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The Reflector

Newsletter of the Peterborough Astronomical Association

Droughts, Floods and the Earth's Gravity, by the GRACE of NASA

Dr. Ethan Siegel

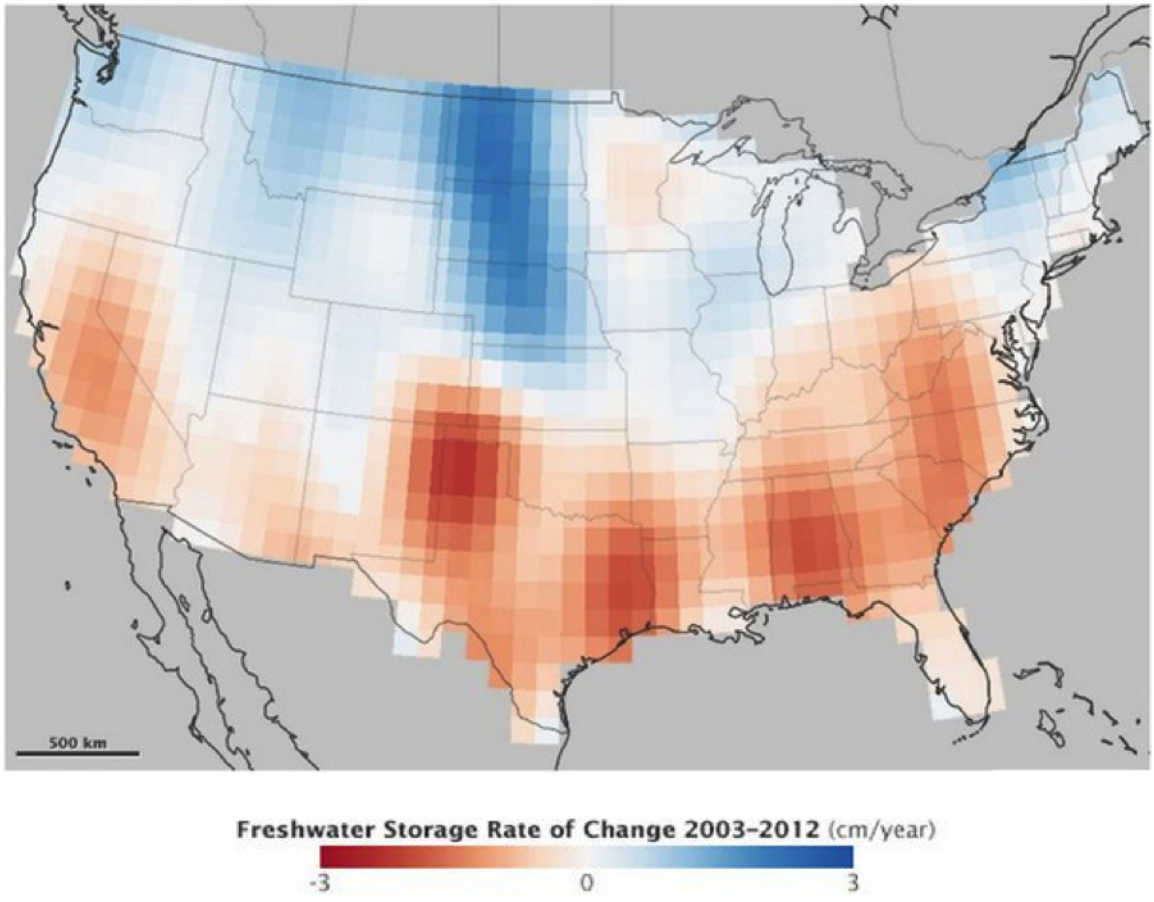

Image credit: NASA Earth Observatory image by Jesse Allen, using GRACE data provided courtesy of Jay Famigleitti, University of California Irvine and Matthew Rodell, NASA Goddard Space Flight Center. Caption by Holli Riebeek.

When you think about gravitation here on Earth, you very likely think about how constant it is, at 9.8 m/s² (32 ft/s²). Only, that's not quite right. Depending on how thick the Earth's crust is, whether you're slightly closer to or farther from the Earth's centre, or what the density of the material beneath you is, you'll experience slight variations in Earth's gravity as large as 0.2%, something you'd need to account for if you were a pendulum-clock-maker.

