NOVA

NEWSLETTER OF THE VANCOUVER CENTRE RASC

VOLUME 2016 | ISSUE 1 JANUARY FEBRUARY 2016

Paul Sykes Lecture – Sat, Jan. 16 @ 7:30

"Plutonic Relationships" featuring Ed Krupp – SFU Burnaby Campus, Room SWH10081

Pluto merged with popular culture as soon as it was discovered in 1930, and since then it has shown up on postage stamps, in comic books, in science fiction, in planetarium shows, in museum exhibits, and elsewhere. When deprived of full planet status in 2006, Pluto became even more conspicuous by its absence. Pluto has a cultural identity that originated in the name it was given from Classical mythology and resonates with its astronomical character. In the last 85 years, it has lodged itself in the public imagination with an influence far out of proportion to its physical profile. The arrival this summer of a spacecraft targeted on this tiny, distant world confirms the obvious: In our hearts, Pluto is not just a dwarf planet. It's a destination.

Dr. E.C. Krupp is an astronomer and Director of Griffith Observatory, which is owned and operated by the City of Los Angeles Department of Recreation and Parks. He led Griffith Observatory's $93-million renovation and expansion, completed in 2006. He majored in physics and astronomy as an undergraduate at

Pomona College in Claremont, California. He began working at Griffith Observatory in 1970 as a part-time Planetarium Lecturer when he was still in graduate school in astronomy at U.C.L.A., where he studied the properties of rich clusters of galaxies with the late Dr. George O. Abell. Since 1973, Dr. Krupp has actively studied ancient, prehistoric, and traditional astronomy and the relationships between astronomy and culture, including modern culture, worldwide. Dr. Krupp is the author and editor of five books on ancient, prehistoric, and traditional astronomy and author of four children's books on astronomy. He has also published dozens of research papers and hundreds of articles for the general reader, including three on the cultural dimensions of Pluto. He has visited more than 2000 ancient and prehistoric sites throughout the world and most recently has returned from an expedition to little known antiquities in the Caucasus. For the June solstice, he is leading a tour to Scandinavia for the midnight sun and ancient and historic sites with astronomical significance, including Tycho Brahe's observatory remains.

See map on Meetup for directions to the SWH10081 lecture hall. ✸

JANUARY 14 **SFU**
Dr. Catherine Johnson of UBC discussing the recently delayed Mars InSight lander mission. Room C9002
SFU

FEBRUARY 11 **SFU**
Dr Phil Stooke of UWO Earth Sciences: Lunar Rovers & the next edition of his book, The International Atlas of Lunar Exploration. Room C9002 SFU

MARCH 10 **SFU**
TBA. See Meetup for updates. Room C9002
SFU

Members' Gallery

The Lunar Straight Wall by Elena Popovici
Equipment: Sony ILCE-5000 camera attached to 102mm Sky-Watcher reflector telescope with prime-focus + barlow adapter setup.

President's Message

by Suzanna Nagy

Happy New Year to all. We start 2016 with a newly elected RASC Council. Almost all of last year's Council members returned with the addition of a few new faces. As always, returning Council members offer continuity to the Society while new faces offer new ideas, insight, and enthusiasm.

We are looking forward to a stellar year for 2016 and are starting off with a big bang by having Dr. Edwin Krupp of the Griffiths Observatory, Los Angeles, CA, give the annual Paul Sykes Memorial Lecture on Saturday, January 16. Dr. Krupp will be presenting on the recent Pluto mission and the amazing discoveries made. We look forward to seeing you there.

A preview of events highlighted for 2016 include Comet Catalina visible in January, Jupiter at opposition on March 8, a rare transit of Mercury across the Sun on May 9, Mars at opposition on May 22, Saturn at opposition on June 3, the Juno spacecraft arrives at Jupiter on July 4, and the Perseid Meteor Shower on August 12/13 under dark skies.

Look to our website and/or Meetup.com for details of upcoming observing and lecture events.

Here's hoping for clear skies! ✸

About RASC

The RASC Vancouver Centre meets at 7:30 PM on the second Thursday of every month at SFU's Burnaby campus (see map on page 4). Guests are always welcome. In addition, the Centre has an observing site where star parties are regularly scheduled.

