Star Gazer News

Astronomy News for Bluewater Stargazers
Vol 6 No. 6 June 2012

June 2012 Contents

Saturn's Moon Helene in Color
Image Credit: *NASA/JPL/SSI; Color Composite: Daniel Machácek*
Explanation: *Although its colors may be subtle, Saturn's moon Helene is an enigma in any light. The moon was imaged in unprecedented detail last June as the robotic Cassini spacecraft orbiting Saturn swooped to within a single Earth diameter of the diminutive moon. Although conventional craters and hills appear, the above image also shows terrain that appears unusually smooth and streaked. Planetary astronomers are inspecting these detailed images of Helene to glean clues about the origin and evolution of the 30-km across floating iceberg. Helene is also unusual because it circles Saturn just ahead of the large moon Dione, making it one of only four known Saturnian moons to occupy a gravitational well known as a stable Lagrange point.*

"Projectiles" Punch Through F-Ring

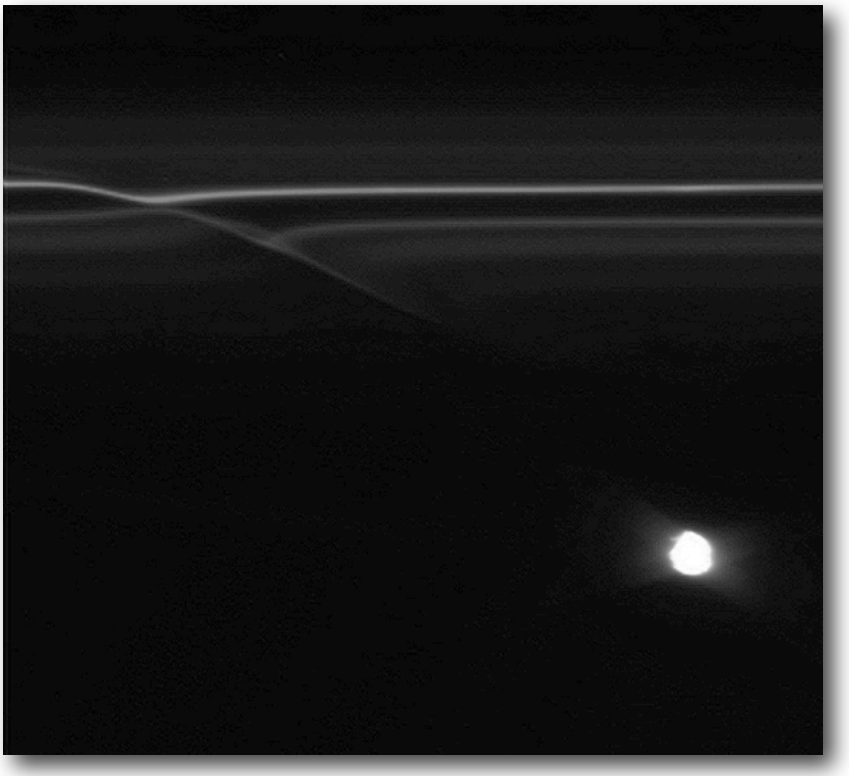
PASADENA, Calif. April 23, 2012 - Scientists working with images from NASA's Cassini spacecraft have discovered strange half-mile-sized (kilometre-sized) objects punching through parts of Saturn's F ring, leaving glittering trails behind them. These trails in the rings, which scientists are calling "mini-jets," fill in a missing link in our story of the curious behavior of the F ring.
New images and movies of the mini-jets and other peculiar F ring behavior are available at http://www.nasa.gov/mission_pages/cassini/whycassini/cassini20120423.html .

Scientists have known that relatively large objects like Prometheus (as long as 148 km across) can create channels, ripples and snowballs in the F ring. But scientists didn't know what happened to these snowballs after they were created. Some were surely broken up by collisions or tidal forces in their orbit around Saturn, but now scientists have evidence that some of the smaller ones survive, and their differing orbits mean they go on to strike through the F ring on their own.

These small objects appear to collide with the F ring at gentle speeds - something on the order of about 2 m/s. The collisions drag glittering ice particles out of the F ring with them, leaving a trail typically 40 to 180 km long. Carl Murray's group based at Queen Mary's University in London, England happened to see a tiny trail in an image from Jan. 30, 2009 and tracked it over eight hours. The long footage confirmed the small object originated in the F ring, so they went back through the Cassini image catalog to see if the phenomenon was frequent.

"We combed through 20,000 images and were delighted to find 500 examples of these rogues during just the seven years Cassini has been at Saturn." In some cases, the objects traveled in packs, creating mini-jets that looked quite exotic, like the barb of a harpoon. Other new images show grand views of the entire F ring, showing the swirls and eddies that ripple around the ring from all the different kinds of objects moving through and around it.

Jia-Rui C. Cook Jet Propulsion Laboratory, Pasadena, Calif.
Dwayne Brown NASA Headquarters, Washington



Images from NASA's Cassini spacecraft have revealed kilometre-sized objects punching through parts of Saturn's F ring, leaving glittering trails behind them. These trails in the rings, which scientists are calling "mini-jets," fill in a missing link in our story of the curious behavior of the F ring.

President's Report

We are heading into the pleasant summer months when astronomical observing becomes less challenging at least when it comes to staying warm. This summer promises to be the most active in BAS history.

Club observing events this month will begin at the ES Fox Observatory with the June 5 Transit of Venus. The transit will replace the June BAS meeting. The event, for those of us in southern Ontario, ends at sunset but members are encouraged to come prepared to observe the whole evening. A short BAS monthly meeting will be conducted between dusk and dark. Please bring lawn chairs and dress for the weather.

The Summer Solstice is being observed at Keppel Henge again this year. Everyone is encouraged to attend this event which will be held at midday on Wed June 20. More information TBA.

Other "official" observing sessions this month include Fri, June 8 at the Grey Roots parking lot and Sat, June 23 at ES Fox. Similar events at both these locations are booked into July and August as well. The Webster C28 will be at Grey Roots on the given nights.

"Un-official" observing at the ES Fox Observatory is encouraged as well. We have a wonderful new facility and also some pretty awesome new equipment to use. Anyone that wants to become an independent user of the facility is encouraged to approach John or myself. Paid up members can use the site with some restrictions once they have been given an orientation session on the operation of the observatory and astronomical equipment. Many weekend nights are open unless already booked by BAS. During the school year student groups may be present during weekdays and use of the site at these times requires approval of the IOEES as they have priority.

The Dark Sky Weekend at the Bruce Peninsula National Park will be held again this year July 20-22. BAS has a group campsite near the Head of Trails in Cyprus Lake campground. The event is posted by the park service for campers to attend and is greatly appreciated by park visitors and club members alike. If you are interested, camping is free but you need to register with Joan S. and it is a tenting only group site. It's a good event and the skies are pretty amazing as well!

I want to encourage members to mention our Kids Astronomy Day Camp to anyone that may have children of a suitable age. This is a wonderful event that Joan Skelton and John Hlynialuk put on at the Fox Observatory and is held this year the week of July 30 to Aug 3. In the past it has been a great success for both the participants and as a fund raiser for the club.

North York Astronomical Association's StarFest is usually the crowning event of my astronomy year. We always have a big turnout of BAS club members and I expect that 2012 will be no different. What will be different this year is that we will be bringing one of the biggest amateur telescopes [in Canada] to the meet. For information on StarFest you can check out the website http://nyaa.ca/index.php?page=sf12/sf.sf2012 . You can register online and there is a $10 discount for registering before July 1.

Sounds like a great summer doesn't it? See you all soon.
Brett

Editor's "Rant" What's the big deal about "Supermoons"?

I am not sure why the media seems to have a bee in its bonnet about a Full Moon at perigee. Since nobody can actually SEE the difference because we need both moons to compare, why the dig deal?. Yes, I know it is a 14% difference in area and thus brightness, but I know of no human that can recall the brightness from a "mini-moon" six months earlier to be able to make a comparison. I doubt if anyone but amateur astronomers bother to take pictures of the mini-moons and no professional astronomers are doing research on the matter as far as I know. It's only benefit is that it gets people out looking -which is a "good thing".

It turns out it is possible to get ANY phase at the two extremes, -you just have to wait until the moon's point in its orbit coincides with the phase you want. Years ago, I waited two years between a LQ at apogee and FQ at perigee to create a pair of images that I could then paste onto one slide. It was a different comparison than any I had seen using the FM at near and far points.