But surprisingly, the amount of water content stored on land in the Earth actually changes the gravity field of where you are by a significant, measurable amount. Over land, water is stored in lakes, rivers, aquifers, soil moisture, snow and glaciers. Even a change of just a few centimetres in the water table of an area can be clearly discerned by our best space-borne mission: NASA's twin Gravity Recovery and Climate Experiment (GRACE) satellites.

Since its 2002 launch, GRACE has seen the water-table-equivalent of the United States (and the rest of

see "GRACE" on page 16

President's Message

Fall Is Upon Us

This has been the "summer that wasn't." Cooler than normal temperatures and the persistent cloud cover made it difficult for many of us to get in the observing that we so much like to do. Rumour has it that there was a meteor shower on August 12th and I suppose if you were at 30,000 feet you may have seen some of it. The event planned for that evening on Armour Hill was cancelled. Our annual event at Emily Provincial Park was cancelled because of solid cloud cover, weather forecasts predicting poor conditions and the Clear Sky Clock showing no break in the clouds until at least 1:00 a.m. the next day. The sky actually did clear sometime before 10:00 p.m. but it was too late.

On a good note we had very good skies for the observing session in June at Robinson Road Observatory and again in July at Buckhorn Observatory. Both nights offered a lot of excellent viewing.

We have made a couple of changes to our loaner telescope lineup so be sure to check the website to view the current offerings. The list and accompanying document with full descriptions and photos have both been updated.

Rodger Forsyth
PAA President

Letter from the Editor

Autumn

Welcome back to *The Reflector*. Hope you enjoyed your summer even if the skies didn't cooperate.

However, our members were cooperative with there pens, er, keyboards and cameras. Rick Stankiewicz reports on the PHC observing session and the solar observing session before last June's club meeting. He also provided the two photos to show how close the last Venus-Jupiter conjunction was in apparent distance.

Kenneth Sunderland returns with a splendid article on globular clusters I think you will truly enjoy. And "novice" amateur astronomer, Paul Ward, pens his first newsletter article. He provides us with a not-so-simple experience with Celestron's StarSense AutoAlign telescope autoguider accessory. We hope Paul submits more articles to this forum.

Brian McGaffney submitted another spectacular image. This time M101, the Pinwheel Galaxy is the object of awe.

With so much to choose from we sometimes feel bad for only allowing one article from John Crossen. Rest assured we have more in the pipeline from him.

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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Peterborough Housing Corp 2014 Session

ISS flying over Peterborough during PHC/PAA obsering session. Photo by Rick Stankiewicz.

Rick Stankiewicz

On August 18th, six members of the PAA put on another "stellar" show for the kids at the Peterborough Housing Corporation (PHC) complex of 1190 Hilliard St. More than two dozen children and their parents came out to participate in the annual show. I think this is the seventh year the PAA has been doing events with the PHC throughout the city and we have only been rained out once.

We had a great time on Monday evening and we were very lucky with the weather as we just got everyone through the six "scopes stations" when a layer of clouds rolled in to cover the stars from view. The kids are always a treat to show things to and I know they learn a lot as I heard some of them telling other adults about what they saw and heard and they did get it. In one case after a child saw and heard about the dense globular star cluster of M13 they told their parent, "Did you know that there are more stars in that cluster than all the people in Peterborough ... times three!"

Included is an image of the International Space Station (ISS) passing over Peterborough on Monday night around 10:00 p.m. I think all the kids got a chance to see this transit of the ISS as it appeared out of the northwest and disappeared overhead in the Summer Triangle. This is the result of an almost two minutes exposure (101 seconds) as the ISS streaked across the sky at 28,000 km/h about 350 km above us, shining at 3.4 magnitude. I used an 8 mm fisheye lens on a Canon 400D camera. Given we were within the light dome of Peterborough and a thin layer of cirrus clouds reflected the light pollution back to Earth, the major constellations overhead show up nicely. I know there are a few kids that will not soon forget this show.