Membership is currently $78.00 per year ($45.00 for persons under 21 years of age; family memberships also available) and can be obtained online, at a meeting, or by writing to the Treasurer at the address below. Annual membership includes the invaluable Observer's Handbook, six issues of the RASC Journal, and, of course, access to all of the club events and projects.

For more information regarding the Centre and its activities, please contact our P.R. Director.

NOVA, the newsletter of the Vancouver Centre, RASC, is published on odd-numbered months. Opinions expressed herein are not necessarily those of the Vancouver Centre.

Material on any aspect of astronomy should be e-mailed to the editor or mailed to the address below.

Remember, you are always welcome to attend meetings of Council, held on the first Thursday of every month at 7:30pm in the Trottier Studio in the Chemistry wing of the Shrum Science Centre at SFU. Please contact a council member for directions.

2015 Vancouver Centre Officers

President	Suzanna Nagy president@rasc-vancouver.com
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At Large	Howard Trottier Elena Popovici Eimi Anazawa
Trustees	Pomponia Martinez J. Karl Miller

Library

The centre has a large library of books, magazines and old NOVAs for your enjoyment. Please take advantage of this club service and visit often to check out the new purchases. Suggestions for future library acquisitions are appreciated.

On the Internet

http://rasc-vancouver.com or
http://www.rasc.ca/vancouver
http://astronomy.meetup.com/131/
http://www.facebook.com/RASC.Van

@RASCVancouver

Mailing Address

RASC Vancouver Centre
PO Box 89608
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Burnaby, B.C.
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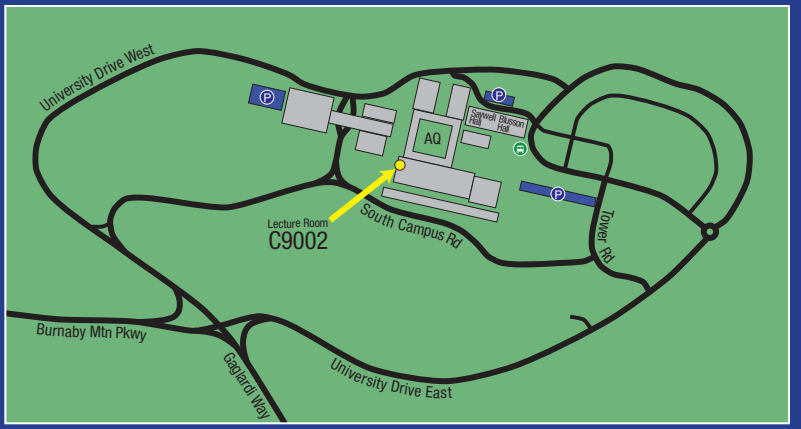
Map to Meeting Site



Our SFU meeting site is in room C9002 in the Chemistry wing of the Shrum Science Centre. Make your way to the southwest corner of the Academic Quadrangle and follow the adjacent hallway south. The theatre is the second room on your right.

Pay parking is available at several locations located around campus (indicated as "P" on the map).

A Call for Volunteers

by Jeremy van den Driesen

Hello fellow RASC members.

As the new Event Coordinator for RASC Vancouver Centre, I am looking for confirmation from those of you who are already committed volunteers and wish to continue, and those of you who wish to volunteer your services for the year. For the uninitiated, a volunteer's duties are as follows:

1) Interacting with the general public with a view to providing information about RASC or anything celestially related.
2) Handing out RASC promotional material.
3) Speaking on a topic of related interest.
4) Assisting the RASC member in charge of the event where needed.
5) Bringing your telescope to an event to introduce members of the public to the heavens above. This is the most called for activity and most rewarding. Especially to see a child's eyes open wide in awe and hear the wonder in his/her voice, perhaps an astronomer in the making.

On the average, we have about one event per month requiring about half a dozen people. However, on Astronomy Day which is on May 7th at SFU we require, at a minimum, about two dozen people. The protocol normally adhered to is for a request to go out about a month before the event calling for volunteers and confirmation made by me a week or two before the event.

Please e-mail me with your response, and/or, if you have any further questions.