So, come Nov 28, when the Full Moon is at apogee and 14% SMALLER, will we get a spate of articles in the paper and online alerts to watch for a smaller Moon than normal? I doubt it. But go out and have a look anyway. Memorize the view so you can compare to the next "Supermoon" on May 25, 2013.

A long-time friend and recent BAS member passed away on May 19, 2012. Irene Stoneman was a teacher and an avid birder as well as being interested in astronomy. I remember conversations with her that ranged from her first view of Saturn's rings to the mind-twists of parallel universes as she (and I) struggled to make sense of the ideas. She was one of those people whose enthusiasm recharged your own interests and afterward made you dive for the textbooks or check out the subject on the internet.

I recall the time that Comet Hale-Bopp was prominent in the sky and she rushed over to have a look. We observed it from the field behind our house and could see several spirals in the gas being emitted. I recall explaining how the gases were being ejected as the comet rotated and formed the spirals. Our conversation ranged from one topic to another, -it was obvious she had been doing her reading. As I put away the scope, I realized just how enjoyable it had been watching and sharing a rare phenomena with a very special person who gave more than they got. Lots of people will miss you, Irene.

M66 Spiral Galaxy image by Frank Williams

New member to BAS Frank Williams is doing some nice work in astrophotography. Frank's image was a total of 2 hours exposure taken from Apr 27 to May 5 (20 X 3 minutes, 10 X 6 minutes, 6 darks, and 22 flats, 6 bias frames). These were stacked in Deep Sky Stacker and the vignetting was cropped out. The other galaxies in the Leo Triplet are M65 and NGC 3628. The triplet didn't fit in Frank's C11 field of view even with an f/6.3 focal reducer. The mount was a Losmandy Titan GEM and the camera used was a Canon Rebel XT DSLR. Frank has a Skypod observatory in Allenford.

BAS Executive 2011-2013

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GREY ROOTS MUSEUM & ARCHIVES

The Bluewater Education Foundation

Ontario Trillium Foundation / Fondation Trillium de l'Ontario

BAS Calendar

Jun 5 **Transit of Venus**: Public and Club Viewing Fox Obs. Solar scopes, filters available. Come 5:45 to see first contact. Transit starts at 6:03 pm to sunset at 9:03 pm. Optional -members bring own picnic supper. If cloud out, regular BAS Meeting @ ES Fox Obs. 7:00 pm

Jun 8	Night Sky Tour	Grey Roots	@dusk
Jun 20	Summer Solstice at Keppel Henge		@midday
Jun 23	BAS Viewing	ES Fox Observatory	@dark
Jul 4	BAS Meeting	ES Fox Observatory	7:00 pm

Astronomy Week Events

Left: Three young astronomers enjoy a solar image.

Right: Three much older astronomers try to keep warm.

Bottom Left: Hands up for a solar halo.

The public viewing following the Celebrate the Night Sky talk was clouded out but the next session on May 11 was a spectacular success. More images like the one below (Amy D. and Peter H. with Webster) in the July SGN.

ES Fox Observatory got a lot of use on Apr 25, and even though the forecast was not promising, the clear skies belied the forecast. PSDS teacher Trevor Gilbert booked an evening observing session for about 20 of his physics students. The students were given the privilege of being the first group to use the Dobsonian telescopes at the ES Fox for personal viewing. A nice crescent moon allowed them to practice with the finders and then attempt Venus, Saturn and Mars. Later we had a good look at Saturn through the 10-inch Meade SCT recently donated by former BCAS member Jim Bishop.

***Image Credit:** All images on this page by J.Hlynialuk.*

Clockwise from top left:

(1) The group from PSDS was augmented by an even larger group of elementary students brought down by Martin Kerr.

(2) PSDS students using one of the 6-inch scopes built by a former Wiarton HS student around 1980.

(3) Trevor Gilbert at left behind a Skywatcher 8-inch Dob.

(4) Trying to locate Venus with Skywatcher finderscope.

(5) Trying to locate Venus with a Telrad on another Wiarton HS 6-inch.

(6) A pretty pose with the 8-inch OSCVI-donated Dobsonian rebuilt just recently.

HST to Use Moon as Mirror to Study Transit

This mottled landscape showing the impact crater Tycho is among the most violent-looking places on our moon. Astronomers didn't aim NASA's Hubble Space Telescope to study Tycho, however. The image was taken in preparation to observe the transit of Venus across the sun's face on June 5-6.

Hubble cannot look at the sun directly, so astronomers are planning to point the telescope at the Earth's moon, using it as a mirror to capture reflected sunlight and isolate the small fraction of the light that passes through Venus's atmosphere. Imprinted on that small amount of light are the fingerprints of the planet's atmospheric makeup.

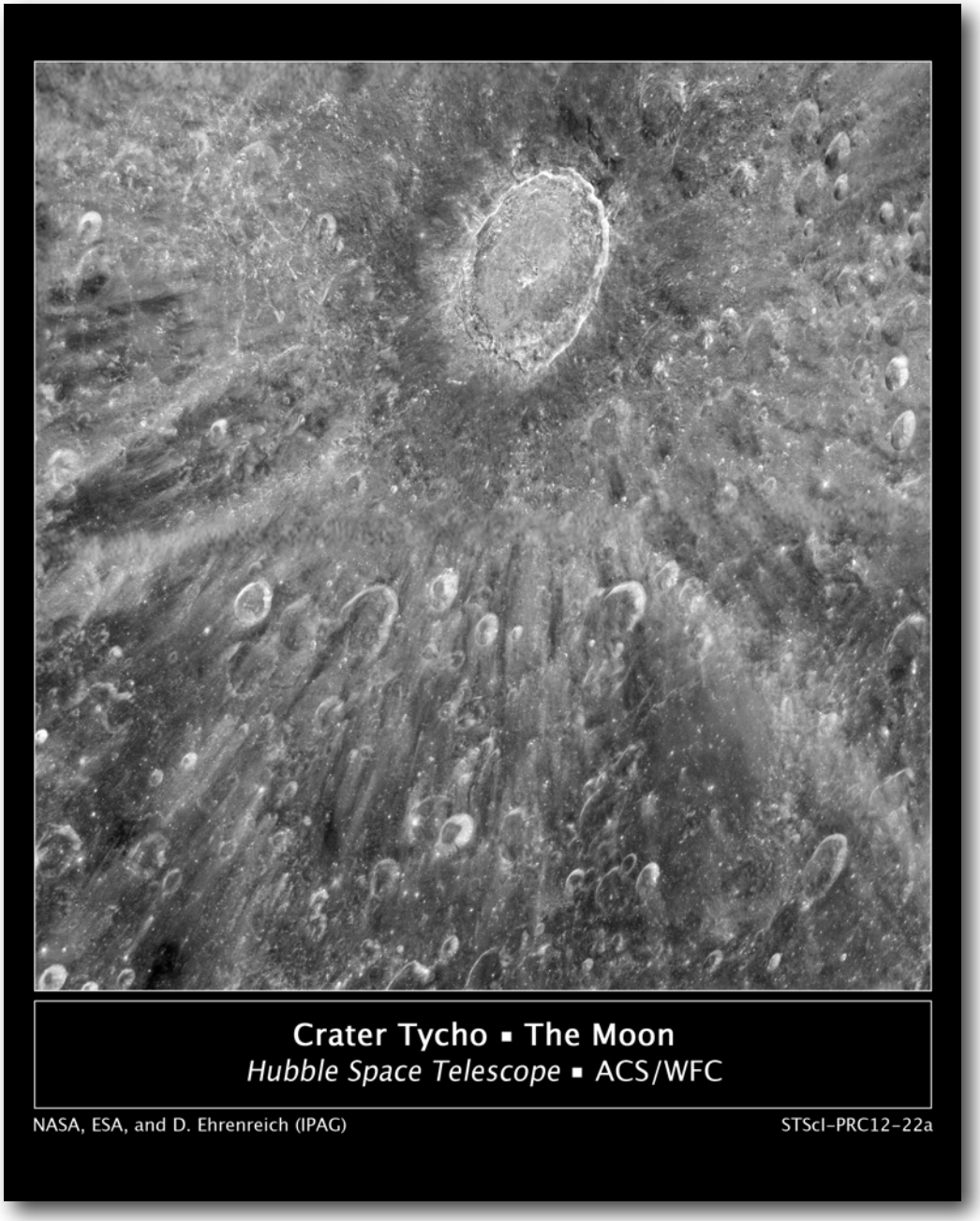
These observations will mimic a technique that is already being used to sample the atmospheres of giant planets outside our solar system passing in front of their stars. In the case of the Venus transit observations, astronomers already know the chemical makeup of Venus's atmosphere, and that it does not show signs of life on the planet. But the Venus transit will be used to test whether this technique will have a chance of detecting the very faint fingerprints of an Earth-like planet, even one that might be habitable for life, outside our solar system that similarly transits its own star. Venus is an excellent proxy because it is similar in size and mass to our planet.