See "PHC Kids" on page 15

Peek-A-Boo Planets

Rick Stankiewicz

In the predawn hours of August 18th, 2014, some members of the PAA got up early to catch a glimpse of a relatively rare astronomical event, the meeting of two worlds, the conjunction of planets far from our own. On this morning, Venus and Jupiter were to be the closest in the sky (as viewed from Earth) than they had been in 14 years. At around 20 arc minutes apart, this is less than half the diameter of a Full Moon. I got a photograph the last time these planets were this close in November of 2000, so you can be sure I was looking forward to this event.

With much anticipation and a good weather forecast I was up early and heading out the door by 4:00 a.m. A band of clouds hid the eastern horizon this morning, but I was sure things would clear off in time. Instead the clouds got thicker, to the point of me almost packing it in. Then, as I sat watching the holes in the clouds to the east from the tailgate of my vehicle, a bright star-like object that could only be Venus, popped out into the open, followed briefly by Jupiter to the right. There was hope after all, so I readied for a round of "peek-a-boo" with this celestial pairing. With the clouds slowly drifting up from the horizon I was lucky only in that it was not a solid wall of cloud, but rather a series of cloud "clumps". I had no more than five to eight second windows of opportunity to view the planets, but this was just enough time to capture a few images before eventually a solid wall of cloud did come in and shut me down for the morning by about 5:50 a.m.

I am thankful and count my lucky stars every day I have the chance to see something I set out to experience. I have to remind myself, it could have been raining, instead I just had to play a game of peek-a-boo with some clouds and planets and in the end I did witness and record the event to share with you. Enjoy and ... keep looking up.

Wanna Take a Ride On a Comet?

COMET 67P/CHURYUMOA-GERASIMENKO. Meet Comet 67P/Churyumoa-Gerasimenko. The mission was first proposed during the 1970's, then approved in the early 1990's and finally launched in 2004. Who says astronomers are impatient? Image courtesy of NASA.

John Crossen

The crafty folks at the European Space Agency (ESA) will be doing that very soon. In fact, by the time you read this they will have already have begun the complex process of landing on a lumpy chunk of real estate they've just seen for the first time.

Getting to that distant space rock wasn't an easy task. You could call it the Rip Van Winkle of space odysseys. That's because the spacecraft, named Rosetta, was launched back on March 2, 2004. Some of you probably have kids who were born then and will have 10 candles on their next birthday cakes.

Getting back to business, Rosetta was essentially sleeping for nearly a decade and was just given its wake up call in June. Believe me scientists on both sides of the Atlantic were doing a bit of fingernail munching at that moment. Happily the spacecraft woke up and was in perfect working order.

The spacecraft takes its name from the Rosetta Stone which unlocked the secrets of Egyptian hieroglyphics and in turn helped us understand that ancient culture. Today scientists are hoping Rosetta's investigations of the comet will help do the same for our understanding of the solar system and how it formed.

After some complex manoeuvres which included three gravity-assist swoops around Earth and another around Mars for navigational purposes and to gain speed, Rosetta is finally at her destination. All told Rosetta has logged 6.4 billion kilometres (4.0 billion miles) on her 10-year trek to be the first spacecraft to snuggle up with a comet.

The comet's name is 67P/Churyumoa-Gerasimenko and as you may have per-

See "Rosetta" on page 13

Globular Clusters

Kenneth Sunderland

"Thirty thousand mighty suns shone down in a soul-searing splendour ..." from* Nightfall *by Isaac Asimov

Globular clusters (henceforth GC's) didn't always interest me. Now they do. It happened like this.

Two years ago: As a new PAA member attending a club observing session, I recall Rodger Forsyth insisting that I look at M13 — my first GC! I obeyed Rodger, while not fully appreciating the characteristics of the object I was observing. In hindsight, I suppose the hook had been set. When the Hercules cluster rides high, it is ideally placed for observation through a minimum of atmosphere.

One year ago: The siren call of the Messier catalogue begins to get louder and I begin to succumb. This "right of passage" list includes 29 GC's. At July's Cedar Knoll observing session, I get my first looks at M4 and M80 through Brett Hardy's big refractor. That summer, and into the fall, I continued to knock off the Messier GC's with my binoculars and 8" catadioptric. In addition, I'm pleased to bag naked eye GC's like M22 and M13 under SQM 21+ skies at Charleston Lake in Eastern Ontario. So far I'm just stamp collecting, but also becoming increasingly taken with these objects which are among the oldest in the deep sky. If you harbour any doubts about the force of gravity, one look at a GC is the cure. The invisible gravitational field gradient pointing toward the core is made visible in the stars.

