

Volume 14 • Issue 3
March 2015
ISSN 1712-4425
peterboroughastronomy.com
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The Reflector

Newsletter of the Peterborough Astronomical Association

The heavyweight champion of the Cosmos



IMAGE CREDIT: NASA, ESA, J. Jee (UC Davis), J. Hughes (Rutgers U.), F. Menanteau (Rutgers U. and UIUC), C. Sifon (Leiden Observatory), R. Mandelbaum (Carnegie Mellon U.), L. Barrientos (Universidad Catolica de Chile), and K. Ng (UC Davis). X-rays are shown in pink from Chandra; the overall matter density is shown in blue, from lensing derived from the Hubble space telescope. 10 billion light-years distant, El Gordo is the most massive galaxy cluster ever found.

DR. ETHAN SEIGEL

AS CRAZY AS IT ONCE seemed, we once assumed that the Earth was the largest thing in all the universe. Two thousand and five hundred years ago, the Greek philosopher Anaxagoras was ridiculed for suggesting that the Sun might be even larger than the Peloponnesus peninsula, about 16% of modern-day Greece. Today, we know that planets are dwarfed

by stars, which themselves are bound together by the billions or even trillions into galaxies.

But gravitationally bound structures extend far beyond galaxies, which themselves can bind together into massive clusters across the cosmos. While dark energy may be driving most galaxy clusters apart from one another, preventing our local group from falling into the

Virgo Cluster, for example, on occasion, huge galaxy clusters can merge, forming the largest gravitationally bound structures in the universe.

Take the “El Gordo” galaxy cluster, catalogued as ACT-CL J0102-4915. It’s the largest known galaxy cluster in the distant universe. A galaxy like the Milky Way might

see “El-Gordo” on page 16

President's Message

Our First Public Outreach for 2015

Before addressing the topic of our first public outreach event I wish to welcome all members, guests and sponsors to our new “digs.” The PAA has been meeting in the Orientation Centre for many years and now has the opportunity to assemble in a new venue. The Orientation Centre has served us well and we will miss it. Maybe not. The new facility is known as the “Guest Services and Rotary Education Centre Building” and one thing for sure it will be a lot easier to find the entrance in the dark.

Every year when March rolls around, we are presented with our first scheduled public outreach event and this year is no different. We will meet on March 28th to celebrate Earth Hour, an annual event. The PAA

has its permit and we “own the hill” from 6:30 p.m. until midnight. Let’s hope for clear skies, something that has been quite rare so far this year. Please join us “on the hill.” If you have a telescope bring it along if not take a look through the equipment of other members.

I’m planning to do a short 5-10 minute item called Gadget Corner. There may be a better title let’s see how it pans out. I will present at the March meeting a brief handy tip. I would hope to have a member offer something at each meeting starting in April. There must be countless little gems of useful information that could be shared.

Once again a reminder that it is membership renewal time. The deadline is April 1st.

Rodger Forsyth
PAA President

Letter from the Editor

Fairweather Astronomer

I’ll be the first to admit that I’m a fair-weather astronomer. I understand there were some beautiful sights this month (see Rick Stankiewicz’s Gallery Photo). Alas, I felt more compelled to stay warm indoors and catch up on my TV shows watching stars of a different nature.

John Crossen is no dwarf, but he writes about our solar system’s dwarf planetoids and in another article, the non-dwarf planet, Jupiter. He also has part 2 of his Rosetta Mission series.

Rick Stankiewicz has an interesting article on Ceres and Asteroid Day as well as a report on Peterborough’s recent by-law update on outdoor electronic signage.

Ken Sunderland makes us jealous with his travelogue from Grenada. He does make the story astronomical with a report of the unusual “Green Flash” phenomenon.

Perhaps by the end of the month I’ll be more inclined to take in the celestial sky. One event that should get us all out is Earth Hour on Armour Hill. We continue our tradition of hosting a public viewing to mark Earth Hour around the world.

Phillip Chee
Editor, The Reflector



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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The Rosetta Mission — Part 2

The Rosetta Mission's Winding Path to Success



ROSETTA IN SPACE. Rosetta's new solar panel material let it go deeper into space than any other 100%-solar-powered vehicle before. Image supplied by ESA.

JOHN CROSSEN

AFTER 20 YEARS OF pre-planning, numerous budget revisions and redesigns, plus delays because of rocket failures, the Rosetta Mission finally stood on its launch pad in Kourou, French Guiana. The date was March 2, 2004 and atop the Ariane 5 rocket was a 1.4-billion-Euro payload of sophisticated electronic equipment—the combined work of nearly 2 thousand people world-wide. The launch went perfectly. As the Ariane 5 punched through the early morning clouds, Rosetta began a journey that would take 10 years. It would also achieve many “firsts” as the kilometres slipped silently by in the cold blackness of space.