The astronomers will use an arsenal of Hubble instruments, the Advanced Camera for Surveys, Wide Field Camera 3, and Space Telescope Imaging Spectrograph, to view the transit in a range of wavelengths, from ultraviolet to near-infrared light. During the transit, Hubble will snap images and perform spectroscopy, dividing the sunlight into its constituent colors, which could yield information about the makeup of Venus's atmosphere.

Hubble will observe the moon for seven hours, before, during, and after the transit so the astronomers can compare the data. Astronomers need the long observation because they are looking for extremely faint spectral signatures. Only 1/100,000th of the sunlight will filter through Venus's atmosphere and be reflected off the moon.

Because the astronomers only have one shot at observing the transit, they had to carefully plan how the study would be carried out. Part of their planning included the test observations of the moon, made on Jan. 11, 2012, as shown in the release image.

Hubble will need to be locked onto the same location on the moon for more than seven hours, the transit's duration. For roughly 40 minutes of each 96-minute orbit of Hubble around the Earth, the Earth occults Hubble's view of the moon. So, during the test observations, the astronomers wanted to make sure they could point Hubble to precisely the same target area.



This image, taken with Hubble's Advanced Camera for Surveys, reveals lunar features as small as roughly 560 feet (170 meters) across. The large "bulls-eye" near the top of the picture is the impact crater, caused by an asteroid strike about 100 million years ago. The bright trails radiating from the crater were formed by material ejected from the impact area during the asteroid collision. Tycho is about 50 miles (80 kilometres) wide and is circled by a rim of material rising almost 3 miles (5 kilometres) above the crater floor. The image measures 430 miles (700 kilometres) across, which is slightly larger than New Mexico.
Image Credit: *NASA/ESA/D. Ehrenreich*

This is the last time this century sky watchers can view Venus passing in front of the sun. The next transit won't happen until 2117. Venus transits occur in pairs, separated by eight years. The last event was witnessed in 2004.

The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency. NASA's Goddard Space Flight Center in Greenbelt, Md., manages the telescope. The Space Telescope Science Institute (STScI) in Baltimore, Md., conducts Hubble science operations. STScI is operated by the Association of Universities for Research in Astronomy, Inc., in Washington, D.C.

For images and more information about Hubble's view of the Moon and the Venus transit, visit: http://hubblesite.org/news/2012/22

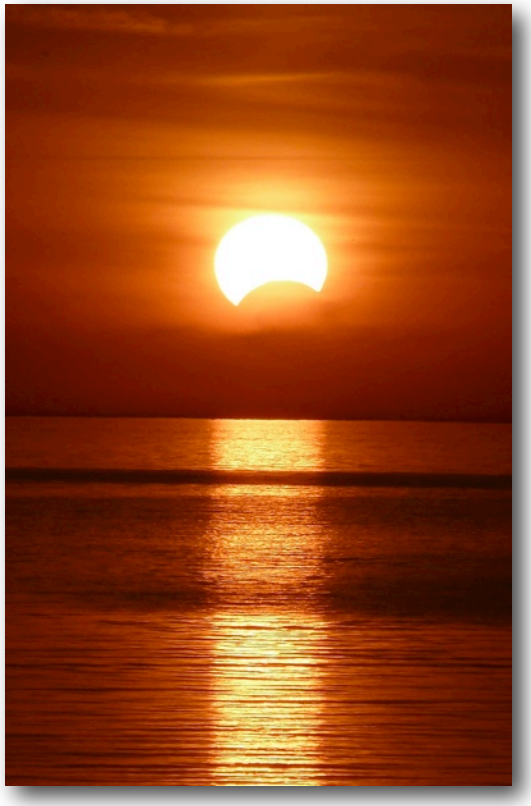
Cheryl Gundy, STScI

Clear Skies for Ring Eclipse

First Contact! The first contact happened pretty much on schedule. This image was taken at 8:21:32 pm DST and the "notch" had just appeared. This is the first of a sequence of about 100 images that will be compiled into a video. Image by John Hlynialuk with Canon 50D at prime focus on a vintage Celestron C-8, 1000 Oaks solar filter, effective focal length 3200 mm, effective focal ratio f/16, ISO 100, exp = 1/10 s

The partial eclipse of the sun was viewed by a large crowd (over 100) from Southampton on May 20, 2012. The weekend weather was spectacular and cloudless skies allowed for viewing of the event right to the horizon. Ten BAS members arrived, some with more than one scope, (including the H-alpha Lunt) to share the view with the public during the last 20 minutes or so before sunset. The images on this page show how pretty an event a nice sunset can be when coupled with a partial eclipse.

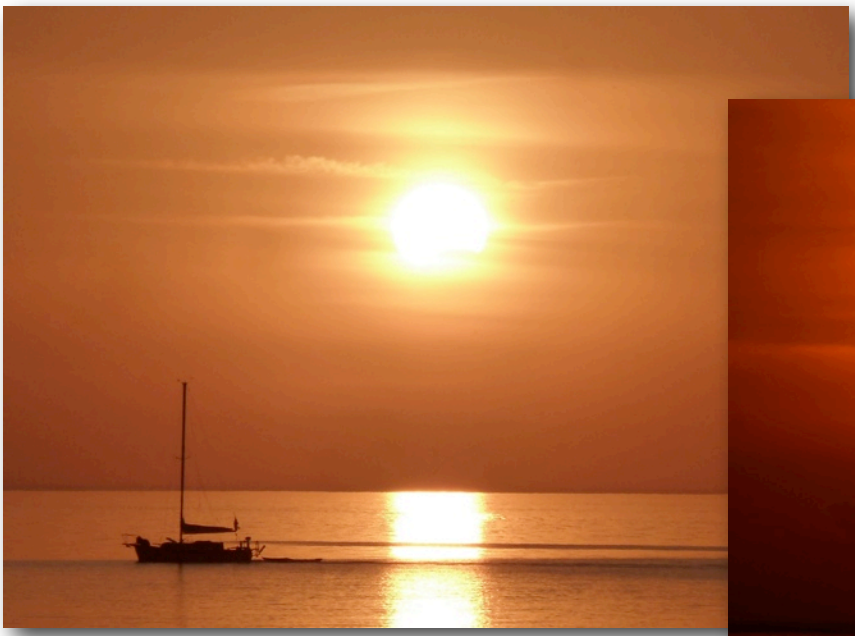
Right: Water Reflection A great image by Dave Green with his point-and-shoot. The sun was less than 5 minutes from setting.



Left: A BIG Crowd Image by Dave Skelton showing about half the crowd watching the sun set. There are at least 33 heads in this shot and the view spans about half the area at the end of the High St. parkette. The sun at this point was less than two diameters from the horizon and still a bit bright to look at with the naked eye. This is a good thing to know in planning for viewing the transit June 5.

Below left: Dave Green caught a scenic sunset as a sailboat glides by.

Below Right: Aaron Top set up at Sauble Beach with a 1000 mm refractor and captured a spectacular cumulus cloud silhouetted against the sun. Canon 50D, ISO 100, fl=1000mm, exp = 0.001 s



"The Rarest of Astronomical Events"

"Thy return
Posterity shall witness; years must roll
Away, but then at length the splendid sight
Again shall greet our distant children's eyes."
Jeremiah Horrocks
Venus Seen on the Sun 1642

We are fortunate to be living at a time when it has become possible to observe the rarest of astronomical events, called Transits of Venus. At these special times, when the orbital geometry of Earth and Venus is just right, the planet Venus at inferior conjunction comes between the Earth and the Sun and appears as a black disk superimposed against it's yellow disk. These transit events occur in pairs separated by 8 years, and these pairs are separated, in turn, by intervals of 121.5 years and 105.5 years. In the history of astronomy, observations of the transits of Venus have became the stuff of legends. Edmond Halley had suggested in 1691 that, by timing the duration of the transit, as seen from different locations on the Earth's surface, it would be possible, using these transit times, in conjunction with the parallax geometry, and Kepler's Laws of Planetary Motion, to accurately determine the distance between the Earth and the Sun. Knowing this distance, called the Astronomical Unit, it would be possible to determine the actual scale of our solar system! The idea was great but its execution was plagued by experimental difficulties, uncertain weather, wars, instrument problems, and the infamous "black drop" effect. This optical phenomenon was not anticipated and occurred at both second and third contacts when a small black teardrop appeared to connect the disk of Venus to the disk of the Sun and prevented an accurate timing of the duration of the transit.

