SIRIUS ASTRONOMER

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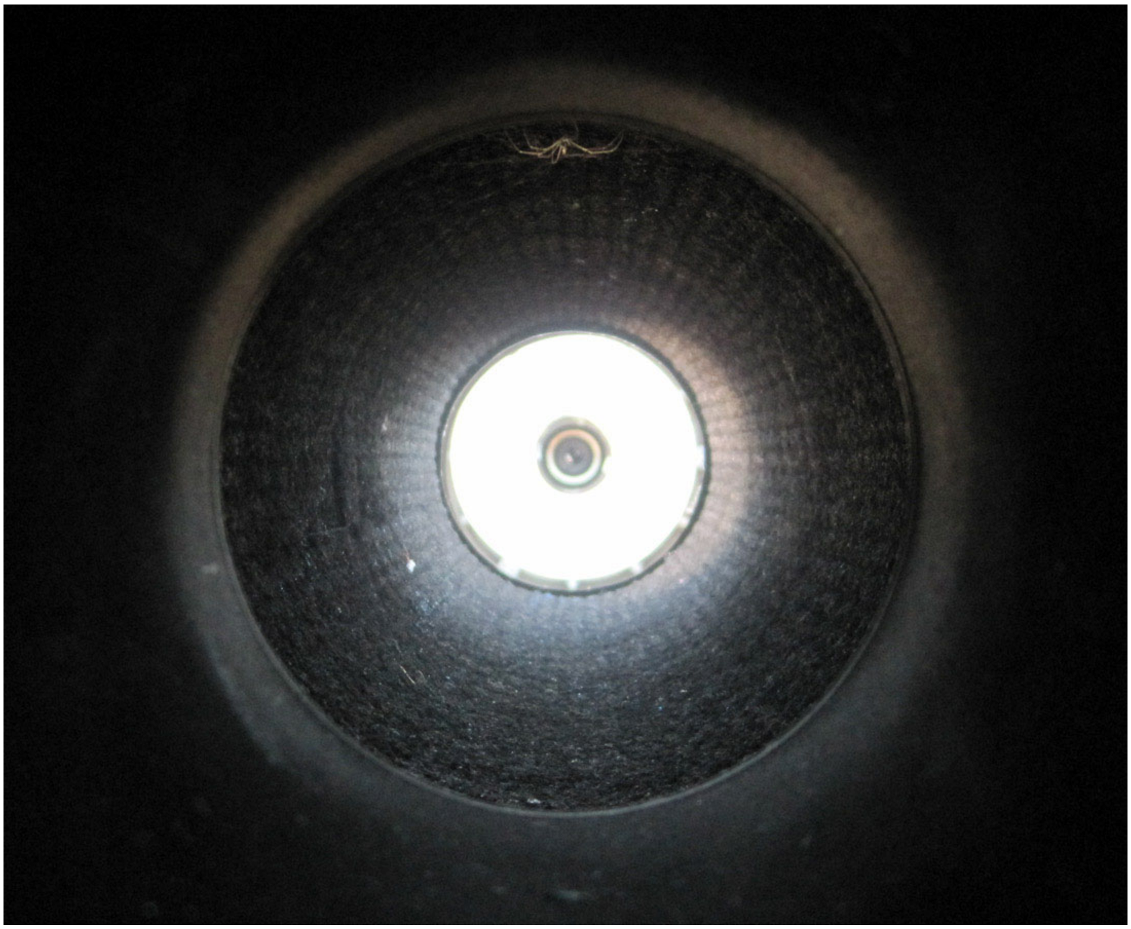


A temporary resident in the tube of the Kuhn telescope was imaged by Pat Knoll prior to being evicted on September 7, 2010

OCA CLUB MEETING

The free and open club meeting will be held October 8th at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. The subject this month will be Astronomers Without Borders: Global Projects for IYA2009 and Beyond

NEXT MEETING: November 12th

STAR PARTIES

The Black Star Canyon site will be open on October 2nd. The Anza site will be open on October 9th. 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, October 1st at the Centennial Heritage Museum at 3101 West Harvard Street in Santa Ana. Next month the class will be offered on November 5th.
GOTO SIG: TBA
Astro-Imagers SIG: Oct. 19th, Nov. 16th
Remote Telescopes: Oct. 28th, Nov. 22nd
Astrophysics SIG: Oct. 15th, Nov. 19th
Dark Sky Group: TBA

NASA's Space Place

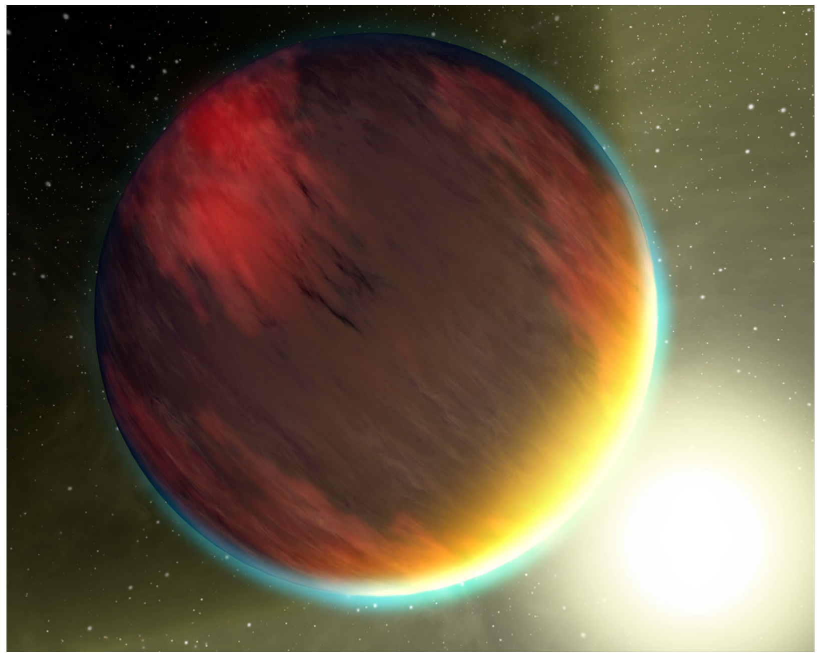
The Hunt is On!

By Carolyn Brinkworth

The world of astronomy was given new direction on August 13, 2010, with the publication of the Astro2010 Decadal Survey. Astro2010 is the latest in a series of surveys produced every 10 years by the National Research Council (NRC) of the National Academy of Sciences. This council is a team of senior astronomers who recommend priorities for the most important topics and missions for the next decade.

Up near the top of their list this decade is the search for Earth-like planets around other stars—called "extrasolar planets" or "exoplanets" —which has become one of the hottest topics in astronomy.