To gain speed, Rosetta made three trips around Earth and one past Mars. Rosetta used the gravitational pull of the two planets to slingshot it faster and faster like the

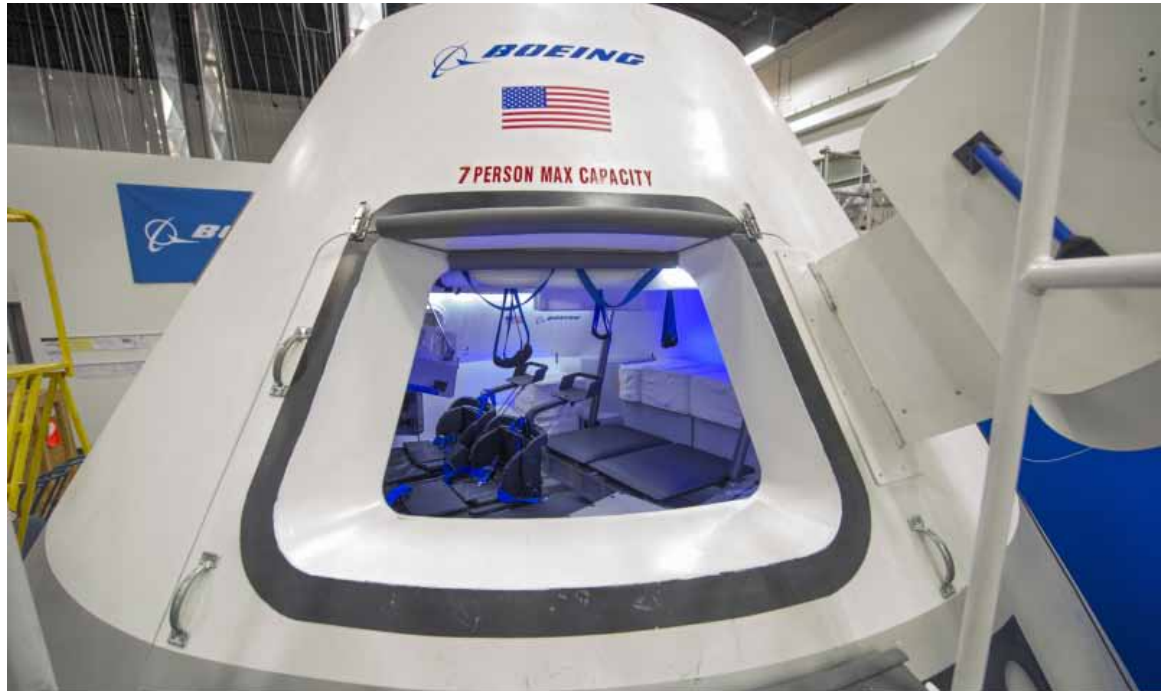
skater at the end of the line in a game of crack the whip. Ultimately Rosetta would reach a speed in excess of 55,000 km/h.

During its flyby of Mars Rosetta had to be powered down as it would be in the shadow of the planet for 15 minutes and its batteries wouldn't last. The procedure was called the Billion Euro gamble. Happily the manoeuvre was successful. Rosetta even took some snapshots of Mars as it sped past the Red Planet at an altitude of just 250 km.

To put the cost of the mission into perspective, 1.4 billion Euros would be just enough money to purchase 4.2 A380 Airbus-es. For the European community who paid the cost, it works out to about 3.80 Euro per person—half the cost of a ticket to see the movie *Interstellar*. But let's get back to the real space travel stuff.

See “Rosetta” on page 15

Racing to Get Astronauts to the ISS and Water From a Rock



CST. Both the CST-100 and SpaceX capsules have room for seven crew members along with a large amount of cargo. The capsules are designed to return to Earth with splashdowns in an ocean. Kind of reminds you of the old-time Apollo landings. Image credit: NASA/Robert Markowicz

JOHN CROSSEN

WITH ALL THE EXCITEMENT about the recent encounter with Comet 67P and the New Horizons spacecraft nearing Pluto, the New Dawn mission to Dwarf Planet Ceres has been sadly overlooked.

First, here's a little background. Ceres is a dwarf planet that lives in the asteroid belt between Mars and Jupiter. That makes it the closest dwarf planet to Earth—if you consider 419 million kilometres to be close. The rest of the dwarf planets are out near Pluto's neighbourhood and beyond. Ceres takes 1,680 Earth days to orbit the Sun and is about 950 kilometres in diameter. Small though that may seem, Dwarf Planet Ceres accounts for about one third of the total mass of the asteroid belt.

In January the New Dawn spacecraft's cameras took the crispest images ever of Ceres. The sharp detail gave astronomers their best view ever of Ceres. If you'd like to

view the images and an animation of Ceres, visit Ceres Images on Google. So what's the reason for all the interest in Ceres? Water.

Scientists have determined that the surface of Ceres consists of a 100-kilometre-thick covering of water ice. Melt it down and you'd have more water than there is on Earth. One of New Dawn's many studies will be to determine if this is correct.