[For some details of the first ever recorded observations by Jeremiah Horrocks in 1639 and an explanation of the "Black Drop" effect, see "Venus Transit, It's Now or Never" on page 9. -ed]

Today's amateur and professional astronomers live at a special time when it is possible to observe both members of the 8-year pair of Venus Transits. The first member of this pair occurred on June 8th, 2004, and Paula and I wanted to observe it. Egypt was the place! It had everything going for it, -an ideal location to see the whole transit, excellent weather prospects, a modern tourist infrastructure, a fascinating ancient history, and, of course, those fascinating PYRAMIDS!

Transit of Venus recorded from Luxor, Egypt June 8th, 2004 by Mike Mah image through H-alpha telescope

Bus Group 1 at the Giza Pyramids

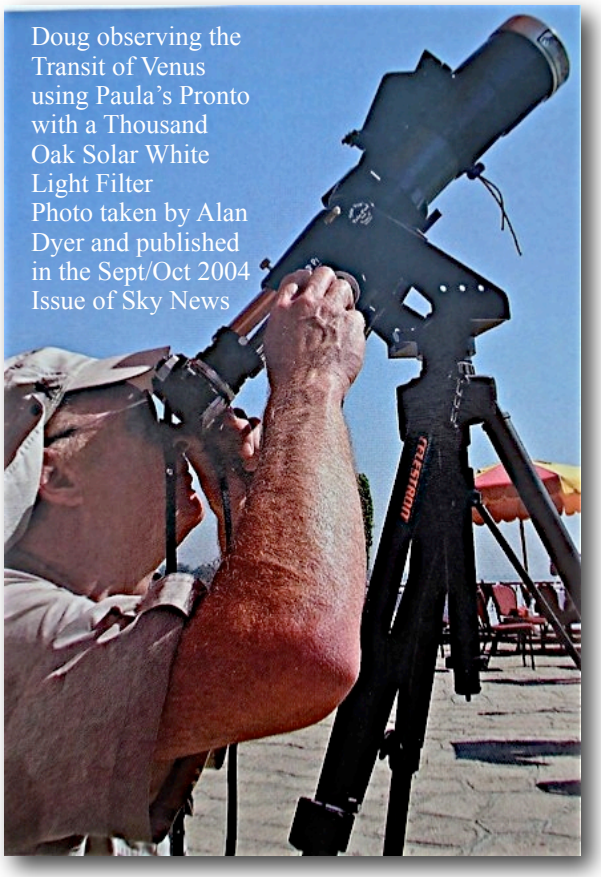
The group included BAS members Doug and Paula Cunningham, Dave and Joan Skelton and Charlie and Sheila Szabototh as well as Owen Sound residents Warren Flint and Christine Richards. The tour was organized by Civilized Adventures under the leadership of Don Hladiuk of the Calgary Centre of the RASC.

[Although the transit was on a "half-event" from Bruce and Grey counties, many BAS members and others observed from the shores of Owen Sound and Big Bay where the sun rose (5:45 am) into a thin layer of cloud that helped to make the sight visible tothe naked eye at the beginning stages. After the sun rose higher, the egress of Venus was observed in clear skies from 7:05 to 7:24 and filters were definitely required. -ed]

So, Paula and I, along with Dave and Joan Skelton, Charlie and Sheila Szabototh, and Warren Flint and Christine Richards, joined Don Hladiuk and members of the Calgary Center of the RASC in a journey to Luxor, Egypt to observe the transit. We were to observe from the Movenpick Resort located on Crocodile Island in the Nile river. If you are ever to visit Egypt, you MUST visit Luxor. It is the site of the ancient city of Thebes and has been called the "world's greatest outdoor museum". It contains the ancient temple ruins of Karnak and Luxor and sits on the Nile River opposite the Valley of the Kings and Valley of the Queens. Superlatives were made for Luxor! It's impossible to overstate the grandeur of the ruins. A stunning ambience!

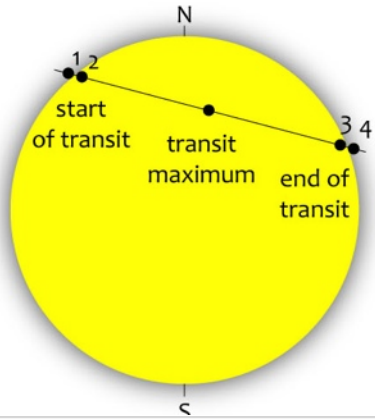
Transit morning dawned bright, hot, and very clear. The smell of bread baking in an outside oven filled the air. As Paula and I walked to our observing location adjacent to the Nile dock we passed a group of white egrets, their reflections mirrored in the Nile ...but not a breath of wind cooled us. It was going to be a HOT day! In fact, temperatures by mid-day reached just above 50 C in the Sun!

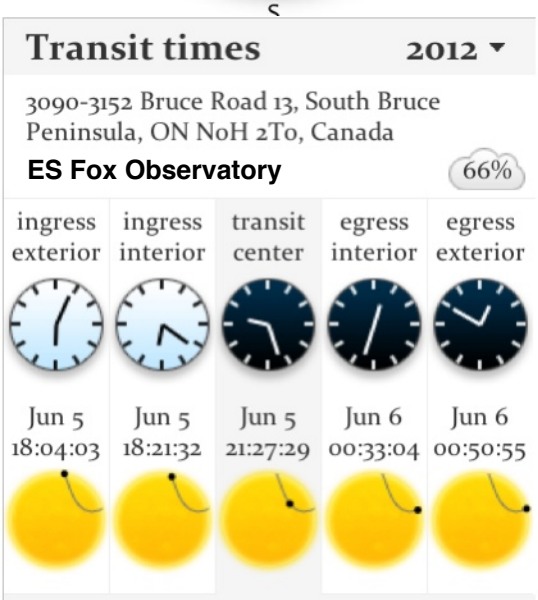
Now, Venus Transits take considerable time. They are not like solar eclipses where the interesting event is over in a matter of minutes. In fact, for this transit, the total time would be about 6 hours and 13 minutes! The most interesting parts of the transit would occur between first and second contacts and between third and fourth contacts. At these times it should be possible to observe the famous "black drop effect" and perhaps detect the "ashen light", -the scattering of sunlight by the Venusian atmosphere. We had to show our transit pin to gain access to the observing area and seven of our group had already set up their equipment. A few (among them Mike Mah) had H-alpha filters attached to their telescopes. This not only allowed them to see solar prominences but gave them an advantage in detecting the time of first contact. Because these filters show the solar chromosphere and solar prominences as well as the solar disk it becomes possible to see the disk of Venus as it occults the chromosphere just before it intrudes in front of the main solar photospheric disk. I distinctly remember the H-alpha people calling out "first contact" prior to my being able to see it in Paula's Pronto.



Doug observing the Transit of Venus using Paula's Pronto with a Thousand Oak Solar White Light Filter Photo taken by Alan Dyer and published in the Sept/Oct 2004 Issue of Sky News

Details of June 5, 2012 Transit





I have re-read my observing notes which were written later that June 8th day. Paula and I both observed the famous "Black Drop" at second contact when Venus had just completely entered onto the Sun's disk and its edge was tangent to the Sun's circumference. We saw it with no difficulty and we noticed that it appeared to linger! It was not a brief phenomenon like a solar eclipse diamond ring and I could have easily imaged it. Some observers suggest that limb darkening of the Sun will prolong this effect. I don't know. Soon, all of Venus was superimposed against the solar disk. It appeared quite black. Using powers as high as 188x there appeared to be a faint yellowish glow to the rim of Venus. We couldn't believe our eyes! It was a low contrast phenomenon and just at the boundary of detection. We called Don Hladiuk and Mike Mah over and they too saw it. Two other observers, Les and Stephen, thought that it was a psychological/ optical phenomenon and not the true "ashen light". Later, I mentioned the phenomenon to Alan Dyer and he said that he had managed to image the scattered sunlight extending around Venus when it was only partially projected against the solar disk. Neat!