This year: As the GC's wheeled back into view after a long winter absence, I had been primed by a number of magazine articles. *Astronomy* magazine's glorious July (Ref. 1) cover featured a story about the night sky as it might appear from inside a GC. The article begins with a reference to Isaac Asimov's classic SF short story *Nightfall* (Ref. 2), in which disaster looms for the inhabitants of Lagash — a planet which lies within a GC. With multiple suns, Lagash is bathed in perpetual daylight, but once every 2,049 years orbital dynamics conspire to produce darkness. When the night sky is revealed, the consequences are dire for the psychological well-being of the inhabitants.

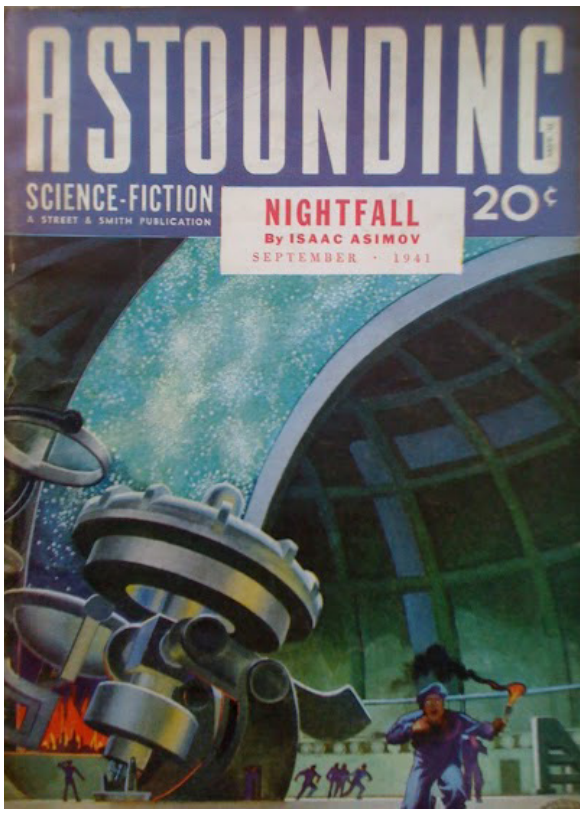

Figure 1. *Nightfall* **cover of Astounding Science Fiction. Credit: Google images.**

Inspired by *Nightfall*, the authors of the *Astronomy* magazine piece created a computer simulation of the night sky as it might appear from a hypothetical planet located at various radii from a GC centre. Their model GC contains about a half million stars. This article gave my imagination a good stir.

I recalled reading an article earlier this year about the Shapley-Sawyer classification of GC's. A search found it in January's *Astronomy* magazine. Twelve classes of GC are described (Ref. 3) in a scheme devised in the 1920s that rates the concentration of the stars as one moves towards its centre. Star concentration determines the overall surface brightness of a GC and the extent to which individual stars can be resolved. For

continued on next page

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example, the stars may be so concentrated that even large apertures are unable to resolve single stars in the core. At the other end, if the concentration is low, it may be possible to not only resolve individual stars to the core, but see through the GC.

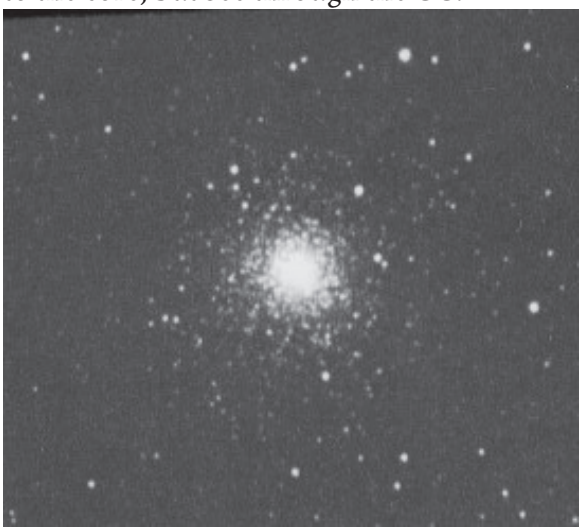

Figure 2. M75 in Sagittarius (Class I). Credit: SEDS/probably Evered Kreimer.

