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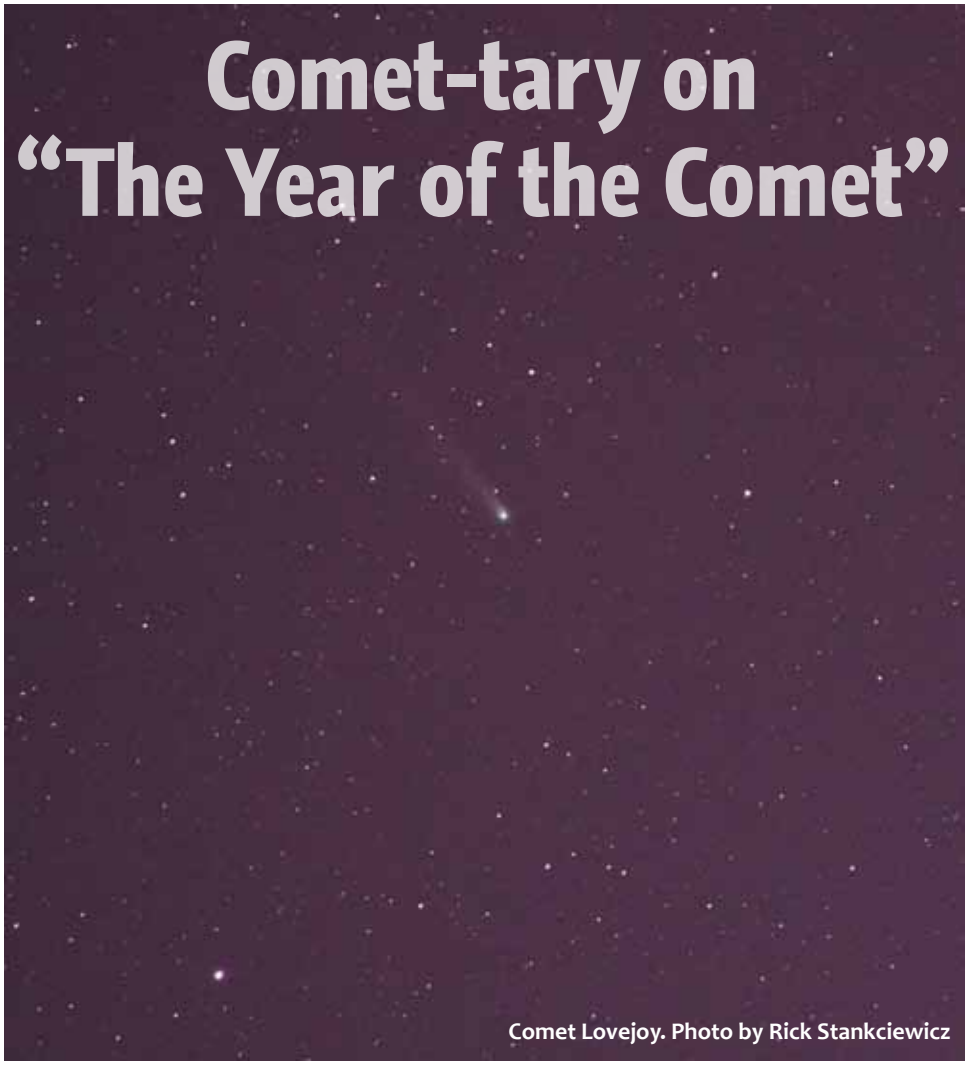
The Reflector

Newsletter of the Peterborough Astronomical Association

Comet-tary on "The Year of the Comet"



Comet Lovejoy. Photo by Rick Stankciewicz

There was much hype early in the year that one comet (ISON C/2012 S1) was going to make 2013 the year of the comet on its own, but as it turned out, it would take a multitude of separate comets to help round out the year on a high note. The high hopes for Comet ISON late in the year were a bust because this first-time visitor to our solar system flamed out as it rounded the Sun and came out as more of a ghost than a fiery apparition, but there were so many other momentary comets that you would be hard pressed to think of more in a single year in your lifetime. None of the comets this past year were all that "flashy", but at least with binoculars they kept you hopping throughout the year and they were nicely "spaced" out too. Winter, spring, fall, comets were in them all!

To name a few that stood out in my mind from our portion of the northern hemisphere, there was Comet Pan-STARRS (C/2011 L4) in March/April that just reached naked eye visibility (see attached image from March 16, back page), but binoculars helped easily pick it out of the evening twilight. It turned out to be a nice start to the year.

Then came Comet Lemmon (C/2012 F6) in May, but this faint morning comet was not an easy one to spot even in binoculars. I did see it and even got a very poor image of it (not worth sharing here) but this comet was not impressive by any means, especially compared to Pan-STARRS just a few months earlier.

Then came the fall climax, with at least three comets stacked up for viewing in the morning sky. Unfortunately, none were overachievers and the once famous (now infamous) Comet ISON definitely underachieved the predictions and expectations of most forecasters. In November Comet ISON got closer to its rendezvous with the Sun and brightened some and did develop a tail, but from the morning I chose to view it, it was not naked eye to me, but I could find it easily enough in binoculars (see image from November 20th, back page). I too had high hopes that early December would produce a news worthy comet to report on, but this was not to be as it broke-up and faded away as it rounded the Sun at perihelion (its close approach) on November 28.