For the next 5 h 33 min, until third contact, people spent their time between the swimming pool and their telescopes. At mid-transit, we were served a tasty 3 course lunch, -a fish salad, a chicken dinner, and frozen sherbet/fruit combo. Finally third contact arrived! For me, the most interesting effect occurred between 3rd and 4th contact when Venus had moved 2/3 of the way off the solar disk. Les shouted out that this was the time for people to see if the Venusian atmosphere was really scattering sunlight. Using 188x I mentally extended the arc of the planet still superimposed on the solar disk out into the blackness just beyond. I relaxed and sharpened the focus and, in my mind, completed the "circle". Then I saw it! ..a faint arc of light outlining the extended disk not on the Sun. It wasn't complete, just an arc 1/3 the way around. Paula came over and saw it as well. The next day at the airport I mentioned this observation to Alan Dyer and he said he saw it too.

The last Venus transit in our lifetimes (details for Fox Observatory at left), the second of the 8-year pair, will occur June 5th, 2012. Paula and I considered going to Yellowknife, NWT where the entire transit can be observed on Canadian soil. However, because of weather concerns, we have decided to travel to Hawaii on June 3rd and join Astronomy Magazine's David Eicher and Alex Filippenko. Unlike Egypt, where the Sun's altitude was quite high and the whole transit was easily seen, conditions in Hawaii will be challenging for observing third and fourth contacts. The Sun at these times will be close to the horizon. However, Paula's trusty Pronto will be going with us again and it has a reputation for bringing good luck! (It has never been clouded out!) We won't get another chance until December 11th, 2117... and, who knows where we will be then? [Maybe Doug has a secret potion, but I know where I will be! -ed]

Venus Transit -its Now Or Never -part 1

from Physics World May 2012

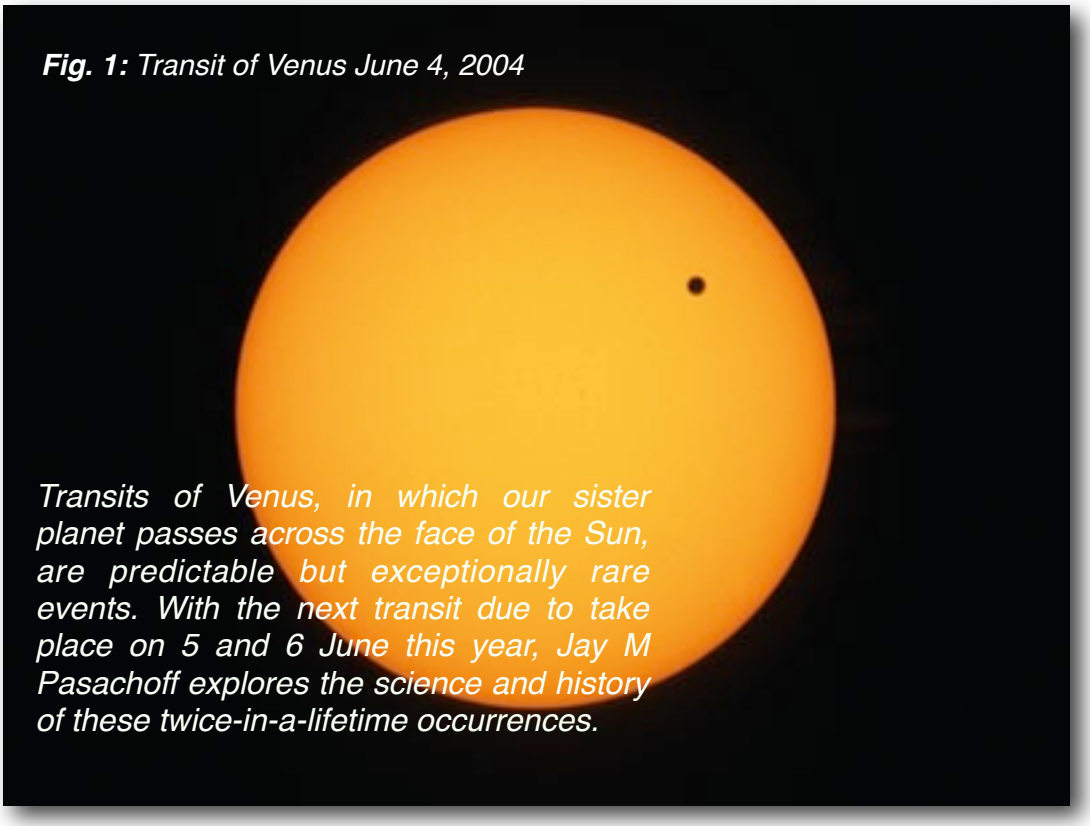


Fig. 1: *Transit of Venus June 4, 2004*

Transits of Venus, in which our sister planet passes across the face of the Sun, are predictable but exceptionally rare events. With the next transit due to take place on 5 and 6 June this year, Jay M Pasachoff explores the science and history of these twice-in-a-lifetime occurrences.

One of the most exciting recent developments in astronomy has been our ability to detect planets orbiting stars other than our Sun. Astronomers have so far spotted more than 700 such exoplanets, which has made the eight planets in our solar system – 13 if you include the dwarf planets Pluto, Ceres, Eris, Haumea and Makemake – perhaps less special than we once thought. Most of these exoplanets are detected as they cross the face of – or "transit" – their parent stars. But spotting these planets from the faint dimming of their star's light is a fiendish task because several things can, at least for a while, mimic this tiny dip. Indeed, of the thousands of additional possible planets we have seen, thanks in part to the French CoRoT and US Kepler spacecraft, some may just be sunspots.

What can aid our search for exoplanets, however, is studying examples of transits in our own solar system. Doing so not only yields an improved understanding of our own cosmic neighbourhood, but also verifies that the techniques for studying events on and around other stars hold true in our own backyard. In other words, by looking up close at transits in our solar system, we may be able to see subtle effects that can help exoplanet hunters when viewing distant suns. The snag is that, here on Earth, just two planets lie between us and the Sun – Mercury and Venus. And, moreover, they cross the Sun only very rarely.

While transits of Mercury occur about 14 times a century, transits of Venus are even scarcer. They always take place in pairs eight years apart, with the gap between the second transit of one pair and the first transit of the next alternating between 105.5 and 121.5 years. In other words, the transits of 1631 and 1639 – around the time that Galileo was imprisoned by the Church – were followed, after a gap of 121.5 years, by a pair in 1761 and 1769, not long before the American Revolution. The next transits occurred 105.5 years later, in 1874 and 1882, and so, continuing this sequence, the transit of 2004 will be followed by another this year – on Tuesday 5 June in the Americas and Wednesday 6 June in Europe, Asia and Australia. It will be an event well worth watching, as the next transit of Venus will not occur until December 2117, when most of us will be long gone.

Origins of a phenomenon

The notion that Venus could potentially pass across the face of the Sun, when viewed from Earth, can be traced back to the work of Nicolaus Copernicus, whose 1543 book *De Revolutionibus* held that Mercury and Venus joined our Earth in orbiting around the Sun and thus could pass between those two bodies. In 1627 Johannes Kepler, best known for his three laws of orbits, published his *Rudolphine Tables*, which showed the superiority of the Copernican theory and allowed the positions of the planets in the sky to be calculated more accurately. This work led Kepler to predict that both Mercury and Venus would transit the Sun in 1631.

That year's transit of Mercury was observed by the French scientist Pierre Gassendi, but that of Venus was not visible from Europe and so went unseen. (Although the Venusian transit could, in principle, have been observed in other parts of the world, it was only in Europe that astronomers had access to new-fangled "telescopes".) A few years later, however, the English astronomer Jeremiah Horrocks, working in the village of Much Hoole in Lancashire, extended Kepler's calculations and discovered that the next transit of Venus would occur in late November 1639. Horrocks informed one friend in London and another in Manchester, William Crabtree, of the prospective event.

On the afternoon of the big day, when Horrocks finally returned to Carr House in Much Hoole – having been delayed by a task that was no doubt to do with the local church on that Sunday – he found Venus already silhouetted on the surface of the Sun. Although it was much smaller than he had expected, by using a telescope to project the solar image, Horrocks was able to make careful drawings (see Fig 3 pg 9) of what he saw. Crabtree, in Manchester, also saw the transit but was so excited to see Venus's silhouette once the clouds had parted that he neglected to make any scientific observations. With clouds obscuring the view of Horrocks' friend in London, it was Horrocks and Crabtree who therefore become the first two people in the world to see a transit of Venus.