Regards and wishes for clear skies to us all. ✸

Jeremy van den Driesen
Event Coordinator
RASC Vancouver Centre
E-mail: events@rasc-vancouver.com

Winter Gear for the New Year

by Kyle Dally

Welcome to 2016, fellow astronomers. While the nights are long and dark, Jack Frost will still be nipping at your nose. Why not bundle up with a nice RASC winter jacket and a matching RASC tuque? Then, warm up by the fire drinking from a RASC mug while wearing one of our, always stylish RASC hoodies.

For those who are new to the stars, we have plenty of helpful guides to satisfy your curiosity. Attending our public lectures is also a great way to learn about space and its infinite horizons from people that are just as interested and enthusiastic about the subject.

Also, stay up to date on celestial events with the new 2016 RASC calendar, available for $16.00. If you don't happen to have cash with you, we now accept all major credit cards for any of your purchases.

This is Kyle Dally, Merchandise chair for RASC Vancouver, wishing everyone a Happy New Year. ✸

RASC–Vancouver & Science World's SWEET

by Leigh Cummings

Back in October, I had been invited by RASC National Education Representative, Lauri Roche, to attend a science teachers' conference in Richmond. I attended the event which I enjoyed very much. I met many keen science teachers as well as some interesting presenters at several booths. One such booth was put on by Science World. I had a wonderful conversation with the staff at the table, who were very interested in exploring ways that our organizations could work together in bringing astronomy education to the public.

Photos by Elena Popovici

One of the projects that they have initiated which they thought we could help them with is a program called "SWEET" which stands for "Science World Extravagant Evenings for Teens." These are free evenings on the second Tuesday of every month for 13- to 18-year-olds to visit Science World and enjoy some social time while engaging in fun science activities. SWEETs are organised with a Teen Advisory Group (TAG Team) who come up with the themes, ideas and activities for each of their evenings. The TAG Team decided on astronomy for their November 13th evening.

I was contacted first by Katherine (Kat) Hamill, Science Facilitator, and then by Samsara (Sam) Marriott, Youth Program Specialist, both staff members at Science World. They were both very excited to have us bring our equipment, handouts, and experience of observing to their event. I also volunteered to give a talk on how telescopes work. As usual, it was easy to get other members to volunteer for the event and agree to bring their telescopes. Of course we were hoping to have our telescopes outside on the roof for the teens to observe through, however Mother Nature once again had other ideas for that night and covered our region with cloud.

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Membership has its Privileges!

New members, did you know? The Vancouver Centre has several telescopes available for loan free of charge! We have telescopes ranging from 60mm to 10" in diameter. For more information see the Director of Telescopes after the members meeting. The loaner period is for one month, to be returned after the next meeting. Telescopes are not allowed to circulate outside of these meetings. You can now reserve two different telescopes per year and use what is left at the end of the meeting anytime.

Your greatest opportunity as a member of the RASC is to take advantage of the company of other enthusiasts to increase your knowledge, enjoyment and skill in astronomy.

The best thing you can do to gain the most from your membership is to get active! Take in the club meetings; engage other members with questions; come out to observing sessions (also known as "star parties"), and, by all means, volunteer to take part in our many public events.

For the usual observing sites and times, visit our website at http://rasc-vancouver.com or contact the Observing Chair at observing@rasc-vancouver.com.

Upcoming Events

January
16 – Paul Sykes lecture at SFU (see page 1 for details)

March
19 – Night Quest at Pacific Spirit Regional Park

May
7 – Astronomy Day at SFU
19-22 – RASC General Assembly in London

July
30 - Aug 7 – Mt. Kobau Star Party

August
27 - Sep 4 – Merritt Star Quest

December
8 – AGM

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I was also fortunate to be able to borrow some hands-on equipment from SFU's Physics department to demonstrate the very basics of how a telescope works. I owe a thanks to Howard for arranging that for me. I was feeling pretty confident until Sam emailed me to inform me that they had 700 teens indicate they were attending. Just before I departed for the event, I discovered while rechecking my emails that the ever entertaining and knowledgeable Dr. Jaymie Matthews was to speak before me.