The first planet to be found orbiting a star like our Sun was discovered in 1995. The planet, called "51 Peg b," is a "Hot Jupiter." It is about 160 times the mass of Earth and orbits so close to its parent star that its gaseous "surface" is seared by its blazing sun. With no solid surface, and temperatures of about 1000 degrees Celsius (1700 Fahrenheit), there was no chance of finding life on this distant world. Since that discovery, astronomers have been on the hunt for smaller and more Earth-like planets, and today we know of around 470 extrasolar planets, ranging from about 4 times to 8000 times the mass of Earth.



Artist's rendering of hot gas planet HD209458b. Both the Hubble and Spitzer Space Telescopes have detected carbon dioxide, methane, and water vapor—in other words, the basic chemistry for life—in the atmosphere of this planet, although since it is a hot ball of gas, it would be unlikely to harbor life.

This explosion in extrasolar planet discoveries is only set to get bigger, with a NASA mission called Kepler that was launched last year. After staring at a single small patch of sky for 43 days, Kepler has detected the definite signatures of seven new exoplanets, plus 706 "planetary candidates" that are unconfirmed and in need of further investigation. Kepler is likely to revolutionize our understanding of Earth's place in the Universe.

We don't yet have the technology to search for life on exoplanets. However, the infrared Spitzer Space Telescope has detected molecules that are the basic building blocks of life in two exoplanet atmospheres. Most extrasolar planets appear unsuitable for supporting life, but at least two lie within the "habitable zone" of their stars, where conditions are theoretically right for life to gain a foothold.

We are still a long way from detecting life on other worlds, but in the last 20 years, the number of known planets in our Universe has gone from the 8 in our own Solar System to almost 500. It's clear to everyone, including the Astro2010 decadal survey team, that the hunt for exoplanets is only just beginning, and the search for life is finally underway in earnest.

Explore Spitzer's latest findings at http://www.spitzer.caltech.edu. Kids can dream about finding other Earths as they read "Lucy's Planet Hunt" at http://spaceplace.nasa.gov/en/kids/storybooks/#lucy.

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

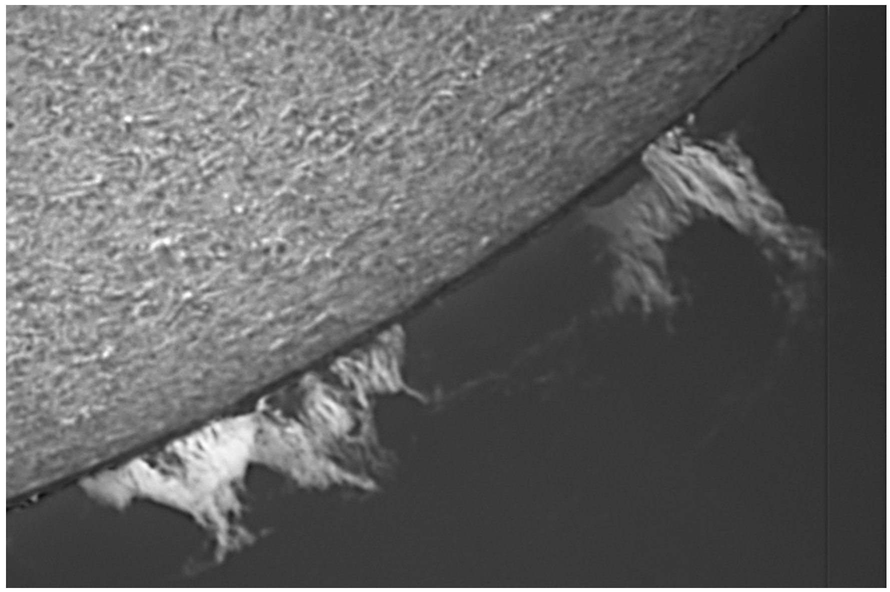
TOP TWENTY THINGS AN ASTRONOMER SHOULD SEE

#12 The Sun With a Hydrogen Alpha Telescope

By Helen Mahoney

The Sun is our nearest star, and observing it is both easy and difficult. Easy because, unlike any other object in the sky, it is there every day in every season, and is visible from anywhere on earth (except near the poles during winter). Difficult because, whereas most things in astronomy are dim and require large apertures to gather enough light, the Sun is so bright that we need optical aids to make it dim enough to see detail.

The lowest and densest layer of the Sun's atmosphere is the Photosphere. As its name suggests, it is where the energy, including light, escapes. Above the Photosphere is the Chromosphere, a thin layer of very hot hydrogen gas that moves with the loops of the magnetic fields and glows in a red wavelength of light called Hydrogen alpha, at 656.28 nanometers. The Photosphere is so bright that the Chromosphere cannot usually be seen. White light solar filters block all but about 0.001% of the sun's light in all wavelengths, making it safe for your eyes; but most of what you see is still coming from the photosphere. You can see sunspots easily with them, but not the fine detail of the chromosphere. For that you need a Hydrogen alpha (or H-alpha) filter. These filters select one wavelength of light, similar to selecting one crayon out of a box of 64 colors.



Pat Stoker captured this image of solar prominences using a Tak Sky 90 with a Solar Spectrum 0.2A H-alpha filter and Skynyx 2-1 imager from Anaheim, CA on 2/11/08. Solar astronomy is one area of our hobby which will never be impacted by light pollution!

Before George Ellery Hale's invention in 1892 of the spectroheliograph, which photographed the sun in the H-alpha wavelength, the Chromosphere was only seen during a solar eclipse, just before and after totality.

The Chromosphere is gorgeous, and changes day to day and even hour to hour. You can see what it looks like on web sites for SOHO (SOlar and Heliospheric Observatory) and now the SDO (Solar Dynamics Observatory), but actually watching it yourself is as exciting as any astronomical viewing. Loops of gas called prominences extend off the limb of the Sun, following magnetic fields. Most of the ones you can see are many times larger than the earth. On the surface, not only can you see sunspots, but also the filamentary penumbras around them, looking like petals of a sunflower. Filaments, cooler and therefore darker than the underlying chromosphere, stretch across the surface. We now know that filaments are prominences that are being seen against the solar disc.

With an H-alpha scope, you can set it up and check prominences and filaments throughout a day, and watch them develop and change. You can see a filament lift up off of the sun's limb and turn into a prominence as the sun rotates. Bright areas of intense magnetism called plages, and occasionally a bright flash of a solar flare lasting minutes or hours, can be seen.

H-alpha filters used to be extremely expensive and bulky, and required temperature stabilization. More recently, Coronado and Lunt Solar System filters and scopes make H-alpha observing much more accessible and affordable.

The sun goes through solar cycles of magnetic activity and sunspots, lasting approximately 11 years. My husband Doug and I purchased a Coronado Helios scope during a sunspot maximum in 2000. That maximum actually had two peaks, with a second in 2002. We have seen dozens of magnificent prominences, filaments and other features. Since we obtained the scope, not only have we enjoyed the views of the sun, but we have shared them at star parties and school programs. We find that solar observing does not require warm clothes or sleepless nights. Astronomy—it's not just for night time anymore!