At this same time Comet Encke (2P/Encke) was making its close encounter with our star and some

see "Comets" on page 16

President's Message

He's Back!

Contrary to the message I delivered in November's *The Reflector* it looks like I will be around for two more years as president of the PAA. This will be my second term, after which as per the Constitution of the PAA, I get my "get out of jail free" card.

I plan a major shift in the format of the monthly meetings and will be discussing this with the executive immediately. We will toss around ideas some of which have come from the membership. We will also consider changing the meeting start time to 7:00 p.m. from the current 7:30 p.m. to allow those with youngsters to enjoy the meeting and still get the little gaffers home at a reasonable hour. There will be more to come on this.

With sadness I announce the passing of George Bryant a long time member of the PAA. Please see John Crossen's kind words in this issue of *The Reflector*.

I'm looking forward to another great year of astronomy related activities and I hope that many members are too and will participate in making the year successful.

Rodger Forsyth
PAA President

Letter from the Editor

Happy 2014

The new year brings a new issue. We begin our thirteenth year of publication with an extra big isssue only because I've been working with a wealth of contributions. Keep it up, people. The more the merrier.

Rick Stankiewicz provides us a with a "comet-tary" on the much-hyped Comet of the Year, [Editor's note: I even caught some media claiming Comet of the Century.] Rick also reports on his visit to Machu Picchu's Temple of the Sun in Peru.

John Crossen has written a fitting tribute to the late George Bryant, a former PAA member. I am sorry I had not the pleasure to make his acquaintance. John also provides his usual wit and charm with a story on Orion and highlights of notable objects during winter viewing.

The third part of Ken Sunderland's Moon series continues this month with a discussion of the lunar highlands, or terrae. Additionally, Ken has written an extended review of Paul Bogard's *The End of Night*.

Once again I wish to highlight the quality of our Photo Gallery. Brian McGaffney is our local astrophotography expert and offers us wondrous Orion Nebulae in the Belt and Dagger regions. From afar our friend John Chumak submitted his detail of the Horsehead Nebula.

Happy New Year to you all!

Phillip Chee
Editor, The Reflector

PETERBOROUGH ASTRONOMICAL ASSOCIATION

The Reflector

The Reflector is a publication of the Peterborough Astronomical Association (P.A.A.) Founded in 1970, the P.A.A. is your local group for astronomy in Peterborough and the Kawarthas.

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Does Orion the Hunter Have Dark, Dual Personality?

John Crossen

The constellation Orion has the honour of being the second most recognizable star pattern in our winter sky. Only the Big Dipper exceeds his popularity with more people in the northern hemisphere.

Orion rides the celestial equator and can therefore be seen by people in both hemispheres. This global exposure probably makes Orion the most familiar constellation of all eighty-eight.

For thousands of years his hourglass shape has been associated with a human form by numerous civilizations. The ancient Arabs saw him as Al Jabbbar, the giant. To the Egyptians of old he was the likeness of Osiris, the god of the underworld. While ancient Indians knew him as Prajapati, the god of creatures. But despite his friendly and familiar countenance, does the mighty hunter who comes to visit with the first snowfall have a darker side? According to Greek mythology the answer is yes. But let's start with Orion the good.

The first thing most people do when you say Orion is to mention his belt. It is made up of three bright stars in a straight line and is highly recognizable. In fact many people spot the threesome first, then the surrounding stars that make up the rest of the constellation.

Some see Orion as holding a club over his head while others see a sword in the same hand. A thin arc of stars to his front is said to be either a shield or a lion's pelt. I'll vote for the club and the lion's pelt. It's just more hunter-like. Besides, if the Orion Nebula is the jewel in his sword, then it must remain hanging from his belt. After all, that's where you look for it.

As hunters go, I always snicker at the fact that the constellation Lepus the Hare

Was Orion a mighty hunter, a great warrior, the lord of the underworld or a drooling womanizer? It all depends on who is telling the tale. But whoever it is, rest assured it will be a good one.

huddles unseen right beneath the mighty hunter's feet. Maybe he just has a taste for bigger game. One thing for certain, Orion certainly does have a taste for women.

According to Greek legend he was in constant pursuit of the gentler gender. To this day he is still hot-footing it after the Seven Sisters of the Pleiades. According to estimates based on lithium depletion, the Pleiades are about 100 million years-old. That's a long time to chase any woman or even a gaggle of girls.

Orion is often associated with stormy weather, be it winter storms on land or on the sea. He is mentioned in poetry as early as *The Odyssey*. He was also boastful

See "The Hunter" on page 19

Jump Into January—and Your Winter Woolies!

John Crossen

Now that Comet ISON has fizzled into dust it's time for a brief post-mortem. What happened to ISON is the same fate that befell Icarus in mythology. He flew too close to the Sun and his wings of wax melted. Icarus fall down go boom. ISON did the same and likewise melted. Plus the Sun's immense gravity ripped it apart. ISON go poof.

It's a shame because comets can be spectacular sights and are a door into astronomy for many people. Unfortunately comets like cats have tails and do whatever they please. In this case it was a vanishing act.

New Moon (no Moon) gets January off to a good start for deep-sky viewers. The constellation Orion the hunter is well up just after dark. Hanging from his belt is the jewel of the winter sky, the Orion Nebula.

