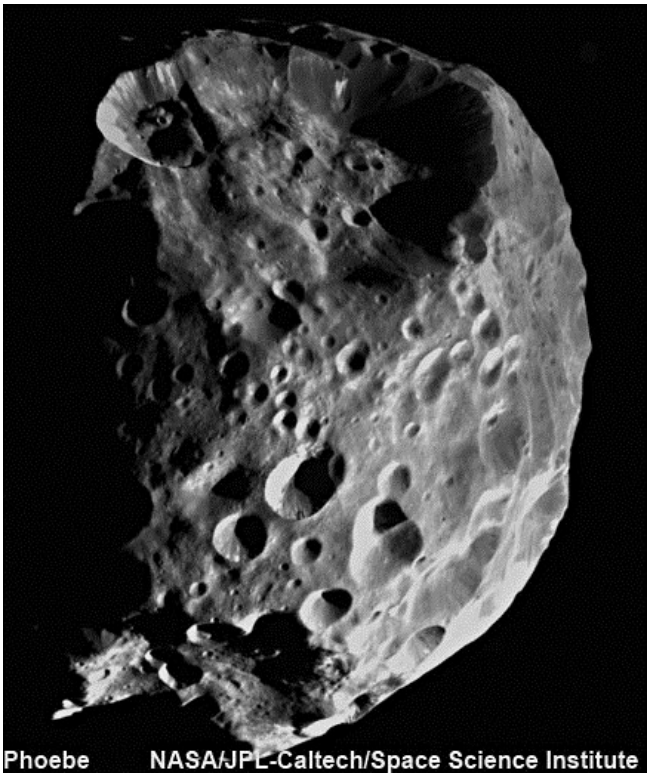
Quartz dust – A team of astronomers has discovered that a relatively nearby star is surrounded by a rare disk of quartz dust. How it formed is not certain, but it could be from collisions of planetesimals and/or rocky Earth-like planets. At least 100 trillion tons of tiny particles exist in the disk. Observations in infrared, including spectra, were made with Spitzer and other telescopes. The star is HD 15407A and is located 180 light-years away.

WISE (infrared space telescope) has caught an old star spraying dust into the cosmos. This is a process by which Sun-like stars seed the universe with building blocks for other stars and planets. WISE images showed a star 100 times as bright as old infrared images taken 20 years earlier, so this phase started in recent years. It is rare to catch a star just when it starts this phase. Astronomers know of one other star currently pumping out massive amounts of dust. The WISE discovery is a red giant. Such stars puff up and shed layers of gas that cool and congeal into tiny dust particles.

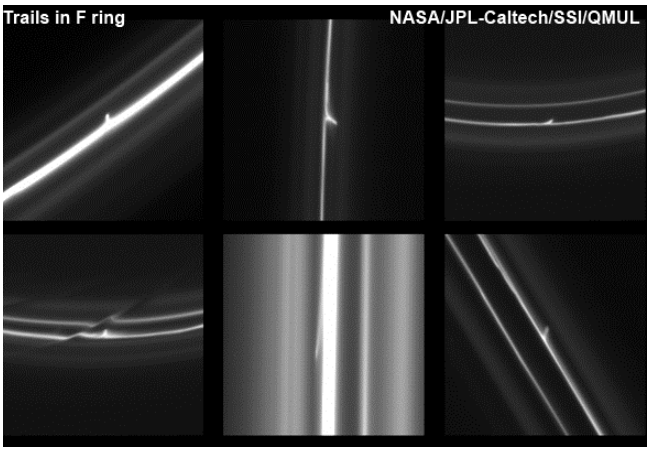
Spitzer (infrared space telescope) has for the 1st time detected the light of a super-Earth size exoplanet. All previous exoplanet light detections were of gas giants, which are larger and easier to detect. The light of the exoplanet cannot be resolved from the light of its star. But when the planet goes behind its star, the difference represents the light of the planet. Super-Earth size is defined as more massive than Earth, but less than Neptune. The planet is 55 Cancri e, and orbits its star every 18 hours. Thus it is quite close to its star and so is heated to about 2000° K (3100° F). Previous observations have shown that this planet is a water world, that is, has far more water than Earth. 5 planets are known to orbit this star, which is located 41 light-years away.