Class I have the highest star concentration toward their core and Class XII the least. The photographs of M75 (Class I) and M71 (Class X-XI) are realistic about what you might expect to see at the eyepiece and demonstrate the difference in resolvability toward their cores. Messier's catalogue contains representatives of each class except XII.

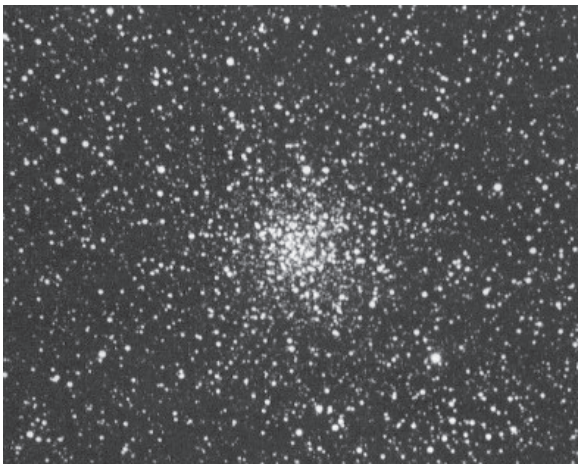

Figure 3. M71 in Sagitta (Class X-XI). Credit: SEDS/probably Evered Kreimer.

The March edition of *Astronomy* magazine contained an article entitled "Run a globular cluster marathon" (Ref. 4) by Tom Polakis. Having mastered Messier marathons, the author wondered how many of the Milky Way's approximately 160 known GC's he could bag in one night. Answer? Under those enviably clear Arizona skies, he managed 105 using a two telescope setup. Biggest challenge? GC's are distributed in a spherical halo surrounding the galaxy core and this geometry delivers them in batches through the night requiring fast observing. Historically, the reverse logic allowed Harlow Shapley to locate the galaxy core toward Sagittarius using the guess that it might be located at the centre of the GC distribution.

A GC search in the cumulative *Sky & Telescope* (*S&T*) index produced dozens of hits over the years. In recent times, a June 2012 feature by Ted Forte entitled "A Springtime Globular Cluster Tour" (Ref. 5) offered commentary on a select list of targets as well as general observing advice. For example, Forte recommends comparing GC's at the same power and looking for differences rather than similarities.

Returning to 2014, a feature article entitled "M5 Surprise" (Ref. 6) in June's *S&T* described a project for monitoring two variable stars (V42 & V84) within M5. (Oh dear, variable stars — another tangent!) Anyway, the author asserts that these variables can be separated from the swarm with an 8" scope under urban skies. Confirmed. I've done it from my Peterborough backyard.

The GC bandwagon continued with Fred Schaaf's regular column (Ref. 7) in July's *S&T*. He highlighted five must-see CG's of summer; M13 (Class V), M3 (Class VI), M5 (Class V), M4 (Class IX) & M22 (Class VII). And so with Fred's reminder, I've got my now familiar friends checked-off for 2014.

Present: By now I've collected most, if not all, of the Messier GC's plus a few others like Caldwell 42 & 47 in Delphinus. While the hunt itself is motivating, the articles discussed above make it clear that each GC deserves to be revisited for closer examination. Possibilities for projects include: comparing, sketching, assessing their classification, padding-out the list, following variables, photography and a GC marathon.

See "GC Notes and Referenes" on page 13

PHOTO GALLERY

Pinwheel Galaxy

Hi to everyone. Enclosed is one of the new images obtained over the last few weeks here by myself at the Nutwood Observatory just south of Bancroft. This is the Pinwheel Galaxy M101 or NGC 5457 located in the constellation Ursa Major (The Big Dipper).

M101 is slightly larger than our galaxy with a size of about 170 thousand light years across. It is about 25 million light years away from us. It shines at about magnitude 9.0 and is visible with a good telescope. However to observe the detailed arm structures seen in my image, one requires a very large telescope. I was using a 17-inch truss scope for this image.

As you can see by the image, M101 is an asymmetrical galaxy. Its spiral arms being forcefully bothered by adjacent neighbouring satellite galaxies.