Also known as Messier Object 42, the huge cloud of gas and dust lies at a distance of 1,500 light-years. It is so large it's visible to the naked eye. In fact, if you had the fastest space ship currently available it would take over 1.5 million years to travel from one side of the Orion Nebula to the other. Small wonder it's such a knockout in binoculars or a small telescope.

Joining Orion is Lepus the Rabbit. You'll find the humble hare hiding just beneath the great hunter's feet. Also major players in the winter sky are Castor and Pollux the two brothers who make the constellation Gemini and Auriga the Charioteer.

Icarus. Like Icarus in Greek mythology, Comet ISON flew too close to the sun and likewise suffered a meltdown.

Follow Orion's belt up and you'll come to the bright star Aldebaran in Taurus the Bull. Look further up and you'll see a misty haze. It's the open star cluster known as the Seven Sisters of the Pleiades.

Moving down from Orion's belt brings you to the brightest star in the winter sky, Sirius in the constellation Canis Major—a.k.a. the Big Dog.

A good star chart will help in finding all of the above if you are new to the hobby. *SkyNews Magazine* is a good starting point and is available at the newsstand of any big box book store.

See "Icarus" on page 19

Water is More Common in the Universe Than Imagined

Artist's Rendering of Europa Geyser. Images from the Hubble Space Telescope suggest that water vapor plumes are venting from Jupiter's moon, Europa. The little moon has previously shown evidence of water. The new findings further support the idea that Europa is home to an ocean hidden beneath its thick outer shell of ice. Artist's concept by NASA.

John Crossen

The search for water on Mars has hogged the astronomy headlines for the past decade—and rightly so. Where there's water there is potential for life and Mars is still our most likely suspect for hiding life forms within its lava tunnels or beneath its surface where water springs to the surface on a seasonal basis.

The rovers Spirit, Opportunity and now Curiosity have gathered substantial evidence that oceans and rivers once flowed across the red planet. The Mars Lander Phoenix even dug down and found frozen water ice just a few inches beneath its scoop.

The Moon, once considered barren and dry, has been shown to have rich deposits of water hidden in the craters at its north and south Polar Regions. Deep in these craters where the Sun never shines, frozen deposits of water await mankind's return.

Estimates from the LCROSS Lunar Orbiter are that the Moon is home to as many as 600 million metric tonnes of water ice. Drinks anyone?

In addition to drinking and nourishing plants, water can be used to make rocket fuel. A lunar colony could mine and melt the "Moon Water" to sustain itself and make fuel for its heating and life support systems as well as the fuel for a trip home.

Scientists think that the water on the Moon arrived via comets over the past 3 billion years. And many think that com-

See "Geysers" on page 18

The Moon (Layer 3 – Terrae)

Kenneth Sunderland

The face of the Moon suggests a figure and ground interpretation from the theory of perception. Any figure in the dark maria cannot be perceived without the bright ground. With all due respect to the venerable Man in the Moon, one is free to see other images, even that of an astronaut feeding a sitting poodle! Of course, the bright areas are the heavily cratered highlands. This is what early telescopic observers imagined as the Moon's dry land—the terrae.

The highlands are composed of a rock called anorthosite (Figure 1). One look at this whitish rock makes it clear why the highlands contrast with the basalt flooded maria. For a specific location, apparent brightness varies with time. Distance from Earth and atmospheric effects are usually cited as reasons. Add the fact that sunlight reflects from the crystalline anorthosite at an ever changing angle as the Moon advances in its orbit. For example, at full Moon sunlight reflects straight back, but at first quarter the reflected light is something like 90° from the incoming sunlight.

Figure 1. Anorthosite (4.4 billion yrs old) returned by Apollo 16. Credit: JPL/NASA

Since the highlands are so old, meteorite bombardment has had time to fracture, shatter, melt and otherwise alter the original anorthosite, producing breccia (Figure 2) from the re-cemented rock fragments. A close look at Figure 2 reveals rock fragments embedded in the matrix compared to the uniform consistency of the anorthosite sample. In terms of reflectivity, it looks like breccia should be comparable to anorthosite.

Figure 2. Breccia (3.9 billion yrs old) returned by Apollo 16. Credit: JPL/NASA.

If maria dominate the surface above the equator, then definitely highlands dominate below it. These Southern Highlands become increasingly rugged toward the South Pole. The highest, easily observable, point (5,484 m) is located here on the NW rim of Curtius crater. (See Reference 2 for details). Whatever the highlands may have looked like in the beginning, by now they have been re-surfaced by impacting meteorites and comets. Craters can be found of every size and shape. Over the eons, impact upon impact has produced a tangled, overlapping mess which gives the Moon its uneven

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topography. Crater rims produce hills and crater floors the depressions. Solar wind and temperature extremes are among space weather factors that have further shaped the landscape.

This highland topography is obviously not analogous to Earth's which results from plate tectonics and weathering processes of a completely different kind. The Moon really should look alien and, of course, it does. Figure 3. shows an example of highlands taken from an orbiting Apollo 16. In the area WNW of Nectaris, the whole undulating landscape is smoothed and softened by space weathering, as seen at the Apollo 16 landing site (Figure 4).

FIGURE 3. Highlands as seen from an orbiting Apollo 16. Credit: NASA.