We now know that these transit pairs occur only when Venus's orbital plane crosses the plane of the Earth's orbit around the Sun, the two orbits being at a slight angle of 3.4° to one another. One can think of Venus's path crossing the lower half of the Sun, then eight years later passing across the upper half of the Sun, before next time passing above the Sun (and so not being a transit). This process goes on for a further 100 years or so until the angle brings Venus around to the lower half of the Sun again.

Astronomical solution

But transits of Venus are much more than a curiosity. In 1716 Edmond Halley proposed using them to solve what George Airy – then Astronomer Royal – later called "the noblest problem in astronomy": finding the distance between the Earth and the Sun, known as the astronomical unit (AU). At that time, distances in the solar system were known only proportionately – measured as fractions or multiples of an AU. Measuring the AU would mean that, for the first time, the absolute size and scale of the solar system could be determined.

Halley's method relied on Kepler's third law of orbits, which tells us that the square of the time it takes a planet to orbit the Sun (its period), P^2, is proportional to the cube of the radius of the orbit, a^3. Since we know how long it takes Venus and the Earth to orbit the Sun, then if it were possible to determine the distance to Venus, we could use Kepler's third law to deduce all distances in the solar system, including the AU.

In practice, Halley's method involved observing Venus from two different locations during a transit – one very far north on Earth and one very far south – and accurately determining when the planet first begins to cross the Sun ("ingress") and when it just leaves ("egress"). A transit lasts about six hours and, if it were possible to time the duration to an accuracy of about 1 s, the distance to Venus could then be determined using the principles of triangulation. Later in the 18th century an alternative calculation involving accurate timing of only ingress or egress was developed by Joseph-Nicolas Delisle, although the method had its own problems, not least that it required knowing the longitude more precisely than was likely possible at that time.

With these methods in hand, hundreds of expeditions were sent all over the world to observe the 1761 and 1769 transits, including the ill-fated voyage undertaken by the French astronomer Guillaume le Gentil (see below). Perhaps the most famous was in 1769, when the British Admiralty entrusted a ship to a young lieutenant by the name of James Cook. Accompanied by former Greenwich astronomer Charles Green and others, Captain Cook took the Endeavour to the island of Tahiti in the South Pacific, where they successfully observed the transit under very clear skies at a site that is still called Point Venus. Having completed that task, which was the official reason for the voyage, Cook then opened a letter with secret orders that took him to explore farther south, searching for and mapping a "southern continent", which turned out to be New Zealand and the east coast of Australia.

The black-drop mystery

Unfortunately, when Cook and Green looked through their telescope to time the precise moment of ingress – when Venus was just inside the outer edge (or "limb") of the Sun – they ran into trouble. They noticed a dark band – linking the blackness of Venus's silhouette with the blackness of the background sky outside the solar limb – that grew for about 1 min and then seemed, like pulled taffy, to pop. Now known as the "black-drop effect", it meant that the accuracy of their timing was closer to 1 min than to 1 s, diminishing the accuracy of the calculated astronomical unit by about a factor of 60. Cook and Green mistakenly thought that Venus's atmosphere was causing the uncertainty in the timing, but we now know that the atmosphere is much too small in diameter to cause much blurring.

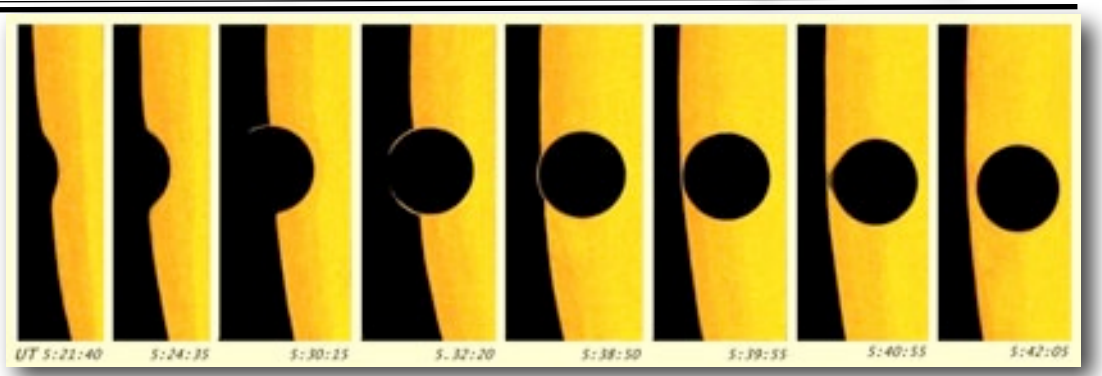


Fig 2: *Venus enters the sun's disk during ingress on 2004 June 8. The aureole effect and the black drop both appear in this sequence drawn by BAA Mercury and Venus Section Director Mario Frassati from Crescentino, Italy. The black drop shows up as a greyish shade between the limbs of Venus and the sun, as well as a slight distortion of Venus' limb [most obvious in the 7th image].*

The two transits of Venus in the 19th century – in 1874 and 1882 – were well observed all around the world. Photography was also used for the first time, although the black drop still foiled accurate attempts to measure the AU using Halley's method, as it had done for the 18th-century transits. There having been no transits throughout the 20th century, Glenn Schneider of the University of Arizona's Steward Observatory and I decided in 2001 – three years before the first transit of the 21st century – to try to solve the origins of the black-drop effect once and for all.

We sought to do this by analysing observations of the effect made by NASA's Transition Region and Coronal Explorer (TRACE) spacecraft during the 1999 transit of Mercury. The black-drop effect, it turns out, has two different causes. One, which had been widely suspected, is down to the fact that no telescope is perfect and that even a point source will have a certain inherent fuzziness, known as the "point-spread function". But the other cause, which had previously not been widely acknowledged, is the fact that the visible Sun is always darker near its edge, with the intensity falling off following roughly the path of a cosine curve. Indeed, the drop in brightness, known as "solar limb darkening", is so severe in the final arcsecond or so at the edge of the Sun that the limb darkening merges with the point-spread function. Given that Mercury has no appreciable atmosphere and yet shows a black drop, our analysis showed that the black-drop effect need not have anything to do with the existence of a planetary atmosphere. Coupled with our current knowledge of the actual thickness of Venus's atmosphere, we showed that Venus's black drop cannot be caused by its atmosphere either.

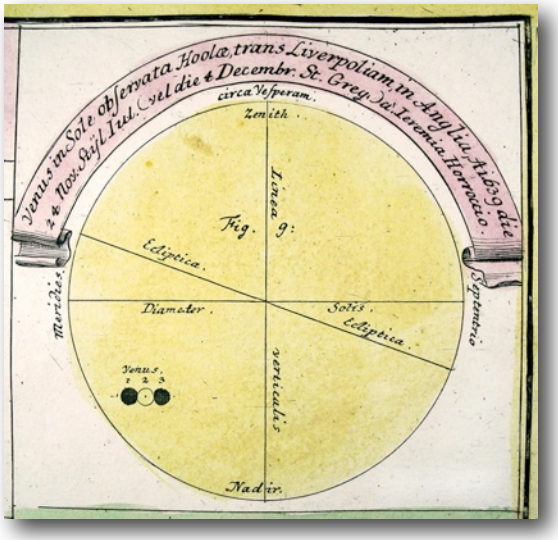


Fig. 3: *The record of the first ever Venus transit as seen by Jeremiah Horrock's on Dec 4, 1639. The dots labelled 1, 2 and 3 are his observations of the silhouette of Venus against the face of the sun. His observations allowed Horrocks to estimate the size of the astronomical unit (distance from Earth to Sun) and provided the best value up to that time.*

Horrock's comments on the 1639 transit:
" I beheld a most agreeable spectacle .. a spot of unusual magnitude, and of a perfectly circular shape which had fully entered upon the Sun's disk on the left so that the limbs of the Sun and Venus were precisely in contact."

With the next transit of Venus due to take place in June 2004, an International Astronomical Union symposium was scheduled to take place at Much Hoole, where Horrocks had observed the first transit all those years ago. Not wanting to take a chance on the notoriously capricious British weather, I took my colleagues and all our astronomy students from Williams College (with the help of a grant from the National Geographic Society, or NGS) to Greece, which lay deeper into the zone from which the whole transit would be visible. In the event, it was clear in Much Hoole after all, but from Greece we were able to observe the whole transit with telescopes and cameras, and I saw the black drop with my own eyes, which was an incredible experience.