The soft pink hues situated in the arms of the spirals, are hot star forming regions and are rich in H II emissions. These regions were imaged here with the aid of other narrow band techniques.

The image attached is the culmination of about five nights of imaging work. Although a hires image, this is an 8-bit jpeg. The larger more detailed image can be seen on my web site: http://nutwood.smugmug.com/AstronomyDarkSkys/Astro-Photography/Nutwood-Observatory/27625686_VQf537#!i=3348855426&k=L2jQdJb&lb=1&s=X3

Taken with a 17-inch truss scope, using an unbinned U16M CCD chip camera for all images. Filters were Astrodon filters including Hα and regular sets. Total acquisition for this image was around 14 hours. Guiding and tracking done with a 80 mm Borg with Galactic star shoot guider.

Image acquisition was done remotely and used MaxIm, Pixinsight along with various Photoshop CS5 fits plug-ins. Final processing was performed with Photoshop CS5.

Brian McGaffney

How Close Is This?

Composite of two photos taken by Rick Stankiewicz. Annotations provided by Phillip Chee.

Rick Stankiewicz wanted to see how close the separation between Venus and Jupiter was during their conjunction on the morning of August 18th. So I obliged him by overlaying his photograph of the Moon with his photograph of the conjunction. Both photographs were taken with the same lens/camera combination at 300 mm focal length. The scale in the photo shows that the Moon's diameter is one-half an angular degree. The conjuction was just half that distance. Now that's what I call a close call.

Phillip Chee

A Novice's Story

Celestron StarSense AutoAlign accessory mounted on Paul Ward's Celestron SE8. Photo by Paul Ward.

Paul Ward

I started looking at astronomy for a hobby after I was released from work at CHEX-TV.

I was at CHEX for 38 years and served as a technician and Chief Engineer. There isn't a part of the broadcast business I wasn't a key part of over the years. Astronomy always held interest for me as it's about the origins of everything we know.

Our knowledge is just starting to touch out into the depth of the universe. Things are measured in thousands of light years, not days. Time and space are measured in thousands and millions of earth years and light years. Thus my interest.

I'm writing this article to let you know how my experience with StarSense Auto-Align from Celestron Telescopes.

It started out because of the position I'm in having a back yard that is to say the least a challenge for viewing. There trees all around, that is what attracted my wife in the first place. I have viewing in the east over the house and some higher in the west. The north is not too obstructed, but the south is a total loss for trees. This made it difficult to find stars to lock on to for alignment and caused lots of frustration over many months.

Some of you might say "OK just move to a place that is better for viewing," but this would not go over with Joan. Anyway this nudged to get the new StarSense accesory for my SE8 computerized scope. For about $350 that might be a small cost if it worked as advertised. I received it about a month ago and quickly got it out of the box and installed it on my scope as instructed. Mechanics are quite easy to do.

One thing you need to know is when you install StarSense you use the bolt holes you would have the finder in, so no finder as the scope does not have any other holes on top. In following the set up I ran into my first challenge. When you connect the StarSense the aiming is very subjective. Just screw it on and your done. Not that easy as the posi-

See "StarSense" on page 12

Solar Observing with the PAA

Librarian Mike McCarthy (centre) demonstrates large binos on his homemade parallelogram mount for fellow members of the PAA. Photo by Rick Stankiewicz.

Rick Stankiewicz

The last meeting night of the PAA before the summer break (June 6th, 2014) was a unique opportunity for club members to view the Sun. Before the meeting started there was a gathering of members and their solar observing equipment on the yard adjacent to the parking lot at the Fairview United Church in Smith Township.

There was a good turnout of more than 14 members and a combination six filtered telescopes and binoculars for everyone to observe with. Sunspots numbers 2077 to 2083 were clearly visible in the late evening sky. The definite highlight was having the opportunity to see the Sun through the Lunt LS-80T Solar Scope that Brian Colville made available. The solar prominences around the edge of the solar disk were impressive, given their relative size (many Earth diameters) leaping into space before our very eyes. Even solar flares were visible as pale streaks on the solar disk, as viewed from above.

This observing session was followed by a regular monthly meeting in which Brian was the guest speaker who enlightened those present on the nuts and bolts of solar viewing at his Maple Ridge Observatory in Cambray. The details Brian is able to capture are second to none as he filters his exposures through Hα and K wavelengths with some of the best equipment available.