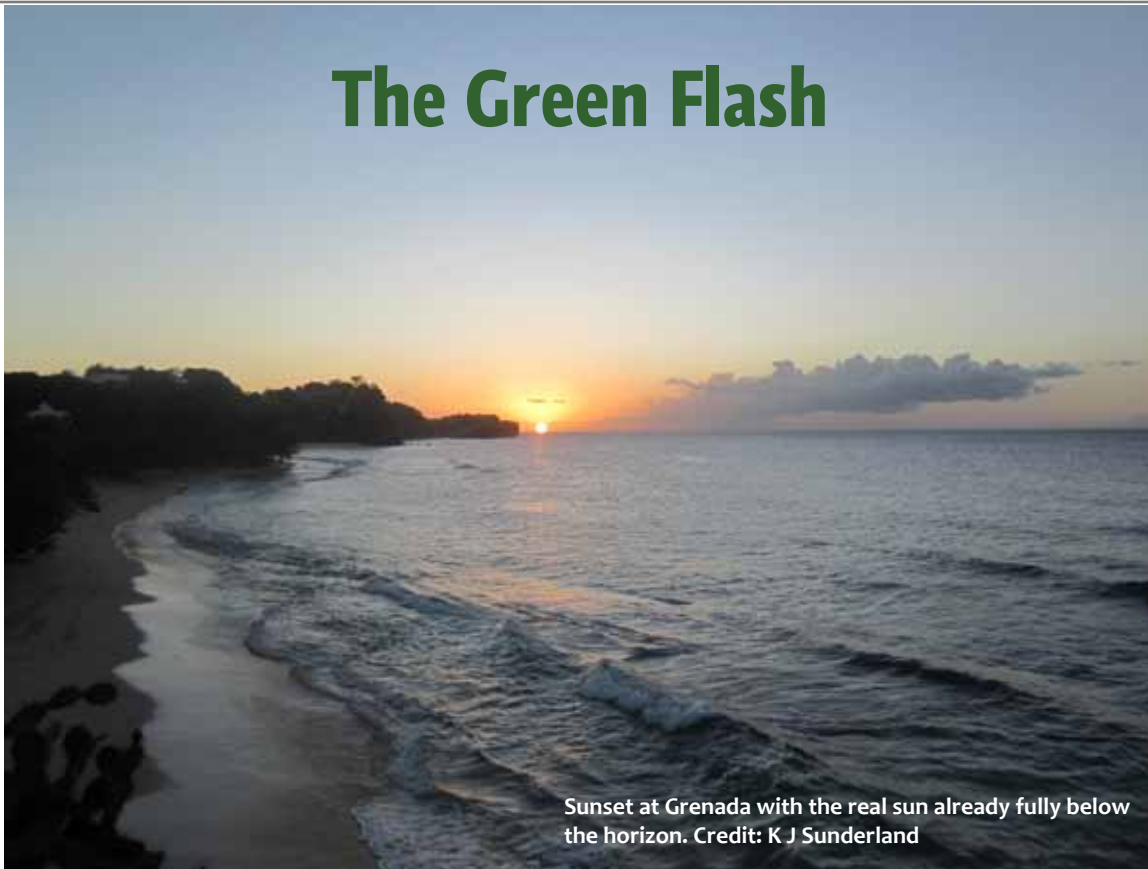
Next up on the astro-agenda is the new space race at NASA.

If you haven't heard the term "space race" since the Apollo Missions won the race to the Moon, get ready to hear it all over again. But instead of Russia and the United States racing to the Moon, this time it's all about two American companies racing to win the contract to ferry astronauts to the International Space Station (ISS).

The contestants are good old Boeing and a relatively new kid on the launch pad,

See "Commercial Crew" on page 15

The Green Flash



Sunset at Grenada with the real sun already fully below the horizon. Credit: K J Sunderland

KENNETH SUNDERLAND

HAVE A DRINK,” SAID HARRY looking out across the gray swell of the Gulf Stream where the round red sun was just touching the water. “Watch that. When she goes all the way under it’ll turn bright green.” —from *To Have and Have Not* by Ernest Hemingway.

The quote above is made by rum-runner Harry Morgan making the night passage from Key West to Havana. Hemingway implies by the tone in this off-hand dialogue that the green flash is ordinary, contradicting its near mythical status. After all, exacting conditions, such as, an unobstructed view to sea level, calm waters, and a transparent atmosphere, are deemed necessary to view this emerald green sensation lasting the time of a wink. Also important for its duration and naked-eye visibility, atmospheric conditions must permit for a mirage effect. It would seem an unlikely shopping list to fulfill, and yet...

The final days of January found me at the pleasing coordinates (12° 00’ N, 61° 47’ W) at the southern tip of “The Spice Island” with

unobstructed western views right down to sea level. Each day, the faithful gathered for a sunset “service” on a raised belvedere, some 10 m above the Caribbean. The photo shows the situation.

Let’s get right to it. I was both delighted, and surprised, to see three green flashes in four consecutive sunsets. After the first green flash, fellow worshippers became curious about my activity and started to see the phenomenon for themselves. Multiple witnesses provide a measure of confidence that an observed phenomenon is real, and not some physiological effect linked to the visual system of a single individual. The power of suggestion is very real, so when a curious fellow asked what I was looking for, I resisted telling and simply said, “keep watching.” Immediately following the critical moment he offered “Hey, I just saw green.” to which I replied, “No kidding.” I thought the first PAA missionary work in Grenada was going well. I was beginning to take a certain pride in my new converts. My

See “Green Flash” on page 13

Ceres One Big Asteroid

RICK STANKIEWICZ

DID YOU KNOW THAT the “asteroid belt”, the region of space between Mars and Jupiter, is filled with millions of pieces of rock from the size of a pea, up to the largest asteroid, called Ceres? (like TV “series” or World “Series”) First discovered in 1801, by an Italian Roman Catholic priest, Giuseppe Piazzi, Ceres was initially thought to be another planet in our solar system until the 1850’s. At that time, it was determined to be a new class of objects called asteroids (“star-like”) in the region between Mars and Jupiter, since then referred to as the “main asteroid belt”. Named after the Roman goddess of agriculture, Ceres currently ranks as the 33rd largest known object in our solar system. With a diameter of 950 km (520 mi) it is by far the largest asteroid in the main asteroid belt. It is dwarfed, however, by the larger moons of a majority of the major planets, including Earth’s moon, the 14th largest object, with a diameter of 3,476 km. For scale, Ceres is about the size of Texas.