Earlier that year, while observing with Sweden's 1 m Solar Telescope on La Palma, which itself went on to make successful observations of that year's transit, I e-mailed the schedulers for TRACE to help them tailor their observations of the transit to meet our requirements. What we particularly wanted to do was to increase the rate at which photographs were taken of the black-drop effect at ingress and egress. But knowing that TRACE can only ever see about a sixth of the Sun at any one time, it was also vital that the craft was pointing in the right direction. Fortunately, when we got the results, we were relieved that everything had gone well. Moreover, while the planet was roughly halfway into the Sun at ingress, we were flabbergasted to see a bright rim appearing around Venus's trailing edge that persisted and brightened asymmetrically (Fig 4). It was, in fact, Venus's atmosphere, which bent sunlight towards us. About six hours later, after Venus had traversed the Sun's disc, we saw the same effect in reverse.

What was also interesting about the 2004 transit was that it extended the study that Schneider and I carried out using measurements obtained by TRACE. We had been intrigued by claims made by the famous 18th-century Russian scientist Mikhail Lomonosov that he had discovered the atmosphere of Venus after sighting a brief brightness at the edge of Venus during the 1761 transit (see "Atmospheric tales" by Robert P Crease). However, what Lomonosov reported did not match our 2004 observations, and seemed more like the first appearance of the solar disc at the end of the black-drop effect. We therefore concluded that the Russian must have seen only artifacts and had not discovered Venus's atmosphere itself. But because Lomonosov believed – as did many scientists of his era – that all planets had atmospheres, it is perhaps understandable that he thought he had discovered one around Venus. In the end, he had the right result, but without a proper train of measurement and reasoning.

The 2012 transit

For the upcoming transit of Venus this June we want to get the most complete set of data possible, so that the astronomers of 2117 will think that their forebears way back in 2012 did a fine job even with their relatively primitive instruments. On the ground, I will be at the University of Hawaii's solar observatory on top of Haleakalā – a 3000 m-high dormant volcano – with a couple of my students, as well as Schneider and Bryce Babcock, all supported by a new NGS research grant. We will have several cameras, with the main aim of studying Venus's atmosphere at ingress and egress, while also verifying our previous conclusion

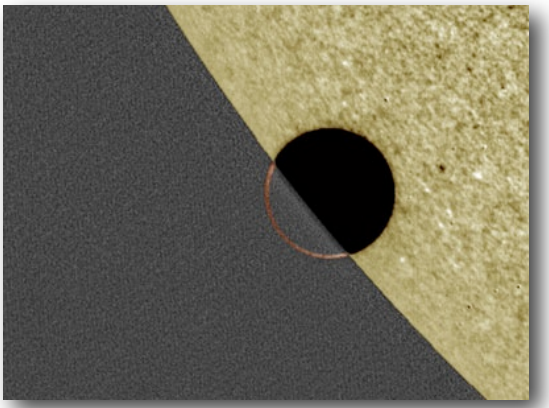


Fig. 4: Atmosphere of Venus as seen by TRACE.

about the black-drop effect. Meanwhile, my former student Kevin Reardon of the Arcetri Observatory in Florence, Italy, will be at Sacramento Peak in New Mexico, using a giant imaging spectrometer on the vacuum tower of the Dunn Solar Telescope.

A major part of our research effort will be with telescopes in space, notably using NASA's Solar Dynamics Observatory (SDO), which was launched two years ago as an improved replacement for TRACE. The SDO contains the Atmospheric Imaging Assembly, built by my colleague Leon Golub of the Smithsonian Astrophysical Observatory, which has pixels the same size as those of TRACE but can view the entire Sun at once. The other huge advantage of SDO is that it moves in a geosynchronous orbit and is always in view of a ground station in New Mexico, allowing it to send down eight individual filtered images six times a minute, 24 hours a day (with only a few minor 20 min outages each year when the Earth eclipses the Sun). We will also be co-ordinating our observations with those of colleagues at Stanford University, who run a second SDO instrument, the Helioseismic and Magnetic Imager, which has pixels of a similar size.

This summer Schneider and I will be working again with Richard Willson, who operates NASA's Active Cavity Radiometer Irradiance Monitor satellite from California, in order to monitor the total brightness of the Sun as a way of studying the transit. It follows our successful collaboration in 2004, when we used the same craft to measure the tiny 0.1% drop in the total solar irradiance caused by Venus's silhouette blocking that same fraction of the solar disc. Interestingly, two years later we were unable to detect the 0.003% drop in intensity from the 2006 transit of Mercury because the effect is smaller than the inherent uncertainty in the signal – information that should help exoplanet hunters to know what they might or might not be able to detect. This year's collaboration will also involve Greg Kopp of the University of Colorado at Boulder, whose Total Irradiance Measurement instrument aboard NASA's Solar Radiation and Climate Experiment spacecraft yields similar information.

Beyond 2012

Until recently we had thought that after June there would be no chance to observe any further transits of Venus until the 22nd century. But last autumn we discovered that David Ehrenreich of the Institut de Planétologie et d'Astrophysique de Grenoble, France, had won time on the Hubble Space Telescope to try to observe this June's transit of Venus as it would be if viewed from the Moon. [See “HST to Use Moon as Mirror to Study Transit” -pg 5. ed] The study is useful because it mimics the problems exoplanet hunters encounter, while still occurring in our solar system, where we know exactly what is happening.

But if Hubble could be used to detect the transit of Venus using the Moon, might it also be possible to observe transits of Venus by observing light reflected off the outer planets? After a meeting of the American Astronomical Society in Nantes, France, last October, my transit team met up with that of Ehrenreich to discuss that idea, along with Thomas Widemann of the Observatoire de Paris, Paolo Tanga of the Observatoire de la Côte d'Azur in Nice and Alfred Vidal-Madjar of l'Institut d'Astrophysique in Paris. Since then we have together submitted a proposal for time on Hubble to observe the transit of Venus using Jupiter on 20 September 2012. (If we miss this date, there will not be another transit of Venus from Jupiter until 2024 – long after Hubble's demise.)

Another, even more exciting event will occur on 5 January 2014 when the Earth, as seen from Jupiter, will pass in front of the Sun. Although we cannot view the Earth directly from Jupiter itself, what we can do is to use Hubble to view the Earth indirectly by watching Jupiter's clouds and studying how much of its light bounces off Jupiter's main moon Ganymede. Detecting this transit and any spectral effect from the Earth's atmosphere would be an astonishing feat – and a spectacular verification of our understanding of exoplanet transits.

If we can study transits via Jupiter, what about doing so with Saturn? As it happens, NASA's Cassini spacecraft can see a transit of Venus, as seen from Saturn, is due to take place later this year on 21 December. Together with Phil Nicholson from Cornell University, we have obtained permission from the Cassini board to turn the craft towards the transit on that day, which will be our last chance to see a transit of Venus from Saturn until January 2028. We are fortunate in that we are truly living in a golden period of planetary transits and it is one of which I hope astronomers can take full advantage.

About the author

Jay M Pasachoff is an astronomer at Williams College, Williamstown, Massachusetts, US

Sky Calendar — June 2012

compiled by John Hlynialuk (**stargazer@wightman.ca**) using the Observer's Handbook 2012(RASC), Sky and Telescope and Sky News magazines. Contact the editor of SGN if you notice errors herein.

June 1	Spica 1.5° N of Moon (Moon=85% lit)
	Saturn 7° N of Moon
June 4	**Partial Eclipse of Moon (best in W. Canada)**
	Locally Moon sets before umbral phase starts
	Full Moon (Honey Moon) rises at 9:31 pm DST
June 5	**TRANSIT OF VENUS 6:03 pm to sunset at 9:03 pm, Viewing at ES Fox Observatory**
June 7	Jupiter 5° S of Pleiades
June 8	Mercury 1° N of M35
June 11	**Last Quarter Moon rises at 1:12 am DST**
June 12	Pallas 0.8° S of Moon (Moon=43% lit)
June 15	Venus 4° N of Aldebaran
June 17	**Jupiter1.1° S of Moon** (Moon=5% lit)
	Venus 2° S of Moon
June 19	**New Moon rises at 5:43 am DST**
June 20	**Summer Solstice (7:09 pm)**
June 21	Mercury 6° N of Moon (Moon=3% lit)
June 26	Saturn stationary
	Mars 6° N of Moon (Moon=40% lit)
June 27	Venus stationary
June 26	**First Quarter Moon rises at 1:13 pm DST**
June 28	**Spica 1.4° N of Moon** (Moon=62% lit)
	Saturn 6° N of Moon
June 29	Pluto at opposition (mag. 14.0)

BAS Events

Jun 5 Transit of Venus: Public and Club Viewing Fox Obs. Solar scopes, filters available.Transit starts at 6:03 pm to sunset at 9:03 pm. We may move to lakeside to view sunset. Optional - members bring own picnic supper. If cloud out, regular BAS Meeting @ ES Fox Obs. 7:00 pm.