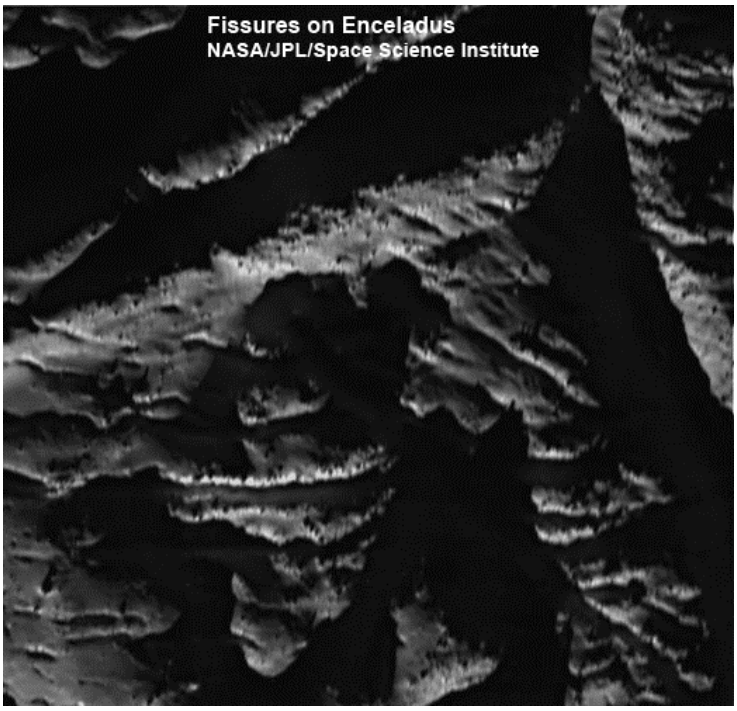
More Spitzer – New infrared observations by Spitzer of the Sombrero Galaxy (M 104) show that it is composed of both an elliptical galaxy and a disk galaxy. It is not disrupted enough to be the result of a collision of such galaxies. So the best explanation is that a large cloud of gas was gravitationally pulled into an existing elliptical galaxy billions of years ago and formed a star-forming disk within it. The Sombrero has almost 2000 globular clusters orbiting it, typical of a large elliptical galaxy, rather than the hundreds of globulars that spiral/disk galaxies have. This indicates it started out as an elliptical, and the disk was added later.

Cassini (Saturn mission) has taken close-up images of the moon Phoebe, and scientists found it has more planet-like qualities than thought. Phoebe was a planetesimal, or remnant planetary building block, that was captured by Saturn. The other inner moons appear to have formed in place in a disk of material orbiting the planet, not elsewhere like Phoebe. Probably the Kuiper Belt beyond Neptune was where Phoebe formed. The moon was hot and spherical early in its history. It has denser rock-rich material concentrated near its center, which happened when it was hot. It probably contained liquid water during some of this hot period, which probably lasted tens of millions of years. The average density is about that of Pluto, 40% higher than the average inner Saturnian moon. Most of the outer moons of Saturn were also captured, but Phoebe is larger than any of them. Phoebe probably formed within the first 3 million years of solar system formation, and acquired enough radioactive material to cause the hot period.


Phoebe NASA/JPL-Caltech/Space Science Institute

More Cassini – Scientists have known that relatively large objects like the moon Prometheus (92 miles, or 148 km across) can create channels, ripples and snowballs in Saturn's F ring when they orbit closely by the ring. A new study of high resolution images of the rings followed what happened to those snowballs after encounters formed them. Some survive with a slightly different orbit than the F ring, so eventually cross the ring again. They cross the F ring at only a fast walking speed and drag glittering ice particles into trails, typically 20-110 miles (30-180 km) long. In 20,000 archived ring images 500 of these trails were found. In some cases, the snowballs traveled in packs and created harpoon-shaped trails.