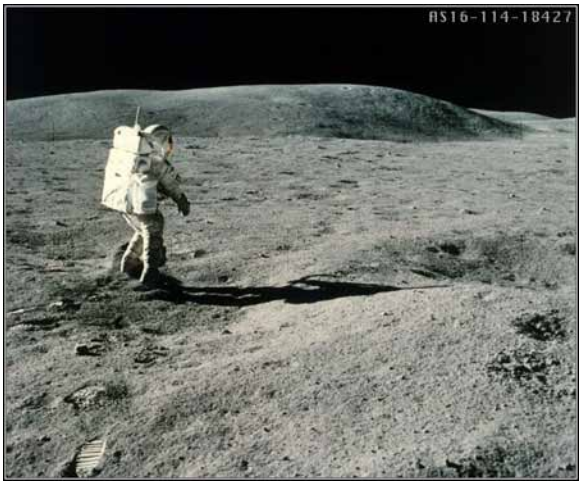

FIGURE 4. Apollo 16 landing site. Credit: NASA.

Even the Apennine Mountains (Figure 5) seen here behind Apollo 15 don't seem to be more than big rounded hills. This is surprising because through the eyepiece the relief in the highlands often looks severe, presenting a kind of chiselled look reminiscent of young mountains on Earth. This bias may arise from the habit of usually observing near the terminator where any relief is exaggerated by shadows. In my case, any prejudice may be the result of a young boy gazing too much at Chesley Bonestell illustrations (Figure 6) in his copy of *The Conquest of Space*. Reality is far removed from the jagged, sharply defined terrain Bonestell imagined in the 1940's. Oh, how I

See "Lunar Highlands" on page 17

FIGURE 5. Apollo 15 at Hadley Valley. Credit: NASA.

FIGURE 6. Chesley Bonestell illustration from *The Conquest of Space*. Credit: Google images.

Observatory in the Andes

FIGURE 1. Overview of Machu Picchu. Photo by Rick Stankiewicz.

RICK STANKIEWICZ

ON NOVEMBER 7TH OF 2012 I found myself in Peru for the very first time, at another item on my "bucket list", the famous "Lost City of the Incas" (Machu Picchu). Not exactly "high in the Andes" mountains, at only 7,970 feet (2,430 m) above sea level, but high enough that you had to take it easy where ever you wandered because even once at this UNESCO World Heritage Site everything seemed to be "up". Stairways lead everywhere and most were opened to the public, but it was not like running the stairs at home, as here you had to really work to get around. I could feel the affects of the elevation change. Luckily our tour group had a day to acclimatize in the regional capital of Cusco (10,860 ft. or

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3,310 m). My lungs and muscles ached if I went too fast. No matter where I was on this large open site there were peaks above me and lots of land falling away from me for thousands of feet. (See Figure 1, which shows an overview of the site from the "Guard House".) It was worth the trip just to stand there in the grandeur of this place and to imagine, just for a moment, how all of the stone blocks you saw arrived there and were put in place. Each block was so well fitted to the next that no mortar was used and yet you can't fit a piece of paper between them.

There are too many points of interest to cover adequately in this article, but one item of astronomical interest was the "Temple of the Sun". This ruin (with no roof structure) was a beautiful example of Inca stone work, including its semi-circular wall. (See Figure 2.) This is thought to have been an Incan observatory. Apparently, on June 22nd (winter solstice in the southern hemisphere), sunlight will shine through a central, trapezoid-shaped window onto a large flat granite stone that may have formed an Inca calendar (See Figure 3, page 16.) and this was also part of their worship of Inti, the Sun. At night looking out the window, astronomers would have also seen the open star cluster we know of as Pleiades, in the constellation of Taurus. This cluster of stars was seen as a symbol of crop fertility. It is theorized that this site was used at least until the

See "Machu Picchu" on page 16

FIGURE 2. Temple of the Sun. Photo by Rick Stankiewicz.

PHOTO GALLERY

Orion Nebulae

Merry Christmas all you astronomy folks. last month I sent a wide field image off to you of the Orion's Belt area. However the moon spoiled a bit of the process. So I am sending the same image off again from being imaged last night but with more detail, longer exposures and more to look at.

This is the 8-bit version for emailing, as the 16-bit is over 100 megabytes. It covers a large area but is fairly high resolution and can be zoomed in to resolve a good bit of detail.

It was taken with a 40 meg chip at 8k by 8k. It can best be viewed on a large hi res LCD monitor

Camera U18 on a pier guided with a 300 mm lens.

Again, Merry Christmas

Brian McGaffney

Horsehead Nebula

B33, The Horsehead Nebula Complex, with 4 hours of H-Alpha data from December 10, 2013.

Been working on this one for a while, actually since last December ... so I just added 4 hours of hydrogen alpha data to my RGB set from December 12, 2012, making it Hα+RGB.

Imaged with a QHY8 CCD + homebuilt 16" f/4.5 Newtonian for 120 min RGB, 24 × 5 minute subs. Used a 7nm Hα filter, 240 minutes Hα, 16 × 15 minute subs. Six hours total exposure.

Just love seeing details in the dust clouds of this Stellar Nursery (star formation region)!

Enjoy!

I hope you all have a great Holiday & New Year!!!