There is currently a NASA mission being carried out with partners from Germany, Netherlands and Italy, to study some of the larger asteroids. Launched on September 27, 2007, the Dawn spacecraft has taken over seven years to reach Ceres. The spacecraft is currently over 508 million km from Earth and travelling more than 39 km/sec (almost 89,000 mph). While on route to Ceres, Dawn went into orbit around another large asteroid called, Vesta, on July 16, 2011. Vesta, is the third largest asteroid, about the size of Arizona. This allowed the mission to cut its teeth on collecting data from a smaller body in the main asteroid belt before moving on to its main target. It left Vesta for Ceres on September 5, 2012.

Since its discovery over 200 years ago, people have wondered what Ceres is made



of, and what it really looks like. Until recently, the Hubble Space Telescope had the best image of this far off world. It was not a very clear image but there was no disputing it’s unusually round shape. From what we know of asteroids, round or spherical shapes are not the norm. Due to their small sizes and weak gravity, they tend to be quite irregular in shape, not unlike giant tumbling potatoes. We are going to learn a whole lot more about Ceres in the weeks to come. On March 6th, 2015, the Dawn spacecraft is scheduled to rendezvous with Ceres and spend the next year conducting experiments and studying it in unprecedented detail. It is expected that the spacecraft will eventually become a satellite of Ceres as it should settle into a stable orbit over time. What will we learn from the Dawn Mission? We already have some of the clearest images to date, showing there are a number of large craters and “white spots” that could be ice formations of some kind. As of the end of February, there is still approximately 44,000+ km to go until the spacecraft arrives at its destination, but every day the gap narrows. Stay tuned in the days to come, as reports from this alien world arrive.

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Why should we care about a big hunk of cold rock, out in space and millions of kilometers from us? The more we know and understand about these “rocks”, the safer we will be. They are our celestial neighbours and in the universal scheme of things, they can end-up in our neighbourhood, sometimes in our backyard. Remember the “little” asteroid that blew up and crashed near Chelyabinsk, Russia, on February 15th two years ago? That was a small, probably 20 m sized, piece of space rock we never saw coming and it sent almost 1,500 people to the hospital with minor injuries and caused millions of dollars in property damage.

You might also recall recent hype around the 1 km wide, Asteroid-2004 BL86, that zipped by Earth at a distance of 1.2 million km on January 26th this year. Unfortunately, we did not have a chance to see it as the weather did not cooperate. NASA, however, used radio dishes to “ping” signals off it to determine its size and shape and also discovered a 70 m diameter companion moon orbiting it. It is not uncommon for asteroids to have companion moons. We currently know of at least 150 asteroids with single and multiple moons. Most asteroids are quite small and even though there are estimated to be millions of these rocky fragments within the main asteroid belt, if you could collect them all up they would not have the same collective volume as our Moon.

Asteroids are the leftover building blocks of our solar system and come in a variety of compositions, from stony, to metallic, to a combination of both. Their composition is a good indicator of where they may have formed and how the Earth may have come to be “seeded” with some of the components for life billions of years ago. The Earth is still bombarded with millions of tons of space material every day. Most of it burns up in the atmosphere as “meteors”, but it is a good thing Earth is comprised of so much water and wide open spaces because some of these meteors do land on Earth as

“meteorites”, usually unnoticed and without doing much damage.

For almost 15 years now, there has been a concerted effort by a number of countries, in a project called the Near Earth Object Program, to find and track 90% of the asteroids and comets over 1 km in size that have wandered outside the main asteroid belt and have a chance of intersecting close to Earth’s orbit. These objects are referred to as Near Earth Objects (NEO’s). Assuming these could really do some earthly damage, there is some wisdom in looking for NEO’s until we have 100% of these objects accounted for. It is estimated that there are at least a million asteroids worth watching at more than a few metres in size and we currently have our eye on only about 1% of them.

We know from studying impact craters around the world that Earth gets impacted every once and a while by large asteroids or comets. We may experience a Chelyabinsk event every few thousand years, but every 20 million years or so, we are hit by Earth-altering objects, like the up to roughly 5 km sized rocks that produced the Manicouagan Crater in northern Quebec, the greater Sudbury Basin or the Brent Crater on the eastern edge of Algonquin Park. Talk about close to home. It is currently an accepted theory that the mass extinction of the dinosaurs 65 million years ago was at least partially the result of just such a life altering event in the Earth’s past.

There is an event on June 30th this year called, Asteroid Day. It is the first of its kind and set to coincide with the anniversary of the Tunguska Event of 1908, which occurred over Siberia. This was when a large object (likely an asteroid) exploded before hitting the ground, with the force of 10-15 megatons of TNT and flattened a forested region of over 2,000 km². Fortunately it occurred in an uninhabited area in Siberia. The purpose of Asteroid Day is to raise some public awareness about asteroids and their threat to Earth as well as what can be done about