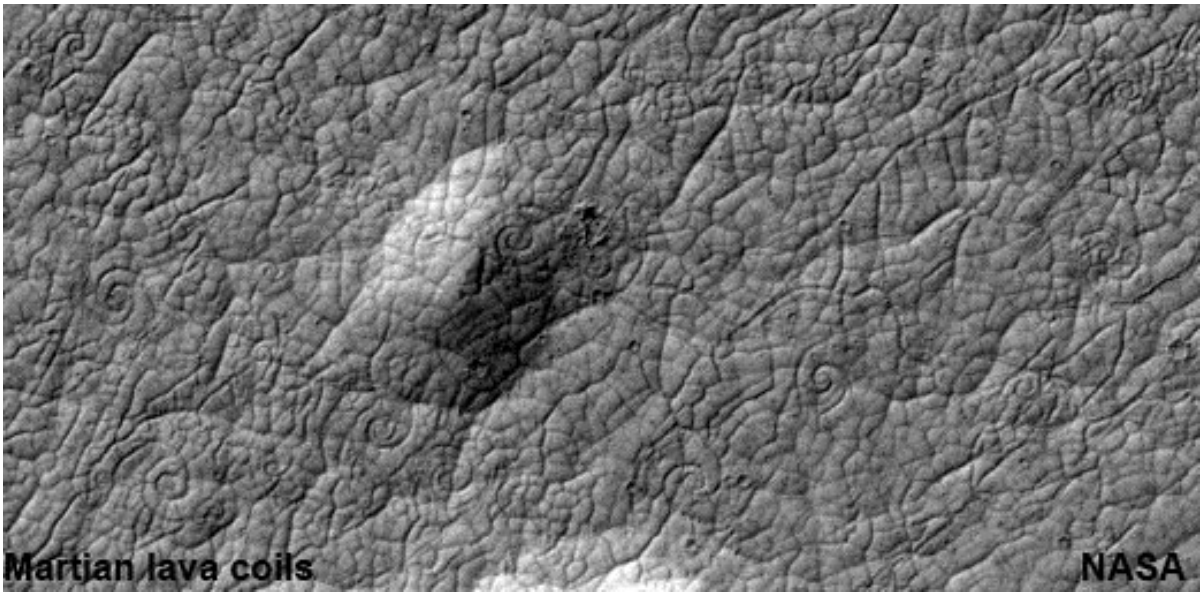

Trails in F ring NASA/JPL-Caltech/SSI/QMUL



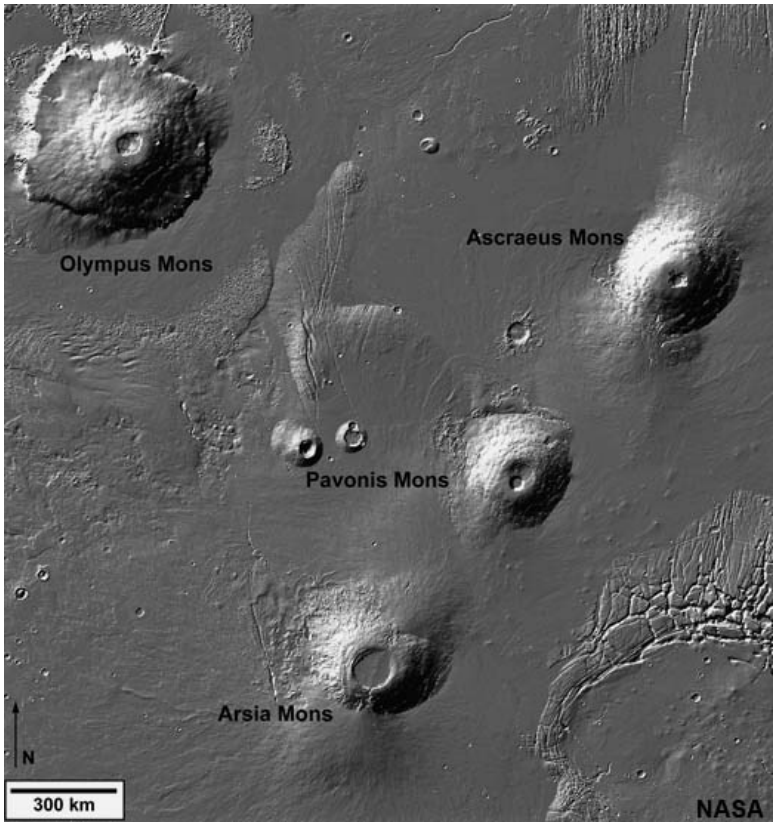
Yet more Cassini – Once again Cassini has flown quite close (46 miles, or 74 km) to geyser-riddled moon Enceladus, and actually went through the plumes of geysers. This allowed the ion and neutral mass spectrometer to ingest the geyser spray and analyze it. That was the 2nd close flyby of the moon in 3 weeks. The spray contains water, salt and carbon compounds. The salt content is about the same as that of Earth's oceans. Excellent images were made of the rough terrain around the geysers. More than 90 geysers have been counted. Excellent images were also obtained of the heavily cratered surface of Tethys in a flyby on the same day.