John Chumack www.galacticimages.com

In Memory of PAA Member George Bryant

John Crossen

Many of our current members never had the opportunity to meet George and that's a shame. George was one of those remarkable people who never stopped learning and trying new things. Quiet and gentle though he was, George had a passion for life and an interest in different cultures that took him around the world. Of course, being the Travel Editor for the Toronto Star was a bit of a help on that front.

The walls on George's office were lined with pictures from numerous far-flung parts of the world. Plus he had an amazing collection of memorabilia to rival his well-decorated walls. Needless to say George could entertain for hours with stories of his travels and the people he had met.

George was particularly well known for being the only journalist to join Marilyn Bell on her swim across Lake Ontario in 1954. She was the first person to make the trek and just 16 years old at the time. Wisely, George took his trip along side Marilyn in a small boat. It was quite a journey!

As an act of kindness, George donated his telescope to the PAA at the end of last summer. Due to failing health, he was no longer using it. So the PAA now has its first Go-To computerized telescope. We are currently doing some minor repairs to undue the damage caused by a small flood, and should have it up and running shortly. The accompanying photo shows George, the scope and a friend at one of the star parties at Buckhorn Observatory.

In remembrance of George the scope will have a brass plaque attached to it. Our thanks to George and sympathy to his wife Stella.

Photo by John Crossen

And the Winner Is?

Photo by Rodger Forsythe

Rick Stankiewicz

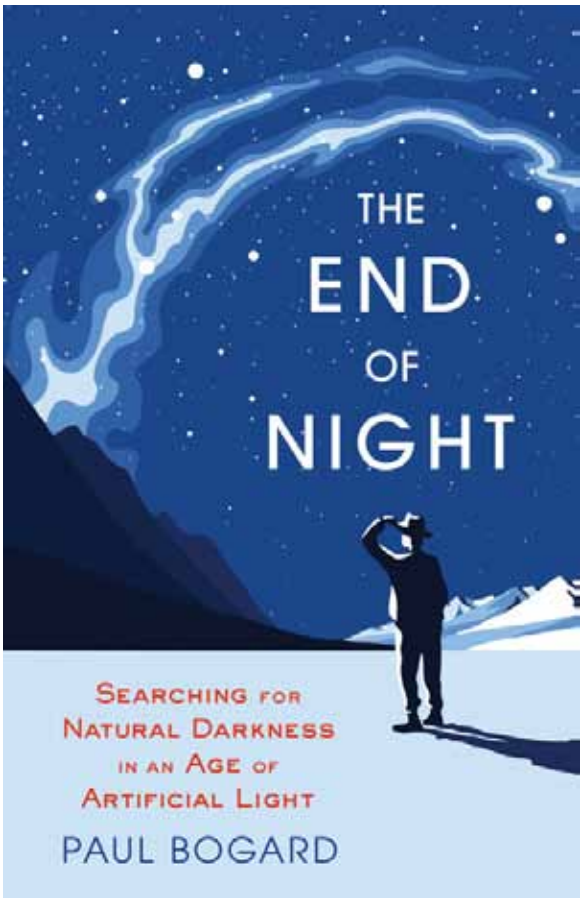
It took four months to find out, but since the decision was made earlier this year to raffle off a copy of the "Sunburst @ 10,000 Feet" image, people have been asking who would win the draw which was to be held at the Annual General Meeting (AGM) on December 6th, 2013. As you can see from the attached photo, the draw winner was none other than our very own Vice-President, Dean Shewring. It was a sought after prize and one that raised more in four months than the usual 50/50 draws could have. However, this would not have happened if it were not for the generous offer and foresight of longtime PAA member, Frances Goschl. She decided that she wanted to do something for the PAA, so she donated the cost of having the image by member and astrophotographer, Rick Stankiewicz, printed on a stretched canvas mount and tickets were subsequently sold at every meeting from September until the AGM, instead of having 50/50 draws at each meeting. This effort raised almost $100 for the PAA to continue its good works.

A "Thank You" to all of you who bought tickets in support of this initiative and a huge debt of gratitude to Frances for her generosity and giving spirit, for without her initiative this would not have happened. So who was the winner? We all were. Thanks again Frances.

BOOK REVIEW

The End of Night: Searching for Natural Darkness in an Age of Artificial Light

Kenneth Sunderland



Paul Bogard

Little, Brown and Company 2013

325 pages; ISBN 978-0316-18290-4, $30, hardcover

The introduction includes words and phrases like; Bortle's scale, NASA photos, Mizar, Galileo, and Milky Way, in addition to the obligatory opening quote, in this case, by Isaac Asimov. All good, and all expected for a pop astronomy book. The introduction also refers to; Van Gogh, barn owl, Wendell Berry (poet), FDR, and Walden Pond. Huh? This is less expected, from what I assume is a science book. A quick look at the dust jacket tells me that "Paul Bogard teaches creative non-fiction at James Madison University."

Ah! The bibliographic record on the verso of the book's title page lists subject headings *1. Light Pollution 2. Night – Psychological aspects 3. Lighting – Physiological aspects 4. Lighting – Social aspects*. This is to be a canvas painted with a great big fat brush. There is not a single equation or graph to be found. So it's not the science book I assumed — that's my problem.