On the night, we had Suzanna Nagy at a table with all sorts of handouts including planispheres to give to the many interested teens. Adrian Mitescu brought a small Dobson-mounted Newtonian as a static display. Adrian and Elena Popovici brought their beautiful little refractor and set up next to our table. That allowed them to help out at our very busy table. Elena also talked to the many interested teens about their telescope and about taking photos through it. I think a lot of the teens were very interested in imaging through telescopes. Michael Levy also brought his Schmitt-Cassegrain telescope and had it hooked up to his laptop in order to show the kids a modern way of controlling a telescope. Jamie Van den Driesen had also brought a refractor which he set up in a spot that allowed the kids to look at some information posters at the end of a hallway. I set my 150mm Mak on the main stage as another static display.

While everyone was kept busy explaining and showing the kids their telescopes, I think Suzanna and Adrian did a yeoman's task of demonstrating star wheels, folding and handing out over 150 during the night. They proved to be very popular. There were other handouts at the table that also proved to be an attraction to the young astronomy enthusiasts.

We also donated some swag to Science World which they used as prizes at the end of the night during a trivia quiz. This included one of our brand new planispheres that merchandise is now carrying. I had also given away some caps, tuques and t-shirts after Jamie Matthews' talk when the kids could answer some quiz questions posed by Jamie. Some of his

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questions were quite challenging and had required a deeper knowledge of cosmology than had been talked about during the evening. It shows how popular the subject of our universe is becoming with our younger generations.

My own talk about telescopes was well received. At least none of the kids fell asleep so I will take that as doing OK. I also handed out some prizes to kids who could answer some trivia questions. I had several of the teenagers come up to me later to ask questions and several commented that they learned lots from my talk, which of course was the point of our involvement with the event. I was glad to be able to give some knowledge and advice to these bright, young kids. As you all know, most of our "wisdom" comes from the mistakes we have made. I certainly have made my share.

The night went very well and I wish to extend my thanks to our RASC volunteers, the staff and management of Science World, the purple-shirted teenage volunteers at Science World ,as well as Kyle Daly for arranging for our swag to give away. I look forward to attending future events with Science World whenever our resources can be of help in educating the public about astronomy. ✸

Your 2016 Vancouver Centre council. From left to right: Michael Levy, Jeremy van den Driesen, Elena Popovici, Bruce Hutchison, Alan Jones, Doug Montgomery, Scott McGilllivray, William Fearon, Leigh Cummings, Kyle Dally, Howard Trottier, Eimi Anazawa, Suzanna Nagy, Gordon Farrell, J. Karl Miller. Not Pictured: Adrian Mitescu, Kenneth Lui, James Smith, Bill Burnyeat, Mark Eburne, Barry Shanko, Pomponia Martinez.

For Sale

For Sale – Celestron 8" Nexstar Evolution Computerized Telescope This telescope is in virtually new condition—used once. Price includes Tripod and mount, GPS Module, Astrozap Dewshield and Starsense Camera. The camera finds suitable alignment stars by automatically slewing the telescope to different parts of the sky. Really convenient, quick and simple. Original cost was $2819. + taxes = $3157. This is an excellent telescope. Please email me for pictures.

Keith Eisler
canuck642@gmail.com
604-626-4004

Hopewell

by Bill Burnyeat

Sasquatch Provincial Park, near Harrison, east of Vancouver, is one of the stops on my yearly astronomy trek in B.C. parks. Long branches of cedar and fir overhang and darken a small clearing where wood benches, in various states of decay, form the seating of a natural amphitheatre. It's early July and the sun lingers as though just another beachcomber aimlessly taking in the sights.

A slide projector sits on a stump facing a whitewashed piece of plywood as screen. The Hick's Lake campground is nestled around the lake of the same name and this body of cold water in turn is nestled, or dwarfed, by huge mountains of the coastal range, impressive peaks of sheets of rock topped by ice, even in summer.

After the slide talk, I set the telescope on the beach and as the day retreated a few stars began to insinuate themselves in the grey-purple sky.

The dark advances. I had my eye on a distant skyline where a small glow was just visible—a tiny disk of light. I suspected the Moon was behind the ridge; I could see an advancing light move on the beach, meaning that from some locations the Moon was in view and sending its soft glow over the scene.