See “Asteroid Day” on page 15

Planetary Pairing and the Moon



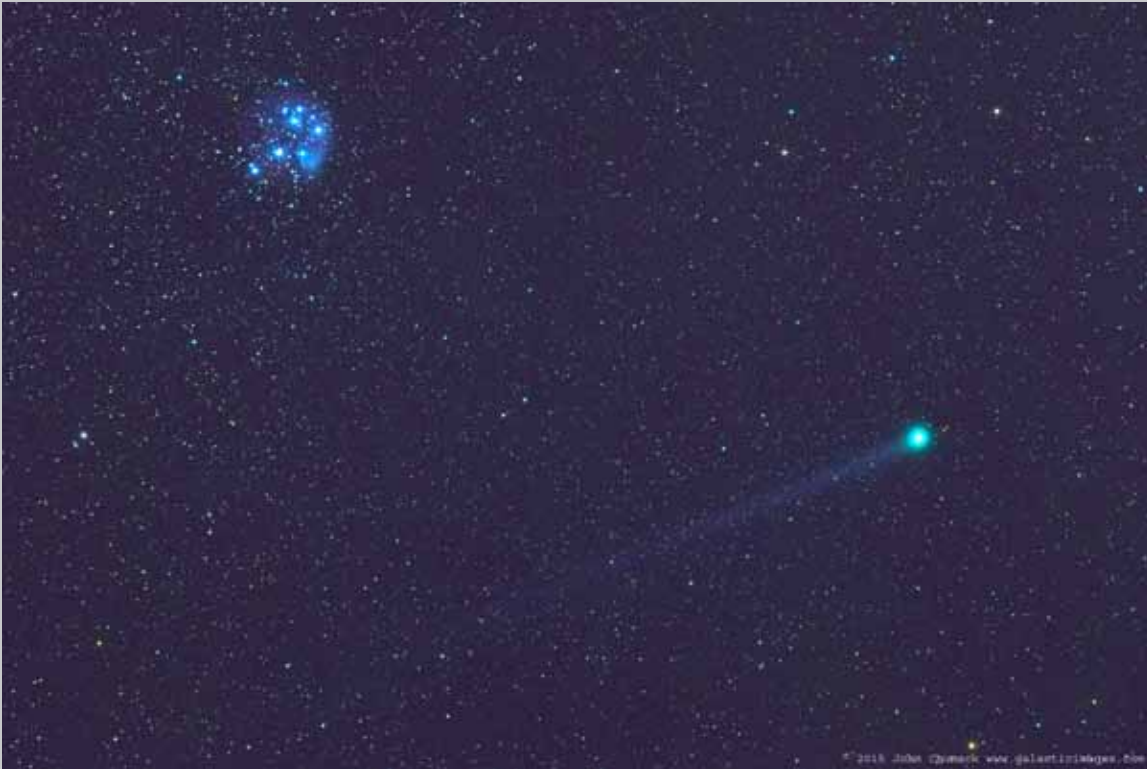
If you missed the beautiful gathering of the planets Venus and Mars with a slender crescent Moon on the evening of February 20th, then you missed one of the best conjunctions with a clear sky in recent memory. By checking out the western sky within an hour after sunset you were treated to a nice close conjunction of these two terrestrial planets. They were less than a degree apart, which is less than the width of two Full Moons. Venus was shining bright white and 100 times brighter than dimmer reddish Mars. The Moon was sitting beside them in the twilight sky. The aspect that really set this grouping off was the “earthshine” that is so obvious with a waxing crescent moon. The reflection of sunlight from the Earth to the Moon is what helps light up the normally dark side of the Moon during this lunar phase and it is always more obvious when an image is slightly over-exposed. This was one of the nicest grouping I have seen in years and except for it being -24C with the wind-chill, it was a perfectly clear evening. You just never know when you will get opportunities like this, so, “strike while the iron is hot,” or “look while the clouds are not.”

These images tripod mounted Canon 400D and Sigma lens 18-70mm; ISO 800; $f/4.5$; 5 second exposure.

Always looking up,
Rick Stankiewicz



Pleiades and Comet Lovejoy



The Bright Comet Lovejoy C/2104 Q2 was cruising past the open star cluster M45 “Pleiades” a.k.a. “The Seven Sisters” Star Cluster!

What a wonderful view last night, the comet was amazingly bright in Binoculars!

I watched and captured it on 01-15-2015 around 8:00 pm from my observatories at JBSPO in Yellow Springs, Ohio.

I captured this image with my Canon 6D DSLR and 105 mm lens, $f/5.0$, ISO 800, on a CG-4 Tracking Mount, 14×180 seconds exposures stacked in DSS, 42 minutes total.

Best Regards,
John Chumack

www.galacticimages.com

Amazing Space



Dwarf Planet Haumea is football shaped because it spins so rapidly. Talk about going deep for a pass. Artist unknown.

JOHN CROSSEN

WHEN IT COMES TO WILD and weird things it's tough to beat outer space for out and out bizarreness. Wrap your gray matter around this one.

Astronomers in the Netherlands and the United States have discovered the first exoplanet (a planet orbiting a star beyond our solar system) with rings around it. It sounds just like Saturn doesn't it? Well, sort of. The ring system is 200 times as wide as those around Saturn.

To establish a base line, Saturn's rings measure 1,200,000 kilometres from edge to edge. Multiply that by 200 times and you've got a ring system so large that it would stretch from Earth to Jupiter and well beyond. The rings are so wide that they actually blocked the view of a background star. If you're ever in the neighbourhood, the exoplanet's name is J1407b. Let's jump from exoplanets to celestial bodies that are light years closer to home, dwarf planets.

Pluto was the first to be decommissioned as a full-fledged planet and reinstated as a dwarf planet. A dwarf planet isn't quite

large enough to be classified as a planet, but isn't small enough to fall into a smaller category such as a moon or asteroid. Earth's Moon is larger than Pluto. Happily Pluto took it well and was proud to step forward as the first dwarf planet to bear the title.

Most of the dwarf planets reside on the outskirts of our solar system in a little-known region called the Kuiper Belt. This area will be studied by the New Horizons mission after it does its flyby of Pluto.

The weirdest of the dwarf planets yet discovered goes by the name of Haumea (how-mee-a). For starters the little guy has a day that is only 3.9 Earth hours long. Ah the joy of life on Haumea, you'd just get to work and it would be time to close. The reason for this is the fact that it's a fast spinner. That fast spin is also the reason Haumea is shaped like a football—longer rather than round. Sorry Haumea, the Super Bowl is over.