Opportunity (Mars rover) has weathered its 5th Martian winter and has resumed driving. For 19 weeks it was parked on a slope that increased the exposure of its solar panels to the low winter Sun to prevent running its batteries down. During the parked period the rover continued to use its spectrometers and microscopic imager on more than a dozen targets within reach. It also performed a radio tracking experiment to precisely measure the planet's axis of rotation. Soon the rover will be heading for deposits of clay minerals that have been detected nearby from orbiters.

Mars Reconnaissance Orbiter (MRO) – Images taken by MRO of Martian lava fields show patterns like snail shells. Similar patterns are seen in Earthly lava fields, but rarely, and far smaller. The size difference is perhaps related to different surface gravity or different lava properties. The coil shapes form where 2 lava flows move past each other at different speeds or in different directions. The Martian features are probably quite young geologically, in the range of 1.5 to 200 million years old.



More MRO – MRO has studied a sand dune field on Mars over time to determine how much the sand is moving. It had been expected that little of no motion would be detected in short time periods because the atmosphere of Mars is more than 100 times thinner than Earth's and Mars's high-speed winds are weaker and less frequent than Earth's. Yet the sand movement measured was quite comparable to earthly dunes. Sand was measured moving more than 2 cubic yards past every yard of dune width per Earth year. Martian dunes as thick as 200 yards (200 m) were found moving as a whole, and small ripples were found moving upon dunes. This means that erosion from blowing sand should be generally higher on Mars than estimated. New calculations of wind erosion rates matched some found on Earth in Antarctic dune areas.



Mars Express – Results have been announced from 5 years of gravity-mapping data taken by Mars Express. They show that the lava at the Tharsis bulge, where 4 of the large volcanoes reside, grew denser over time. This probably was caused by falling water content in the lava over time. The 3 volcanoes in a line, Arsia Mons, Pavonis Mons and Ascraeus Mons, formed in that order as a hot spot of welling lava moved northeasterly. Similar formations on Earth, the Hawaiian volcanoes, formed differently as plate tectonics (not present on Mars) moved the surface material over a hot spot. The Tharsis region is thought to have been volcanically active until 100-250 million years ago, relatively recently geologically. The high density of the lava in the region matches the density of meteorites that are known to have originated at Mars. Surprising variations were found in the thickness of the outer shell of the planet over the Tharsis area. Olympus Mons, the volcano not in the line, is on a thinner base shell. But apparently it is more rigid there, because it supports a taller volcano with sinking under the weight. The greater shell thickness probably held in internal heat longer, causing the lava at the 3 volcanoes to be hotter than at Olympus.

Dawn (mission orbiting asteroid Vesta) has sent us data that indicates Vesta formed more like a small planet or our Moon more than it like other asteroids. Vesta is a layered planetary building block with an iron core, a mantle and a crust. The patterns of light and dark markings on Vesta, however, more resemble those on Saturn's moons than those on our Moon, due to the lower surface gravity. Vesta's topography is quite steep and varied. Some craters on Vesta formed on very steep slopes and have nearly vertical sides. Landslides on Vesta are more frequent than expected. Data confirmed that HED type (Howardite Eucrite Diogenite) meteorites match the surface properties of Vesta. As long suspected, this means HED meteorites resulted from material being thrown off Vesta by impact, which then eventually fell to Earth. About 6% of all meteorites falling on Earth are HED type. The 2 major impact basins that overlap in the south polar area of Vesta have now been dated as about 1 and 2 billion years old. These ages were a surprise because the largest impact basins on our Moon are more like 4 billion years old.