In the twilight skies that followed the meeting some members made their more conventional telescopes available to view the night sky with the planets Jupiter, Mars and Saturn taking centre stage. A big, "Thanks" for all those that made the effort to bring out their equipment and share it with the rest of us. It

see "Solar Observing" on page 12

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StarSense

tion of StarSense determines if you even see the object you want to.

As my luck goes the Starsense after several tries said alignment OK. Well I thought I was done. NO! Apparenly there is a second part to the alignment that says to find the star and center in the eyepiece. With a short scope like the SE8, aiming up the barrel is not easy as it's big and short. It seemed to be going in the right direction, but nothing was in the eyepiece. I jogged it up and down and left and right, but couldn't find the star.

So I went back a couple of weeks later (weather this year) and remounted the StarSense in the exact middle of the screw holes. My next try in deed showed the star in the extreme north of view. Now I could continue with the fine alignment (one time). This part sets the camera to correct for miss alignment with the scope center. It worked!

A couple of nights later I was away looking at stars and clusters: WOW! One thing it seemed there weren't all of the objects in the Messier catalog that should be there. The instructions say all 110 should be there to select, but I was missing about ¼ of them.

The next night out was Friday at John's and it turned out to be a good night. I set up the scope and started to view object and noticed when everyone else was looking at the Ring Nebula I couldn't get it in any catalog. What would I do? Well, I just looked at the stuff that was in the catalogs for this night. Saw lots of stuff there and called it a night some time after midnight.

At home the next day I thought how to proceed and remembered Rodger had suggested reloading the software might fix it. I went on the internet and read for hours on the support web site and finally found the updated files. In the mean time I had sent a note to support techs to get help from them. After about two days I got a reply to reload the software.

If you haven't ever done this be warned: it's not a simple process. The file comes with a drawing on how to hook it all up, which I followed. Using my laptop and Windows 8 I got the files unzipped and attempted to do the update, but just got an error. After some time and thought I took it all down to my Windows 7 system down stairs and ran the update. Well it worked and went as in the documents. OK we are done,right?

After some checking during the day I found I still don't have all the Messier object. Back to Tech support at Celestron. I think I have the object that I need such as M56 and M57 now, but I still have a list of 22 items missing.

It was suggested by tech support that these might not be viewable at this time, but the manual says all objects should be listed. They also say they are rewriting the manual.

They have not given a date for the updated manual as of yet. This was just one of my adventures in hobby of astronomy. *to next article*

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Solar Observing

is through your efforts that we all benefit from a special evening such as this.

Member Jean Crebar has nice filtered view of Old Sol, along with Rick Elliott and John Cameron. Photo by Rick Stankiewicz.

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Rosetta

ceived it was discovered by a team of Ukrainian/Russian astronomers from the Kiev Astronomical University and the Alma-Ata Astrophysical Instituted in Kazakhstan.

But we're not quite there yet. As Rosetta orbits the comet it has been looking for landing sites for its onboard lander called Philae (*file-lee*). As of August, 5 potential spots had been identified. The final decision will be made in October and Philae will set its robotic toes on Comet 67P/Churyumoa-Gerasimenko in November.

The lander will do the analysing of sample materials from the comet. Meanwhile NASA cameras aboard Rosetta will be taking images of the comets surface in three different wavelengths of light. All of this data will be sent back to Earth which is currently 405 million kilometres from Rosetta and the comet.

Those samples will take us back 4 billion years, possibly more, to the period when our solar system was just forming. The end results will help us understand the processes our solar system went through in building the planets and possibly seeding them with water and life. Touch down is scheduled for November 11. Stay tuned.

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GC Notes and References

So that's how it happened—how I came to be interested in GC's.

Endnotes

a. Our very own *The Reflector* (2014, February) ran a lead article about unique GC stars called "blue stragglers". While this topic didn't fit my purposes here, I do recommend the article to you.

b. The membership should be aware that digital versions of *Astronomy* magazine (back issues to September 2013) are available to Peterborough library card holders at no charge. They can be downloaded for offline reading and yours to keep. Fantastic! *SkyNews* recently became available also but without back issues. There is no free digital version of *S&T* ... yet.