NASA's Kepler spacecraft has created enough exoplanet candidate data that astronomers are still wading through it. Most

See "Kepler 444" on page 12

If You Like to “Biggie your Fries” You’ll Eat up Jupiter

JOHN CROSSEN

JUPITER IS THE GIGANTIC centrepiece on a table we call the March night sky. Nobody’s going to argue with Jupiter, it’s big enough to swallow all the other planets and their moons.

Earth is just a pipsqueak compared to Jupiter. The immense planet could gobble Earth up 1,300 times over. But most of Jupiter’s size is a bloated façade, because Jupiter is mostly gas. Somewhere thousands and thousands of kilometres beneath that huge ball of hydrogen, nitrogen, ammonia and methane is a rocky core that some astronomers think is no larger than planet Earth.

With all that cloud cover it’s like the whole planet is an unbelievably deep weather system. And there are storms brewing all over the place. Let’s start with the famous Great Red Spot visible on Jupiter’s uppermost cloud layer.

The GRS, as it’s often referred to, is large enough to squeeze Earth into it twice over with room to spare. But size isn’t its only notable feature. The winds it generates are whipping around at 360 km/h. Astronomers have been watching it for the past 300 years so nobody knows how old the GRS really is. Let’s just call it the oldest known storm in our solar system.

But the Great Red Spot isn’t the only thing spinning rapidly. Jupiter itself whirls like a break dancer on steroids. A day on the giant planet is just under 10 Earth hours long. The combination of Jupiter’s rapid rotation and the fact that it is mostly gas causes Jupiter to be oblate. That’s right it’s wider than it is tall, sort of like me.

Yet another feature you’ll notice is that Jupiter wears stripes. They’re called weather bands and they alternate between dark bands and light zones. They’re caused by different gasses whipped up from inside



JUPITER. Planet Jupiter shows its stripes in this image taken by Peterborough Astronomical Association member Brian Colville. The Great Red Spot is below centre to the right.

Brian is a talented solar system imager who works out of Maple Ridge Observatory in Cambray, Ontario. His work has been published across North America and internationally. Brian also has a chapter in Patrick Moore’s book *The Art and Science of CCD Astronomy*.

the planet. And “whipped up” is the correct term. The winds on Jupiter have been clocked at over 600 km/h. Not only do they rotate fast, they also rotate in alternating directions which is why you can see little festoons on the edges where they rub together.

Jupiter’s huge mass is one of the reasons astronomers often refer to the planet as Earth’s protective big brother. When Comet Shoemaker/Levy-9 rounded the Sun in 1994 it broke into numerous large chunks. Any one of them would have been an extinction event if it had slammed into Earth. But Jupiter’s gravity pulled them in and they harmlessly punched holes in Jupiter’s upper layer of clouds. I watched it through my telescope from downtown Toronto.

Weighing in on Jupiter would be good for business if you owned a Jenny Craig franchise. A dainty 100 pound ballet dancer would tip the scales at 250 pounds on Jupiter. Maybe a career as a linebacker would be a better choice for our prima ballerina.

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Kepler 444

recently they have uncovered an ancient star that has five Earth-sized exoplanets orbiting it. Given that the universe is 13.7 billion years old and the host star (Kepler 444) is nearly 11 billion years old, the exoplanets may be the oldest ever discovered.

Current theory holds that the solar system we live in began to take shape about 4.5 billion years ago. That means that exoplanets were forming in distant galaxies about 7 billion years earlier.

Kepler 444 can be seen in binoculars. It lives 117 light years away in the constellation Cygnus the Swan, also known as the Northern Cross. But don't get too excited you'll need some very hefty artillery to see the exoplanets. All of which orbit closer to their sun than Mercury does to ours. So they're hot ... hot ... hot!



Peterborough Local 590



KW Telescope
PERCEPTOR



Electronic Sign By-law

February 23, 2015, saw the final Peterborough City Council approval of a new sign By-Law #15-045 that is the result of over a one-and-a-half year review undertaken by the City Planning Committee, headed by City Planner, Brian Buchardt. *The Peterborough This Week* reported in their February 13th edition, that the Planning Committee had approved the amendments to the existing sign by-law. Some of the issues addressed include not distracting drivers with sign displays that pulse, flash or twirl, although there may still be moving type signs that could scroll characters.

During the initial stages of public input to the draft amendments the PAA had an opportunity to comment on other issues covered in the plan regarding issues like over-lighting and controlled lighting situations and it appears that the current document addresses these issues. "It was good to see that they took these issues seriously and that they are reflected in the final draft by-law," says Rick Stankiewicz, the PAA Light Pollution Abatement Director. The PAA offered to be part of a review committee during this consultative process, but we were not required for further involvement by the City.

New lighting restrictions will mean that all electronic signs will be required to have an ambient light sensor, to help control the brightness of the sign depending on weather and time of day. Signs will not be allowed to be more than .05 times the ambient light level. Some other rules include not having electronic signs over 6.5 metres in length or installed within 20 metres of residential properties and all signs within 120 metres of residential properties must be turned off between 9 p.m. and 7 a.m.

The City will be giving existing sign owners six months to abide by the new bylaw or eventually face fines. To assist in ensuring compliance the City will be purchasing a luminance meter.

Stankiewicz says, "It looks like the City is off on the right foot regarding electronic signage."