Paralleling the Bortle scale, the book contains nine chapters in reverse order — clever! Chapters 9, 7, 5, 3, 1 contain descriptions of typical skies with the same Bortle number. Chapters 8, 6, 4, 2 do not. An extensive section of chapter notes is included.

The opening chapter takes us to bright places, featuring Las Vegas and Times Square. It contains a brief description of magnitude, a Q&A with Bob Berman (*Astronomy Magazine* columnist), and Van Gogh's *The Starry Night* (1889) is sharply contrasted with Giacomo Balla's Street Light (1909). Chapter 8, Tales from Two Cities, contains lengthy descriptions of London's gas lighting which has survived to the present day and the purposeful engineering that has brought artistic lighting to that "City of Light" — Paris. Among other things, the following chapter discusses the connection (or lack of) between security lighting and crime rates, ubiquitous "wallpacks", glare, the importance of contrast, and our primal fear of the dark. Chapter 6 contains lengthy interviews with night shift workers. The discussion covers the biology of circadian rhythms, sleep deprivation and disease rates. The discovery (2002) of specialized retinal cells that do not participate in vision, but set the circadian rhythm suggests that the health risks may be hard-wired. i.e. night work is biologically beyond adaption.

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The middle chapter finds the author at Walden Pond, at night, to commune with Thoreau, but the sky glow from nearby Boston produces Class 5 skies. The wildness of the 1840's is contrasted with today and especially the lighting difference. Life forms have evolved with the natural light-dark cycle which artificial light disrupts. Astronomical light pollution is differentiated from ecological light pollution. Astronomers are concerned about the former, but perhaps should also be sensitive to the latter, for any artificial light disrupts nature to some degree. For example, the lighting related mortality rates for moths, bats, and birds are outrageous. (A comment on style: the narrative often trips over itself. Still in Chapter 5, consider the following sentence fragment "… having made a long detour through Nauset Marsh, past hollow cracked crab shells and frazzle-feathered bones of long-ago broken birds, around a section of beach closed to protect piping plover and least tern habitat, species Beston would certainly have known — I am nearly alone." Really? What has this to do with light pollution? The extra weight of words often becomes tiresome. To get more quickly to the point, he could have simply written "… having made a detour through the marsh, I am nearly alone.")

Chapter 4, entitled Know Darkness, begins with a description of New Mexico's Chaco Culture National Historical Park and ends considering the psychological elements of death — our ultimate fear of the dark. This reviewer found it a stretch. The subsequent chapter describes some dark sky sites; Isle of Sark, our very own Mont Mégantic Dark Sky Reserve which he reviews enthusiastically, and The Canaries. A visit to Florence, Italy, to see Galileo's telescope rounds out the chapter. The irony is that 400 years ago everyone could see the stars but only Galileo had a telescope and now many people have a telescope but no one can see the stars. Chapter 2 consists mostly of quotes and paraphrase taken from interviews with activists who are trying to make a difference in their countries — an Italian, an Englishman and, of course, Americans. The final chapter poetically describes Bortle Class 1 skies. We are talking here about the Sagittarius-Scorpius region of the Milky Way casting visible shadows! We are told that in such conditions the horizon can disappear and you feel like you're falling into the stars. It is called "celestial vaulting" and now I really, really, really, want to experience it! There are very few accessible places where one might find such conditions in the US mainland. But Mecca is found, and it is Nevada's Great Basin National Park.

The outline above illustrates that the book ranges far and wide. It is structured around the author's parallel journeys to find the darkest skies. The physical journey takes him to England, France, Spain, Italy, The Canaries, and all over North America. He learns much from the many people he meets along the way, and quotes them liberally. However, it's the inner spiritual journey that is the soul of the book, even if it is difficult to participate in the subjective feelings of another. He considers the dark sky issue from many points of view ensuring that a readership with wide interests and sensibilities will have something to think about. For me, this was both its weakness and its strength. *The End of Night* is an emotional appeal, written by a creative writer, to preserve the planet's remaining Class 1 skies. Passionate writing like this can only help the cause.

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Anniversaries

golden age of the Inca's in the mid-15th century.

You can find astronomical sites in some of the strangest places and some very enchanting ones too, just keep looking up or down, depending where in the world you find yourself.

FIGURE 3. Interior of the Temple of the Sun. Photo by Rick Stankiewicz.

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Comets

people were lucky to see it in the sky at the same time as ISON. I however missed this one, but it was not a visually obvious pairing.

The final show of the year was that put on by Comet Lovejoy (C/2013 R1) and even though I liked Pan-STARRS the best in 2013, Lovejoy was a nice binocular view. It too was barely naked-eye and getting up early in the wee hours of a cold December morning was not most people's idea of a good time, it was worth the effort, I thought (see image on front page from December 12).

Lessons about comets that were once again driven home, "Comets are like cats, they do what they want", or "The only thing predictable about comets is their unpredictability", remain true and proved out again in 2013.

Comet PanSTARRS, March 16. Photo by Rick Stankciewicz.

see "Comet ISON" on page 20

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Lunar Highlands

wish I still had that, now collectible, book by Willy Ley!

The Moon's surface, overall, is dominated by highlands. How is elevation determined? On Earth, sea level provides a natural zero. With no water to fill the maria basins, the Moon's zero is defined to be its average radius of 1737.4 km. The highlands are definitely high compared to maria basins but often not so high compared to the Moon's zero. To illustrate, consider the elevation transect (Figure 7) from the Apollo 15 landing site across the highlands to Mare Serenitatis. Apart from a bump at the start, most of these highlands are, by definition, at a grand elevation of… zero!