I waited. Then, as the last of the line of campers had seen the nebula in the Harp that looks like a pale ring, I swung the telescope about and trained it on the mountain peak. The firs on the ridge were silver, as though they were about to burst in flame. Then, with no announcement or preamble, the Moon rose. It looked like a curved platter of light and the trees seemed planted in the Moon like shrubs in some luminous planter pot. The Moon was very bright and its craters and irregularities—clearly visible—seemed poking out amid the forest. The sense of perspective, and the great difference in the range of the skyline and the Moon, made not the slightest impression and one after another campers looked and some of them gasped with astonishment at the lunar forest plainly before their eyes. Children were especially welcoming of this strange idea, and as a sworn educator, responsible to unleash all the rights facts, I had to break in on their childish trances, not too abruptly, to say that the trees were on the mountain and not really potted in the sterile soil of the Sea of Fertility. The silence is telling when the Moon comes over a hill.

Early peoples were the first to discovery the regularities of the Moon's monthly trip across the sky. (I am ignoring the birds, fish and insects that take account of the Moon's phases for their various travels, but I hope this preoc-

Photo by Lon&Queta

cupation with humanity will not seem too species-o-centric.)

To learn the phases of the Moon, understand the nightly habits of Earth's near neighbour, as well as just enough lunar history and physics to say something of interest as the Moon sails up over the fence, all this is not too hard to learn.

Photo by Kyle Pearce

The motions of the Moon

The Moon is the Earth's only natural satellite. It moves around us from start to finish in just under one month. The exact time may be looked up in a textbook, so it's not necessary to remember the 27.3 days needed for the Moon to travel around the Earth. Besides, should the diligent reader look up this period one might become confused. The source could say instead: 29.5 days. The first number is the period the Moon takes to orbit the Earth, considering the Earth as fixed and the Moon to circle the static planet. The second number is the time between two successive full Moons. This is longer by about two days since the Sun and Earth also play a role in the apparent motion of the Moon around the sky. The orbital antics of the Earth and Sun mean that the Moon needs just over two additional days to catch up each time it circles our planet. A third idea of the Moon's orbital period comes from Vancouver's Maritime Museum. At the wharf, a sign states the time it takes the Moon to circle the Earth is 24 hrs 50 minutes! This isn't even close to the others.

Let's tabulate the times:

Time for the Moon to go around the Earth once:

Time	Source	Reasons
27.322 days	school physics book	Moon circles earth
29.5 days	observer's book	two full Moons seen
24 hrs 50 min.	Maritime Museum	Moon returns to same spot

Which is right? All three. Truth here is defined by utility. Each answer is correct for the type of use it entails. The third one, so much at odds with the first two, is the time it takes the Moon to appear in the sky in the same place, or, as the navigation officer would say, the average time between two successive lunar transits of the meridian. It is much shorter than the first two values since most of the motion is effected by the daily rotation of the Earth. If the Moon were stationary, it would appear overhead at the same point in about 24 hours as the Earth rotated under it. Since the Moon is busy circling the Earth, it moves towards the east about 13° during the 24 hours of one day. Therefore, it sits in the same place in the sky 24 hours and 50 minutes later, very roughly, each day. The extra 50 minutes is the time needed for the Earth to catch up the 13° the Moon has moved during one day. This carried out, the Moon appears to stand in the same part of our sky as the day before.

For the purposes of understanding the Moon's place in the heavens, it is this last one that makes

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most sense. A purist (meaning someone who does astronomy in a library) could argue that this is the least "true" of the three numbers. This is fine, but the first two are more useful if we could somehow situate ourselves in space far from the Earth-Moon system and inspect it from a gods' eye view and in speeded up motion. But the Moon in the sky is not a movie but a reality. The Maritime Museum's number is best if we expect to be looking at the Moon from the surface, wet or dry, of the Earth. Readers will have to decide for themselves into which group they expect to be included.