Rick Stankiewicz

Light Pollution Abatement Director



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Green Flash

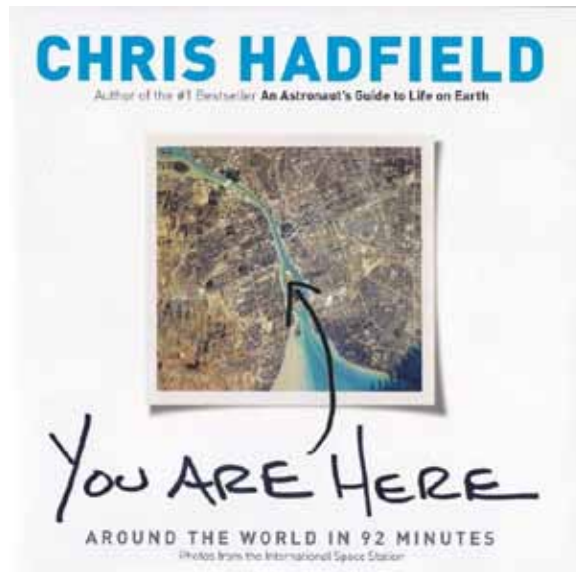
observant wife even claimed to see a green flash as the sun momentarily slipped below a sharp line of cloud. I was skeptical but, research reveals that, yes, it too is an acknowledged green flash condition. Minutes later, she witnessed the usual green flash at sea level. Now that's getting greedy!

What's going on? Earth's atmosphere forms a hemispherical shell about 100 km thick. During daytime, this spherical geometry isn't apparent, with light coming down through a rectangular slab of atmosphere. At sunset, however, when the bottom of the sun touches the horizon, its light is now coming fully through the hemispherical shell of air. Surprisingly, the real sun is already fully below the horizon as we watch it set! Atmospheric lensing bends the light to the position where we see the setting sun.

In a simplified model, it can be shown that the atmosphere is mimicking a very, very thin prism that is nevertheless splitting white light into its spectrum of colours. In effect, at sunset one is looking at slightly shifted, overlapping, multiple images of the sun, each in a pure colour. The eye blends these images except around the edge where we find a final set of non-overlapping images in green, blue and violet. With the eye's peak sensitivity tuned to green by evolution, it's those final emerald photons that register forcibly as "she goes all the way under".

And so, Hemingway was probably correct to treat the green flash casually in his novel's setting. If my experience is valid, then almost certainly anyone who spends time at sea will bear witness regularly. And the rest of us? Well, you'll have to put yourself in the right place, at the right time, with exacting atmospheric conditions, and be really, really, looking. And don't blink!

Endnote: Earlier in the month, at the regular January meeting, I had been put on high alert about the green flash by Rick Stankiewicz, who presented "Strange Skies", an episode from the series *Secrets of the Earth*. Having once seen the flash 35 years ago across Lake Huron, it was satisfying to get so well reacquainted with this short-lived phenomenon.

BOOK REVIEW

I was treated to another wonderful surprise last Christmas. I received a copy of the above book and have to say that Chris Hadfield did not disappoint. This book of photographs from the vantage point of the International Space Station (ISS) was anything but ordinary. Most, if not all the images used in this book, are never before published images. In almost 2,600 orbits of Earth in the ISS, the author took over 45,000 pictures, so he had lots of material to work with.

The aspect of the book that I enjoyed the most was the focus of using images that illustrated the phenomenon called "pareidolia" (parr-i-DOH-lee-a). This is the ability to perceive things like faces or figures in clouds, landforms or a piece of toast. Like the shape of a section of coast line that resembles a bird, an elephant or a whale. Some are subtle and other not so much. The way the images have been cropped to aid in "seeing" something else, is quite cool.

In my humble opinion, the only downside to this volume was its small format (21cm x 21cm) and having only 200 pages. I really felt like I wanted to see more of the thousands of images that must be available for consumption.

No heavy reading here, just lots of eye candy from near earth orbit of 350km, traveling at 28,000 kph. True entertainment and a feast for the eyes! What's for dessert?

Rick Stankiewicz

Trish's Salts & Scrubs

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Durham Skies
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natalie.graham@live.ca
Email for a free quote.

The Sky this Month

Mercury is visible only to southern observers.

Venus is in the western evening sky. On the 4th passes with 0.1° of Uranus and for European observers as close as $6'$.

Mars is low in the western evening twilight sky, moving eastward. Spends a day in Cetus from the 1st to the 2nd before moving back into Pisces for most of the month then moves into Aries on the 29th. Occulted by the Moon on the 21st.

Jupiter is well placed in the evening sky after its opposition and is retrograding in Cancer.

Saturn is in Scorpius rising after midnight. Begin retrograde motion on the 14th.

Zodiacal Light visible in W after evening twilight for the next two weeks from the 8th.

Daylight Savings Time begins on the 8th.

Spring Equinox arrives at 5:45 pm on the 20th.

Moon Phases

Full Moon	1:05 PM	March 5
Last Quarter	12:48 PM	March 13
New Moon	4:36 AM	March 20
First Quarter	2:43 AM	March 27

*continued from page 3***Rosetta**

As part of its 6.4 billion km journey to Comet 67P, Rosetta would have to pass through the hazard-strewn asteroid belt. Along the way it would also perform flybys of asteroids Lutetia and Steins. In both instances Rosetta was able to image the asteroids and transmit the data back to the ESA. These were also “firsts” for the mission.

The most nerve-racking moment so far came when it was time to put Rosetta into “Hibernate Mode”. The mission was 803 million km from the Sun. At that distance the sunlight collected by Rosetta’s solar panels was only 4% of what it would be on Earth.