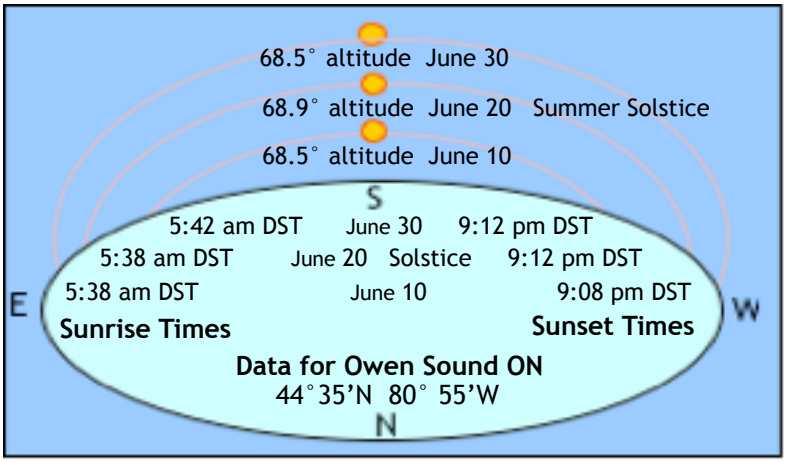
Jun 8	Night Sky Tour	Grey Roots	@dusk
Jun 20	Summer Solstice at Keppel Henge		@midday
Jun 23	BAS Viewing ES Fox Observatory		@dark
Jul 4	BAS Meeting ES Fox Observatory		7:00 pm

Planets

Venus transits the Sun June 5.

MERCURY,(-0.1) makes a mediocre showing in the West in the last 2 weeks of June. It is near the 2-day old crescent Moon on Jun 21. **VENUS,** (-4.4), crosses in front of the Sun on Jun 5. By the second week in June, Venus becomes a Morning Star and appears below the crescent Moon and Jupiter on Jun 17 and Jun 18 -a pretty planet/moon grouping. **MARS** fades to magnitude 0.8 by the end of June and the disc shrinks to only 7.0". It moves quickly eastwards and crosses into Virgo (halfway to Spica) by Jun 20. **JUPITER**, (-2) is farther away from the morning Sun in June and is between the Pleiades and Hyades this month. Jupiter, the crescent Moon and Venus are near each other Jun 17. **SATURN,** (mag 0.6), is past the meridian at midnight and starting to drop towards the western horizon. Ring tilt is minimum this month at 12.5°. **URANUS,** (5.9) is in the morning sky in Cetus. **NEPTUNE,** (7.9) is visible in Aquarius. Two asteroids, Pallas (9.4) and Juno (9.8) can be found with suitable maps. (See your favourite astronomy magazine website). **PLUTO** (mag. 14) rises in the east by 11:00 pm and may be found with accurate charts and large telescopes.

The diagram below gives the sunrise/sunset times and the sun's altitude on three dates this month. Note that **Summer Solstice occurs at 7:09 pm on Jun 20**. The calendar below the sun chart shows the moon phases for the month. Times of moonrise for NM, FQ, FM and LQ are in the Sky Calendar listing at left.



Special Events

Venus Crosses the Sun

During this winter and spring, Venus has been a spectacular Evening Star. But the time has come for it to switch over to the morning sky and catch the eye of early morning risers. Before it does so, it has to pass between the Sun and Earth. Normally it goes above or below the Sun but twice every century or so it is nicely lined up and crosses the face of the Sun. The first transit of the current century occurred in 2004 and the second of the pair will happen June 5, 2012. Don't miss it!

BAS will be observing from the ES Fox Observatory, a year old facility that was only a dream at the previous Venus transit. Now we have a comfortable observing location, an H-alpha telescope (the view should be spectacular!), an 8-inch SCT with Thousand Oaks solar filter, and a nice collection of eyepieces. Joan S. has a supply of solar viewing glasses from the RASC, and we are hoping to record the event with the Mallincam on one of our scopes.

First contact occurs a few minutes after 6 pm DST but arrive earlier. When Venus crosses the limb of the sun it is possible to see the Venusian atmosphere (see Fig 4 on pg 11) as well as the famous black drop effect just before the planet "breaks" away from the solar limb around 6:22 pm DST. All times are best guesses from SN Pro and there may be several minutes error one way or the other. For example, "Astronomers Without Borders" gives 6:04:03 and 6:23:32 DST for the contact times for Owen Sound. The time difference across Canada is something like 2.5 minutes for the respective contact times. The Pasachoff article on pages 9 to 11 has more about these early observations. Local circumstances for the transit are found on pg. 8. The sun sets around 9 pm DST in our area. Find a location with a flat western horizon to see the maximum duration possible.

June 2012

By permission
University of Texas
McDonald Observatory

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4 FM	5	6	7	8	9
10	11 LQ	12	13	14	15	16
17	18	19 NM	20	21	22	23
24	25	26 FQ	27	28	29	30

FOR SALE: Meade 8-inch SCT model 2080 Telescope

SOLD!

This telescope was sold to the **Bruce Peninsula Biosphere Association** for its **Bayside Astronomy Program**.

The program will run during the summer months of July and August on the best weather night of each weekend and will be modeled somewhat around the San Francisco Sidewalk Astronomers model. This initiative has been discussed for the past year by the BPBA and its Dark Sky Committee and now an observing platform has been constructed beside the Lion's Head Lighthouse to use in the daytime for tourists to view the cliffs and at night to view the stars. Monies have also been raised and spent to install all-weather binocular observing equipment that can be used mainly during the day time so tourists can observe the Lion's Head Cliffs and check out the rock climbers! Two telescopes are also being added for the night viewing. BAS members, Doug and Paula Cunningham, will be overseeing the program.

BAS involvement is most welcome and could be as modest as one or two visits ... i.e. once each in July and August on a suitable weekend ... bring your telescope and expertise. On the 3 long weekends when there will be lots of people in Lion's Head, any telescopes to complement those of the BPBA (two telescopes: a C11 and a Meade 8") would be greatly welcome. However, involvement by BAS members during the other weekends would certainly be helpful and appreciated. For the weekends of Starfest and one other when Doug will be away, extra help would also be appreciated. Already, two BAS members have offered to assist the program. If you are interested and there is some cosmic space in your summer calendar, or you have some questions before making a commitment, contact Doug directly at: quetican@amtelecom.net

Do you know any university student who would be interested in being the Manager of the Bayside Astronomy Program for the summer?

A grant has been received by the BPBA to hire a student (must be returning to school) to assist with the program and continue with BPBA's dark sky initiative. Paula and Doug have volunteered to mentor the student and recently bought Anton's Meade 8 inch scope for the student or a Committee member to use in showing representative celestial objects during the Bayside astronomy presentations. **The deadline for applications is June 1st** so if you know if any interested university student have them contact:

Elizabeth Thorn
Chair, BPBA
elizabeth@thorn.ca
(519) 377-5166
(519) 900-0352

Telescopes For Rent (free to BAS members)

Two 12-inch Dobsonian telescopes.

Come with some eyepieces, collimating tool and finder. Available for use by BAS members for their viewing pleasure for periods up to 3 months, (or longer if there is no one on the waiting list). Contact Brett T or John H for availability. Free set-up lesson at a location of your choice. You transport.

For Sale: HUTECH part # 3101 Single Arm Compact Fork Mount Head,

Can be used in Alt-Az as well as Equatorial mode with lightweight Scope (I have used it with PRONTO on Manfrotto 128RC Photo-tripod). Has Slo-Mo knobs (flexible shafts can be added to it - not included)
1/4 - 20 thread on base Size: 3" x 3" x 6".
Asking $ 200.-- Firm

Anton VanDijk 519 376-9912
e-mail: ravand@rogers.com

Review/pictures can be found here: http://www.cloudynights.com/item.php?item_id=798

Well, not really, but there are some other neat items still available...

→

FOR SALE: Televue Pronto

2 element E.D. Refractor, 2.7" / 70mm diameter. f.l. 480mm, f/6.8. Ser. # 5789, with 1-1/4" Star Diagonal, with 45 degree Prism diagonal (for terrestrial viewing), with TeleVue Red dot finder, complete with TeleVue Soft Case. Asking $ 700.-- Firm
Anton VanDijk 519 376-9912 ravand@rogers.com