We begin our study of the Moon's phases

Going outside to look at the Moon is a pleasant diversion. The sight of the Moon scudding through clouds lightly painted by the Moon's diffused light never fails to suggest wonder. Let's suppose it is in the evening, an hour or so after sundown. The Moon is in the south and it is a half Moon. The half Moon, whatever the month of the year, has certain constraints on how it looks and where it goes. The first thing to note is the half of the Moon that is lit up. The westerly side is brightly lighted up. Why? Since the Moon shines by reflected sunlight, it is always the Sun-facing hemisphere that receives light. Select the centre of the Moon's disk. Now, draw a line in your mind from this centre out to the westerly horizon. The line is slightly curved since it is following the contours of a globe—the celestial sphere on which the sky objects appear to rest. The end of the line cuts the horizon just where the Sun recently set. The best time to try this is when the Sun has recently set, furnishing a bright horizon glow to mark its retreat into night. This line, which you have imagined, is nothing less than a cross-section of the entire solar system from the Sun and Mercury out to lonely Pluto. It is amazing that such a vast structure is discovered with

so little effort. The solar system is right before you, drawn out by you from your front step or backyard lawn. Since the Moon is within the solar system, it follows the path that you have delineated. A few days before the Moon would have sat on this line about half way between its current location and the Sun. It would, however, have looked much different. It would appear as a narrow crescent. Here is the first principle of the Moon watcher. The closer the Moon is to the Sun, the smaller it appears. Narrow crescents are always close by the Sun, and never far away. The larger Moon flies from the Sun and the full Moon is on the opposite side of the sky from the Sun.

As it gets later in the evening, the half Moon moves towards the western horizon. Since the sky is apparently in motion towards the west, the half Moon that first attracted our attention will move with the sky and set some six hours after the Sun. Why six hours? The half Moon is one half of the way across the sky from the Sun. Its location on the sky is 90°, roughly, from the Sun. Since the whole sky turns in about 24 hours, it takes six hours to turn through one quarter of a circle. These figures are rough since the seasons add complications to these numbers but, as a fair enough guide, six hours is good enough. Now, when and where will the full Moon appear? Remember the line in the sky? Just extend it towards the east. It now forms a cord from west to east with its high point at the place the half Moon sits at sundown. One week after the half Moon the full Moon will sit on the eastern extremity of the line. The full Moon rises in the east when the Sun goes down in the west. The one rises as the other sets. Myth and folklore around the world often tell of an argument between Sun and Moon. The Moon went to the far side of the sky to cool off or to pout. Since the full Moon rises as the Sun sets, it moves across the sky all night long and therefore enjoys the longest tenure in the sky of any of the Moon's phases. Each day, the Moon moves towards the east as it sails around the sky. The 50 minutes later per day rule allows some idea of when it will rise, come high in the sky and be visible. The rule must be looked at flexibly, for it can be almost twice as long as 50 minutes or, at other times, only one-half this time. A rule with such a margin of error might seem ridiculous but only until we reflect that it is the visible Moon we seek, not the confirmation of a timepiece. The reason for the late or early Moon has to do with the angle the imaginary line makes on which the Moon flits about the sky. Called the ecliptic, it circles the sky. Think of it as a rope on which a hollow bead is placed. The bead is free to move around the rope. The bead is, of course, the Moon. Once you have gained an understanding of the little rope's location on the sky, you will be able to determine where the Moon must be.

Moon physics

This is the only one of the activities that benefits from a special piece of equipment. Unlike the motions and phase watching aspects, best done by eye alone, lunar physics involves a consideration of the Moon's visible surface itself. A pair of binoculars or a little telescope can help here. However, if no such equipment is available, much of our work can still be done. As a compromise, I have watched the Moon and made the observations needed for this section using only a pair of opera glasses that magnify the Moon a measly four times. I do much observing with the opera glasses since they fit easily into the pocket of a jacket. Many years spent setting up and packing away large, heavy telescopes has taught me the value of having modest optical aids on hand.