Endnote: Figure 7 was generated using data from NASA's Lunar Reconnaissance Orbiter (LRO) which is a robotic spacecraft currently in a 50 km orbit above the Moon. Among its instruments are a precision altimeter and camera. The resolution is amazing. The data is accessible through an interactive QuickMap at `http://target.lroc.asu.edu/q3/`. In fairness, I must issue a Health Warning: This map can lead to addiction!

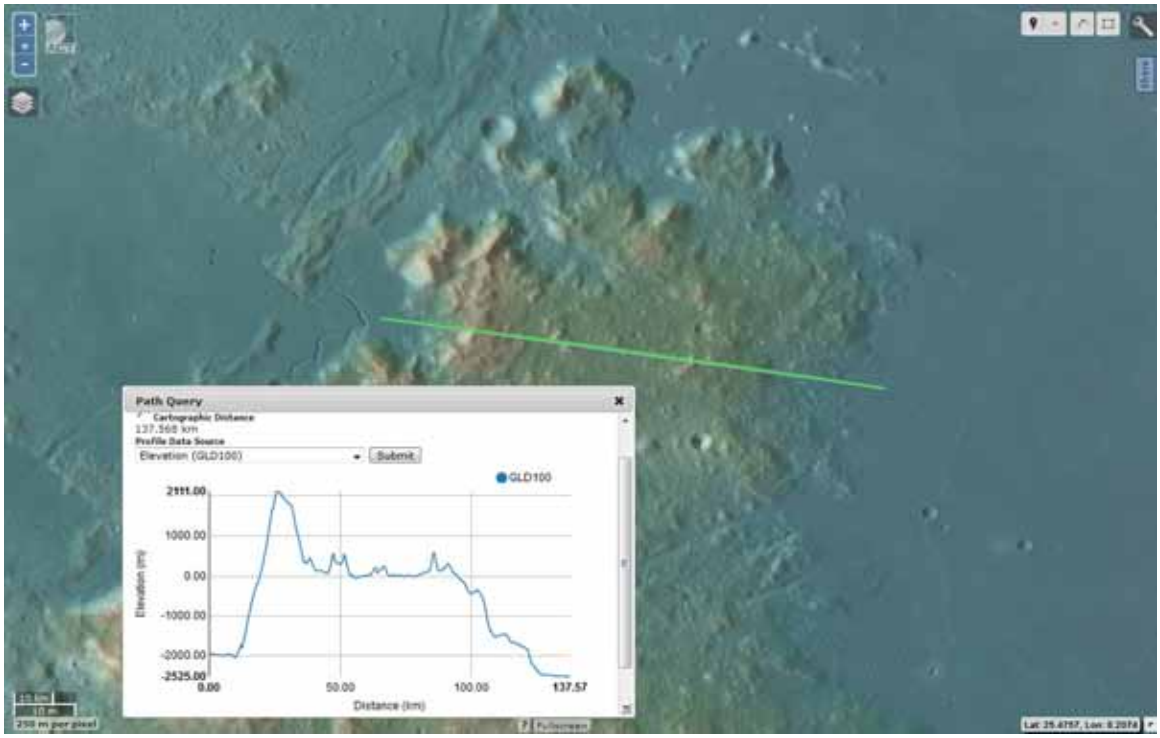

FIGURE 7. Elevation transect across lunar highlands. Credit: generated using ACT-REACT-QuickMap.

Further Reading & References

1. Seronik, G., (2013, Jan/Feb), **Mountains of the Moon**, *SkyNews*, 34-35 (relevant to understanding the highlands)

2. Seronik, G., (2013, Sept/Oct), **Highs and Lows on the Moon**, *SkyNews*, 36-37 (relevant to observing features in the highlands)

3. Seronik, G., (2013, Nov/Dec), **Finding Your Way on the Moon**, *SkyNews*, 20-21 (his list of favourite resources including QuickMap with LRO data)

4. Wood, C., (2012, August), **A Tool for Lunar Observers**, *Sky & Telescope*, 54-55 (an introduction to QuickMap with LRO data)

5. To learn more about the AC-REACT-QuickMap technology go to their website at `http://www.actgate.com/home/quickmap.htm`

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Geysers

ets are also one of the sources of water here on Earth. After all, a comet is often described as nothing more than a big dirty snowball.

The planet closest to the Sun, Mercury with an average surface temperature of nearly 400 degrees Celsius is also known to be harbouring water thanks to the latest news from the Messenger orbiter. It does so in the same way that our Moon hides its frozen treasure—in deep craters at its top and bottom. Again the Sun's rays never strike these regions. Plus Mercury has no atmosphere to transfer the heat to these regions. So despite its high temperature the ice never melts.

Saturn's moon Enceladus has been imaged shooting geysers of water hundreds of kilometres into space. That's right, several geysers like "Old Faithful" on a moon orbiting a planet that's 1.2 billion kilometres from Earth. Until the Cassini Mission started exploring Saturn 7 years ago this wasn't considered possible if it was considered at all.