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AstroSpace Update

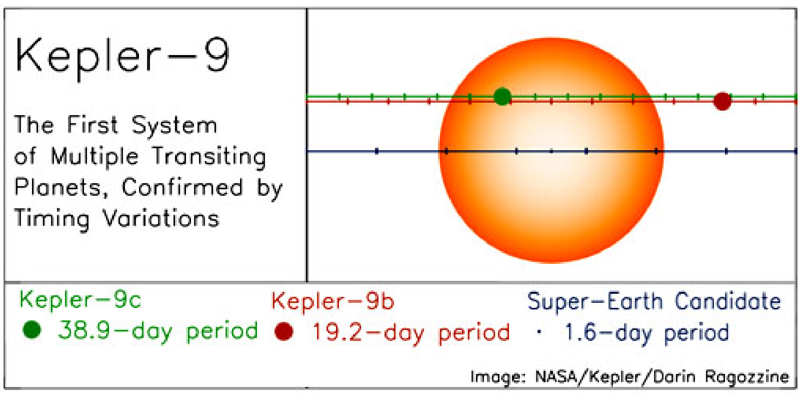
October 2010

Gathered by Don Lynn from NASA and other sources

Planet formation – It is now believed that planets can form by 2 different processes: 1) at the same time as their star, like a companion star, but without enough mass to be a star, and 2) from accretion of dust and gas in a disk left orbiting a newly formed star (planets form after their star). The Earth and the rest of the solar system had to have formed in the 2nd process. But a new study of parameters of known exoplanets (those orbiting other stars) concluded that the parameters better statistically matched that expected from the 1st process. The parameters studied were eccentricity (ellipticalness) of orbit, size of orbit, configuration of planetary system, and content of heavy elements. However, this study cannot be used to conclude that most planets form by the 1st process. This is because the methods used to detect exoplanets favor finding massive ones close to their stars, and the 1st formation process is likely to produce more massive close planets.

Dusty exoplanet – Astronomers have measured the temperature (from the spectrum) of a young gas-giant exoplanet using the Keck Observatory in Hawaii and found the results unlike that of any previously studied exoplanet. The only known way that the measured temperature could occur is if the planet is covered with very thick dust and clouds. The planet is 1 of 3 known to be orbiting the star HR 8799, located 130 light-years away in Pegasus. The mass of the planet is about 7 times that of Jupiter, but is the smallest known planet at this star. The planets there were discovered by direct imaging in 2008. Although over 500 exoplanets have been discovered, only 6 of them have been directly imaged so far.

Kepler (planet-searching space telescope) has discovered a system with 2 Saturn-sized planets with maybe a 3rd planet only 1.5 times the diameter of the Earth. If gravitational influences between planets are strong enough, it will cause measurable changes in the timing of the planets transiting in front of their star. This was the case in this newly discovered system. The timing changes allow calculating the mass of the planets. Those masses were then confirmed and refined with observations from the Keck Observatory in Hawaii. The 2 confirmed planets have masses of 80 times Earth's mass and 54 times, and they take 19 and 39 days respectively to orbit their star. The gravitational interaction is causing the inner planet to slow down 4 minutes per orbit, and the outer to speed up 39 minutes. This large change is due to the resonance of their orbital periods (nearly 2 to 1). The as-yet unconfirmed 3rd planet has a period of only 1.6 days. The planets have probably migrated to their current orbits from farther, where they likely formed.



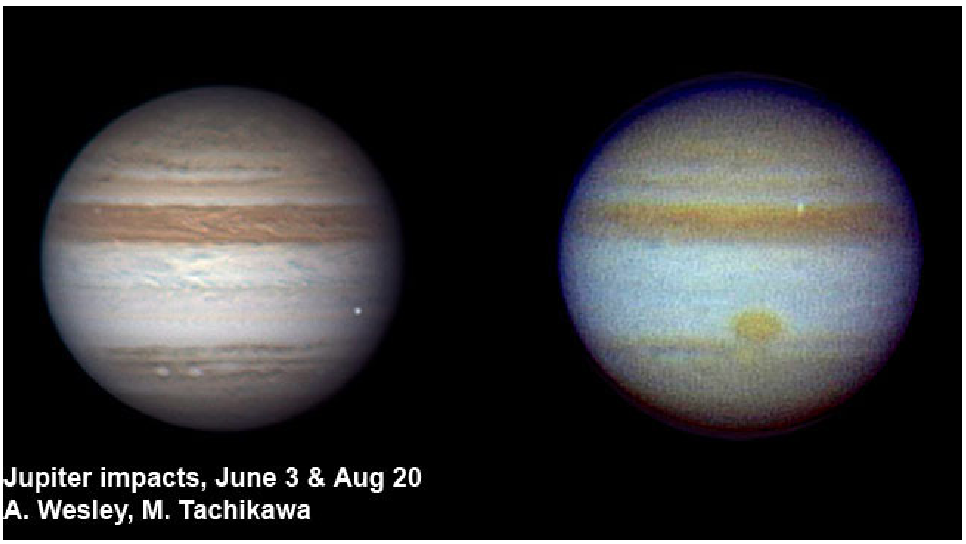
More exoplanets – Astronomers discovered a planetary system containing 5 confirmed planets, and are working at confirming 2 other possible planets. The system orbits the star HD10180, located 127 light-years away in Hydrus. The confirmed planets are roughly the size of Neptune, ranging from 13 to 25 times the Earth's mass, with orbital periods from 6 to 600 days. The planets' distances from their star range from 7 times closer than Mercury is to our Sun out to about Mars's distance. The distances of the planets from their star form a regular pattern, which our Solar System also does. The question once again arises as to whether the way planets form causes them to form a regular pattern of distances. The unconfirmed planets appear to be a Saturn-sized planet (65 Earth masses) outside the 5 Neptune-likes, orbiting in 2200 days, and one with 1.4 times the Earth's mass orbiting 3 times closer to its star than the inner 1 of the 5, and taking only 28 hours per orbit. Finding this system took 6 years of observing the tiny motions of the star in response to the gravitational tugs of its planets, using the 3.6-meter telescope in Chile. The system probably has no Jupiter-sized planets. It is much more populated with massive planets in the inner parts than our Solar System. All the planets have nearly circular orbits, which does resemble our Solar System.

Ex-exoplanets – A new study using Spitzer (infrared space telescope) data has spotted a surprisingly large amount of dust around 3 mature close-orbiting star pairs. Since the initial dust from the time of star and planet formation should have dissipated, the dust is likely the result of recent collisions of planets. The class of binary star studied consists of close orbiters, typically only 2 million miles apart. Their sizes are similar to our Sun, and their ages range from 1 to a few billion years. Another similar dusty disk about a close binary star was found in Spitzer data, but not within this binary star study. The fact that 4 dusty stars in this class were found implies that collisions of planets are common with such binary stars.