Pioneer Anomaly solved – The spacecraft Pioneers 10 & 11, leaving the solar system after visits to Jupiter in the 1970s, have long been known to be slightly off track from their predicted positions. Generally they have slowed from prediction. This has become known as the "Pioneer Anomaly". All sorts of solutions have been proposed, including changing Relativity's equations for gravity. A new study has explained the entire anomaly without any new physics. The explanation is that certain parts of the spacecraft were warmer than thought, and radiated heat in certain directions, primarily away from the Sun. The pressure of the infrared light radiated away caused the slowing of the spacecraft. Primary hot spots were an electronics box, the nuclear power source, and the back side of the radio dish antenna, which was being heated by radiation from the power unit. A detailed computer simulation of temperatures and heat transfer of the spacecraft agreed exactly with the slowing and with the records of internal temperatures reported by the spacecraft themselves. Previous attempts to simulate temperatures had not been as precise. The heat radiated from the power unit had been previously accounted for, but was found insufficient by itself to explain the anomaly. A grant from the Planetary Society had allowed preservation of nearly all the spacecraft telemetry data, to make it available to scientists who wanted to study the Pioneer Anomaly. The reason that this effect has not been seen in other spacecraft is that the Pioneers were spin stabilized, not using stabilizing jets that most other spacecraft use. The anomaly was smaller than the uncertainty in jet energy, so it was too small to detect in most spacecraft.

Asteroid impacts – Study of spherule beds in rock layers in Australia show that large asteroid impacts were more common than thought in the period 2.5 to 3.7 billion years ago. It had been generally believed that large impacts became rare after the Late Heavy Bombardment period, ending about 3.8 billion years ago. Spherule beds are formed when molten droplets from an impact rain down to form a new rock layer. The new study concluded that about 70 asteroids at least 6 miles (10 km) across hit Earth in the period 1.8 to 3.8 billion years ago. At least 12 impacts created spherule beds in the area studied. The impact that probably killed the dinosaurs is the only impact known to have created similar spherule beds that occurred in the last ½ billion years.

Instant AstroSpace Updates

Meteorite hunters have located near Placerville, California, fragments of a huge meteor briefly visible in daytime skies over the state. Some have been identified as carbonaceous chondrites, a rare type of primitive **meteorite** rich in carbon compounds.

Astronomers using polarized light and interferometry on the Very Large Telescope in Chile have seen **dust flowing** off dying stars, red giants. 3 stars were involved: W Hydra, R Doradus, and R Leonis.

A team of astronomers using the Subaru Telescope in Hawaii have located the **most distant protocluster** (cluster still forming) of galaxies whose distance is firmly established (by redshift measurement). Its light took 12.7 billion years to reach us.

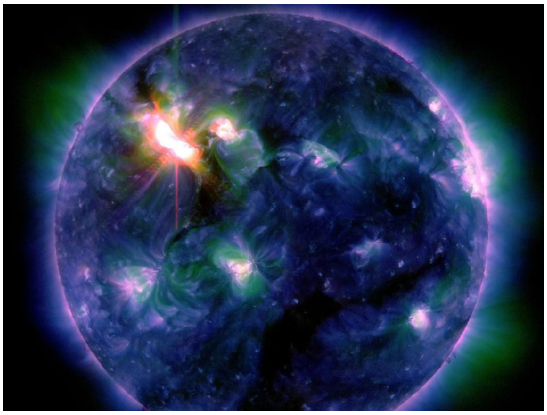
A company called Planetary Resources has developed a plan to **mine asteroids** for metals and rare minerals, estimating that a small asteroid contains trillions of dollars worth of such material. They plan to launch an exploratory spacecraft within 2 years.

The European Space Agency has approved a mission called **JUICE** to explore Jupiter and its icy moons starting in 2030, after a launch in 2022. It will be solar powered and spend at least 3 years exploring the Jovian system.

Daniel Schechter obtained this image of the 2004 Venus transit from Cape Cod, MA. Daniel used a Borg 76 with AP 2-inch Barlow and double-stacked Solarscope H-alpha filter. As emphasized elsewhere in this issue, the Sun should never be observed under any circumstances without adequate shielding or indirect projection techniques.

Thank Goodness for Magnetism

By Dr. Tony Phillips



Multiple-wavelength view of X5.4 solar flare on March 6, captured by the Solar Dynamics Observatory (SDO) in multiple wavelengths (94, 193, 335 angstroms). Credit: NASA/SDO/AIA

Only 93 million miles from Earth, a certain G-type star is beginning to act up.