Now the latest Hubble images show what appear to be geysers shooting out from the surface of Jupiter's Moon Europa. Suspected to have an ocean beneath its icy surface, since the Galileo Mission which ended in 2003, it now appears that some of that water vapour is venting, possibly due to tidal heating caused by Jupiter's immense gravity.

The Sky this Month

Mercury is just past superior conjunction at New Year. Becomes an evening twilight apparation by mid-month. Reaches greatest elongation E (18°) on the 31st.

Venus appears low in the SW evening twilight but disappears into the Sun's glow within the first week of the year. At inferior conjunction on the 11th. Reaappears in the eastern dawn sky by the 18th.

Mars in the morning sky in Virgo and rises around midnight. At aphelion on the 3rd and passes 5° N of Spica on the 28th.

Jupiter is at opposition on the 5th in Gemini. Rises at sunset and remains visible the whole night.

Saturn in Libra in dawn sky. Occulted by the Moon on the 25th.

Quadrantid Meteors peak 3 p.m. on the 3rd.

Moon Phases

New Moon	6:14 AM	January 1
First Quarter	10:39 PM	January 7
Full Moon	11:52 PM	January 15
Last Quarter	12:19 AM	January 24

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The Hunter

claiming that no animal could kill him. The goddess Hera put an end to that when she placed a scorpion at his feet. Although he clubbed the scorpion to death, it had already bitten him and thus mighty Orion fell to a small insect.

The bodies of both were placed in the sky. The scorpion took up residence in the summer sky while Orion got the winter sky. Thus the two shall never meet again.

The next time we enjoy the winter luxury of a clear night bundle up, venture out and have a look at Orion. Chances are he's not as bad as mythology makes him out to be.

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Icarus

Planet observers have mighty Jupiter to capture their rapture in the evening sky. The huge gas giant planet is 1,000 times larger than Earth. A set of 10 × 50 binoculars will reveal four moons orbiting Jupiter—just as Galileo saw in his primitive telescope over 400 years ago. Those with access to a telescope can also observe the weather zones that wrap around Jupiter like metal bands around an old wooden barrel.

Mars rises in the east just after midnight, but it isn't very large or much of a sight—even in a telescope. Still it shines with a bright red glow so at least you can say you saw it if asked. Later in the year it will rise earlier and be a bit closer to Earth.

Uranus, Mercury and Neptune are low in the southwest as darkness falls. Venus will be swinging across the Sun and switching from "the evening star" to "the morning star" this month.

So bundle up, then get out and look up this January. The winter sky is filled with dazzling stars and star clusters.

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Comet ISON

Comet ISON, November 20. Photo by Rick Stankciewicz.

Was 2013 really the Year of the Comet? I would say, a qualified, "Yes". The quantity helped make up for the lack of quality.

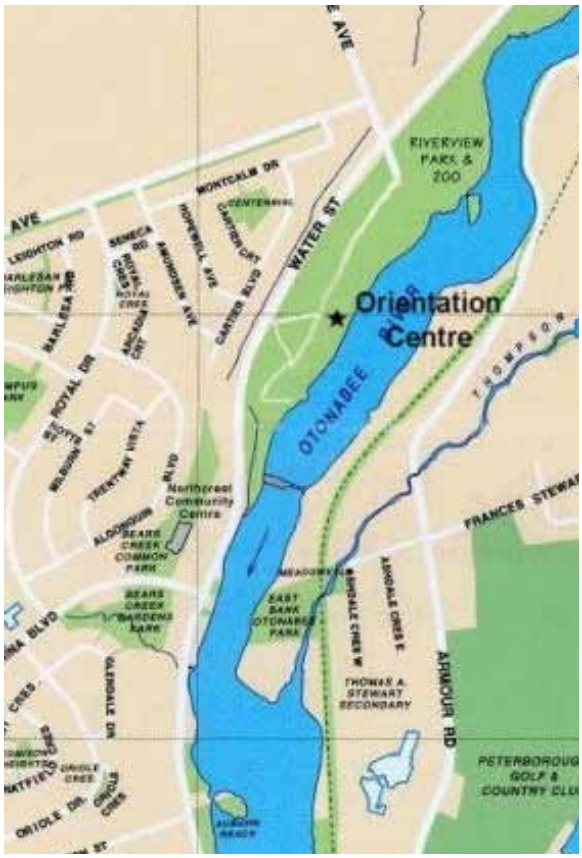
Your Comet-tator,
Rick Stankiewicz

Articles

Submissions for *The Reflector* must be received by the date listed below. E-mail submissions are preferred (Microsoft Word, OpenDoc, ASCII and most common graphic formats are acceptable). If your article contains photso or graphics, please provide a separate file for each. Typed or hand-written submissions are acceptable provided they are legible (and not too long.) Copyrighted materials will not be published without written permission from the copyright holder. Submissions may be edited for grammar, brevity, or clarity. Submissions will be published at the editor's sole discretion. Depending on the volume of submissions, some articles may be published at a later date. Please submit any articles, thoughts, or ideas to:

phillip.chee@gmail.com

Next submission deadline:
January 27, 2014



Meetings

The Peterborough Astronomical Association meets every first Friday of most months at the **Peterborough Zoo Orientation Centre** (Next to the PUC Water Treatment Plant) at 8 p.m. P.A.A. executive business will be conducted starting at 7:30 p.m. Members and the public are welcome to attend the earlier time.