Phoenix (Mars lander) – Another study of data from the now-defunct Phoenix concluded that liquid water has interacted with the Martian surface throughout the planet's history, not just its early history, and that volcanic activity has persisted throughout Martian history, not just early on. These conclusions are based on the analysis of isotopes of carbon and oxygen in the carbon dioxide gas in the Martian atmosphere. Isotopes are variations in elements that have different numbers of neutrons, and therefore different atomic weights. Gas lost to space at the top of the atmosphere favors lighter isotopes. The ratio of the carbon-12 isotope to carbon-13 measured by Phoenix did not match that predicted after loss to space, implying that some source has released carbon dioxide into the Martian atmosphere in recent times, replenishing the isotopes lost to space. This source is likely volcanic activity. Yet the ratio of oxygen isotopes does not match that predicted from volcanic activity, unless it has also reacted with liquid water in recent times (which favors certain isotopes). The isotopes did not match what is predicted if hot springs are common on Mars, implying that hot springs are fairly rare. The Mars rover Spirit has found evidence of past hot springs, so they did exist, even if rarely. So the Phoenix data supports that cold liquid water existed on Mars in contact with the atmosphere, at least occasionally, but more often than hot springs, throughout the planet's history.

Viking (Mars landers) – The discovery of the chemical perchlorate on Mars by Phoenix has prompted scientists to re-examine the results of the Viking missions, which landed on Mars in 1976. The chemical analysis of Martian soil done by the 2 Vikings found very few carbon (organic) compounds. This was a blow to those who hoped to find simple life on that planet, because it is believed life could arise only if carbon compounds were plentiful. Also, present or past life should be plentiful in carbon compounds. The result was also surprising because meteorites falling on Mars should have supplied detectable carbon compounds to the soil. The new study shows that the presence of perchlorate in Martian soil would break down all carbon compounds during the Viking analyses, resulting in only carbon-chlorine compounds being detected, such as chloromethane and dichloromethane, which were indeed found by Viking. These were originally attributed to chlorine contamination of the Viking analyzers on Earth before launch. This interpretation was supported by finding that the chlorine isotopes in the chloromethane matched those found on Earth. Now scientists need accurate isotope measures of the chlorine in Martian perchlorate, to see if it also matches what the Vikings found, in which case Martian perchlorate may be a better explanation of the Viking results than the Earthly contamination theory.

Jupiter impacts – Amateur astronomers have reported 2 flashes on Jupiter this summer, apparently caused by small asteroids or comets impacting the planet. The first of these was reported here in July. Analysis of the videos by professional astronomers show that the June flash was caused by an object 30-40 feet across, and resulted in an energy release that was 5-10 times smaller than that of the 1908 Tunguska impact, where millions of trees were blown down in a remote part of Russia. Analysis of the later Jupiter collision this year (August 20) is not complete, but it appears that it was roughly comparable to the June one. Neither of the impacts this summer left a visible scar on Jupiter, apparently because the objects were far smaller than past observed Jupiter impacts, and so burned up entirely in the upper Jovian atmosphere. The June impactor was estimated to be 100,000 times less massive than the one that left a scar on Jupiter for many days in July of 2009.


Jupiter impacts, June 3 & Aug 20
A. Wesley, M. Tachikawa

Trans-Neptunian objects (TNOs) – Astronomers used a new technique to sift through some archived Hubble Space Telescope (HST) images to find TNOs, and 14 new discoveries were found. One was a binary, that is, a pair of TNOs orbiting each other. The technique should produce hundreds more TNOs if applied to more of the archive. TNOs are icy asteroids found orbiting beyond Neptune, and are also known as Kuiper Belt objects. The new technique is a computer program that recognizes the short faint streaks made by TNOs as they slowly move in their orbits during a long time exposure. It then finds the same object in other images. Using standard techniques, each object's orbit is calculated and its size is estimated based on brightness. The streaks in the images are examined by eye to weed out image defects. Inclinations (tilt of the orbits with respect to the plane of the Earth's orbit) and numbers of the various sizes of TNOs were studied. The distribution of sizes is a result of collision history, which tends to break up or build up, depending on type of collision. The conclusion was that both low and high inclination TNOs have similar distributions of sizes, and therefore similar collision histories.

Near-Earth asteroids – Spitzer has studied 100 near-Earth asteroids and found they have a surprising variety in their surface composition. Also they range from bright to dark, and from shiny to dull. Some smaller objects were surprisingly reflective (high albedo). It is known that exposure to sunlight in space darkens asteroids over millions of years. So the highly reflective ones must be relatively young or have had their surfaces recoated. The study will continue, with 600 more near-Earth asteroids scheduled for examination by Spitzer. There are 7000 known near-Earth asteroids, but it is projected that over 100,000 of them may exist.

Asteroid break up – Theoretical work indicated that if an asteroid was spun up by sunlight pressure, to the point that spin breaks it in two, then gravitational interactions between spin and revolution should throw the smaller piece off into a different orbit if the smaller is less than 60% the mass of the larger, but the pieces should remain orbiting each other if the smaller is more massive than 60%. A new study of 35 pairs of asteroids whose orbits could be traced back to a close encounter within the past million years showed that indeed they all obeyed this mass relationship. The asteroids studied varied in size from about 0.6 to 6 miles across.

(continued next page)

Weighing planets – Astronomers have found a new way to measure the masses of the planets in our Solar System. The Earth orbits the barycenter of the Solar System. Barycenter is the point (which moves as planets orbit) about which the sum total mass of the Solar System is centered. When measuring the extremely regular pulses of radio emission from pulsars, astronomers must correct that timing for the Earth's motion very precisely. After calculating the location of the barycenter and the Earth's motion about it, if there remain any repeating timing errors in pulsar measurements, it is due to error in calculating the barycenter, which is in turn due to error in the position or mass of some planet or planets. The masses are less certain than the positions. The period of the repeating timing errors immediately tells which planet's mass is in error. So the new method of measuring the mass is to correct each planet's mass until the pulsar timing errors disappear. This has been done now for all the planets out to Saturn. The results are not quite as accurate as the masses calculated from tracking spacecraft during flybys or orbits of these planets, but are more accurate than any other mass-determination method. It is predicted that averaging several years of pulsar data will be able to increase the accuracy of the masses beyond the spacecraft flyby method, at least for Jupiter and Saturn.