The first thing we notice about the Moon is that it is very bright. The full Moon casts enough light to read your newspaper. This is curious since the light of the full Moon is less than the Sun's luminance by a factor of about 500,000 times at least. Put another way, if the whole sky were covered from zenith to horizon in every direction with copies of the full Moon until the whole sky was covered (that's 160,000 Moon copies) there would still be less light reaching the ground than the light of one Sun. The fact that we can still see reasonably well under the light of just one full Moon is a testament to the remarkable nature

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of the eye. We are able to compensate for a radical reduction in light level in order to continue seeing objects around us. The half Moon, in contrast, is only 11 per cent as bright as the full Moon. This, at first glance seems odd. If the half Moon shows 50% of the area of the full Moon why does not it shine with 50% as much light? If the Moon were smooth like the surface of a ping-pong ball it would obey this rule. But, as anyone knows who has looked at the Moon's surface, it is wrinkled, bumpy and irregular. The moon is like a golf ball and not a ping-pong ball. The two surfaces scatter light in very different ways. A ping-pong ball is essentially a small smooth globe. Scientists call this kind of surface a Lambertian reflector. This means that it reflects light away in an easily modelled way. Also, for Lambertian reflectors, reducing the size of the surface reduces the amount of reflected light in a linear way. If the Moon were completely covered in a smooth uniform glaze, the half Moon would be half as bright as the full Moon. The Moon's golf ball shaped surface means lots of the light it receives fails to be returned. It is hidden in the depths of craters or under the silent shadows of mountains.

Johann Heinrich Lambert (1728–1777) was one of the great polymaths of the 18th century. Lambert is best known for his *Photometria*, the first significant book on the quantification of light and its effects. Written in Latin and published in 1760, it is a precursor to what would become illumination engineering and photometry.

It's of interest that the nature of the Moon's surface could be derived from the simple measurement of its light even if telescopes were unavailable. We might still suppose the existence of deep chasms, hills and mountains on the lunar domains on the basis of lunar scattering of light. Modern day explorers of the solar system make similar shrewd guesses about the surface properties of bodies circling the Sun when it is not feasible to achieve image clarity upon very remote or very tiny objects.

Looking at the Moon over several days around full Moon reveals the Moon is very bright. People who know the Moon only from pictures in books really owe themselves a good look in a telescope or even a large pair of binoculars. The Moon is much brighter than any photo and its surface seems alive with tiny details just at the limits of visibility. At higher powers, the wealth of detail is breathtaking. In the small opera glasses or, to a certain extent, even with the unaided eye, it is apparent that the Moon has two different global features. A sort of darker stain called "maria" covers about half the visible surface. The maria—the word means "water" or "ocean"—was named on the belief that the Earth might be copied

in other astronomical bodies. It seemed reasonable that the dark maria might be water while the highlands or brighter areas might be the dry land. We know today that the Moon is extremely dry, even its rocks are termed anhydrous meaning they contain little water within. Unlike the heavy Earth, the Moon has a small mass. It cannot retain the flighty water molecule which would sail away like a tiny space ship and leave the Moon's weak gravitational field. It is for this reason that the Moon has little or no atmosphere. Scanning the Moon at four-power increases the sense that the dark and light surfaces form the most noticeable gross feature type on the Moon. The famous man on the moon (or lady or rabbit) are portraits drawn in this dark landscape, a sort of Rorschach test for cultural motifs. The sense that the maria are an addition to the Moon or a later feature is the impression that the small opera glasses reveals. It is a correct impression. The series of lunar space missions has given us a rough chronology of the events that formed the maria. Its seems the whole solar system was formed at the same time out of a vast collection of gas and dust, the cosmic leftovers of gigantic star forming processes. The details are sketchy but the broad themes have been pieced together. The whole solar system whirled into existence about 4.6 billion years ago. This number seems certain since in rocks from a wide variety of solar system objects including from meteors, Moon and Mars rocks all have the same upper limit as to age. There is simply nothing older than 4.6 billion years. Yet the universe as a whole is three times this age. When the Moon and the Earth were very young, they were extremely hot. The Moon must have had a molten surface. As the Moon slowly cooled, rocks slammed into it. These impacts were more common early on simply because the formation of the solar system seems to have been a messy affair. There must have been all kinds of errant objects, probably whole classes of bodies not seen today, that were whirling around the Sun, getting into harm's way and collisions must have been common. Since the Moon's surface was plastic, the hits were like dropping peas into a boiling pot of stew. No surface features have survived from this early period. At some point, the surface became hard enough to take and retain the impact of falling bodies. By 3.9 billion years ago, the Moon's surface was hard and hits began to be retained as permanent features. There is some uncertainty in whether the 3.9 billion year date is simply the time at which the hit registering became possible or if there was some increase in hits at this date. It's possible that both events happened at the same time. The 3.9 billion year ago time is called the Major Impact Period in the solar system. The Moon would have collected new materials by all these collisions but it gained something else as well. The heat of the collisions, heat like the impacts of huge nuclear weapons, was stored within and there was little in the way of opportunities for the Moon to rid itself of this heat. Since the Moon had a hardening shell and molten bodies remained within, there was a tension on this surface and the hot stuff within pressed on the crust seeking a way out. This chance came about 3.7 billion years ago. The great dam burst and a flood of stored Moon material came flowing out. The new material was relatively rich in titanium and iron. Titanium at the concentrations here is dark and reddish compared to the original surface. Iron causes the new substance to flow like molasses, encouraging the material to run all over the Moon, filling in low areas. After the formation of the maria, the number of hits fell dramatically. Surveying the Moon with a powerful telescope reveals that there are far fewer hits within the dark areas than in the brighter highland areas. The conclusion? Most of the hits were laid down before the 3.7 billion year old maria-making epoch. Since that time, over that whole unimaginably long time, the Moon has been quite placid. It is true that here and there within the maria are some white patches, the tell-tale sign of the late arrival of a giant rock from space. Even the little opera glasses reveal the whitish signatures of the hits now called the crater's Copernicus and Aristarchus. Yet, statistically, these are lunar newcomers. One other piece of information is