Every 11 years or so, the solar cycle brings a period of high solar activity. Giant islands of magnetism—"sunspots"—break through the stellar surface in increasing numbers. Sometimes they erupt like a billion atomic bombs going off at once, producing intense flares of X-rays and UV radiation, and hurling massive clouds of plasma toward Earth.

This is happening right now. Only a few years ago the Sun was in a state of deep quiet, but as 2012 unfolds, the pendulum is swinging. Strong flares are becoming commonplace as sunspots once again pepper the solar disk. Fortunately, Earth is defended from solar storms by a strong, global magnetic field.

In March 2012, those defenses were tested.

At the very beginning of the month, a remarkable sunspot appeared on the Sun's eastern limb. AR1429, as experts called it, was an angry-looking region almost as wide as the planet Jupiter. Almost as soon as it appeared, it began to erupt. During the period March 2nd to 15th, it rotated across the solar disk and fired off more than 50 flares. Three of those eruptions were X-class flares, the most powerful kind.

As the eruptions continued almost non-stop, Earth's magnetic field was buffeted by coronal mass ejections or "CMEs." One of those clouds hit Earth's magnetosphere so hard, our planet's magnetic field was sharply compressed, leaving geosynchronous satellites on the outside looking in. For a while, the spacecraft were directly exposed to solar wind plasma.

Charged particles propelled by the blasts swirled around Earth, producing the strongest radiation storm in almost 10 years. When those particles rained down on the upper atmosphere, they dumped enough energy in three days alone (March 7-10) to power every residence in New York City for two years. Bright auroras circled both poles, and Northern Lights spilled across the Canadian border into the lower 48 states. Luminous sheets of red and green were sighted as far south as Nebraska. When all was said and done, the defenses held—no harm done.

This wasn't the strongest solar storm in recorded history—not by a long shot. That distinction goes to the Carrington Event of September 1859 when geomagnetic activity set telegraph offices on fire and sparked auroras over Mexico, Florida, and Tahiti. Even with that in mind, however, March 2012 was remarkable

It makes you wonder, what if? What if Earth didn't have a magnetic field to fend off CMEs and deflect the most energetic particles from the Sun. The answer might lie on Mars. The red planet has no global magnetic field and as a result its atmosphere has been stripped away over time by CMEs and other gusts of solar wind. At least that's what many researchers believe. Today, Mars is a desiccated and apparently lifeless wasteland.

Only 93 million miles from Earth, a G-type star is acting up. Thank goodness for magnetism.

With your inner and outer children, read, watch, and listen in to "Super Star Meets the Plucky Planet," a rhyming and animated conversation between the Sun and Earth, at http://spaceplace.nasa.gov/story-superstar.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

'Cosmos: A Personal Voyage', a PBS TV series which globally inspired millions to a love of science, learning, and freedom of inquiry, is being shown at the Regency Theater in San Juan Capistrano. Written, produced and hosted by the iconic astronomer and science popularizer Carl Sagan. This is the series that created the high level mark for all science documentaries to follow.

June 13th "Who Speaks for Earth?": Retracing the 15-billion-year journey from the Big Bang to the present, this episode intertwines the history of science (the martyrdom of Hypatia) with the advancement in space exploration. Dr. Sagan also takes aim at environmental issues as he illustrates the dangers of Global Warming. This episode is arguably the most passionate, the most compelling of all episodes. It points to our survival as a species, as Dr. Sagan stated: "It is as if there were a God who said to us, 'I set before you two ways. You can use your technology to destroy yourselves … or to carry you to planets and the stars. It's up to you."

Presenters for this concluding episode will be Bill Nye 'The Science Guy'. Scientist, engineer, comedian, author, and inventor, Bill is committed to fostering a scientifically literate society. Making science entertaining and accessible is something Bill has been doing most of his life. While a student at Cornell University, Bill Nye was introduced to the wonders of astronomy in a class taught by Carl Sagan himself, one of the original founders of The Planetary Society. So for Nye, it was like coming full circle to become its newest Executive Director.

Michael Shermer is an American writer and historian of science, founder of The Skeptics Society, and Editor-in-Chief of Skeptic magazine, largely devoted to investigating pseudoscientific and supernatural claims. Shermer recently spoke at the Social ***Singularity Summit*** in New York on ***Why Things are Getting Progressively Better***.

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