Herschel (infrared space telescope) has taken a spectrum of the carbon-rich cloud surrounding the red giant star CW Leonis and found water vapor where none was expected. Previous detections of water there were unable to determine the location and had detected only cold water. It was assumed that icy objects like comets existed far from the star to explain the water presence. The new spectrum clearly showed water as hot as 1300° F., which had to be quite close to the star. A new theory has been developed to explain how water got there. Hydrogen was already known to be abundant throughout the cloud, as are compounds containing oxygen, such as carbon monoxide and silicon monoxide. Ultraviolet (UV) light can break up the oxygen compounds, and then the oxygen reacts with hydrogen to form water. The new theory simply needed a source of UV, but red giant stars do not give off UV. The UV must have come from surrounding space, ultimately from other stars. The UV from other stars would not penetrate far enough into the cloud around the red giant to reach where the water is forming, except that the cloud is quite lumpy, allowing UV penetration between the lumps. Herschel will test the theory by observing other carbon-rich red giants.

Star-spot cycle – Scientists using data from the COROT satellite have been monitoring the sound waves in stars, and in one of them have now identified a star-spot cycle, similar to the Sun's 11-year sunspot cycle. The sound waves are affected by the presence of star spots, so the spots can be detected by COROT even though the spots are too small to be seen. The star-spot cycle is less than a year, the shortest known cycle. The exact end of the cycle was not seen because the star went behind the Sun as seen from Earth (and COROT). It will be confirmed from ground-based observations over a longer time period. The star is HD49933, located 100 light-years away in Monoceros. It is much bigger and hotter than the Sun. This is the first time a star-spot cycle has been detected using this technique. If short cycles are common, then many more star-spot cycles should be measurable in data from COROT and from the Kepler spacecraft.

Non black hole – The supernova explosion of a star so massive that it should have formed a black hole has been found to have created instead a magnetar (an extremely magnetic neutron star). A supernova of any star with mass greater than 25 times that of our Sun should create a black hole. Astronomers used a spectrograph on the Very Large Telescope in Chile to observe a magnetar in the star cluster Westerlund 1, which contains hundreds of very massive stars. There are only about a dozen magnetars known, evidently because they lose their extreme magnetic fields in only several thousand years, so are rare. Because the age of the Westerlund 1 cluster is known, it puts a lower limit on how massive a star can be that has already reached the end of its life as a supernova. Less massive stars take longer to reach end of life. That limit is at least 33 solar masses; one star in the cluster that has not yet gone supernova is known to have a mass of 33. A theory has been proposed to explain the magnetar. The progenitor (star before going supernova) must have been part of a binary star. It was indeed more massive than 33 solar masses, which led to it reaching end of its normal stellar life recently. The progenitor then swelled up and engulfed its companion star. The orbital energy of the companion star would then throw off much of the outer parts of the progenitor, reducing its mass below the 25 limit, no longer massive enough to form a black hole. The force of the supernova ejected the companion star, which is why we don't see it now.

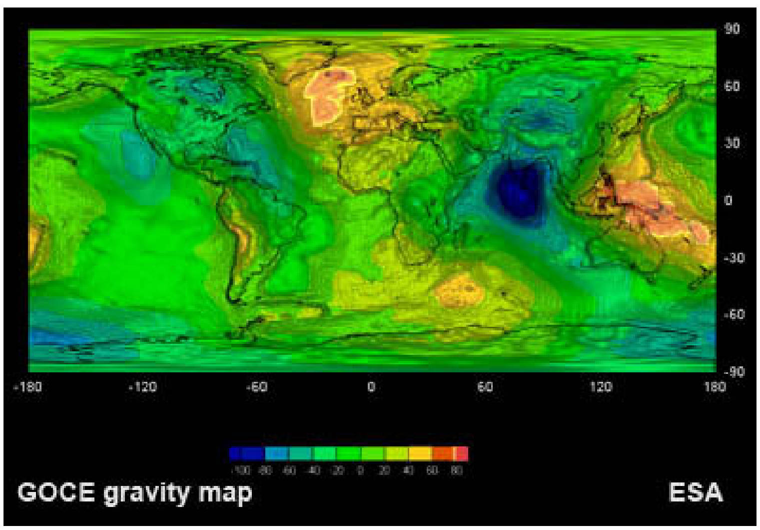
Spiral galaxy disks – It has been known since the 1970s that spiral galaxies have a double disk; that is, a thin disk densely populated with stars and gas, centered within a thicker sparsely populated disk. Stars in the thick disk tend to be older and more deficient in heavy elements. There are 2 competing theories on how the thick disk forms: 1) the stars were captured gravitationally by the thin disk from dwarf galaxies that passed through the disk, or 2) the stars were thrown out of the thin disk by gravity slingshots or supernovas. Computer simulations of galaxy formation recently showed that the 2 theories should result in different patterns of eccentricities of the orbits of the stars about the center of the galaxy. So a study was made of the eccentricities of 34,000 stars in the thick disk of the Milky Way, using data from the Sloan Digital Sky Survey. The result matched the computer predicted eccentricities for captured stars from dwarf galaxies (first theory), and did not match the other theory. The match was not strong enough to entirely rule out being thrown out of the thin disk, but at least most thick disk stars in the one galaxy studied must have come from passing dwarf galaxies.

Black holes and globulars – 2 new studies, which included 33 galaxies, have concluded that there is a correlation between the mass of the black hole in the center of a galaxy and the number of globular star clusters that orbit the galaxy. However, the correlation does not hold as well for spiral galaxies as it does for elliptical ones, and does not hold at all for lenticular galaxies. In particular, the Milky Way seems to have a poor correlation, having too many globulars or too small of a central black hole. Some authors of the studies pointed out that we may be misidentifying globulars; that is, many objects that appear to be globulars may actually be remnants of dwarf galaxies that have been torn apart. The masses of central black holes are already known to be correlated to other galaxy properties, such as central bulge mass and content of dark matter.

Dark energy – Astronomers have devised a new way to measure dark energy, the force that is accelerating the expansion of the Universe. They took HST images of the galaxy cluster Abell 1689, whose huge mass is bending light from galaxies located behind it, forming a giant gravitational lens, as predicted by Einstein's General Relativity. The amount and arrangement of bending of the light depends on the distribution of mass in the galaxy cluster, the distance to the cluster, the expansion speed of the Universe, and the strength of dark energy. This allows the strength of dark energy to be calculated when the other factors have been measured. When combined with other methods of measuring dark energy (such as the supernova surveys), the accuracy has been increased in measuring dark energy. It took several years of analysis to determine the distribution of mass in the cluster, but now the same method should be workable on other gravitationally lensing clusters much more quickly.

String theory has for many years been attempting to tie together the conflicting theories of general relativity and quantum mechanics. So far it has produced no prediction that could be tested by observations. Now it has been found that the string theory equations for a certain class of black hole are the same as the equations describing 4 entangled quantum particles. This could either be a coincidence or it could be that the same underlying physics applies to both. But the interesting thing is that the quantum entanglement may be measurable by laboratory experiment (but probably difficultly). If the experiment matches the equation, it won't prove string theory is right, but it may show that one string theory equation is right.