Despite having a span of over 30 metres, the solar panels couldn’t collect enough sunlight to keep the power on. This hadn’t been such a scary thought back when Roset-

ta passed into Mars’ shadow, but this time the lights would be off for 31 months!

On January 20, 2014 Rosetta’s alarm clock went off. Nearly an hour later news of the successful wakeup reached Earth to the delight of hundreds of staff and press members who filled ESA headquarters in Paris, Rosetta’s control centre in Darmstadt, Germany and numerous supporting groups across Europe, the U.S. and the South Seas.

Next it was time to glide up beside Comet 67P and release the Philae Lander at just the right moment so that it would drift down onto the comet’s surface. But first Rosetta would have to survey the comet’s topography to select an appropriate landing area. Given that this was the first time anyone had seen Comet 67P up close, it would be an important undertaking. Join us next edition for “The Terror of Touching Down.”

*continued from page 4***Commercial Crew**

SpaceX. The company began operations in 2002 and made the first supply mission to the ISS by a private sector company in 2012.

Since NASA’s shuttle program closed down in 2011 the U.S. has relied on the Russian Soyuz to ferry astronauts to the ISS. But at \$70 million per ride, NASA is looking for a cheaper way out ... or should I say up.

To that end they have created the Commercial Crew Program and have given \$2.6 billion to SpaceX for development of their Dragon capsule and \$4.2 billion to Boeing for their CST-100 spacecraft. In addition to designing and building the craft there will be extensive testing along the way. Both companies are aiming for a manned launch in 2017.

*continued from page 7***Asteroid Day**

Meteor Crater in Arizona is a 1.2 km wide crater resulting from a 50m asteroid that slammed into Earth 50,000 years ago with the force of a 10-megaton bomb. (Photo by Rick Stankiewicz)

it. If globally we decide we need and want to do something about it, we can identify the threats and potentially deal with them. This sounds like science fiction or Hollywood fantasy, but the reality is that we can

do something about it, but we have to be smarter than the dinosaurs. For more information about Asteroid Day and what you can do to educate yourself about it, check-out www.asteroidday.org

*continued from page 1***El Gordo**

contain a few hundred billion stars and up to just over a trillion (10^{12}) solar masses worth of matter, the El Gordo cluster has an estimated mass of 3×10^{15} solar masses, or 3,000 times as much as our own galaxy! The way we've figured this out is fascinating. By seeing how the shapes of background galaxies are distorted into more elliptical-than-average shapes along a particular set of axes, we can reconstruct how much mass is present in the cluster: a phenomenon known as weak gravitational lensing.

That reconstruction is shown in blue, but doesn't match up with where the X-rays are, which are shown in pink! This is because, when galaxy clusters collide, the neutral gas inside heats up to emit X-rays, but the individual galaxies (mostly) and dark matter (completely) pass through one another, resulting in a displacement of the cluster's mass from its center. This has been observed before in objects like the Bullet Cluster, but El Gordo is much younger and farther away. At 10 billion light-years distant, the light reaching us now was emitted more than 7 billion years ago, when the universe was less than half its present age.

It's a good thing, too, because about 6 billion years ago, the universe began accelerating, meaning that El Gordo just might be the largest cosmic heavyweight of all. There's still more universe left to explore, but for right now, this is the heavyweight champion of the distant universe!

Learn more about "El Gordo" here: <http://www.nasa.gov/press/2014/april/nasa-hubble-team-finds-monster-el-gordo-galaxy-cluster-bigger-than-thought/>

El Gordo is certainly huge, but what about really tiny galaxies? Kids can learn about satellite galaxies at NASA's Space Place <http://spaceplace.nasa.gov/satellite-galaxies/>.

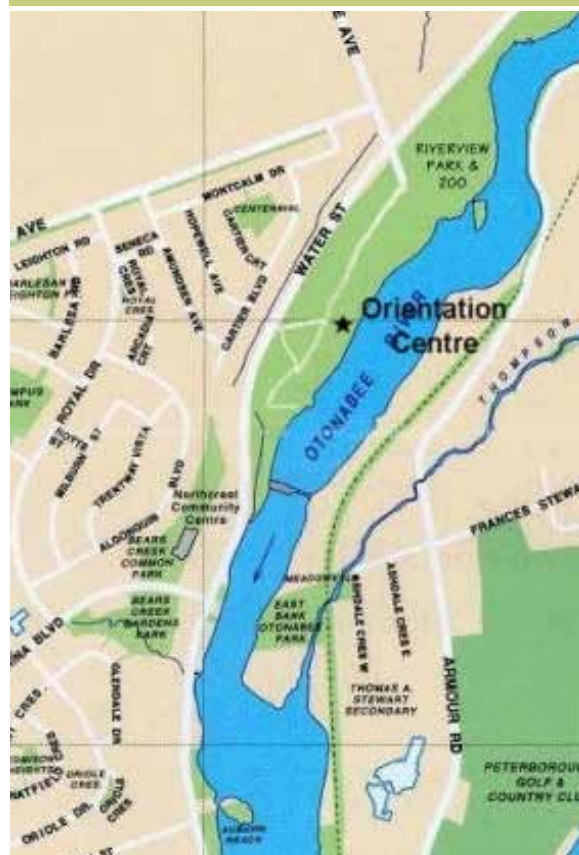


Articles

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 photos 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:
March 26, 2015



Meetings

The Peterborough Astronomical Association meets every first Friday of each month, except July and August, at the **Peterborough Zoo Orientation Centre** (Next to the PUC Water Treatment Plant) at 7 p.m. P.A.A. general announcements will begin each meeting with the guest speaker starting at 7:30 p.m.