References

1. Harris, W., Webb, J., (2014, July), "Life inside a Globular Cluster", *Astronomy*, 18-23 (Harris is in the McMaster physics department and maintains a serious data file on Milky Way CG's at physwww.mcmaster.ca/~harris/mwgc.dat).

2. Asimov, I., (1941, September), *Nightfall*, *Astounding Science Fiction* (This intense short story is easily found on the internet. Never mind the watery 1990 book length version.)

3. Pommier, R., (2014, January), "Target 12 kinds of globular clusters", *Astronomy*, 62-65.

4. Polakis, T., (2014, March), "Run a globular cluster marathon", *Astronomy*, 57-59.

5. Forte, T., (2012, June), "A Springtime Globular Cluster Tour", *Sky & Telescope*, 62-66.

6. Banich, H., (2014, June), "M5 Surprise", *Sky & Telescope*, 60-64 (In this same issue, Sue French discusses M10 & M12 in her regular column Deep-Sky Wonders).

7. Schaaf, F., (201, July), "The Fabulous Five", *Sky & Telescope*, 47.

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The Sky this Month

Mercury in evening twilight low in the WSW. Passes 0.6° south of Spica on the 21st. The crescent Moon nearby on the 26th.

Venus is in the E dawn twilight early in the month but moving into the solar glare by month's end. Passes 0.8° north of Regulus on the 5th.

Mars is low in the western evening sky. Moving eastward crosses from Libra to Scorpius on the 13th and into Ophiuchus on the 25th. Passes 3° north of Antares during the last 5 days of September.

Jupiter is low in the morning sky in Cancer. Passes 5° north of waning crescent Moon on the 20th.

Saturn low in the WSW evening sky setting mid-evening.

Zodiacal Light in the E before morning twilight from the 21st for the next two weeks.

Autumnal Equinox arrives at 10:29 PM on the 22nd.

Moon Phases

First Quarter	7:11 AM	September 2
Full Moon	9:38 PM	September 8
Last Quarter	10:05 PM	September 15
New Moon	2:14 AM	September 24

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PHC Kids

For those members that have never been involved with events such as this one, you should consider volunteering to do one in the future with us. You don't even need your own equipment to be involved, as some of us have lots of extra that we need help with and you don't need to be an "expert" when dealing with a crowd like this either. We can work with you to feel comfortable and on the right track. So why not give it a try next time we are doing a public event. It is a great way to learn and share your experience with others less knowledgeable and fortunate than you. I know I can speak for those of us that do this regularly and there are few things as rewarding for the time spent. I always feel like I should give back to a hobby that continues to give me so much.

See you out there under the stars.

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GRACE

the world) change significantly over that time. Groundwater supplies are vital for agriculture and provide half of the world's drinking water. Yet GRACE has seen California's central valley and the southern high plains rapidly deplete their groundwater reserves, endangering a significant portion of the nation's food supply. Meanwhile, the upper Missouri River Basin — recently home to severe flooding — continues to see its water table rise.

NASA's GRACE satellites are the only pieces of equipment currently capable of making these global, precision measurements, providing our best knowledge for mitigating these terrestrial changes. Thanks to GRACE, we've been able to quantify the water loss of the Colorado River Basin (65 cubic kilometres), add months to the lead-time water managers have for flood prediction, and better predict the impacts of droughts worldwide. As NASA scientist Matthew Rodell says, "[W]ithout GRACE we would have no routine, global measurements of changes in groundwater availability. Other satellites can't do it, and ground-based monitoring is inadequate." Even though the GRACE satellites are nearing the end of their lives, the GRACE Follow-On satellites will be launched in 2017, providing us with this valuable data far into the future. Although the climate is surely changing, it's water availability, not sea level rise, that's the largest near-term danger, and the most important aspect we can work to understand!

Learn more about NASA's GRACE mission here: http://www.nasa.gov/mission_pages/Grace/.

Kids can learn all about launching objects into Earth's orbit by shooting a (digital) cannonball on NASA's Space Place website. Check it out at: http://spaceplace.nasa.gov/how-orbits-work/ .

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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:
October 27, 2014

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 annoucements will begin each meeting with the guest speaker starting at 7:30 p.m.