International Space Station (ISS) – The European and Japanese space agencies have each provided resupply spacecraft for the ISS. These, along with cargo craft from Russia and soon the American SpaceX company, will be able to keep ISS supplied with food, water, fuel, clothing, and experiment equipment needed by astronauts even after the Space Shuttles are retired early next year. However, none of these has the capability to bring people or equipment back down to Earth. When the supply spacecraft leave ISS, they burn up entering Earth's atmosphere. Normally they are filled with trash, providing a convenient way to dispose of ISS discards. Bringing people down will be performed solely by the Russian Soyuz spacecraft after Shuttle retirement. It has very little room for anything besides the 3 passengers. The European and Japanese space agencies recently announced that they are each going to develop supply spacecraft with heat shields to allow them to bring equipment down from ISS. These vehicles should be in operation in the range of 2016-2020. Space experts expect that these spacecraft later will be safety rated to carry people, though the space agencies have not committed to this. SpaceX has long been working on a returnable vehicle, and plans to have theirs operating long before the European and Japanese ones.



GOCE (European gravity mapper) – Engineers are sending by radio new software up to GOCE in an attempt to revive the broken satellite. Last February the main controlling computer failed on GOCE. No problem, they just turned on the backup computer. But then in July the module broke that takes data from the backup computer to send it back to Earth. The new software is going to reroute the data to avoid both broken parts. GOCE is in an unusually low orbit (about 160 miles high) so that it feels the gravity of concentrations of mass on the Earth. Then precise measurements of its path allow mapping these concentrations. GOCE is producing a gravity map with 100 times the precision of all previous efforts, but has completed only 2/3 of its mission. The low orbit subjects GOCE to drag from the top of our atmosphere, so to keep this from pulling it down out of orbit, an onboard ion engine keeps reboosting it. The satellite was boosted an extra 6 miles to give a little working room while the new software is installed.

Lunar Reconnaissance Orbiter (LRO) completed its exploration phase in mid September and is transitioning to its science phase, and as such, responsibility for the mission is being transferred from the Exploration Directorate to the Science Directorate within the NASA organization. The spacecraft has completed a one-year exploration of the Moon from polar orbit about 31 miles above the surface. It produced a comprehensive map of the lunar surface in unprecedented detail; searched for resources and safe landing sites for potential future missions; and measured lunar temperatures and radiation levels. By mission end, LRO will have sent more information to the Planetary Data System archive than all other previous planetary missions combined. LRO is expected to continue mapping the Moon for 2-4 years after the originally planned 6-month science phase.

Solar Probe+ – NASA has announced the instruments that will be included on the Solar Probe+ spacecraft, which will launch by 2018, and plunge into the Sun's atmosphere. Reaching only 4 million miles above the Sun's surface, far closer than any other spacecraft, the probe will withstand over 2000° temperatures and strong blasts of radiation. The instruments include: a particle counter and analyzer; a 3-D wide field imager; a detector for electric fields, magnetic fields, radio emissions and shock waves; and a monitor for electrons, protons and ions accelerated to high energies. Solar Probe+ will make multiple passes by Venus to gravity slingshot it toward the Sun.

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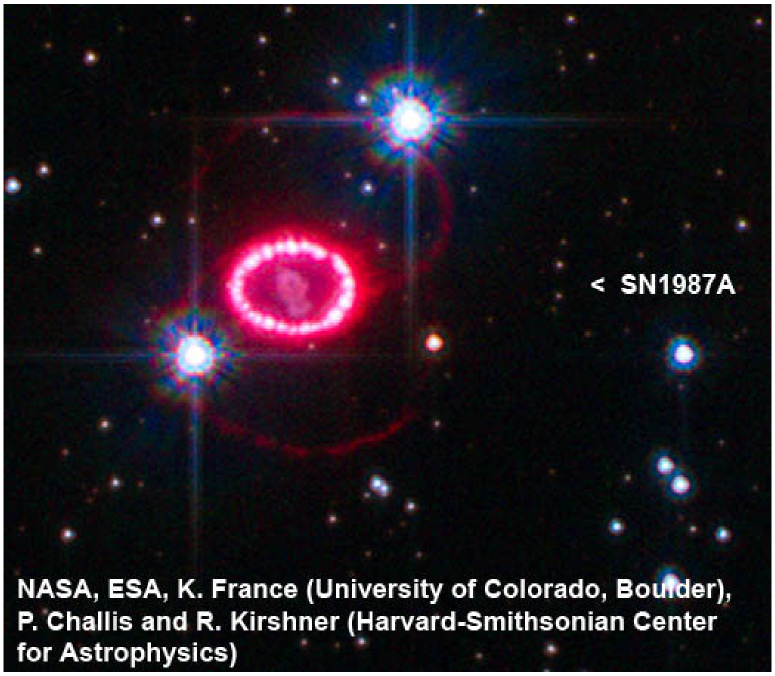
Chandrayaan 2 – The Indian space agency has announced details of Chandrayaan 2, their next mission to the Moon, to launch in 2013. Russia will supply a lander, and India will supply an orbiter and a rover. The rover will be equipped with a laser to zap rocks and

Instant AstroSpace Updates

Astronomers using HST found a significant brightening of the shock wave emitted by **supernova 1987A** in the nearby Large Magellanic Cloud galaxy as the wave plowed through surrounding material thrown off by the star about 20,000 years before the supernova. Over the last few years, a few spots of glow have grown into nearly a complete ring about a light-year in radius.



NASA, ESA, K. France (University of Colorado, Boulder), P. Challis and R. Kirshner (Harvard-Smithsonian Center for Astrophysics)

Study of a **gamma-ray burst** that occurred 2 years ago showed that it was so distant that its light took 12 billion years to get here, and was still among the brightest bursts seen, despite dust and gas in its galaxy obscuring 95-99.5% of its light, depending on wavelength.

Computer simulations of the early formation of galaxies indicate that the first **supermassive black holes** probably formed as a result of galaxies colliding and merging.

A new measurement of byproducts of radioactive decay of uranium in a meteorite showed that it formed 4.5682 billion years ago, up to about 2 million years older than previous dating of meteorites using radioactive dating in calcium-aluminum inclusions. Meteorite dating is considered the most accurate way to find the **age of the Solar System**.

Images of the massive galaxy **M87** made of combined data from the VLA radiotelescope and the Chandra orbiting X-ray telescope show that an eruption that lifted up cool gas away from the galaxy center occurred about 150 million years ago, and another eruption of warmer gas happened 11 million years ago that produced a shock wave still visible. The gas thrown out was sufficient to form hundreds of millions of stars, but now will not because it is too disrupted. ■

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The Venus Transit Voyages of Le Gentil

by Matt Ota

This is a story about Guillaume Le Gentil, a French astronomer who went on a long expedition to view the Transit of Venus that was predicted to occur in June of 1761. Transits of Venus had importance at this time in astronomy history since it was thought to be the best way to determine the value of the Astronomical Unit - the average distance from the Earth to the Sun. Venus transits occur in pairs eight years apart separated by long gaps of 121.5 years and 105.5 years. Thus it is one of the rarest of predictable astronomical events that can be viewed in a human lifetime.