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gleaned from watching the Moon. It is always one hemisphere that is on display. This leads some to remark that the Moon, since we don't see both sides, does not rotate on its axis. Yet, this can't be the case. If the Moon were non-turning while moving around the Earth its other half would slowly be revealed. Let's consider the problem of the unseen half of the Moon. A good method is one the early Greek thinkers applied: a model for solving problems in general. We take as a given that the Moon circles the Earth in 27.3 days. Then, there are three states the Moon's rotation can assume:

1) The Moon rotates more slowly than a 27.3-day period.
2) The Moon rotates more quickly than a 27.3-day period.
3) The Moon rotates in exactly 27.3-days.

Notice that the cases cover all rotation periods. Our demonstration will show that situations (1) and (2) allow earthlings to see the hidden part of the Moon at some point. Only (3) keeps the far side hidden. For the demonstration, place a chair or coat rack stand in the middle of the room. This will be the Earth. Your job (as Moon) is to move around this furniture. Stand a couple of meters from the middle and, with your hands raised up, start moving around the centre. As you walk, introduce a slow rotation of your body at the same time. Start out facing the centre. If this is done, you will find that your front is facing away from the centre. Your back (the hidden side) is now on view from the point of view of the middle. Now repeat the experiment this time introducing a swift rotation into your movement. Again, at some point you will show your back to the centre. Try the third way. Execute a rotation that will return you to the same orientation after exactly one revolution around the centre. It is here that you find yourself permanently facing the centre point. So, the Moon hides one face from us because it rotates on its axis in the same 27.3 days it takes for it to go once around the Earth. Some people are put off by this seemingly unlikely coincidence. Yet all the major moons of the solar system obey the same law. The reason has to do with the gravitational tension between these bodies and the parent planet. These frictions are minimised if the two periods are identical. Therefore there exists a tendency to speed up slow rotation rates, (case 1) and slow down fast rotation rates (case 2). Therefore, by a process similar to evolution, the moons tend to migrate and stay at (3). The process must be very slow, but think of the long periods of time there is for the action to make itself felt. It's just one more of the wonders of the Moon. ✸

Awards were presented at the December AGM, with the Public Event Volunteer Award going to Jeremy van den Driesen (left) and the Vancouver Centre Appreciation Award plaque going to Gordon Farrell (right). Congratulations to this year's recipients! *[Editor's note: I do feel weird typing that to myself.]*

Members' Gallery

Aurora by Mark Eburne

Venus–Saturn Conjunction by Elena Popovici
Shot on the morning of January 9. Sony ILCE-5000 camera attached to 102mm Sky-Watcher reflector telescope, with prime-focus adapter.