Le Gentil left France on boardd the ship Berryer on March 26, 1760 in order to view the Transit from a French plantation in Pondicherry, India in 1761. His trip took a long route around the Cape of Good Hope. The ship was becalmed on the way to India and they did not arrive to the area until May 24th. Le Gentil's ship stopped in Isle de France (Mauritius) on July 10th, 1760. The northeast monsoon season was coming and there were no French ships sailing to India at that time. During his stay on the Isle of France he caught dysentery. For some time he contemplated traveling east to the island of Rodrigues, in the Mauritius Islands where M. Pingré was planning to observe the transit. When he was ready to sail for Rodrigus, he found a French frigate was going to go to the coast of Coromandel, an area in India still in French control. So he changed ships. But the frigate did not leave Mauritus until the middle of March 1671, which was less than three months before the transit.

Then he and the crew of the French frigate found out that the plantation that he had planned to use for the observation had been taken by the British. Due to this war between France and Britain, The captain turned the ship around and headed back to Mauritius. Le Gentil had only been 200 miles short from his goal after such a long trip.

On June 6th, 1761 Le Gentil was able to witness the Venus Transit from the ship, but his measurements were of little scientific value due to the unsteadiness of the ship at sea and the lack of accurate timing:

"…The winter at Grille was in full force; we went through a hard time. We left this coast the 30th of May; the great breeze with which we were accompanied took us to the Isle de France the 23rd of June. I shall not enter here into greater discussion about this expedition, of the route that I had thought that we would take, and that which we did take.... This memoir which is only an extract from my journal which I kept quite regularly day by day shows that I busied myself as I ought with my observations, that my aim was always to go to the coast of Coromandel and that I should not be blamed if I did not appear there; it is a justice which I beg astronomers to do me and which I will have reason to expect from them when they see the details of my memoir. On June 6 1 was at 5 degrees 45 minutes of south latitude, and almost 87 degrees 15 minutes of longitude east of Paris. I observed as best I could the transit of Venus, its beginning and end. This observation which I neither published nor calculated has remained as it was made with remarks in a scaled memoir…"

Not lacking in resolve and determination, he decided to stay on Mauritius to do some exploring until the next Venus transit, which was due to occur eight years later. During his stay he made trips to Madagascar and the Isle de Bourbon. He made a map of the east coast of Madagascar. He studied the customs and clothing of the native people there, and did studies in natural history. He also made observations of refraction, and of the winds and the monsoons.

He decided to travel to the Philippines, not an easy feat for an 18th century scientist. He had determined that Manila would be the best place to see the Venus Transit of 1769, as the entire transit would be visible from there. So he sent a letter to the Academy of Sciences in Paris and asked them to get official permission from the Spanish government for him to observe from that location.

While he was waiting in Mauritius for an answer to his letter, he managed to hitch a ride with the Spanish warship Bon Conseil to Manila. He left the Isle de France on May 1, 1766 and arrived in Manila on August 10, 1766. He began to prepare for the transit by determining the longitude and latitude of the location. However, the Governor of Spanish Manila was not of favorable disposition to Frenchmen. On July 10, 1767 When Le Gentile presented him with a letter of recommendation from the French court, he was rebuffed. The Governor did not believe the letters were authentic, saying that a year and two months was too quick to receive a reply from France.

Le Gentile then received another letter from the French Academy of Sciences. He was ordered to go to Pondicherry, India to view the transit there. Pondicherry had been restored to France by peace treaty in 1763. He went there as instructed, even though the entire transit would not be visible from there, only the egress.

He arrived in Pondicherry in March 27, 1768, with more than a year to go until the transit:

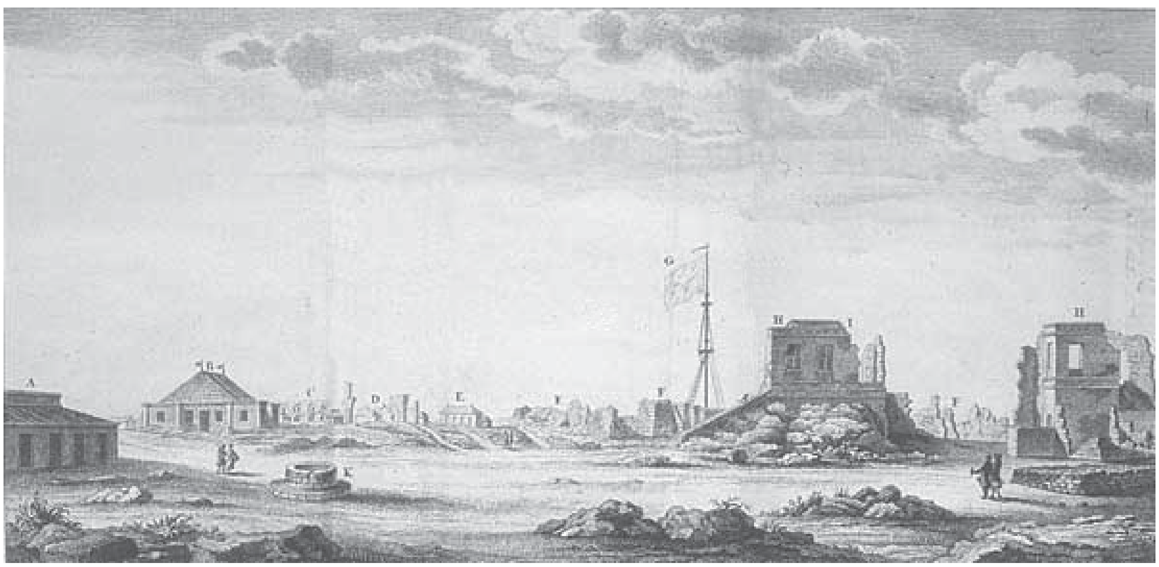
(continued next page)

"On the 27th, at five-thirty in the morning, we sighted Pondicherry. …we anchored a half league from land… a little boat was sent to us from land, in which I embarked with all my possessions and astronomical instruments of which you know. It was therefore on March 27th [1768] at nine o'clock in the morning that I saw myself on the land which fate had marked for me. My first step was to present myself to the governor.... M. Law therefore gave at once the order to disembark my possessions and to be careful of them; he had me get into his open carriage with him and took me to his country house where I found a large and pleasant company, good music, and an excellent dinner. I spent the day in enjoying myself and at eleven o'clock in the evening I returned to Pondicherry with the governor. The next day he told me to go to look for a site to build an observatory for myself; he himself went with the chief engineer to reconnoiter the spot which I had pointed out, and ordered that masons be sent there at once."

He was recommended to use the ruins of a citadel that was built by M. Dupleix. He chose the easternmost pavilion, placing his observatory atop a vault that was still being used to store sixty thousand pounds of gunpowder. This is certainly one of the most unusual and dangerous sites for an observatory in history!

Construction began on April 18th and concluded on June 11th, with the structure and windows put into place. By July 14, 1768 he had his quadrant cleaned and his clocks ready in order to fix the longitude and latitude of Pondicherry to a precision that had never been attained before.

Le Gentil's Observatory, seen built atop a magazine just to the right of the flagpole.



Le Gentil also became interested in the astronomy and native myths of the people of the area. He learned the different methods that they used to calculate and predict eclipses. He compared their methods to the ones used in his European culture.

On June 3, 1769 Le Gentil began monitoring the weather. This day before the transit the weather was clear. The following day, June 4, it was time to observe the transit:

"…. having awakened at two o'clock in the morning, I heard the sand-bar moaning in the south-cast; which made me believe that the breeze was still from this direction, or at least that it would blow from there in the morning. I regarded this as a good omen, because I knew that the wind from the south-cast is the broom of the coast and that it always brings serenity but: curiosity having led me to get up a moment afterwards, I saw with the greatest astonishment that the sky was covered everywhere, especially in the north and. north-east, where it was brightening; besides there was a profound calm. From that moment on I felt doomed, I threw myself on my bed, without being able to close my eyes. I no longer heard the bar in the southeast, but in the northeast; it was another very bad omen for me. Indeed, when I got up a second time I saw the same weather still, the northeast was even more overcast. At five o'clock the wind blew ever so little from the south-west: which gave me again a gleam of hope, all the more because the part of the sky from the south to the east was a little clear; I believed therefore that the breeze might turn in this direction, and that it might clear the sky. However, the north and the northeast were continually threatening; the clouds did not move, and I still heard the bar in the northeast, so that I was between hope and fear. But this state of uncertainty did not last for very long: little by little the winds passed to the west, to the north-west, and to the north; in less than seven or eight minutes the weather was obstructed, as it were, by the *approach of a gust of wind; from the north the winds passed to north north-east, and north-cast, where they were at about five thirty.*

Then they blew with fury; the great clouds which until then had been motionless in the northeast began to move. They soon spread out so that they formed a second curtain. Among several little gaps that they left between them could be perceived the upper layer of clouds, which was pale and continuous, but quite sufficient to hide the sun if it had been the only layer. The ships which until then had not swung before the wind, were forced to do so; the sea was white with foam, and the air darkened by eddies of sand and of dust which the force of the wind kept raising continually. This terrible squall lasted until about six o'clock. The wind died down, but the clouds remained. At three or four minutes before seven o'clock, almost the moment when Venus was to go off the sun, a light whiteness was seen in the sky which gave a suspicion of the position of the sun, nothing could be distinguished in the telescope.

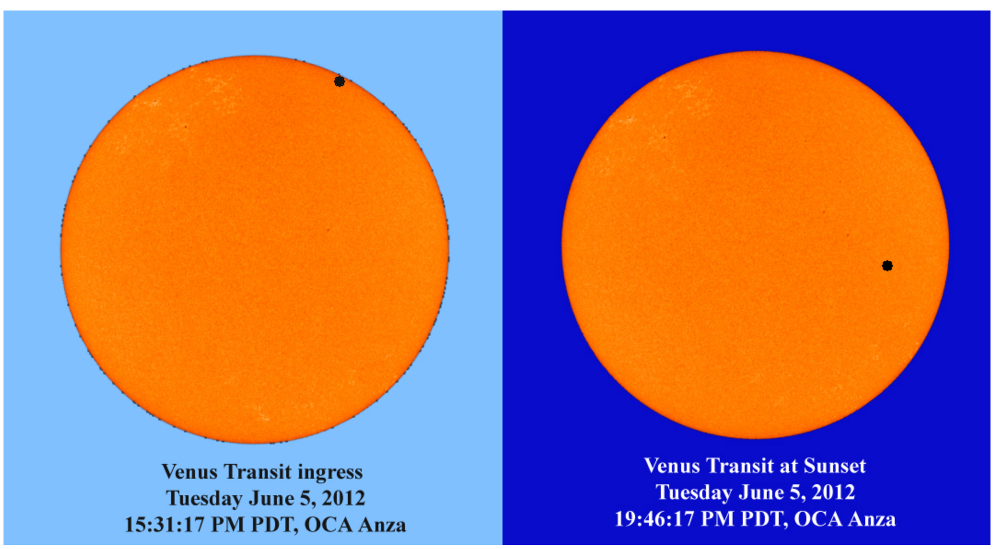
Little by little the winds passed to the east and to the south-cast where they were at nine o'clock for a little while; the clouds brightened, and the sun was seen quite brilliant; we did not cease to see it all the rest of the day although the base of the sky remained covered with a whitish cloud…That is the fate which often awaits astronomers. I had gone more than ten thousand leagues; it seemed that I had crossed such a great expanse of seas, exiling myself from my native land, only to be the spectator of a fatal cloud which came to place itself before the sun at the precise moment of my observation, to carry off from me the fruits of my pains and of my fatigues....I was unable to recover from my astonishment, I had difficulty in realizing that the transit of Venus was finally over. . . . At length I was more than two weeks in a singular dejection and almost did not have the courage to take up my pen to continue my journal; and several times it fell from my hands, when the moment came to report to France the fate of my operations...."

The next transit would be 105 years later. To make matters more excruciating, he found out by letter from Don Estevan y Melo that the weather in Manila had been perfectly clear during the entire transit.

This is not the end of his story. Le Gentil stayed in Pondicherry for a while then started his way back to France. On the way there he was shipwrecked twice, and eventually landed in Cadiz Spain. The last part of his journey home was done on foot over the Pyrenees Mountains to France.

When Le Gentil finally arrived in Paris, twelve years after his journey had begun, he found that he had been declared legally dead and his family was dividing his estate. He had to take legal action to regain his property. He was also demoted by the Academy as they were convinced he had made personal gain while disregarding his official duties. Le Gentil was eventually vindicated and got his rank and position back at the Paris Observatory. He then married, raised a daughter and wrote his papers. He died at age 67 in 1792.

Venus transits occur only twice in your lifetime. They are rarer than solar or lunar eclipses. The last transit of Venus occurred on June 8, 2004, but was not visible in the western hemisphere. Fortunately, the next transit on Tuesday, June 5 in 2012 favors the western hemisphere, centering on the Pacific Ocean. Even better, the first part of the transit will be visible from the west coast of the USA. Here is a projected view of the transit from our Anza observing site:



If you decide to go and see this transit two years from now remember the perseverance and travails of Le Gentile, especially if you get clouded out.

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